UNITED WAMBO OPEN CUT COAL MINE PROJECT

May 2017

RESPONSE TO SUBMISSIONS
PART B

GLENCORE

Peabody ENERGY

umwelt

UNITED WAMBO OPEN CUT COAL MINE PROJECT

Response to Submission – Part B

FINAL

Prepared by
Umwelt (Australia) Pty Limited
on behalf of
United Collieries Pty Limited

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1.0 Introduction

The Environmental Impact Statement (EIS) for the United Wambo Open Cut Coal Mine Project (the Project) was placed on public exhibition from 11 August 2016 to 22 September 2016. This Response to Submissions (RTS) has been prepared to address the key issues raised in the submissions received during the public exhibition period. The RTS is divided into two separate reports. This Report (Part B) responds to specific issues raised by the Independent Expert Scientific Committee on Coal Seam Gas and Large Coal Mining Development (IESC) and matters relating to biodiversity. Part A responds to the remaining issues raised in the submissions including the submissions made by NSW government agencies.

Under a Joint Venture arrangement, United Collieries Pty Limited (United) and Wambo Coal Pty Limited (Wambo) propose to develop the Project which will involve combining the existing open cut operations at Wambo with a proposed new open cut coal mine at United. The Project has been designed to optimise future open cut coal mining operations across these two adjoining mining areas, maximising coal recovery and the efficient use of Wambo's existing mining infrastructure, while providing the operational flexibility required to actively manage the mine to minimise environmental impacts.

During the public exhibition period 101 submissions were made on the Project. This included 13 government agency submissions and 88 community and interest group submissions. The 88 submissions received from the community and interest groups included 3 submissions in support of the Project. A full analysis of the submissions is provided in Part A of the RTS.

This RTS has been prepared by Umwelt (Australia) Pty Limited (Umwelt) on behalf of United and Wambo to address the key issues raised in the submissions.

This Report (Part B) includes:

1. a brief summary of the Project to provide context for the submissions (**Section 1.1**)
2. a detailed response to the IESC submission (**Section 2.0**)
3. a detailed response to matters relating to biodiversity (**Section 3.0**)
4. the additional management and mitigation measures proposed by United as an outcome of this Part B report (**Section 4.0**).

1.1 United Wambo Open Cut Coal Mine Project

United Collieries Pty Limited (United) and Wambo Coal Pty Limited (Wambo) operate neighbouring mining operations located approximately 16 kilometres west of Singleton in the Hunter Valley region of NSW (refer to **Figures 1.1** and **1.2**). Under a Joint Venture arrangement, United and Wambo propose to develop the Project which will involve combining the existing open cut operations at Wambo with a proposed new open cut coal mine at United.

The existing Wambo underground mine is not part of the Project and will continue to be operated separately by Wambo.

FIGURE 1.1

Locality Plan

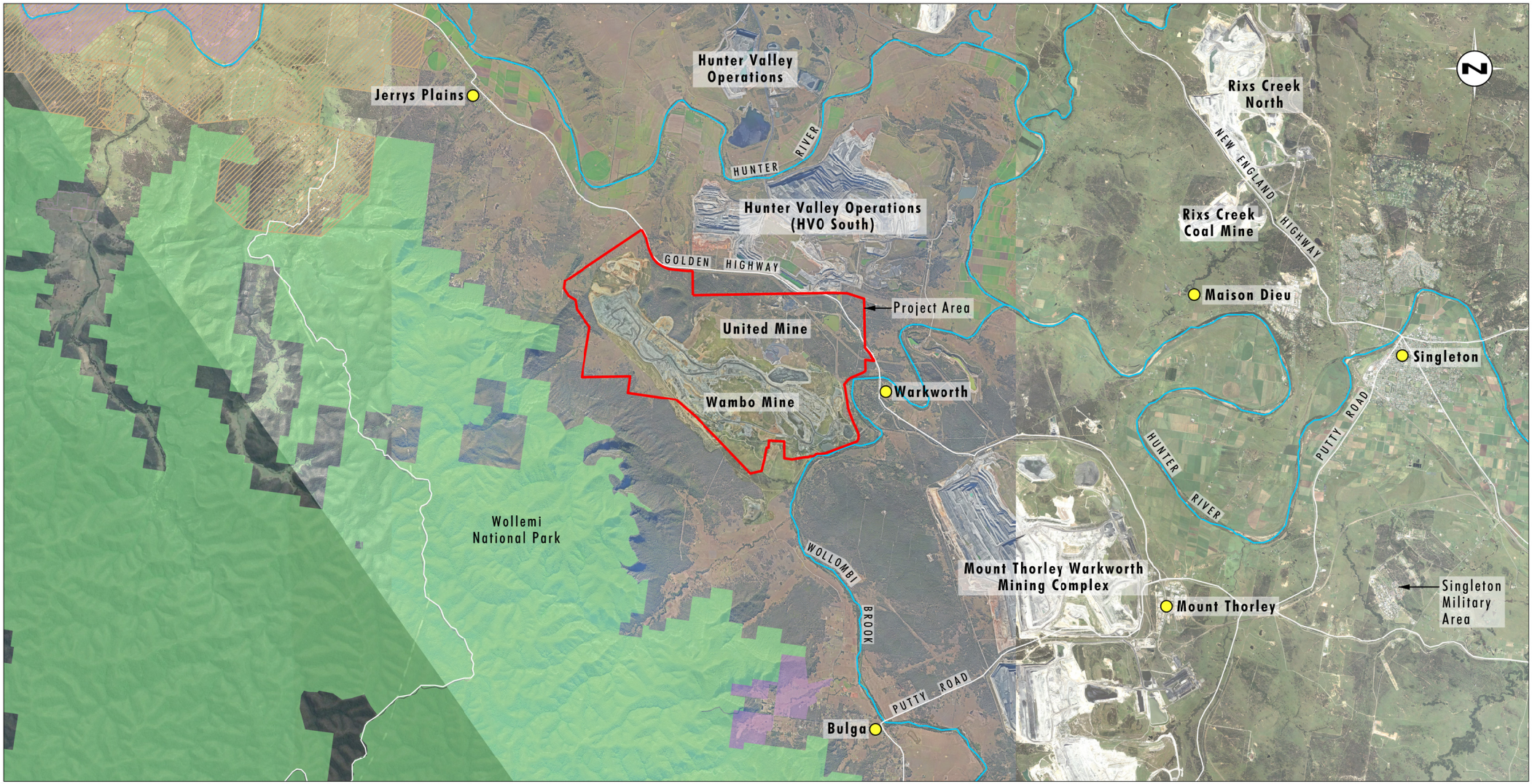

Image Source: AAM (2012), United (2016), Google Earth - CNES/Astrium 2016, Sinclair Knight Merz 2016, (2008)
Data Source: Glencore (2015), Minview (2015)

0 2.5 5.0 7.5km
1:150 000

Legend

- Project Area
- National Park
- SRLUP Viticulture CIC
- SRLUP Equine CIC
- Road
- River

FIGURE 1.2

Regional Context

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20170201 9.55

The Project

The Project includes open cut mining operations in two areas (refer to **Figure 1.3**):

- the proposed United Open Cut
- ongoing mining of the approved Wambo Open Cut with a proposed minor surface boundary extension in addition to a depth increase to maximise coal recovery.

The Project will maximise resource recovery by integrating the management of these two mining operations and removing operational constraints, enabling extraction of an additional approximately 150 million tonnes (Mt) of run-of-mine (ROM) coal over 23 years. The Project will provide continued employment for the existing Wambo open cut workforce (approximately 250 positions) and create additional employment from the development of the Project (up to approximately 250 additional positions at peak production).

The Project is anticipated to deliver up to 10 million tonnes per annum (Mtpa) of ROM coal from the combined operations of the United and Wambo Open Cuts. The Project will deliver ROM coal to the Wambo coal handling and preparation plant (CHPP) along with coal deliveries from the Wambo underground. Total deliveries of ROM coal to the Wambo CHPP will be limited to the currently approved production rate of 14.7 Mtpa ROM coal.

In addition to seeking approval for integrated open cut mining at United and Wambo, the Project will require changes to existing mining and public infrastructure within the Project Area including:

- ongoing use of the Wambo CHPP, mine infrastructure area and related facilities for the life of the Project (approval sought via a modification to the existing Wambo mine development consent, refer to **Section 1.1.1**)
- ongoing use of the Wambo train loading facility for the life of the Project (approval sought via a modification to the existing Wambo train loading facility development consent, refer to **Section 1.1.1**)
- ongoing use of, upgrades to and expansion of the existing Wambo and United mining infrastructure
- realignment of a 2 kilometre section of the Golden Highway and the relocation of sections of 330 kV and 66 kV transmission lines to maximise coal recovery from the United Open Cut.

The design of the Project was developed having regard to the potential environmental and social impacts associated with mining operations, with the aim of minimising potential impacts. A comprehensive stakeholder engagement strategy was implemented as part of the Project design and environmental assessment process which included consultation with approximately 665 stakeholders, with Project newsletters also being distributed to approximately 700 stakeholders. Since the exhibition of the EIS, the Joint Venture has continued to engage with government agencies and the community (refer to **Section 1.3**).

The engagement strategy outcomes assisted in refining the Project design and identifying appropriate management and mitigation measures.

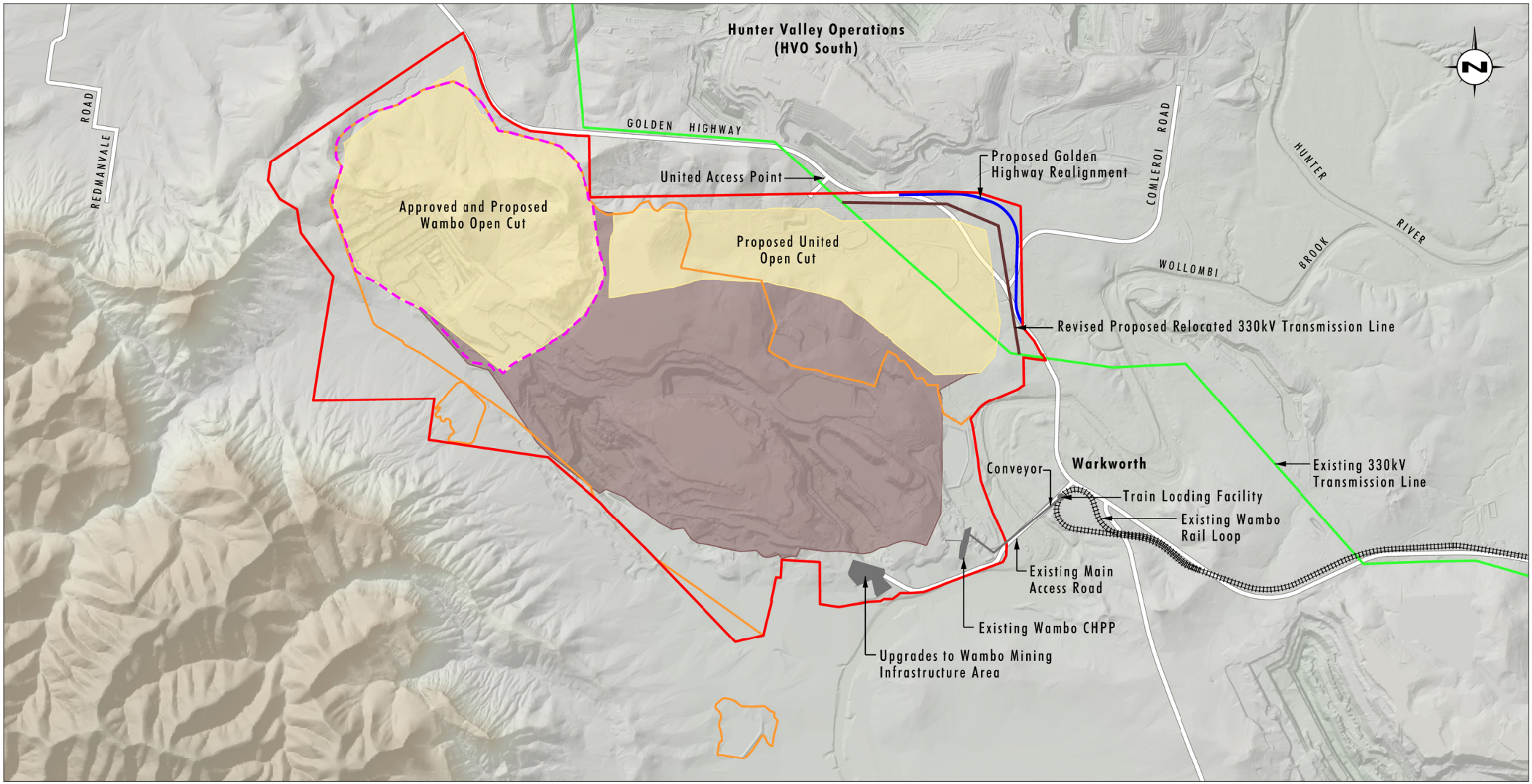

Image Source: United LiDAR (2015)
Data Source: Glencore (2015)

0 1.0 2.0 3.0km
1:60 000

Legend

- Project Area
- Proposed Conceptual Extraction Area
- Active Mining Area
- Approved Wambo Surface Development Area
- Approved Wambo Open Cut
- Proposed Golden Highway Realignment
- Existing 330kV Transmission Line
- Revised Proposed Relocated 330kV Transmission Line

FIGURE 1.3

Overview of the Project

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20170130 16.59

Benefits of the Project

As discussed in the EIS, the Project will result in significant benefits at a local, regional and State level. These benefits include:

- an improved final landform across the Wambo and United mining areas, with the proposed mining operation placing overburden extracted as part of the mining process to achieve a more natural final landform. The final landform achieved for the Project will be a substantial improvement on the final landform that would have resulted from two adjoining and separate mines. The approach to developing the final landform included in the EIS incorporated community feedback to achieve an improved design and in response to some of the submissions received on the Project, further work has been undertaken and revisions made to the conceptual final landform as discussed in **Section 1.2**
- maximising coal resource recovery from the existing disturbed mining footprint and adjoining areas, utilising the existing disturbed landscape, whilst minimising environmental and social impacts
- optimising use of the existing Wambo mining infrastructure, maximising the use of existing capacity and removing the need for duplicating infrastructure to meet production demands
- ongoing employment for the Wambo Open Cut workforce whilst adding up to approximately 250 operational positions at peak production (up to approximately 500 total operational positions), with resultant flow on effects to the local and regional economy
- Wambo currently has approval to produce up to 14.7 Mtpa ROM coal. The Project combined with the separately managed Wambo underground will remain within this existing limit. That is, no change is proposed to total maximum production that is already approved for the Wambo complex
- peak construction phase employment of approximately 120 employees, combined with the economic benefits flowing from the expenditure of approximately $380 million capital required to implement the Project
- recovery of an additional approximately 150 Mt of ROM coal
- an ongoing contribution to the local, regional and State economies from two long standing and well established mining operations
- increase the gross regional product by a projected approximately $2.1 billion in net present value terms, over the life of the Project
- increase the NSW gross State product (including the Hunter region) by approximately $3.0 billion in net present value terms over the life of the Project
- a net benefit of $414 million to NSW over the life of the Project in present value terms
- royalty revenue stream flowing to the NSW government estimated to be $369 million over the life of the Project
- significant export earnings for Australia.

Through implementation of this Project, the Joint Venture believes it can contribute substantial economic benefits at local, regional and State levels whilst coexisting with the local community.

1.1.1 Harmonisation Modifications

In addition to seeking approval for integrated mining of the United Open Cut and Wambo Open Cut and associated activities, a modification to the current Wambo development consents is also proposed to align these consents with the Project. This will include modifications to both the Wambo mine development consent (DA 305-7-2003 Modification 16) (covering the mine, CHPP and associated activities) and the Wambo train loading facility development consent (DA 177-8-2004 Modification 3).

For the purposes of the EIS, these modifications were collectively referred to as the Harmonisation Modification. In summary, the proposed modifications include extending the life of these consents so that the existing mining infrastructure (including but not limited to the Wambo offices, MIA, CHPP, train loading facility, water management infrastructure, and other ancillary infrastructure) can continue to be operated for the life of the Project at currently approved capacities (where capacity is relevant). The existing Wambo underground mining operations will not be modified as part of this application.

As discussed in the EIS, it is intended that the Wambo Open Cut will continue to operate under the existing conditions of the Wambo mine development consent until such time as mining operations commence under a development consent which is granted for the Project. This will provide for ongoing operation of the Wambo Open Cut under its existing approvals until mining operations comprising the Project have commenced, at which point it is appropriate for these operations to be regulated by a new development consent for the Project. It is noted that some construction activities may be undertaken under the new development consent prior to United commencing mining operations for the Project. United will notify the Department of Planning and Environment (DPE) of the date on which mining under the new development consent commences in order to provide clarity as to the date from which operations at the Wambo Open Cut will be regulated by the new development consent for the Project.

The modifications proposed for the Wambo mine development consent include:

- extension of life of the existing and approved Wambo infrastructure for the life of the Project, including
    - the Wambo CHPP
    - the MIA and sites offices
    - explosives magazine and hydrocarbon storage facilities
    - access roads and internal haul roads
    - water management system
    - tailings and reject management facilities
    - other ancillary infrastructure and associated activities
- upgrades to the existing Wambo wash bays, workshop capacity, fuel farm and stores areas
- upgrades to the administration, car parking and bathhouse facilities in the existing Wambo MIA
- upgrades or modifications to ancillary infrastructure and services including power and telecommunication infrastructure
- placement of tailings including within the Project's open cut voids and capping with overburden and coarse rejects for the life of the Project

- allowance for the Wambo CHPP to receive coal from the United Open Cut (and modified Wambo Open Cut) for processing and stockpiling prior to being transported from the Wambo train loading facility

- upgrades to increase the capacity of the ROM receival facility for the open cut operations

- ongoing exchange of water between the United and Wambo operations to allow for integration of the water management systems.

The modification proposed for the Wambo train loading facility development consent (DA 177-8-2004) includes:

- extension of life of all of the coal handling and train loading facilities including the rail spur, rail loop, coal reclaim area, product coal conveyor, train load-out bin and refuelling infrastructure for the life of the Project and ongoing receipt of coal from both Wambo and United

- an increase to the number of trains utilising the train loading facility, including the refuelling infrastructure, from a maximum six trains to a maximum of eight trains per day for the life of the Project. No change is proposed to the existing approved total annual movements as no change in maximum capacity is proposed.

1.2 Project Changes Following EIS Exhibition

Three minor changes have been made to the Project since the public exhibition of the EIS. These changes are:

- changes to the design of the final voids in response to submissions on the EIS. Further details about these changes are provided in Section 3.1 of Part A of the RTS

- a change to the alignment of the 330kV transmission line which results in a slight reduction in the additional disturbance footprint for the Project. The change to the alignment has been determined in consultation with TransGrid. The revised alignment is shown on **Figure 1.4**

- United has also revised the additional disturbance footprint for the Project as part of its ongoing refinement of the Project design. This refinement has resulted in a reduction in the additional disturbance footprint by approximately 37 hectares as shown on **Figure 1.5**. This reduction in the additional disturbance footprint has resulted in the following reductions in impacts of the Project:

    - avoidance of impacts on 19.2 hectares of vegetation conforming to the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) listed Central Hunter Valley Eucalypt Forest and Woodland Critically Endangered Ecological Community (CEEC)

    - avoidance of impacts on 27.1 hectares of native woodland vegetation and fauna habitat

    - avoidance of impacts on 7.9 hectares of native grassland vegetation.

Since the lodgement of the EIS for public exhibition the Joint Venture has been undertaking ongoing investigations to identify and secure additional biodiversity offsets for the Project. As an outcome of these ongoing investigations the area of the Wambo Offset site has been increased from approximately 56 hectares to approximately 338 hectares. The site is proximate to the additional disturbance area for the Project and provides a local offset.

The site contains approximately 150 hectares of CEEC and another approximately 48 hectares of land (including areas of derived native grassland created by historic land clearing) that will be regenerated to CEEC. In total, the offset site will provide approximately 200 hectares of offset for the CEEC. The site is currently used for grazing and as discussed in **Section 3.1.1**, part of the site may be subject to subsidence due to underground mining. Subsidence and biodiversity assessments undertaken for the potential underground mining have indicated that impacts will be minimal due to the depth of mining and the site is therefore available for establishment as a biobank offset site with appropriate management controls in place.

It is also noted that a private residence, Residence 28, which was placed on the market during the assessment process, has been purchased by the Joint Venture since the EIS was exhibited. Residence 28 is now considered a mine owned residence. Residence 28 was predicted in the EIS to be significantly impacted by noise and would likely have been afforded acquisition rights if the Project is approved.

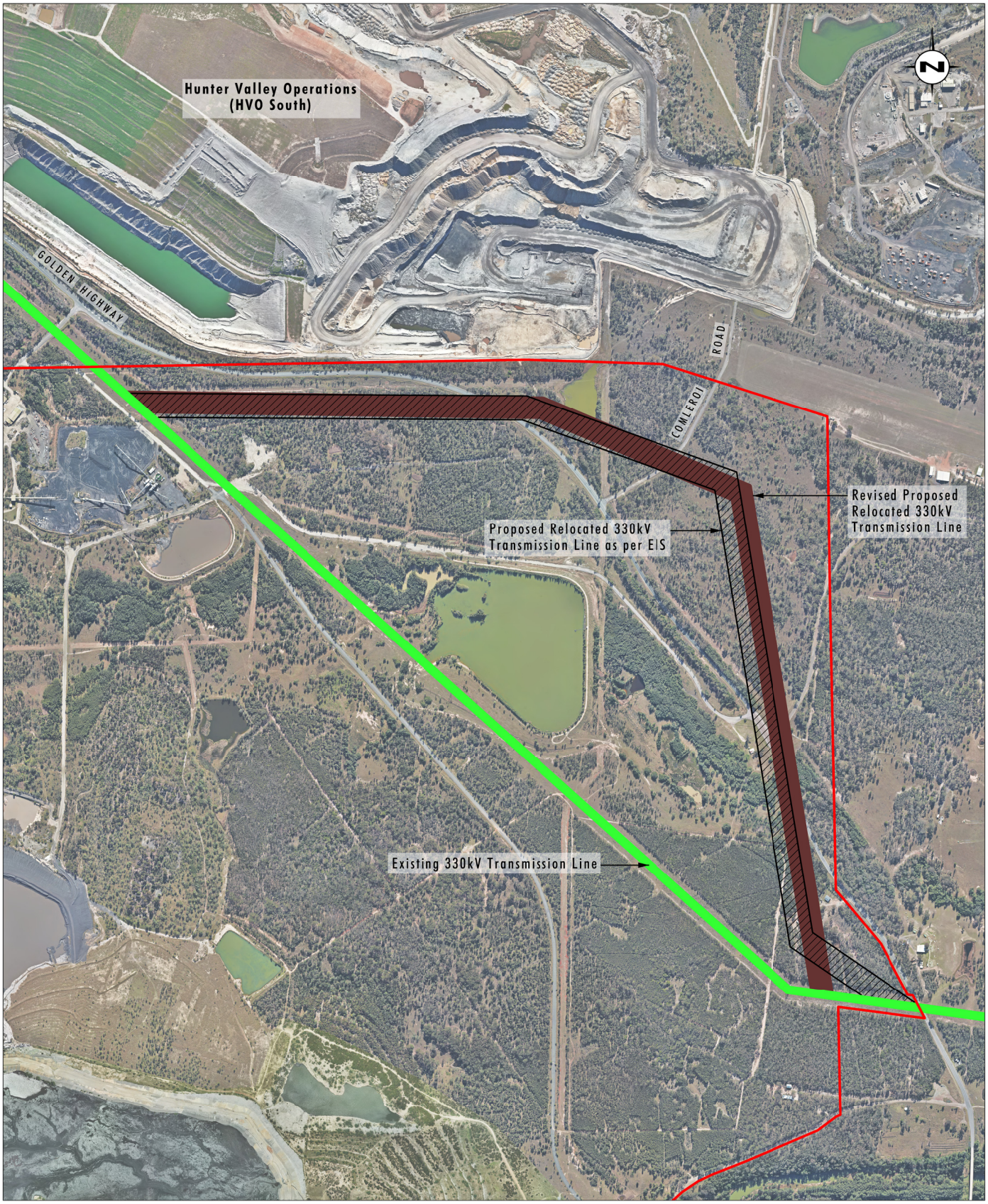

Image Source: AAM (2012), United (2016)
Base Data Source: Glencore (2015)

0 250 500 750m
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Legend

- Project Area
- Existing 330kV Transmission line
- Revised Proposed Relocated 330kV Transmission Line
- Proposed Relocated 330kV Transmission Line as per EIS

FIGURE 1.4

Revised Conceptual Alignment of 330kV Transmission Line Relocation

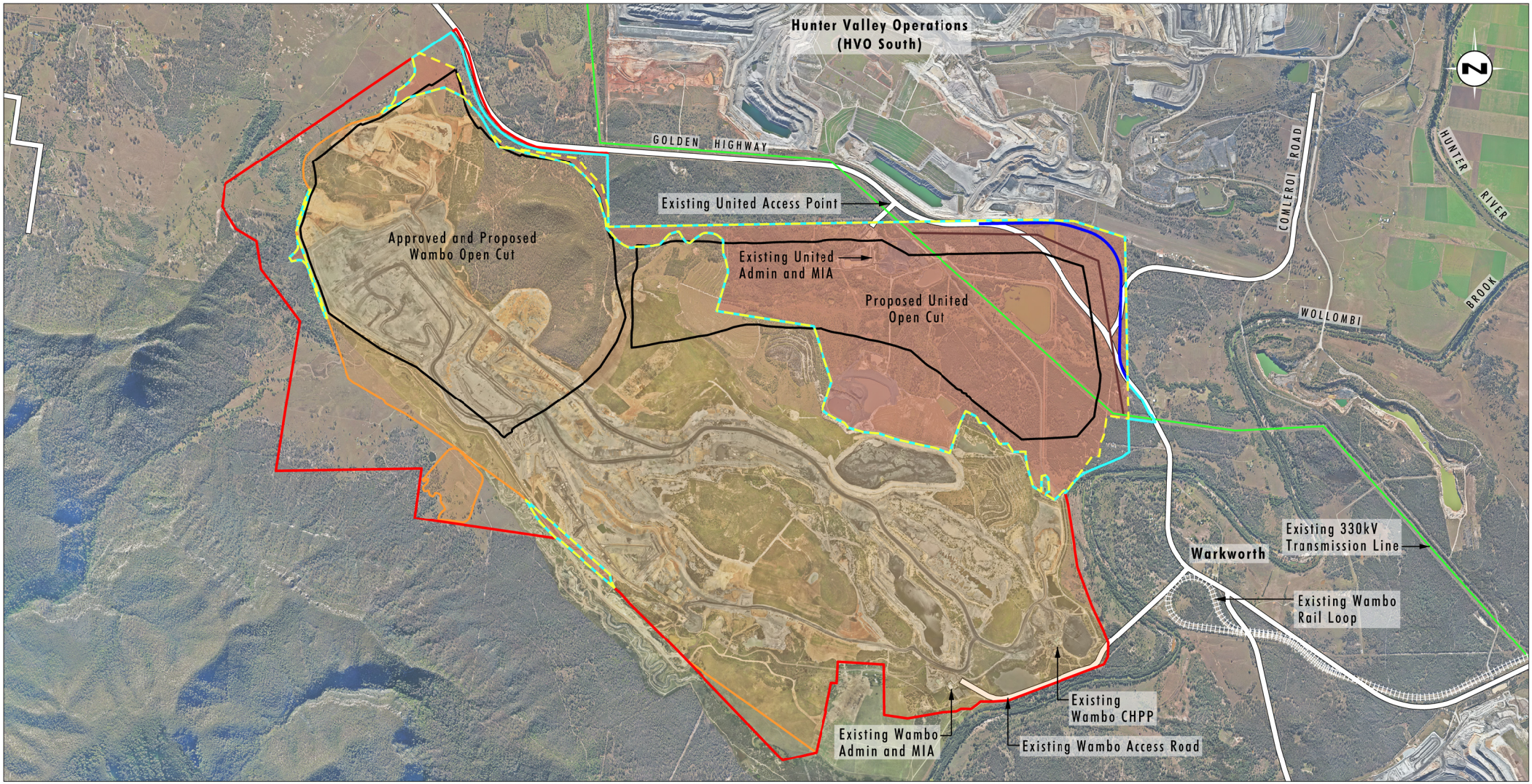

Image Source: United (2016)
Data Source: Glencore (2014)

0 1.0 2.0 2.5km
1:50 000

Legend

- Project Area
- Revised Conceptual Additional Disturbance Area
- Conceptual Additional Disturbance Area
- Approved Wambo Surface Development Area
- Proposed Conceptual Extraction Area
- Conceptual Golden Highway Realignment
- Existing 330kV Transmission Line
- Revised Conceptual Relocated 330kV Transmission Line

FIGURE 1.5

Revised Conceptual Additional Disturbance Area

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2.0 Independent Expert Scientific Committee on Coal Seam Gas and Large Coal Mining Development

The Department of Environment and Energy (DoEE) and DPE requested the IESC to review the EIS and supporting documentation to provide advice on the Project in relation to specific questions which were provided by DoEE and DPE. This section provides a response to the issues raised in the letter of advice received from the IESC.

The IESC advice uses numbered paragraphs to summarise the answer to each question and provides further explanation of the issues identified in the answer to the question. The key answers raised in the IESC submission have been reproduced below and addressed in this report by issue.

The following responses in relation to groundwater have been prepared with input from AGE who completed the Groundwater Impact Assessment (GIA) for the Project.

The issues identified by the IESC response were grouped under the following headings:

- relevant data and information
    - limitations in spatial and temporal representation of water quality data for both surface water and groundwater
    - comparison to site-specific trigger values
    - downstream impacts
    - lack of a geochemistry assessment
    - groundwater dependent ecosystems
- application of appropriate methods and interpretation of model outputs
    - uncertainty in the surface water modelling results due to a lack of information on the construction, parameterisation and calibration of the individual models
    - influence of faults on groundwater modelling
    - underground water storage.

This report provides a detailed response to each of the issues raised by the IESC a number of which were technical clarifications. In some instances additional work has been undertaken to meet the requests from the IESC. It is important to note that although the responses relating to these technical clarifications and additional work are quiet detailed, they have not changed the water resources assessment outcomes presented in the EIS for the Project. The technical clarifications and additional work have simply provided additional rigor to the already very detailed water resources assessments undertaken as part of the EIS. Some additional management commitments have also been made in response to comments from the IESC (refer to **Section 4.0**).

Water Resources Context

When considering the potential of the Project to impact on water resources, it is important to consider the Project in the context of its location within an existing mining area and within the NSW water resource management system. As discussed in Section 7.0 of the EIS, the Project exists within a well-regulated water resource management system that has been designed by the NSW government to provide for the sustainable management of the State's water resources and the Project complies with all of these NSW requirements reducing the risk of the Project resulting in significant impacts to water resources. This includes:

- licensing of allowable water take from both surface water and groundwater with consideration of the environmental flow requirements of watercourses and the needs of other water users – that is, making sure that with the Project in place sustainable environmental flows will be maintained

- control of water pollution, including management of sustainable salt loads associated with all water sources, including mine water discharges – that is, making sure that poor quality water is not discharged from the Project and that any water released meets relevant quality requirements such that it does not result in significant impacts on downstream water quality

- guidelines that govern the appropriate design of water management systems for mines to provide for appropriate water quality in accordance with pollution control requirements.

As discussed in the EIS, both the Project Area and the surrounding areas have been subject to open cut mining operations for over 55 years. Recent and existing mining at the site include the United underground and open cut pits and Wambo underground and open cut pits. In the local region other mining operations include Mt Thorley Warkworth Open Cut, Lemington underground and open cut pits and HVO South open cut pits (refer to **Figure 1.2**).

The Project Area is located within the catchments of Wollombi Brook and Waterfall Creek, both tributaries of the Hunter River. Wollombi Brook is located to the east of the Project Area and flows into the Hunter River approximately 5 kilometres northeast of the Project Area (refer to **Figure 2.1**). Waterfall Creek is a minor tributary of the Hunter River and flows into the Hunter River approximately 4 kilometres northwest of the Project Area.

The Hunter River is a regulated river with releases from Glenbawn Dam and Glennies Creek Dam managed by Water NSW under a Water Sharing Plan. As a regulated river, the flow in the river is maintained through releases of water from these upstream dams ensuring that sufficient water is available for environmental flows and licensed water users.

The majority of the Project Area lies within the Wollombi Brook catchment. The existing mining operations at United and Wambo are also located within these catchment areas. The catchment area of Wollombi Brook is substantial (approximately 1850 km^2) and approximately 99 per cent of the catchment area lies upstream of the Project Area.

Wollombi Brook catchment in the vicinity of the Project Area includes sub-catchments of Wambo Creek, North Wambo Creek and Redbank Creek (refer to **Figure 2.2**). Waterfall Creek, a sub-catchment of the Hunter River, is located in the north of the Project Area. The existing United and Wambo Water Management Systems (WMS) are also located within the Project Area. The extent of the existing WMSs is shown on **Figure 2.1**. The water within the existing United and Wambo WMSs is captured, treated and reused onsite, with controls in place that are designed to avoid the mining operations resulting in significant impacts on the surrounding water resources.

The two main aquifer systems identified as occurring within and surrounding the Project Area are the Quaternary alluvium (including 'highly productive' and 'less productive' alluvium) and the Permian coal measures. The quaternary alluvium in the vicinity of the Project Area occurs along Wollombi Brook and parts of its tributaries and along the Hunter River to the north (refer to **Figure 2.3**). The Hunter River alluvium flows in an easterly direction, while groundwater within the Wollombi Brook alluvium flows in a north to north easterly direction towards the Hunter River. Recharge to the Quaternary alluvium occurs via 'diffuse' recharge from rainfall and 'focussed' recharge through the stream bed. The available data indicates that the alluvial groundwater is largely restricted to the thicker sequences of sand and gravel (highly productive alluvium) along the Hunter River and Wollombi Brook.

The Permian coal measures are generally confined above and below by impermeable overburden and interburden layers of sandstone, siltstone or clays. These aquifers are recharged by downward leakage from the upper strata within the escarpment areas of Wollemi National Park, from the area where the measures outcrop (i.e. reach the surface) to the north of the Project Area and from localised downward leakage from the Quaternary alluvium. In areas unaffected by mining, the Wittingham Coal Measures are saturated across their extent with groundwater levels generally 30 metres below the surface, ranging between 80 mAHD to the southwest beneath the escarpment down to 50 mAHD near the Hunter River.

Water Management System and Water Impacts

Both United and Wambo mines have extensive existing WMSs in place which include mine dewatering systems, water storages, sedimentation and retention basins, and water diversions and catch drains. Both WMSs have similar key objectives. The key objectives are to:

- prevent the contamination of clean water by mining activities
- segregate clean waters away from active mining areas to reduce the volume of mine affected water requiring subsequent storage and treatment
- minimise the discharge of pollutants from mining affected areas into the environment
- quantify the water used, stored and imported/exported
- maximise recycling and water sharing opportunities.

The conceptual water management strategy for the Project has been designed to integrate water management of the Project with the existing WMSs. The key drivers for the strategy are:

- the separation of clean and dirty water
- preventing the contamination of clean water by mining activities
- maximising water recycling and reuse opportunities
- effectively managing water across United and Wambo
- managing compliance with statutory obligations.

A detailed description of the proposed conceptual WMS for the Project is provided in Appendix 11 of the EIS.

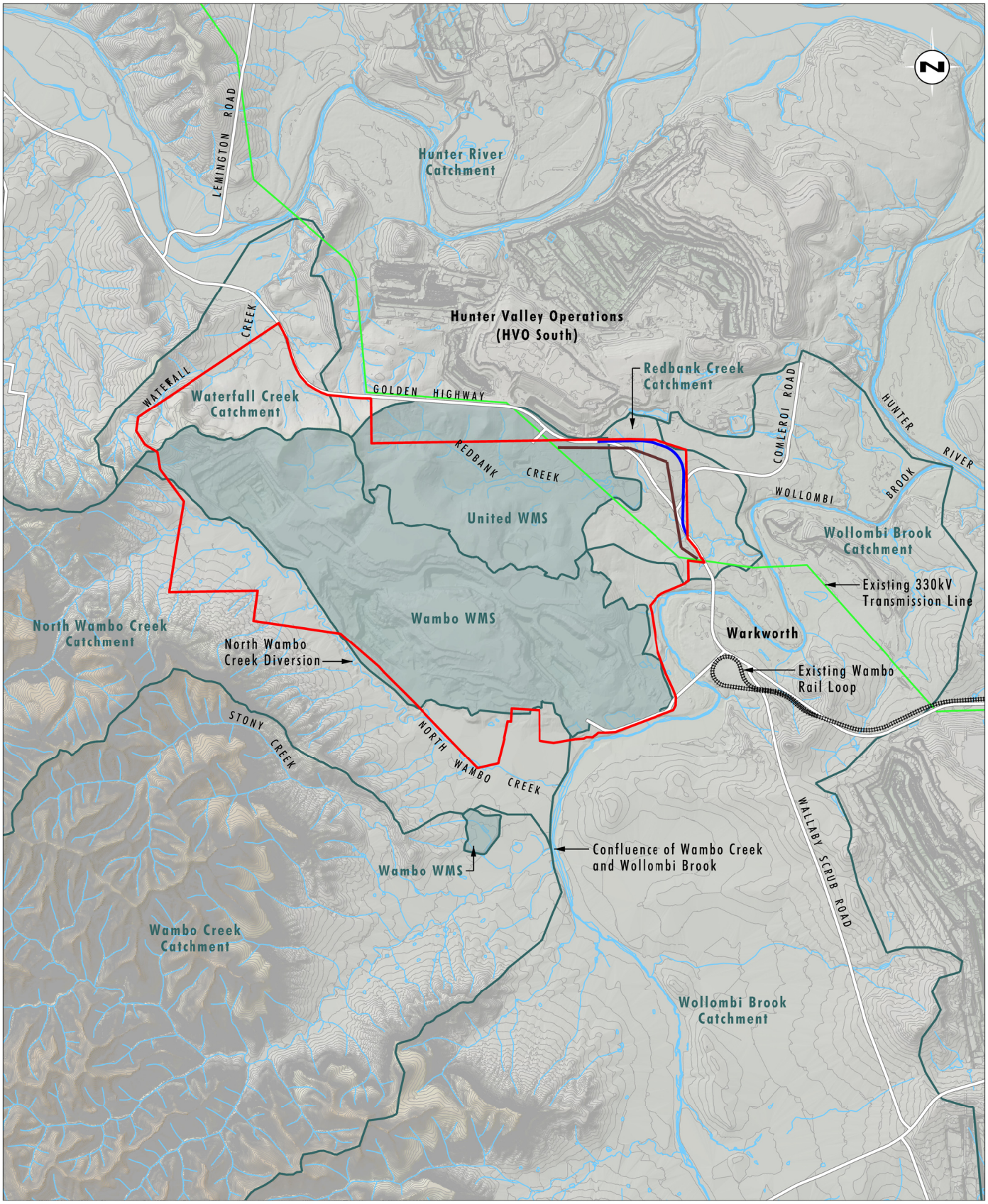

Image Source: United LiDAR (2015)
Data Source: Glencore (2014)
Note: 5m Contour Interval

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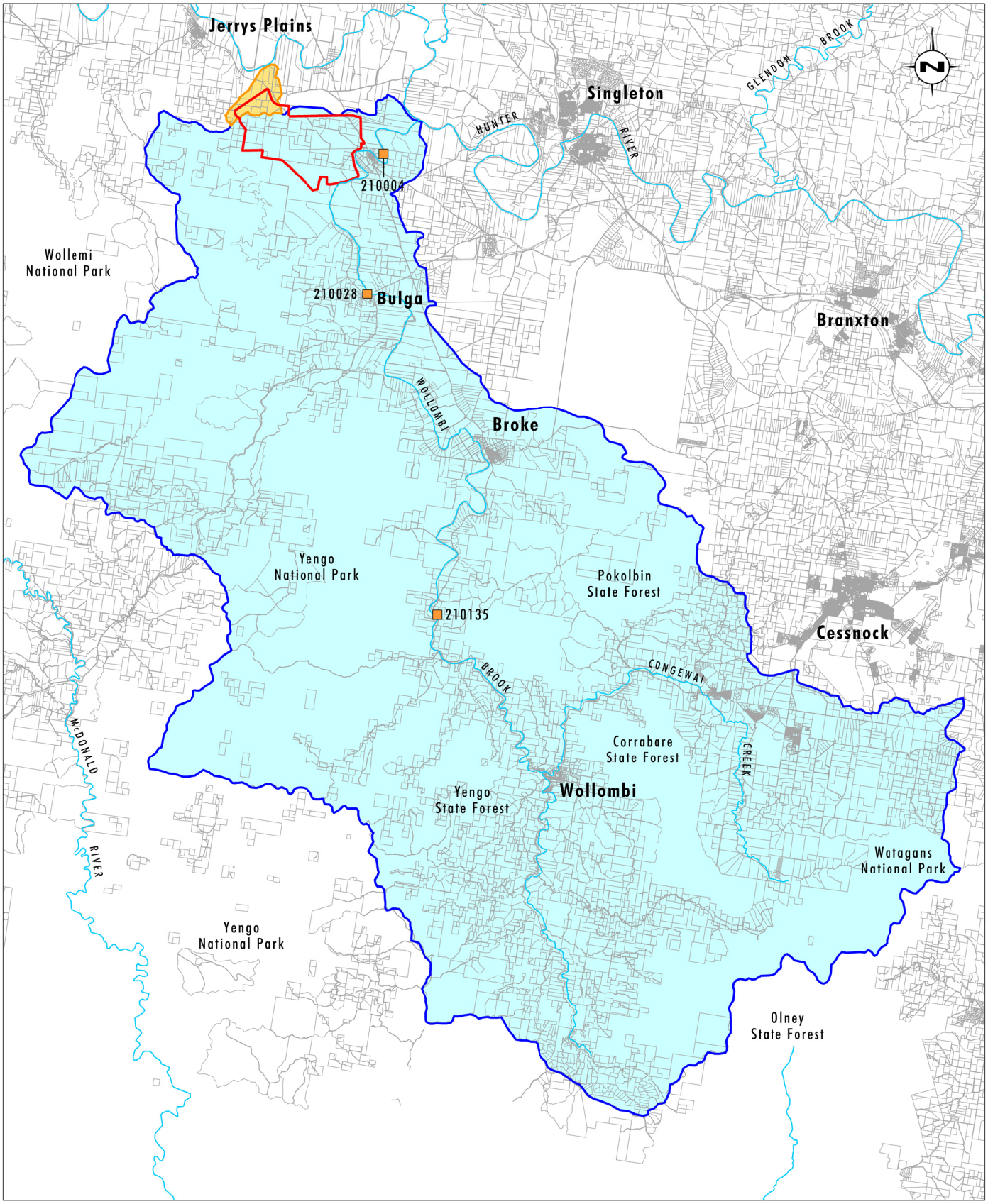
Legend

- Project Area
- Proposed Golden Highway Realignment
- Existing 330kV Transmission Line
- Proposed Relocated 330kV Transmission Line
- Catchment Area
- Water Management System Catchment

FIGURE 2.1

Topography and Drainage of Project Area and Surrounds

File Name (A4): R18/3509_605.dgn
20170523 13.55



Legend

- Project Area
- Wollombi Brook Catchment
- Waterfall Creek Catchment
- Stream Gauging Station

FIGURE 2.2

Catchment Context

Water management for the existing mines and for the Project considers three categories of water, each with different potential to cause environmental harm. The target design criteria for each of the three categories of water are summarised in **Table 2.1**.

Table 2.1 Design Criteria for Components of the Project WMS

Water Category	Water Description	Target Design Criteria
Clean	Runoff from undisturbed or established rehabilitation areas	Intercept, convey and/or release, where practicable, to downstream environment
Dirty (Sediment Laden Water)	Runoff from disturbed areas (also referred to as sediment laden water)	Managed in line with the Blue Book (Managing Urban Stormwater: Soils and Construction Volumes 1 and 2E)
Mine	Runoff from areas exposed to coal, groundwater inflow, water used in coal processing or from coal stockpile areas	Mine water storages to have sufficient freeboard to contain runoff for events up to and including the 1 per cent 24 hour AEP (annual exceedance probability) storm event.

As described above, the intent of the WMS is to convey clean water around the mining operations or, when runoff water from the rehabilitated areas becomes clean, enable runoff from these rehabilitated areas to flow directly to the downstream environment instead of being managed as part of the WMS.

Dirty water (i.e. runoff from disturbed areas outside the mining pit and infrastructure areas, such as overburden emplacement areas (both active and under rehabilitation) captured in the sediment dams) is pumped to the mine water management system. Mine water (i.e. runoff from areas exposed to coal, groundwater inflows and water used in coal processing or from coal stockpile areas) is also managed as part of the mine water management system.

Pollution in NSW is regulated by the POEO Act with discharges from the mine water management system required to be licensed by an Environment Protection Licence (EPL) if the discharge would otherwise constitute a pollution of waters (section 120 of the POEO Act). The quantity and quality of water discharges from mining operations in the Hunter Region are managed in accordance with relevant EPLs and consistent with the provisions of the Hunter River Salinity Trading Scheme (HRSTS). As part of the development of the HRSTS, the NSW Government has determined the sustainable salt load for the Hunter River, considering the impacts on the environment. The HRSTS is managed such that discharges from industrial operations can only occur in suitable conditions. Wambo has a licence and salt credits to discharge water in accordance with the HRSTS into Wollombi Brook. United also holds salt credits under the HRSTS but does not currently have a licence to discharge saline water. Water within the mine water management system will continue to be either reused on site or shared within the Wambo Underground, CHPP and train loading facility. Surplus water within the mine water management system will be managed under the EPL and HRSTS and discharged in accordance with these controls.

The site water balance indicates average inflows are predicted to total 6316 ML per year, while average usage / outflows total 6962 ML per year indicating a net average inventory reduction of approximately 96 ML per year.

All water take predicted for the Project, that is all capture of groundwater and surface water by the mine itself and any pumped extractions from Wollombi Brook and the Hunter River, is within the existing licensed allocations held by United and Wambo for each of the relevant water sources. In terms of the water captured in the mine itself, as much of the area is already active mining areas, the change from the existing situation is not substantial. As discussed above, the water policy framework in place in NSW is designed to ensure that licensed take of waters does not exceed the sustainable yield of the water systems and therefore all of the water take for the Project will be within the sustainable yield of the water systems as determined by the NSW Government.

Surface Water and Groundwater Monitoring and Water Quality

Surface water and groundwater monitoring programs are currently being implemented at United and Wambo with the content of these monitoring programs being approved by the NSW Government. This data is being used to monitor and report on the water management performance of the mines with the results and analysis conclusions being regularly reported to the NSW Government and made available to the community through the United and Wambo websites.

The surface water quality monitoring programs have developed over the period of historical mining to focus on the key water management risk areas for the mining operations. The key routine water quality monitoring parameters are pH, electrical conductivity (EC), total dissolved solids (TDS) and total suspended solids (TSS). This is because these parameters have been determined to appropriately characterise the water quality at and surrounding the mining operation and would provide for impacts on downstream water quality to be identified if they occur. Monitoring of other analytes, including metals and metalloids, also occurs on a campaign basis or if routine monitoring results indicate that additional investigations are required.

The monitoring data shows that the water quality parameters are highly variable across the monitoring network, as would be expected within ephemeral drainage systems. Wollombi Brook, being more perennial, exhibits notably less variation in its water quality. Surface water runoff captured in the existing WMSs tends to exhibit notably more variation in TDS, TSS, EC and pH than the waters of Wollombi Brook as would be expected due to the ongoing change that occurs within the landform of an active mining operation and changes in the rate of groundwater interception as mining areas move. The water quality in Wollombi Brook shows little variation at monitoring locations upstream and downstream of the existing operations, indicating that Wollombi Brook is not exhibiting any measurable impacts due to the existing mining operations.

The ephemeral creek systems within and adjacent to the Project Area also generally exhibit similar water quality results upstream and downstream of the existing operations. Again, this suggests little to no measurable impact on the surrounding ephemeral watercourses as a result of the mining operations. Notably, the measured TSS load actually decreases downstream of the existing operations in Redbank Creek and Stony Creek, and is similar in North Wambo Creek, indicating that the existing WMS is generally effective at managing TSS within the site.

Analysis of the concentrations of various metals and metalloids reveals a generally wider spread in the concentrations detected in the samples from the existing operations compared with the samples from the Hunter River. There are several parameters monitored within the existing WMSs for which the mean and median values exceed the ANZECC 95th percentile guideline value for the protection of freshwater ecosystems including cadmium, chromium, copper, lead, nickel and zinc. This is to be expected as the mine water includes poor quality groundwater which inflows from the coal seam aquifers and due to the contact of the mine water with coal and other strata excavated from below the surface, the properties of this water will of course be different to that in surrounding natural surface water systems.

However, the WMSs have been designed to contain and reuse this water within the mining area and these exceedances are not reflected in downstream receiving waters, supporting the contention that metals and metalloids are not a significant environmental risk due to the effective operation of the existing WMSs.

In regards to groundwater monitoring, United and Wambo have a combined groundwater monitoring network that has evolved since 2000. The network comprises 77 bores and 24 vibrating wire piezometers (VWPs), of which 27 bores and 11 VWPs (55 sensors) are currently monitored as part of ongoing groundwater monitoring programs (refer to **Figure 2.3**). This extensive network combined with data from the past and current mining operations provide a sound understanding of the local groundwater environment.

Groundwater quality monitoring results for the alluvium ('highly productive' and 'less productive') indicate that groundwater is not suitable for long-term irrigation according to the ANZECC (2000) guideline levels for total manganese. The results indicate that groundwater within the 'highly productive' alluvium is suitable for stock water supply. Overall, the results indicate that groundwater within the 'less productive' alluvium is not suitable for stock water supply (excluding sheep) in accordance with the ANZECC (2000) guidelines. However, alluvial groundwater is occasionally used for stock (cattle) water supply and some domestic applications (i.e. gardens) within the region. It is noted that the Project will not directly intercept any areas of alluvium with significant set-back distances to both the Hunter River and Wollombi Brook alluvium included in the Project design.

Water quality monitoring results for the Permian coal measures (and interburden) indicate that the groundwater is not suitable for stock water supply due to elevated salinity levels and total aluminium concentrations. Groundwater monitoring within the Permian coal measures also records total manganese concentrations above the ANZECC (2000) long term irrigation trigger. Total selenium concentrations above the ANZECC (2000) guideline level for short-term irrigation are recorded for the groundwater occurring in the coal seams. The results also indicate that groundwater within the Permian coal measures and spoil is not suitable for stock water supply or irrigation according to the ANZECC (2000) guidelines. As the Project involves mining coal seams, groundwater from the Permian aquifers will continue to seep into the mine as it does with the existing mining areas.

The Groundwater Assessment for the Project concluded that the Project is not predicted to impact on groundwater quality in either the Quaternary alluvium or Permian aquifer.

Project Design to Minimise Impacts on Water Resources

Detailed environmental studies were undertaken to inform the proposed conceptual design for the Project as outlined in the EIS. Specifically in relation to minimising the impact on water resources this includes:

- The extent of existing and approved open cut and underground mining within and surrounding the Project Area, with mining already significantly altering the water environment within the Project Area. Where practicable the Project was designed to maximise use of these existing mining areas, minimising the extent of additional disturbance area for the Project. As discussed in **Section 1.2**, since the lodgement of the EIS the proposed additional disturbance area for the Project has been further reduced.

- The management of impacts from the Project within the regime established by NSW water and pollution control legislation, which provides for sustainable water take from water sources, management of water quality by imposition of discharge quality criteria and management of salt loads within sustainable targets by managing water discharges to the environment.

- Design of the water management system to meet legislative requirements and relevant guidelines (e.g. guidelines for treatment of runoff from disturbed areas) (as described above).

- By maintaining substantial buffer distances to Wollombi Brook (approximately 370 metres) and the Hunter River (approximately 1.7 kilometres) when compared to the recommended 200 metre offset in the NSW Aquifer Interference Policy.

- Minimisation of works within the flood prone areas of Wollombi Brook to minimise the potential to impact on flood behaviour.

- Maximised water recycling and sharing across the Integrated WMS to minimise import of water to the complex and to minimise discharges of excess water from the complex.

These factors reduce the potential for the Project to result in a significant impact on existing water resources.

It is important to note that coal mining will always impact the groundwater regime, as dewatering of the mine workings is essential to the safe extraction of coal. The *Significant Impact Guidelines 1.3: Coal seam gas and large coal mining developments - impacts on water resources* (DoE 2013) have been interpreted to mean that this unavoidable impact is only considered significant where there is a consequence from this impact; that is, that groundwater users or the environment are affected by changes in the quality or quantity of groundwater.

A summary of the potential water impacts against the *Significant Impact Guidelines 1.3: Coal seam gas and large coal mining developments – impacts on water resources* (DoE 2013) is included in **Table 2.2**.

Table 2.2 Summary assessment against Significant Impact Guidelines: Coal Seam Gas and Large Coal Mining Developments – Impacts on Water Resources

Aspect	Impact
Flow Regimes	The footprint of mining operations will increase with the Project and water from this increased area will be captured, treated and reused within the water management system. The Project includes placement of a flood levee adjacent to the United Open Cut to provide protection from flooding associated with flood flows in Wollombi Brook and backflows into Redbank Creek. The assessment indicates that the Project will have minor to negligible impacts on flow regimes including flood flow velocities and depths, and associated potential impacts on downstream landholders and watercourse stability in Wollombi Brook and its tributaries when compared to the existing approved operation. The potential impacts on flow regimes, including flood flows in Waterfall Creek, are considered to be minor when compared to the existing approved operation. Flow to alluvial aquifers and baseflows in streams are predicted to be reduced during mining. However, the predicted reduction is comparatively low compared to cumulative impacts. The detailed assessment of potential impacts on flow regimes includes assessment of impacts on catchment areas and annual flow volumes, including flow duration impacts as a result of changes to catchment areas and baseflow contributions at flow monitoring locations on both Wollombi Brook and the Hunter River, and flood modelling of Wollombi Brook and Waterfall Creek.
Recharge Rates; Aquifer pressure or pressure relationships between aquifers; Groundwater table levels	There will be no areas of alluvial aquifer that are directly intersected by the Project with substantial setbacks provided from both Wollombi Brook and the Hunter River alluvial zones. Recharge rates will potentially increase in the open cut mining area and recharge to alluvium and streams (baseflow contributions) will potentially decrease in some locations. Pressures will reduce in the Permian aquifer and in some relatively small sections of the alluvium during the Project life but will recover post mining. The groundwater table for the Permian aquifer and in some relatively small sections of alluvium will decline during mining but partially recover post mining.

Aspect	Impact
Groundwater/surface water interactions	Water table drawdown within the alluvium will reduce base flow to the interconnected streams; however, these reductions will be managed through licences for take already held by United and Wambo. The surface water assessment indicates that the predicted worst case impacts on baseflows will not have a significant impact on flows in either Wollombi Brook or the Hunter River. In addition, the assessment of the final voids indicates that the voids will be self-contained systems which will act as a sink in perpetuity, with no surface spills predicted to downstream watercourses. Interactions between groundwater and surface water, in regard to baseflow impacts, have been assessed by way of flow duration curves for flow gauges on Wollombi Brook and the Hunter River. This assessment identified a negligible level of impact.
River/floodplain connectivity	The Project is not expected to have an impact on river/floodplain connectivity as no mining is proposed in flood plain areas. The Project is located on the edge of the flood prone land associated with Wollombi Brook. The assessment indicates that the Project will have negligible influences on flood behaviour in Wollombi Brook and as such it is considered that the Project will not influence river/floodplain connectivity.
Inter-aquifer connectivity	There are no changes predicted to inter-aquifer connectivity as a result of the Project. The predicted changes in aquifer pressure are discussed above.
Coastal Processes	No impacts on coastal process are predicted as a result of the Project which is located well inland, being approximately 80 kilometres from the coast.
Impact on water users	The assessment of impacts on water users indicates that there will be negligible impact on surface water users. There is one potentially impacted private bore as a result of groundwater drawdown associated with the Project; however, as noted above, this bore is currently not serviceable. United, on behalf of the Joint Venture, has consulted with the landholder in relation to the predicted impacts from the Project including the potential groundwater drawdown and the proposed mitigation measures. All water take associated with the Project will be licensed in accordance with the *Water Management Act 2000*, with predicted take within the capacity of the water licence allocations currently held by United and Wambo.
State Water Resource Plans	The surface water and alluvial water sources within the Project Area are managed under the water sharing plans prepared by the NSW Government. All water take for the Project will comply with these water sharing plans and Acts which are designed to provide for the sustainable use of NSW's water resources. As noted above, the predicted water take for the Project is within the capacity of the water licence allocations currently held by United and Wambo.

Aspect	Impact
Water Quality	Both United and Wambo have comprehensive WMSs in place to manage the potential impacts of the existing mining operations on water resources. The WMS for the Project has been designed in accordance with relevant government standards to limit potential impacts on downstream water qualities by managing water that has the potential to cause environmental harm. To manage water quality during construction, operation and rehabilitation phases of the Project, erosion and sediment control measures and other water quality control measures implemented in accordance with the relevant government standards to minimise any potential impact on water quality. Monitoring results will be assessed against trigger values. The Project proposes to continue to discharge surplus water from the WMS in accordance with relevant approvals. The water quality of such discharges will be in accordance with EPL limits and consistent with the provisions of the HRSTS. Discharges from the WMS will be monitored prior to release to ensure compliance with the requirements of the HRSTS. With these measures in place and considering the management of cumulative salt loads under the HRSTS, discharges of water from the Project are not considered likely to result in significant cumulative impacts on downstream environments. The risks to downstream environments associated with sediment laden water are mitigated by the design of the Project's WMS in accordance with design criteria established by the NSW Government specifically for sediment control at mining and quarry operations. These controls will effectively manage this risk. Through management of sediment laden (dirty) water and mine water within the WMS over the life of the Project, and based on flood assessment findings that indicate no changes to velocities and associated scour potential in Wollombi Brook, it is not anticipated that water quality in downstream waterways will be adversely impacted by the Project. As noted above, all discharges of saline water will be undertaken in accordance with the HRSTS, ensuring that they remain within the sustainable salt level for the Hunter River determined by the NSW Government. The Project is therefore considered to have a low potential to impact on water quality in downstream watercourses.

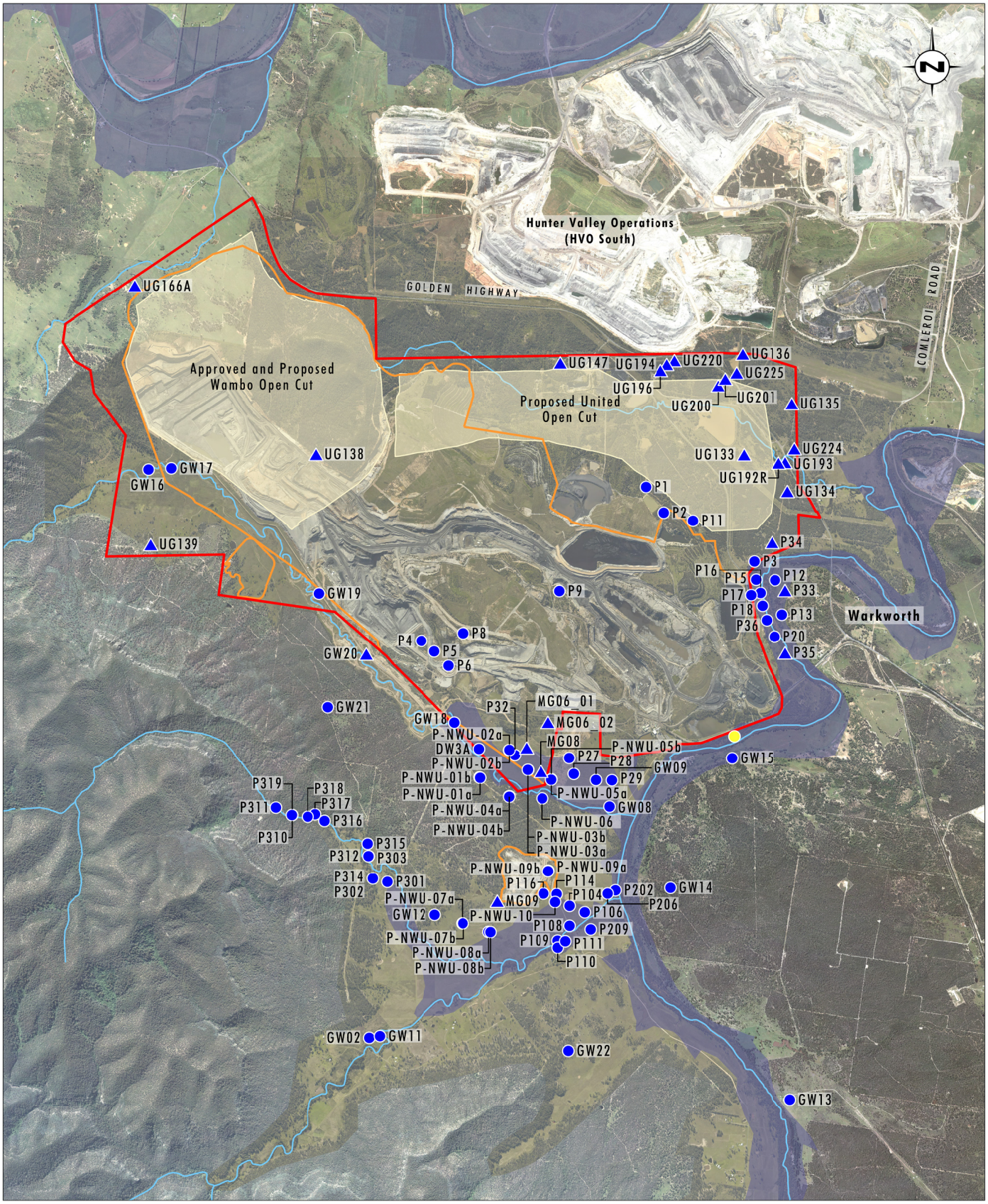


Image Source: AAM (2012), United (2015)
Data Source: Glencore (2014)

0 1.0 2.0 3.0km
1:60 000

Legend

- Project Area
- Approved Wambo Surface Development Area
- Proposed Conceptual Extraction Area
- Quaternary Alluvium (1:25k AEG)
- Monitoring Bore
- VWP
- Wambo Discharge Point

FIGURE 2.3

Groundwater Monitoring Bores and Extent of Alluvium

File Name (A4): R18/3509_608.dgn
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2.1 Question 1

Question 1: Do the groundwater, surface water and ecological assessments provide adequate mapping and delineation of surface and groundwater resources? Does the analysis, including any numerical modelling, provide reasonable estimates of the likely impacts to water resources and water dependent ecosystems, with particular reference to the Wollombi Brook/Redbank Creek and Waterfall Creek sub-catchments and the water quality and flows in the downstream reaches of the Hunter River? Consideration should include, but not necessarily be limited to, potential changes to water quality, water quantity, aquifer connectivity, depressurisation, flow and recharge regimes, ecological community composition and cumulative impacts.

1. **No. Adequate mapping and delineation of the condition and extent of surface water and groundwater resources has not been provided. Further consideration should be made regarding:**

a. **The spatial and temporal presentation and analysis of baseline data for surface water and groundwater quality.**

Summary Response

The groundwater and surface water assessments provide mapping and delineation of water resources within and surrounding the Project Area. The Project Area is located within the catchments of Wollombi Brook and Waterfall Creek, both tributaries of the Hunter River. Wollombi Brook is located to the east of the Project Area and flows into the Hunter River approximately 5 kilometres northeast of the Project Area. Waterfall Creek is a minor tributary of the Hunter River and flows into the Hunter River approximately 4 kilometres northwest of the Project Area.

There is a detailed understanding of the existing water resources within the Project Area and surrounds based on the long-history of mining in the Project Area and the coverage of the existing water monitoring programs. The key surface drainage systems (Wollombi Brook and Hunter River) both have long-term flow data available. There is also a long term water quality monitoring data set for the Project Area and surrounding areas. There is an extensive groundwater monitoring program in place and in addition to the data collected by United and Wambo, data has been shared with another neighbouring mining operations to provide a more comprehensive dataset for use in the analysis. In addition, data from available NSW Government reporting and monitoring has been used in the assessment.

Although the dataset used in the EIS was considered sufficient for assessment purposes, to address the request from the IESC that further consideration of spatial and temporal presentation and analysis of baseline data for surface water quality is made, additional work has been undertaken and is presented in the detailed response in **Section 2.1.1**. It is noted that the additional data collection and analysis work undertaken has not resulted in any changes to the assessment outcomes detailed in the EIS.

The monitoring of water at the existing mining operations has focussed on the key parameters pH, EC, TDS and TSS, which have been determined to be the key water quality risk indicators for the mining operation considering the nature of the operation and the geological context within which it sits, and there are significant data sets for these key parameters.

As expected, the monitoring results show that the water within the WMS is of poorer quality than that found in the surrounding surface water environment. These are as expected given that the mine water is not representative of the natural surface water quality within the surrounding environment. Mine water has a strong influence from groundwater from the coal seam aquifers intercepted during mining with this water being of poorer quality than that of surface waters. It is for this reason that the WMS for the Project separately manages this water and contains it on the site for reuse. The WMS has been designed to avoid overflows of mine water and the only potential release path for mine water is via the Wambo licenced discharge point to Wollombi Brook. As discussed in the EIS, there are existing NSW government imposed water quality discharge limits on this existing Wambo licenced discharge point and no changes are proposed to these quality limits for the Project. Water must meet these quality limits prior to being discharged, with these limits determined by the NSW Government to acceptably manage downstream water quality impacts.

Site specific water quality triggers have been determined for the Project to provide for the implementation of trigger action response plans (TARPs) aimed at protecting the environment and identifying any unforeseen impacts on downstream water quality. The TARPs work by triggering a response by United with the triggers set at a level that is designed to generate this response prior to any harm occurring to the environment. When a trigger occurs (e.g. through an event such as an elevated monitoring result or a dam reaching full capacity) a response is put in place. This may include actions such as diverting water flows, pumping water to another holding location, water treatment or similar, or it may be a trigger for a more detailed investigation of why a trigger has occurred (e.g. further monitoring or review of a part of the WMS performance with actions to be determined as an outcome of these further investigations). These TARPs are put in place for the internal performance of the WMS as well as for the surrounding environment. The TARPs for internal performance are designed to identify and address any deviations from 'normal performance' prior to them reaching a level where they may impact outside of the WMS.

Detailed Response

Surface Water

To address the request from the IESC that further consideration of spatial and temporal presentation and analysis of baseline data for surface water quality is made, the following additional work has been undertaken:

- Additional surface water quality monitoring has been undertaken since the EIS was prepared, including: an expanded analyte regime at existing monitoring locations to inform the characterisation of baseline water quality; additional monitoring within the water management system for an increased suite of analytes to further characterise mine water; and collection of additional samples as part of ongoing monitoring at the site since the EIS Surface Water Assessment was prepared.

- The full suite of surface water quality data, including all of the data previously reported in the EIS and the newly collected data for both the surrounding surface waters and the water management system, has been subject to detailed analysis both temporally and spatially (spatially by comparison between different water systems/surface water types and different parts of the WMS). This analysis is more detailed than that undertaken as part of the EIS providing further analysis on the spatial and temporal distribution of surface water quality as raised in the IESC comments. This analysis, whilst more detailed as requested by the IESC, does not change any of the findings outlined in the EIS Surface Water Assessment as it did not result in any changes to the outcomes of the previous assessment and did not identify any new issues.

- As part of the analysis, further discussion is provided relating to existing surface water quality triggers used by United and Wambo and proposed future triggers to be used for the Project, as well as comparison to default triggers provided in relevant guidelines, to address specific comments by the IESC on comparison to triggers. This analysis also provides a guide for the triggers to be applied as part of the surface water quality monitoring program for the Project. In the future monitoring programs, should monitored water quality exceed the selected trigger values, a trigger action response plan (TARP) will be implemented including further investigations and implementation of additional controls as required to address any identified impacts on surface water quality. Further discussion of the TARPs and the triggers are provided below.

The following sections provide detailed discussion of the above key points and outline the findings of the additional work undertaken to address the IESC submission as described above, as follows:

- summary of background information contained in the Surface Water Assessment (refer to Appendix 11 of the EIS)

- baseline data for the surface waters, including the data collated after the EIS submission, and site specific trigger analysis

- expanded monitoring data for the water management system (WMS) and comparison to baseline data for the surrounding surface waters.

The data and conclusions are summarised below with charts of the full data sets included in **Appendix 1**.

Further detailed discussion of the proposed surface water quality monitoring program is provided in the response to Question 3.

Background Information Contained in the EIS

Historical water quality data was presented in the Surface Water Assessment (Appendix 11 of the EIS) with a summary description of the data provided in Section 2.3 and charts showing historical readings for pH, electrical conductivity (EC), total dissolved solids (TDS) and total suspended solids (TSS) included in Appendix A. The monitoring locations were presented on Figure 2.5 of the Surface Water Assessment and the data included results for clean, dirty and mine water systems. The historical surface water monitoring programs for United and Wambo are briefly described below and also discussed below.

United's surface water monitoring program, as outlined in its NSW government approved Environmental Monitoring Program, consists of monitoring undertaken to satisfy Development Consent and Environment Protection Licence (EPL) conditions as well as monitoring undertaken for onsite environmental management purposes. The program includes monthly monitoring of pH, EC, TSS and TDS at six locations on North Wambo Creek, Wollombi Brook and Redbank Creek. In addition, surface water storages are monitored monthly for pH, EC, TSS, TDS and hydrocarbons, and annually for selected metals, micro-organisms, phosphorous, nitrogen and ammonia (UCPL, 2016).

Wambo conducts surface water monitoring as outlined in its NSW government approved *Surface Water Monitoring Program* (Wambo Coal Pty Ltd, 2015). Wollombi Brook, Wambo Creek, North Wambo Creek and Waterfall Creek are monitored monthly (and following rainfall events of greater than 20 millimetres in a midnight-to-midnight period) for pH, EC, TSS and TDS. Wambo's licensed discharge point (SW15) is monitored continuously during discharge for pH and EC and daily for TSS.

Baseline Data – Surface Waters

Data Suite Available

As discussed above, the water monitoring data set used in the assessment for the Project has been sourced from monitoring undertaken by United and Wambo, data shared from neighbouring mining operations and data from available the NSW Government. This dataset is considered suitable for assessment purposes for the Project.

Baseline water quality monitoring data for watercourses surrounding the Project Area has been collected since mid to late 2011 as part of both the United and Wambo surface water monitoring programs. In addition, Glencore undertook a period of data collection for metals/metalloids and nutrients in the Hunter River during 2014.

Subsequent to the public exhibition of the EIS, the JV has collected additional water quality data, in particular relating to metals/metalloids in Wollombi Brook as well as in the WMS. Monitoring for a suite of metals/metalloids was undertaken on: 26 October 2016, 1 December 2016, 4 January 2017 and 9 February 2017.

The additional monitoring data collected over the period October 2016 to February 2017, was during a summer with very low rainfall. Two samples were collected on Wollombi Brook (one upstream and one downstream of the site) during the monitoring period during October 2016. Wollombi Brook had no flow during the other sampling dates. As no discharges or overflows occurred from the water management systems at either mine site during October 2016, both the upstream and downstream water quality results for Wollombi Brook are representative of the receiving water quality on this date.

The available baseline data, including period of record and number of samples, for the surface waters baseline data is summarised in **Table 2.3**.

Table 2.3 Summary of Baseline Data – Watercourses Surrounding the Project Area

Location	pH	EC	TSS	TDS	Metals	Nutrients
Wollombi Brook (SW01)	Jul 2011 – Aug 2016 (60)	Jul 2011 – Aug 2016 (60)	Jul 2011 – Aug 2016 (54)	Jan 2014 – Apr 2016 (41)	Oct 2016 (1)*	Oct 2016 (1)*
Wollombi Brook (SW40)	Jul 2011 – Aug 2016 (61)	Jul 2011 – Aug 2016 (61)	Sept 2011 – Aug 2016 (53)	No data	No data	No data
South Wambo Creek (SW06)	Jul 2011 – Jun 2016 (50)	Jul 2011 – Jun 2016 (50)	Jul 2011 – Jun 2016 (45)	No data	No data	No data
Wambo Creek (SW07)	Oct 2011 - Aug 2016 (43)	Oct 2011 - Aug 2016 (41)	Oct 2011 - Aug 2016 (39)	No data	No data	No data
North Wambo Creek (SW04)	Dec 2011 – Mar 2013 (2)	Dec 2011 – Mar 2013 (2)	Dec 2011 – Mar 2013 (2)	No data	No data	No data
Stony Creek (SW08)	Jul 2011 – Feb 2016 (10)	Jul 2011 – Feb 2016 (9)	Jul 2011 – Feb 2016 (10)	No data	No data	No data
Waterfall Creek (SW39)	Aug 2011 – Jan 2016 (24)	Aug 2011 – Jan 2016 (24)	Aug 2011 – Jan 2016 (24)	No data	No data	No data
Hunter River (Lemmington Road Crossing)	No data	No data	No data	No data	Mar 2014 – Aug 2014 (12)	Mar 2014 – Aug 2014 (12)

* - Note: 2nd sample at SW02 (Wollombi Brook downstream) considered in analysis to represent receiving water on this date – see description above.

Water Quality Triggers

The IESC made comment, in their explanation to the response to Question 1, that the available water quality data should be compared to site-specific trigger values where available. To address this comment included below are the current triggers used by United and Wambo, a discussion of potential triggers that could be used for the Project and the preliminary site specific triggers to be utilised in the WMP. There is currently limited water quality data across many of the analytes, except pH, EC, TDS and TSS, to determine site specific triggers. As noted earlier in **Section 2.0**, the monitoring of water at the existing mining operations has focussed on these parameters as they have been determined to be the key water quality risk indicators and there are significant data sets for these parameters.

The comparison of water quality results included in the following sections, as requested by the IESC, is against a range of default trigger values (the default trigger values are compared below to site specific trigger values).

The water quality triggers currently used by United and Wambo mines were presented in the Surface Water Assessment (Table 2.2). This table is reproduced below as **Table 2.4**.

Table 2.4 Water Quality Triggers

Parameter	ANZECC default trigger[1]	United	Wambo				
			Wollombi Brook (SW02)	North Wambo Creek (SW05)	Wambo Creek (SW07)	Stony Creek (SW08)	Waterfall Creek (SW39)
pH	6.5 - 8.5	6.5 – 8.5	7.4 - 8.1	7.3 - 7.9	7.4 - 7.9	6.8 - 7.4	7.3 - 7.8
EC (µS/cm)	125 - 2,200	-	599 - 1,947	1,155 - 2,246	360 -724	288 - 416	159 - 429
TSS (mg/L)	NA	<50	17 (low flow) – 308 (high flow)	53 (low flow) - 1,110 (high flow)	29 (low flow) – 331 (high flow)	5 (low flow) – 15 (high flow)	582 (low flow) - 1,922 (high flow)

Note: As historical ranges vary greatly to ANZECC default values the United Collieries Surface and Groundwater Monitoring Program indicate historical data should also be used in assessment of water quality

1. Included for reference/comparison only. The default triggers presented are for South-east Australia, lowland rivers, 95th percentile ecosystem protection.

Sources:
United Collieries Surface and Groundwater Monitoring Program (2009)
Wambo Coal Surface Water Monitoring Program (2015)
ANZECC Guidelines (2000)

To assist in addressing the IESC comments, further information on the application of default water quality triggers to monitoring programs and their values are included below. The ANZECC guidelines and ADWG limits provide a starting point for water quality assessment across Australia, including NSW. For sensitive environments, water quality is typically compared to the default ANZECC criteria for 95% ecosystem protection in slightly disturbed systems. However, it should be noted that the Project flows into tributaries of a highly-regulated river system (i.e. the Hunter Regulated River System) for which both discharges from industry (including mining) and extractions for, irrigation, power generation, town water use, mining, industrial and other uses are regulated. The range of possible default limits are shown in **Table 2.3**.

Table 2.5 Overview of Water Quality Guidelines and Limits

Analyte	ANZECC Default Guideline Limits (2000)			ADWG Limits (2011)		
	95% Ecosystem Protection*	Irrigation	Livestock	Recreation	Health	Aesthetic
Aluminium	0.055	5	5	-	-	0.2
Arsenic	0.024	0.1	0.5	-	0.01	-
Barium	-	-	-	1	2	-
Beryllium	-	0.1	-	-	0.6	-
Cadmium	0.0002	0.01	0.01	-	0.002	-
Chromium	0.001	0.1	1	-	0.05	-
Cobalt	-	0.05	1	-	-	-
Copper	0.0014	0.2	0.4	-	2	1
EC (µS/cm)	125-2200[1]				-	
Iron	-	0.2	-	-	-	0.3
Lead	0.0034	2	1	-	0.01	-
Manganese	1.9	0.2	-	-	0.5	0.1
Mercury	0.0006	0.002	0.002	-	0.001	-
Nitrate	-	-	-	-	-	-
oil and grease	-	-	-	-	-	-
pH (field)	6.5-8.0[1]				-	6.5-8.5[1]
pH (lab)	6.5-8.0[1]				-	6.5-8.5[1]
Phosphorus	-	-	-	-	-	-
Selenium	0.011	0.02	0.02	-	0.01	-
TDS	-	-	-	-	-	-
TSS	-	-	-	-	-	-
Zinc	0.008	2	20	-	-	3

Note: Recommended/default water quality limits are in mg/L unless otherwise specified.
1. Lowland Rivers in NSW
*Freshwater

Utilising the water quality collected up to the end of 2016 preliminary site specific triggers based on upstream monitoring data collected by both Wambo and United mines at SW01 and SW40 respectively on Wollombi Brook are presented in **Table 2.6** below. It is proposed that these triggers be refined to include any additional data available after this date and that the final triggers are include in the Project Water Management Plan (refer to response to Question 6). However, it is noted that there is sufficient data for these parameters to establish triggers that are appropriate to assess the performance of the Project and that will provide protection for the downstream environment.

Table 2.6 Preliminary Site Specific Water Quality Trigger Analysis – Wollombi Brook

Parameter	20th Percentile	80th Percentile	#Samples
pH	7.4	7.9	121
EC (µS/cm)	466	822	123
TSS (mg/L)	3	9	109
TDS (mg/L)	266	432	34

The preliminary analysis shows site specific triggers for Wollombi Brook when compared to default ANZECC triggers for low land rivers in NSW, to be similar for pH, and within the guidelines for EC. There are no default ANZECC triggers for TDS or TSS.

Based on the historical data presented in charts in **Appendix 1** a low flow and high flow trigger for TSS, similar to the current approach (refer to Table 2.2 of the SWA) will be included in the surface water monitoring program for the Project.

Building on the preliminary triggers provided above, it is proposed to update and review the site-specific water quality triggers as part of the development of the Project Water Management Plan as outlined in the response to Question 6. This will include review of additional water quality data to inform the development of site specific triggers for other analytes. Water quality triggers for the Project will be used to implement trigger action response plans (TARPs) aimed at protecting the environment and identifying any unforeseen impacts on downstream water quality.

The TARPs work by triggering a response by United with the triggers set at a level that is designed to generate this response prior to any harm occurring to the environment. When a trigger occurs (e.g. through an event such as an elevated monitoring result or a dam reaching full capacity) a response is put in place. This may include actions such as diverting water flows, pumping water to another holding location, water treatment or similar, or it may be a trigger for a more detailed investigation of why a trigger has occurred (e.g. further monitoring or review of a part of the WMS performance with actions to be determined as an outcome of these further investigations). These TARPs are put in place for the internal performance of the WMS as well as for the surrounding environment. The TARPs for internal performance are designed to identify and address any deviations from 'normal performance' prior to them reaching a level where they may impact outside of the WMS.

Analysis of Baseline Data – Surface Waters

Further analysis of water quality, to consider spatial and temporal variation, has been undertaken utilising the expanded data set (i.e. the additional monitoring of metals/metalloids undertaken to address the IESC comments). All of the data used in the analysis is presented in charts in **Appendix 1**. This data is compared to a range of default trigger values, as discussed in water quality trigger section above. The outcomes of the analysis are discussed below.

The analysis in **Appendix 1** shows the following:

- Water quality in Wollombi Brook is typically within the ANZECC default guidelines for lowland rivers in NSW. An analysis of the EC data for Wollombi Brook for post mid 2011 where data has been recorded both upstream and downstream of the operations shows similar water quality at both sample locations, indicating no impact to EC in Wollombi Brook with the operations. The median EC value for Wollombi Brook upstream of the site recorded post mid 2011 is 657 µS/cm compared to a median EC value for Wollombi Brook downstream of the site for the same period of record of 683 µS/cm. TSS in Wollombi Brook is typically low, however, spikes are present in the data at both upstream and downstream monitoring locations which appear to occur during flood flows.

- Historically, higher readings of EC in Wollombi Brook were recorded downstream of the site prior to mid-2011 compared to post mid 2011 data (refer to Graph 1.16). There is no evidence that this is related to impacts from the operations and this is supported by the post mid 2011 data being similar in EC both upstream and downstream of the operations. The analysis (for the full suite of data) shows higher average/median EC readings in Wollombi Brook downstream of the site relative to upstream of the site as a result of the different periods of record and is not considered to indicate impacts associated with discharges from Wambo or United.

- The ephemeral creek systems typically have alkaline water (ranging higher than the default ANZECC guidelines for lowland rivers in NSW), similarly EC ranges significantly higher than default ANZECC guidelines for lowland rivers in NSW, due to the ephemeral nature of ponding/evapotranspiration effects. The higher EC values for downstream ephemeral creek systems are understood to be heavily influenced by water quality samples at SW05 (United) which are taken from behind a weir as well as their ephemeral nature. The poorer water quality of the ephemeral creek systems is also reflected in the monitoring results for TSS with high TSS readings which appear to reflect, at times, the higher TSS monitored in Wollombi Brook. However, the poorer water quality in the ephemeral creeks system is consistent with expectations based on their ephemeral nature.

The box and whisker plots included in **Appendix 1** present the routine water quality and additional water quality monitoring results. The charts graphically depict the range of data (maximum, minimum), as well as 80th percentile, 20th percentile, median and average results. A summary of the data counts for the plots is included in **Appendix 1**. It is acknowledged that there is limited data available to be statistically significant for some sections of this analysis, however, it is considered, along with the proposed extended monitoring program (refer to Question 6) that this data is sufficient for the assessment of the Project. As discussed above, the monitoring of water at the existing mining operations has focussed on the key parameters determined to be the key water quality risk indicators for the mining operation considering the nature of the operation and the geological context within which it sits, and there are significant data sets for these key parameters.

The statistical analysis, displayed in the box and whisker charts in **Appendix 1** show the following typical relative levels (i.e. based on comparison of median water quality values) presented in **Table 2.7** and **Table 2.8**. The analysis indicates that metals are present in the surface waters of the Hunter River with the typical analyte concentrations higher than the default ANZECC values (where published) for 95% ecosystem protection but lower than the default ANZECC guidelines for livestock and/or irrigation water. The highlighted analyses are those that indicate water qualities where the receiving waters are higher than one default trigger.

Table 2.7 Summary of Statistical Analysis – Metals and Nutrients

Analyte	Median Concentration (mg/L)			ANZECC Default Trigger			Relative to ANZECC Default Criteria	
	Hunter River Upstream	Hunter River Downstream	Wollombi Brook	95% Ecosystem Protection	Irrigation	Livestock	Hunter River	Wollombi Brook
Aluminium (Al)	1.08	0.69	0.045	0.055	5	5	Higher to Lower	Lower
Arsenic (As)	0.001	0.001	0.001	0.013	0.1	0.5	Lower	Lower
Barium (Ba)	0.04	0.03	0.06	-	-	-	-	-
Cadmium (Cd)	0.0001	0.0001	0.0006	0.002	0.01	0.01	Lower	Lower
Chromium (Cr)	0.002	0.002	0.001	-	0.1	1	-	-
Cobalt (Co)	0.001	0.001	0.001	-	0.05	1	-	-
Copper (Cu)	0.002	0.002	0.0005	0.0014	0.2	0.4	Higher to Lower	Lower
Iron (Fe)	1.010	0.700	0.64	-	0.2	-	-	-
Lead (Pb)	0.0070	0.0010	0.0010	0.0034	2	1	Lower	Lower
Manganese (Mn)	0.103	0.094	0.214	1.9	0.2	-	Lower	Lower
Mercury (Hg)	0.0001	0.0001	0.0001	0.0006	0.002	0.002	Lower	Lower
Selenium (Se)	0.010	0.010	0.010	0.011	0.02	0.02	Lower	Lower
Zinc (Zn)	0.005	0.007	0.005	0.008	2	20	Higher to Lower	Lower
TDS	392	378	369	-	-	-	-	-

Analyte	Median Concentration (mg/L)			ANZECC Default Trigger			Relative to ANZECC Default Criteria	
	Hunter River Upstream	Hunter River Downstream	Wollombi Brook	95% Ecosystem Protection	Irrigation	Livestock	Hunter River	Wollombi Brook
Nitrates	0.13	0.12	0.07	0.7	-	-	Lower	Lower
Total Phosphate (TP)	0.09	0.07	0.01	0.05	-	-	Higher	Lower

Note: "-"indicates that no ANZECC default trigger values are published for the analyte.

Table 2.8 Summary of Statistical Analysis – pH, EC and TSS

Analyte	Median Result				ANZECC Default[1]	Relative to ANZECC Default Criteria	
	Hunter River Upstream	Hunter River Downstream	Wollombi Brook Upstream	Wollombi Brook Downstream		Hunter River	Wollombi Brook
pH	8.15	8.17	7.60	7.52	6.5-8.0	Within	Within
EC (µS/cm)	758	809	657	747	125 - 2200	Within	Within
TSS (mg/L)	12.5	23.0	5.0	7.0	-	-	-

1. Lowland Rivers in NSW

Note: "-" indicates that no ANZECC default trigger values are published for the analyte.

The analysis shows:

- Receiving waters of the Hunter River are typically higher in Al, Cu, Zn and TP relative to the default ANZECC guidelines for 95% ecosystem protection in freshwaters but lower than the ANZECC guidelines for Irrigation water.

- Receiving waters of Wollombi Brook are typically within the default ANZECC guidelines for 95% ecosystem protection in freshwaters.

The baseline data shows a wide range of water quality in the receiving watercourses. The lowest water quality is present in the ephemeral creek systems adjacent to the Project Area and the Hunter River system. The analysis also shows that site specific triggers can be set for the receiving watercourses for pH, EC, TDS and TSS for Wollombi Brook, and pH, EC and TSS for the ephemeral watercourses. The analysis also indicates metals/metalloids and nutrients in the receiving watercourses range between meeting irrigation water ANZECC default triggers to, in some instances meeting the 95% ecosystem protection ANZECC default water triggers.

It is noted that fluctuations in water quality occur in each of these systems along with fluctuations in flows. This is particularly apparent in the ephemeral watercourses and also in Wollombi Brook which has periods of low surface flows. It is further noted that any active discharge of water from the mining operations in accordance with EPL conditions can only occur when sufficient flow occurs in Wollombi Brook (as defined by a flow limit in the Wambo EPL) and this provides increased resilience for the Wollombi Brook system to accommodate such discharges.

Baseline WMS Data and Comparison to Baseline Surface Waters

Data was presented on the water quality within the WMS as part of the Surface Water Assessment (refer to Appendix 11 of the EIS).

In response to the comments from the IESC, further analysis of water quality within the WMS has been undertaken, to consider spatial and temporal variation for the clean, dirty and mine waters, has been undertaken utilising the expanded data set (i.e. the additional monitoring of metals/metalloids). All of the data used in the analysis is presented in charts in **Appendix 1**. The outcomes of the analysis are discussed below.

The analysis in **Appendix 1** shows the following (refer to Table 2.4 for ANZECC default guidelines):

- Clean water systems, which include Dam 1 at United mine, show pH readings typically elevated above the default ANZECC trigger range for lowland rivers in NSW (refer to Graph 1.1), EC typically within default ANZECC triggers for lowland rivers in NSW (refer to Graph 1.2) and TSS ranging between low to high values (i.e. 5 mg/L to 100 mg/L) (refer to Graph 1.3), indicating that the baseline conditions are typically above the default ANZECC default triggers for lowland rivers in NSW.

- Sediment dam water within the dirty water system ranges from neutral to alkaline with pH readings up to 10.4 recorded. EC in the sediment dams has historically been within the range of the default ANZECC guidelines for lowland rivers in NSW. TSS in the sediment dams shows similar spikes to that recorded in the surrounding surface waters and appears to reflect the influence of rainfall/storm events on water quality.

- Mine water is typically neutral to alkaline with pH, EC and TSS typically being above the ANZECC default triggers for lowland rivers in NSW. EC in the mine water system ranges typically up to 10,000 µS/cm and shows a decreasing overall trend in EC in recent years. High EC is to be expected in mine water systems due to the influence of coal seam groundwater within the system. This water is managed in the separate mine water system.

The box and whisker plots included in **Appendix 1** present the routine water quality monitoring results collected by United and Wambo and the additional water quality monitoring results collected in response to the IESC submission. The charts graphically depict the range of data (maximum, minimum), as well as 80th percentile, 20th percentile, median and average results. A summary of the data counts for the plots is included in **Appendix 1**.

The statistical analysis, displayed in the box and whisker charts in **Appendix 1** show the following typical relative levels (i.e. based on comparison of median water quality values) presented in **Table 2.9** and **Table 2.10** below. The analysis indicates that there are metals in the WMS that have typical analyte concentrations higher than the default ANZECC values for 95% ecosystem protection (where published) but within the default ANZECC values for irrigation water. It should be noted, however, that as outlined in the EIS the water management system has been designed to capture and reuse mine water with the only offsite discharge being via the approved Wambo discharge point in accordance with the Wambo EPL and HRSTS.

Table 2.9 Summary of Statistical Analysis – Metals and Nutrients

Analyte	Median Concentration (mg/L)	ANZECC Trigger			Relative to ANZECC Criteria
	Mine Water	95% Ecosystem Protection	Irrigation	Livestock	Mine Water
Aluminium (Al)	0.99	0.055	5	5	Higher to Lower
Arsenic (As)	0.01	0.013	0.1	0.5	Higher to Lower
Barium (Ba)	0.09	-	-	-	-
Cadmium (Cd)	0.0001	0.002	0.01	0.01	Lower
Chromium (Cr)	0.002	-	0.1	1	Lower
Cobalt (Co)	0.004	-	0.05	1	Lower
Copper (Cu)	0.007	0.0014	0.2	0.4	Higher to Lower
Iron (Fe)	0.58	-	0.2	-	Higher
Lead (Pb)	0.0010	0.0034	2	1	Higher to Lower
Manganese (Mn)	0.019	1.9	0.2	-	Lower
Mercury (Hg)	0.0001	0.0006	0.002	0.002	Lower
Selenium (Se)	0.010	0.011	0.02	0.02	Higher to Lower
Zinc (Zn)	0.010	0.008	2	20	Higher to Lower
TDS	3865	-	-	-	-

Analyte	Median Concentration (mg/L)	ANZECC Trigger			Relative to ANZECC Criteria
	Mine Water	95% Ecosystem Protection	Irrigation	Livestock	Mine Water
Nitrates	2.08	0.7	-	-	Higher
Total Phosphate (TP)	0.07	0.05	-	-	Higher

1. 95% species protection

Note: "-" indicates that no ANZECC default trigger values are published for the analyte.

Table 2.10 Summary of Statistical Analysis – pH, EC and TSS

Analyte	Median Result				Median Result		ANZECC Default[1]	Relative to ANZECC Default Criteria[1]		WMS compared to Receiving Waters	
	Hunter River Upstream	Hunter River Downstream	Wollombi Brook Upstream	Wollombi Brook Downstream	Mine Water	Sediment Dams		Mine Water	Sediment Dams	Hunter River	Wollombi Brook
pH	8.15	8.17	7.60	7.52	8.94	8.21	6.5-8.0	Higher	Higher	Higher	Higher
EC (µS/cm)	758	809	657	747	3520	1100	125 - 2200	Higher	Within	Higher	Higher
TSS (mg/L)	12.5	23.0	5.0	7.0	45.0	10.0	-	-	-	Higher	Higher

1. Lowland Rivers in NSW

Note: "-" indicates that no ANZECC default trigger values are published for the analyte.

The analysis shows that mine water quality typically exceeds the default ANZECC guidelines for 95% freshwater ecosystem protection for the same analytes as the Hunter River (Al, Cu, Zn and TP) as well as for As, Cd, Fe, Pb, Se, pH, EC and Nitrate. However, only Fe is higher than the ANZECC irrigation guidelines.

It should be noted that one elevated reading for TP for the Homestead Open Cut Pit influences the analysis for TP for mine water. Similarly, water quality samples for the C11 weir are elevated in nitrates and influence the analysis for nitrates for mine water.

The above results for mine water quality are as expected given that the mine water is not representative of the natural surface water quality within the surrounding environment. Mine water has a strong influence from groundwater from the coal seam aquifers intercepted during mining with this water being of poorer quality than that of surface waters. It is for this reason that the WMS for the Project separately manages this water and contains it on the site for reuse. The WMS has been designed to avoid overflows of mine water and the only potential release path for mine water is via the Wambo licenced discharge point to Wollombi Brook. As discussed in the EIS, there are existing NSW government imposed water quality discharge limits on this existing Wambo licenced discharge point and no changes are proposed to these quality limits for the Project. Water must meet these quality limits prior to being discharged, with these limits determined by the NSW Government to acceptably manage downstream water quality impacts.

Comparison of Water Quality - WMS to Surface Waters

A comparison of the water quality in the WMS to the surface waters shows the mine water quality typically has higher concentrations of the following analytes compared to the surface waters: Al, As, Ba, Cd, Cr, Co, Cu, Fe, Pb, Mn, Se, Zn, TDS, Nitrates and TP. As discussed above, given the source of the mine water and the strong coal seam aquifer influence this is as expected, with the WMS designed to separately capture and manage this water.

The likely risk of water quality impacts associated with the Project are further discussed in response to Question 4 with the discussion of strategies to avoid and mitigate impacts, and Question 5 in the assessment of potential discharges.

Based on the additional water quality and geochemistry data sourced since the submission of the EIS and the analysis presented in further detail above and in **Appendix 1**, it is considered, that the additional data presented above does not change the overall assessment outcomes provided in the EIS as it did not result in any changes to the outcomes of the previous assessment and did not identify any new issues that had not been considered in the EIS assessment. However, to provide additional surety, based on the outcomes of the geochemistry report and IESC review comments, additional commitments for the Project in regards to water quality monitoring are included in the response to Question 4. Further details on how the proposed design of the WMS avoids / mitigates impacts to downstream water quality are included in the response to Questions 4 and 5 of the IESC review.

Groundwater

As outlined within the GIA, the main water bearing units at and surrounding the Project Area are the Permian Wittingham Coal Measures and the alluvium. As categorised by the AIP, the alluvium can be divided into less productive and highly productive alluvium. The highly productive alluvium is localised along Wollombi Brook and the Hunter River. The GIA and Part A of the RTS compared available site and surrounding groundwater quality data to ANZECC (2000) guidelines for irrigation, stock water, irrigation and fresh water aquatic ecosystems (slightly-moderately disturbed systems), as well as the Australian Drinking Water Guidelines (NHMRC 2011). Based on the available data collated at site since 2004 and from neighbouring mine operations since 2000, it was found the highly productive alluvium is generally suitable for drinking water and stock water supply, the less productive alluvium can be suitable for water supply for some stock (i.e. sheep) and the Permian groundwater has no beneficial use.

Focusing on site specific data, the conditions of consent for the currently approved Wambo and United mines require they routinely collect data from the groundwater systems. As part of these monitoring programs a combined total of 28 bores are routinely monitored for water quality. The groundwater monitoring network at United and Wambo is presented in Figure A-1 of the GIA. Water quality analysis includes testing physical parameters (EC, pH, TDS and temperature) on a bi-monthly basis. Annual testing of a more comprehensive suite of analytes, including physical parameters, major ions (Na, Cl, K, Na, Mg and $S0_4$), alkalinity, hardness, nutrients and metals (Al, As, Ba, Cu, Fe, Mn, Ni, Pb, Se and Zn) is conducted for a selection of bores. AGE considers that the current monitoring programs provide adequate water level and quality data for analysis in relation to the Project. To provide greater clarification in response to the IESC submission, further discussion on the spatial and temporal distribution of site data is presented below. This includes additional water quality data collected as part of routine site monitoring since completion of the GIA in July 2016.

Spatial Distribution

Spatial distribution of groundwater quality data collected in 2015 is presented in **Appendix 2** for EC (Figure 1), pH (Figure 2) and total aluminium (Figure 3). As outlined above, several metals are monitored at the site, however, total aluminium was chosen as it is readily solubilised from clay minerals under acidic conditions, and therefore a good indicator of potential contamination. The salinity ranges presented in Figure 1 of **Appendix 2** are based on the Food and Agricultural Organisation (2013) classification outlined within the GIA. Figure 1 of **Appendix 2** shows that alluvial groundwater along creeks and tributaries is generally fresh to slightly brackish, but becomes moderately saline to highly saline further from creeks and tributaries and within the weathered overburden.

The pH distribution presented in Figure 2 of **Appendix 2** indicates that pH is relatively neutral across the region, ranging between 6 and 8 in most areas. More alkaline conditions are visible within the less productive alluvium (GW09 and P29) and within the Permian overburden (GW22).

The distribution of total aluminium presented in Figure 3 of **Appendix 2**, is highly variable largely due to natural and external (i.e. upstream) influences. However, as discussed in further detail below, the trends at bores P114 and P116 may relate to localised site influences (i.e. surface water depressions).

Temporal variation and trends – pH and EC

As outlined earlier, pH and EC has been tested at the site monitoring bores on a bi-monthly basis since 2004. This provides an extensive dataset to assess temporal variations and trends in EC and pH in the Project Area. Figure 4 to Figure 20 of **Appendix 2** show trends in pH, EC and total aluminium in site bores over time. This includes additional water quality data collected since completion of the GIA in July 2016. The figures for EC and pH show recorded groundwater levels, allowing trends in quality to be compared with groundwater levels, as well as the 2015 site trigger levels as outlined in the existing Wambo WMP (Wambo 2015). There are no trigger levels for total aluminium within the existing approved site monitoring programs. The site uses a control chart approach, which specifies bounds, which if exceeded, triggers an investigation. The existing Wambo WMP specified that two consecutive samples falling outside the trigger bounds for pH, and three for EC triggers an investigation. The most recent 2015 annual groundwater review (Hydrosimulations 2015), reported no bores exceeded the pH or EC trigger levels. The figures show that whilst there are fluctuations in pH at each bore, the groundwater is generally neutral, ranging from pH 6 and pH 8. The results for EC are more variable. This is because the rate at which salts accumulate in groundwater depends on a large range of factors, including recharge/discharge processes and the physical/chemical properties of the host rock.

Trends in EC, pH and total aluminium are discussed further below for bores intersecting the Permian coal measures, highly productive alluvium and less productive alluvium.

Permian coal measures

Trigger levels are prescribed within the Wambo Groundwater Monitoring Program for two of the bores within the Permian coal measures, P202 and P206, and water quality data is available for overburden bore GW22. Trends in pH and EC for the three bores are shown in Figure 4 to Figure 6 of **Appendix 2**. Bore P202 intersects shallow Permian overburden underlying alluvium, and is located approximately 60 metres west of Wollombi Brook. As shown in Figure 4 of **Appendix 2**, P202 has recorded stable to slightly rising groundwater levels since 2004 that correlate to stream levels recorded at the downstream gauging station (station 210004 Wollombi Brook @ Warkworth) and peak rainfall events. This indicates a degree of hydraulic connection between the shallow overburden and Wollombi Brook and the influence of rainfall recharge. Bore P206 is located approximately 150 metres west of Wollombi Brook and outside the mapped extent of alluvium. Groundwater level trends at P206 differ greatly from P202, indicating that the influence of stream recharge processes are localised. It is noted that the closest mining to Wollombi Brook as part of the Project is approximately 370 metres and therefore outside of any influence of any stream recharge in the weathered zone. P206 recorded a gradual decline in EC since 2004 that potentially relates to increased recharge from overlying strata and depressurisation of the coal measures due to mining, which reduces upward seepage of more saline groundwater from the coal measures. The results for P206 also show two rapid declines in EC (June 2007 and February 2015) that correspond with rapid rises in groundwater level (Figure 5 of **Appendix 2**). In both cases, the rise in groundwater level appears to correlate with peak rainfall and stream flow events as recorded at stream gauge station 210004 (Wollombi Brook @ Warkworth) and BoM rain gauge station 61191. Bore GW22 is located approximately 1.2 km south of South Wambo Creek and over 1.3 km west of Wollombi Brook. GW22 records fluctuating to slightly rising EC, which ranges between 6,110 µS/cm and 7,010 µS/cm, and alkaline pH ranging between 7.9 and 8.5 (Figure 6 of **Appendix 2**). Bore GW22 also recorded total aluminium concentrations of around 4 mg/L between 2011 and 2013, which reduced to below 1.5 mg/L since October 2013. Results for bores P202 and P206 show that total aluminium concentrations have remained below 2 mg/L, with current levels below 0.2 mg/L.

Highly productive alluvium

The Project will not intercept any areas of highly productive alluvium with a significant buffer distance from alluvial zones incorporated into the design of the mine. Regardless, further analysis of the groundwater quality is provided below in response to the IESC submission.

Trigger levels have been prescribed for one of the bores within the highly productive alluvium, GW15 (Figure 7 of **Appendix 2**). Trends in EC and pH for two other bores within the highly productive alluvium, P12 and P13, are also presented in Figure 8 and Figure 9 of **Appendix 2**. The graphs include stream levels recorded at gauge station 210004, Wollombi Brook @ Warkworth. As shown in Figure 7 to Figure 9 of **Appendix 2**, groundwater levels, EC and pH within the highly productive alluvium are responsive to changes in stream levels. This indicates hydraulic connection between the highly productive alluvium and stream which is as expected. For the three bores, pH fluctuates between 5.42 and 9.69 and the EC fluctuates between 312 µS/cm and 1,980 µS/cm; however, the water at bore GW15 is fresher with a maximum EC of 879 µS/cm. Figure 7 of **Appendix 2** also shows the total aluminium concentration measured for highly productive alluvium bore, GW15. Total aluminium concentrations for GW15 were around 2 mg/L between 2011 and 2013, with concentrations below 0.2 mg/L since October 2013. Concentrations of total aluminium at GW15 appear similar to those recorded within the Wollombi Brook, but without the peak spikes observed for the surface water. Unlike EC and pH, the total metals concentrations do not appear to fluctuate with stream levels.

Less productive alluvium/regolith

The Project will not intercept any areas of less productive alluvium with a significant buffer distance from alluvial zones incorporated into the design of the mine. Regardless, further analysis of the groundwater quality in the alluvium is provided below in response to the IESC submission.

Areas of shallow overburden or regolith within the mining footprint will be intercepted by the Project and the small amount of groundwater stored within these strata will be removed. Further discussion of the water in the regolith is also provided below.

Trigger levels have been prescribed for nine bores intersecting colluvium, less productive alluvium and shallow overburden material, as shown in Figure 10 to Figure 18 of **Appendix 2**. Salinity levels within colluvial bores P16 and P20 have remained relatively consistent since 2004, excluding initial readings that may relate to bore installation. The EC for P16 and P20 generally ranges between 6,500 µS/cm and 12,400 µS/cm. The graphs for P16 and P20 also include stream levels recorded at gauge station 210004, Wollombi Brook @ Warkworth. The peaks in stream levels correlate to rising groundwater levels, indicating potential hydraulic connection.

Bore GW13 intersects the less productive alluvium upstream and east of Wollombi Brook. As shown in Figure 12 of **Appendix 2**, GW13 recorded a general decline in EC since 2011, with readings between 518 µS/cm and 4,820 µS/cm. The salinity trend at GW13 may reflect a decrease in upward seepage from the underlying Permian coal measures due to depressurisation from surrounding mine operations (i.e. Mount Thorley Warkworth mine). Total aluminium concentrations at GW13 have remained relatively stable since 2011, under 0.4 mg/L.

Bores P114 and P116 intersect regolith and are located approximately 100 metres and 220 metres south-east, respectively, of South Dam. South Dam has been used to store water pumped from the open cut and underground operations across Wambo. As shown in Figure 13 of **Appendix 2**, bore P114 has recorded an increase in EC since 2011. Bore P114 also recorded total aluminium concentrations of around 4 mg/L between 2011 and 2013, which reduced to below 1.5 mg/L since October 2013. GHD (2012) and Hydrosimulations (2015) both investigated the potential for South Dam to be interconnected to the shallow water table, and concluded groundwater at P114 is not influenced by water in South Dam. The trend was considered to be related to a change in upward seepage due to the base of the bore intersecting unweathered Permian coal measures. In contrast to P114, bore P116 (Figure 14 of **Appendix** 2) recorded a rapid decline in EC following the peak rainfall and flood event in June 2007. A similar response was observed at bore P206; however the groundwater levels at P116 remained elevated, whilst the levels at P206 later declined. Bore P116 also recorded higher concentrations of total aluminium between 2011 and 2013 (22.4 mg/L), which reduced in 2013 and have since remained at concentrations of below 4 mg/L. Hydrosimulations (2015) concluded the elevated water levels were due to the presence of another recharge source, identified as a depression adjacent to P116 that collects rainfall and surface water flow, likely enhancing recharge locally.

Figure 15 to Figure 20 of **Appendix 2** presents EC, pH and total aluminium trends for bores installed within the less productive alluvium and regolith along the minor tributaries, Stony Creek (P315), South Wambo Creek (GW02 and GW11) Wambo Creek (P106) and North Wambo Creek (GW16 and GW17). The less productive alluvium bores generally record a relatively neutral to slightly alkaline pH of between 6.3 and 8.6. Data for a bore located along Stony Creek upstream of the mine (P315), includes a pH reading of 3.7 in 2012. This reading appears to be anomalous, as no other pH readings have been recorded below 5.9 for P315. Salinity within the less productive alluvium is largely fresh to brackish, with EC between 290 µS/cm and 5,300 µS/cm. Figure 15 to Figure 20 of **Appendix 2** show that salinity and groundwater levels fluctuate regularly within the bores, reflecting the ephemeral nature of flow within the minor tributaries and

variability in recharge. Therefore, the saturated thickness and yield from the alluvium along minor tributaries is variable both spatially and temporally.

Bores near South Wambo Creek (GW02 and GW11) and Stony Creek (P315) have maintained total aluminium concentrations of below 2.5 mg/L since 2013. Wambo Creek bore P106 recorded higher total aluminium concentrations between 2011 and 2013 (7.4 mg/L), which reduced in 2013 and have since remained at concentrations of below 1.5 mg/L. North Wambo Creek bores GW16 and GW17 recorded total aluminium concentrations of around 16 mg/L from December 2011, which is well above concentrations recorded at site bores intersecting the Permian coal measures (i.e. GW22, P202 and P206). Currently the total aluminium concentration at bore GW17 is under 2.5 mg/L. In contrast, bore GW16 recorded a spike in total aluminium concentration of 21.8 mg/L in October 2016. Both bores are located up-groundwater gradient of the mine, with the higher total aluminium concentration recorded at the bore furthest from the mine (GW16). The spike in concentration at GW16 coincides with above average rainfall experienced over January 2016 (over 200 mm), which may have flushed weathered strata and caused solubilisation of metals from clays. Therefore, the results for GW16 and GW17 are believed to reflect natural processes, unrelated to mining.

Overall, the temporal site data shows a degree of variability in response to groundwater recharge and discharge processes, with some trends caused by localised features and bore construction (i.e. P114). However, in general the quality of water within the Permian coal measures, highly productive alluvium and less productive alluvium/regolith have remained consistent with historic trends. These results align with findings discussed within Section 5.4.2 of the GIA.

b. Including additional water quality analytes in the sampling program (e.g. metals, nutrients and organics).

Summary Response

Surface water and groundwater monitoring programs are currently being implemented at United and Wambo with the content of these monitoring programs approved by the NSW Government.

The surface water quality monitoring programs have developed over the period of historical mining to provide indicators of any increased risk or environmental harm. As such, these monitoring programs focus on the key risks associated with the water management system to downstream received waters being spills from sediment dams in the dirty water system to the downstream environment. These parameters, being pH, EC, TDS and TSS, have been determined to be the key water quality risk indicators for the mining operation considering the nature of the operation and the geological context within which it sits, and there are significant data sets for these key parameters. Monitoring of licensed discharges is also undertaken to confirm that discharge criteria are met (volume and quality).

Both United and Wambo mines have extensive existing WMSs in place which include mine dewatering systems, water storages, sedimentation and retention basins, and water diversions and catch drains. Both WMSs have similar key objectives. The key objectives are to:

- prevent the contamination of clean water by mining activities
- segregate clean waters away from active mining areas to reduce the volume of mine affected water requiring subsequent storage and treatment
- minimise the discharge of pollutants from mining affected areas into the environment
- quantify the water used, stored and imported/exported
- maximise recycling and water sharing opportunities.

Additional water quality analytes (including metals and nutrients) have been monitored since the EIS was exhibited in response to comments received by the IESC.

Current monitoring of organics includes oil and grease and phenols within the clean and mine water systems at United and Wambo mines, including oil and grease monitoring of all discharges from the Wambo licenced discharge point. No additional monitoring of organics was undertaken as part of the extended monitoring suite as the historical monitoring data for phenols and oil and grease indicates negligible concentrations (typically below the limits of detection) indicating that there is not contaminated water within the water management system or receiving watercourses. The Project will not change the nature of operations as they relate to organics and therefore the proposed mining operations are not considered to pose a risk of contamination from organics.

Further details have been provided in the detailed response below.

Detailed Response

Additional water quality analytes (including metals and nutrients) have been monitored since the EIS was exhibited in response to comments received by the IESC. The additional data is presented in Appendix 1 and discussed in response to Question 1. Current monitoring of organics includes oil and grease and phenols within the clean and mine water systems at United and Wambo mines, including oil and grease monitoring of all discharges from the Wambo licensed discharge point. No additional monitoring of organics was undertaken as part of the extended monitoring suite as the historical monitoring data for

phenols and oil and grease indicates negligible concentrations (typically below the limits of detection) indicating that there is not contaminated water within the water management system or receiving watercourses. The Project will not change the nature of operations as they relate to organics and therefore the proposed mining operations are not considered to pose a risk of contamination from organics. The surface water monitoring program is discussed in response to Question 3 (item 14).

Groundwater

The management of water quality risks as part of the mine closure process for currently approved operations are outlined within the existing water management plan (WMP) for both sites. These proposed actions to address all potentially contaminating sources associated with the Project will be outlined within the WMP. The WMP will be developed in consultation with DPE and DPI Water, and will include a preliminary site investigation to ensure all appropriate analyses are considered and adopted. Potentially contaminating sources associated with the Project include the proposed in-pit TSF (South Bates TSF), upgrades to the Wambo Mining Infrastructure Area (MIA), temporary construction facilities, changes to the mine water management system and increased usage of the Wambo CHPP and infrastructure.

As outlined within the EIS, there are no contaminated sites currently recorded within the Project Area. However, as with all activities that involve earthworks and mining, activities carried out at United and Wambo have the potential to cause contamination if not properly managed. Both mines have a range of controls in place to manage this risk including appropriate chemical handling and storage procedures, appropriate waste management systems, spill and emergency response procedures and equipment, and regular inspection and reporting processes. The proposed groundwater monitoring program also includes analysis of pH, EC, sulphate, total and dissolved metals (i.e. Al, As, Co, Cu, Fe, Mn, Ni, Se and Zn) on a quarterly basis at proposed new sites and bores around the proposed South Bates TSF for a period of two years, in order to collect baseline data. The proposed monitoring program outlined in Part A will also be updated for the WMP to include analysis of nutrients and organics in source areas, such as septic tanks and treated water storage areas. This will include testing of nitrate for bores P11 to P13, P15 to P18, P20, P30, P31 and P35 as per the current monitoring program for United.

Discussion of additional water quality results is provided in subsequent responses. The proposed groundwater monitoring program includes analysis of total and dissolved metals on a quarterly basis at several sites for a period of two years, in order to collect baseline data. The water management plan will be developed in consultation with DPE and DPI Water, and this process will ensure all appropriate analyses are considered and adopted. This includes for example analysis of nutrients and organics within the groundwater where site infrastructure, such as workshops and fuel storage, is proposed as part of the Project.

c. Groundwater levels of the regolith groundwater system overlaid with the location of groundwater dependent terrestrial vegetation, especially critically endangered ecological communities (CEECs).

Summary Response

As discussed in the EIS, potential groundwater dependent ecosystems (GDEs) have been identified in proximity to the Project Area, primarily associated with riparian vegetation along the main watercourses. The process for identifying these potential GDEs covered the full extent of the potential affection area for groundwater and it is considered that all relevant GDEs that have the potential to be impacted by the Project and that therefore require assessment have been identified and considered. The EIS undertook an assessment of potential impacts on GDEs considering direct mining impacts, surface water impacts and groundwater impacts. The groundwater impact assessment determined the potential drawdown impacts associated with the Project and other mining operations at GDEs.

It is noted that there are no GDEs potentially impacted by the Project that are critically endangered ecological communities (CEECs).

In regard to impacts on GDEs, there are no changes to the impacts assessed in the EIS. Potential groundwater drawdown impacts on GDEs are predicted to be relatively limited in area and impact upon only a small portion of Hunter Valley River Oak Forest and possibly a small number of River Red Gum trees. Hunter Valley River Oak Forest is not listed under the EPBC Act or the *Threatened Species Conservation Act 1995* (TSC Act). However, River Red Gums are listed under the TSC Act as an endangered population in the Hunter Catchment. As outlined in the EIS, the anticipated potential impact on these trees would not be significant in terms of the impact on the endangered population.

Detailed Response

As discussed in further detail below, there are no groundwater dependent ecosystems that are CEECs that are subject to impact by the Project.

The following vegetation types occurring outside the additional disturbance area but in proximity to the Project (refer to Figure 21 of **Appendix 2**) have the potential to be at least partially groundwater-dependent:

- Central Hunter Swamp Oak Forest
- Hunter Floodplain Red Gum Woodland Complex
- Hunter Valley River Oak Forest
- River Flat Eucalypt Forest
- Stands of individual river red gum trees (*Eucalyptus camaldulensis*)
- Warkworth Sands Woodland.

Potential drawdown is predicted to be relatively limited in area and impacts upon only a small portion of possible Hunter Valley River Oak Forest and possibly a small number of River Red Gum trees (refer to Figures 22 and 23 of **Appendix 2**). Hunter Valley River Oak Forest is not listed under the EPBC Act or the TSC Act. However, River Red Gums are listed under the TSC Act as an endangered population in the Hunter Catchment. The anticipated potential impact on these trees would not be significant in terms of the impact on the endangered population. The Project is not predicted to impact on any known GDEs that are CEECs.

Temporal groundwater level data for bores presented in Figure 10 to Figure 20 of **Appendix 2** shows that the shallow regolith and less productive alluvium is variably saturated. Groundwater levels vary at each monitoring bore site over time based on variable recharge/discharge processes and the physical hydraulic

properties of the stratigraphy. Available groundwater levels for the alluvium and shallow overburden in 2015 are presented within Figure 21 of **Appendix 2**. As shown in Figure 21 of **Appendix 2**, most shallow monitoring points are restricted to areas adjacent to waterways or close to alluvium. There is a wider spread of monitoring points around the site within deeper strata. Exploration logs and anecdotal information from site indicates that the shallow overburden was largely unsaturated in these areas. This is particularly evident around the open cut mine area where during a site visit by AGE in December 2016 the shallow strata were observed to be largely unsaturated.

Figure 22 of **Appendix 2** shows the drawdown attributable to the Project only within the saturated alluvium and shallow overburden, which are represented by layers 1 and 2 within the groundwater model. The drawdown shown in Figure 23 of **Appendix 2** is based on interpolated groundwater level measurements from 2015. This figure presents drawdown in saturated stratigraphy only, and does not represent future cumulative impacts from surrounding operations. It shows drawdown is predicted to occur within the surficial strata north of North Wambo Open Cut, near the North Wambo Creek Diversion, along Redbank Creek and between United Open Cut and Wollombi Brook. However, as presented in Figure 23 of **Appendix 2** this predicted drawdown is already predicted to occur as a consequence of previous and existing approved operations at Wambo, United and other nearby operations. As shown in Figure 23 of **Appendix 2**, the Central Hunter Swamp Oak Forest is not impacted by the Project alone where it occurs along Wollombi Brook. The only areas of Central Hunter Swamp Oak Forest potentially impacted by the Project alone are where it occurs immediately north and south the proposed United open cut (refer to Figure 23 of **Appendix 2**).

2. The numerical modelling and analysis presented in the assessment documentation do not provide reasonable estimates of the likely impacts of the proposed project on water resources. Further consideration of the following is needed to better understand the nature and magnitude of impacts to water resources and GDEs:

a. Surface water assessment and flood modelling, particularly details of model construction, parameterisation, calibration, validation, and sensitivity and uncertainty analysis.

Summary Response

For the assessment of potential surface water impacts a range of assessment methods were used. The methods included quantitative and qualitative methods to assess the potential impact, as outlined in the Surface Water Assessment. In response to the IESC comments additional detail on the surface water assessment approach taken including details of model construction, parameterisation, calibration, validation, and sensitivity and uncertainty analysis are provided below. It is noted that while additional data on the assessment and modelling approaches have been provided to address the questions raised, none of the assessment outcomes as outlined in the EIS have changed and no assessment deficiencies requiring further assessment work were identified.

The Surface Water Assessment considered the potential of the Project to impact on:

- catchment areas and flow volumes in downstream watercourses
- flooding, including flow rates, velocities and depths
- water quality in downstream watercourses
- geomorphological and hydrological values of watercourses, including environmental flows
- riparian and ecological values of watercourses
- water users, both in the vicinity and downstream of the Project.

Specifically in regard to flooding, potential impacts on flood behaviour were assessed for Wollombi Brook and Waterfall Creek. A Flood Assessment Report is included as an appendix to the Surface Water Assessment. The flooding assessment undertaken for the EIS has been accepted by the NSW Office of Environment and Heritage (OEH) and was identified as being conservative. In summary, the OEH submission in regard to flooding and floodplain management confirms the following:

- The flood assessment includes all the items required by the SEARs.
- The outputs of the Umwelt Flood Assessment are considered to be conservative and may be used for the assessment of the Project.
- The Umwelt Flood Assessment demonstrates that there will be negligible minimal impact on privately owned land and has proposed a levee to protect the mine pit from Wollombi Brook flooding up to the 0.1% Annual Exceedance Probability (AEP) event.

Additional data on the flooding assessment methodology has been provided as part of the detailed response.

Detailed Response

For the assessment of potential surface water impacts a range of assessment methods were used. The methods included quantitative and qualitative methods to assess the potential impact, as outlined in the Surface Water Assessment (Umwelt, 2016b). The methods used for each component of the assessment and associated description, including parameters (where relevant) are described in **Table 2.11**.

Table 2.11 Summary of Assessment Methodologies

Assessment Aspect	Relevant Section of Surface Water Assessment	Assessment Type	Description
Catchment areas and annual flow volumes – flow duration impacts (Wollombi Brook and Hunter River)	6.1.1	Quantitative	Flow gauging data was used from the Wollombi Brook @ Warkworth DPI Water gauge to assess potential impacts on flow duration, and as such flows in the Wollombi Brook. Although the gauge is located upstream of the total contributing catchment, changes associated with the full Project catchment and baseflow impacts were applied to the analysis. As such the most significant impacts to streamflow are included in the analysis through this conservative (i.e. worst case) approach which overestimates the predicted impacts. Flow gauging data was used from the Hunter River @ Singleton DPI Water gauge to assess potential impacts on flow duration, and as such flows in the Hunter River. In order to provide the basis for a suitable assessment, flow gauging data from a gauge with a long term record in the vicinity of the Project Area was required. For both watercourses, Wollombi Brook and the Hunter River, a flow duration curve was created using the records available from NSW DPI water. The gauge data was subsequently adjusted for the approved final landform and Project final landform impacts on catchment area and baseflows at each gauge. The changes to catchment area were applied as a pro rata to the existing flow gauge data. The baseflow impacts were sourced from the AGE Groundwater Assessment (refer to Appendix 12 of the EIS). The above described approach was also used to assess flow duration impacts for the gauged catchment areas downstream of the Mount Owen Continued Operations Project (MOCO) in July 2016 and was accepted by DoEE as appropriate.

Assessment Aspect	Relevant Section of Surface Water Assessment	Assessment Type	Description
Catchment areas and annual flow volumes – catchment changes on ephemeral creeks	6.1.4	Quantitative	The method used in the Surface Water Assessment to determine potential impacts on annual flow volumes in ephemeral creek systems included a comparison of the catchment areas for Year 16 (worst case disturbance) and the final landform of the Project within the currently approved catchment areas for each of the downstream catchment and sub catchment areas, that is, Wambo Creek, North Wambo Creek, Redbank Creek and Waterfall Creek. This approach relies on the assumption that the change in catchment area will be an indicator of the change in annual flow volumes for each catchment. This is considered to be a reasonable assumption given that these creek systems are ephemeral and directly reliant on rainfall in the catchment for flows. This approach is considered the best available due to the limited flow volume data available for the sub catchments and is consistent with the approach used by the NSW Government which applies an average annual runoff rate to consider water use by landholders. The above described approach was also used to assess flow duration impacts for ephemeral creeks downstream of the Mount Owen Continued Operations Project (MOCO) in July 2016 and was accepted by DoEE as appropriate.
Flooding – Wollombi Brook	6.2.1	Quantitative	Hydrological and Hydraulic (2D) models – refer below for more detail.
Flooding – Waterfall Creek	6.2.2	Quantitative	1D Hydrodynamic model – refer below for more details.

Assessment Aspect	Relevant Section of Surface Water Assessment	Assessment Type	Description
Water Quality	6.3	Quantitative/ Qualitative	A combination of review of historical water quality data as well as consideration of the likely risks to downstream water quality based on historical performance, design criteria for the Water Management System (in accordance with NSW Government Guidelines), spill pathways and the likely risk of spills was used to assess potential impacts on water quality. Further assessment information, as requested by the IESC, including geochemical analysis is included in this section.
Geomorphological and Hydrological Values	6.4	Qualitative	Using the quantitative assessment of changes to flood flows and annual flow volumes a qualitative assessment of impacts on "values" as requested by the NSW Government in the SEARs was undertaken. The qualitative assessment considered both the changes to catchment areas and the existing condition/ flow regimes within the watercourses.
Riparian and Ecological Values	6.5	Quantitative/ Qualitative	Quantitative sampling of ecological values in accordance with relevant NSW government guidelines. Using the quantitative assessment of changes to flood flows and annual flow volumes, as well as ecological mapping, a qualitative assessment of impacts on "values" as requested by the NSW Government in the SEARs was undertaken.

Assessment Aspect	Relevant Section of Surface Water Assessment	Assessment Type	Description
Water Users	6.6	Qualitative	Using the quantitative assessment of changes to annual flow volumes and known water users in the local tributaries a qualitative assessment of impacts on downstream water users was undertaken. As part of the NSW *Water Management Act 2000*, Water Sharing Plans (WSPs) have been developed across NSW to protect the health of rivers, whilst at the same time securing sustainable access to water for all users. The WSP's specify maximum water extractions and allocations. By complying with the requirements of the WSP's, water take will be within the sustainable yield for the water system as determined by the NSW government. This in turn provides for sustainable environmental flows within the water systems. All water extraction in NSW, apart from some exemptions for government authorities and basic landholder rights extractions, must be authorised by a water licence. Harvestable rights which are a Basic Landholder Right under the Water Management Act 2000 allow a landholder to capture and use up to 10 per cent of the average regional runoff from a specific area of land. All water use/take for the Project will be accounted for either by harvestable rights provisions or licences issued by the NSW Government. Standard project approval conditions for NSW development consents for coal mines include requirements to meet state licensing policies. Compliance with licence limits set by the NSW Government for the Project will ensure that the Project complies with the relevant Water Sharing Plans and that sufficient water will be available for other water users and the environment.

Assessment Aspect	Relevant Section of Surface Water Assessment	Assessment Type	Description
Cumulative Impacts	6.7	Quantitative/ Qualitative	The assessment of cumulative impacts considered both the direct impacts assessed for the Project and also the legislative requirements put in place by the NSW Government, in particular the requirements of the NSW *Water Management Act 2000* and the NSW *Protection of the Environment Operations Act 1997*. Activities that do or may lead to pollution of waters in NSW are regulated by the EPA under the *Protection of the Environment Operations Act 1997* (POEO Act). Under Section 120 of the POEO Act, it is an offence to pollute waters unless licensed to do so. Discharges from mine water management systems require licensing by an Environment Protection Licence (EPL) and are strictly controlled by licence conditions such that discharges do not result in significant impacts on water resources. In addition to an EPL, mines discharging water into the Hunter River system also need to operate in accordance with the Hunter River Salinity Trading Scheme (HRSTS). The HRSTS is a cap-and-trade system designed to facilitate saline discharges into the Hunter River by coal mining operations. The HRSTS considers salt inputs to the system by coal mines, industrial and agricultural operations, with an aim to maintain sustainable water quality by setting a cap on saline discharges that can be undertaken by mining operations. The HRSTS is administered under the Protection of the Environment Operations (Hunter River Salinity Trading Scheme) Regulation 2002 and all discharges must be undertaken in accordance with EPLs issued by NSW EPA.

Wollombi Brook Flooding Assessment

The flooding assessment undertaken for the EIS has been accepted by the NSW Office of Environment and Heritage (OEH) and identified as being conservative. In summary, the OEH submission in regard to flooding and floodplain management confirms the following:

- The flood assessment includes all the items required by the SEARs.
- The outputs of the Umwelt Flood Assessment are considered to be conservative and may be used for the assessment of the Project.
- The Umwelt Flood Assessment demonstrates that there will be negligible minimal impact on privately owned land and has proposed a levee to protect the mine pit from Wollombi Brook flooding up to the 0.1% Annual Exceedance Probability (AEP) event.

As discussed in Section 1.3 of Appendix D of the Surface Water Assessment (Flood Assessment - Wollombi Brook), the flooding assessment uses the RMA-2 two dimensional (2D) hydrodynamic model to produce a description of existing flood behaviour in Wollombi Brook and the downstream reaches of North Wambo Creek and Redbank Creek, and potential impacts from the Project. The RMA-2 model has been developed to model the floodplain area using inputs and boundary conditions derived from hydrological and stream flow analysis.

The modelling approach included:

- define the landform and drainage features
- define the inflows into the model
- define the tailwater conditions
- determine critical storm duration
- undertake sensitivity analysis of model assessing sensitivity to hydraulic roughness, marsh porosity factors and climate change impacts, to confirm that suitable parameters had been chosen for the modelling analysis (further details and outcomes described below)
- define the existing flood extents, depths, velocities and flood hazard categories for the 10 per cent, 5 per cent and 1 per cent AEP flood events and the PMF
- compare results of the flood modelling to historical flood data
- define the Flood Planning Area; Flood Prone Land and Hydraulic Categories (in accordance with the NSW Floodplain Development Manual (2005))
- determine potential relative impacts of the Project on flood behaviour in Wollombi Brook
- undertake modelling of 0.5 per cent and 0.2 per cent AEP flood events as proxies for climate change sensitivity

Further details in regards to the construction, parametrisation, sensitivity analysis and calibration of the models used to assess potential impacts of the Project on flooding in Wollombi Brook below.

Table 2.12 provides a high level summary of the key parameters / data used in the Flood Assessment. Further details of each of the aspects are discussed below.

Table 2.12 Model Construction / Parameters Summary

Key Aspects	Flood Assessment Approach
Digital Terrain Data / Model Base	Triangular irregular mesh used to represent the varying scale of features associated with the channel, overbank and hydraulic features of the floodplain. Mesh orientated to represent hydraulic features. Estimated no flow in the brook at the time of LiDAR survey.
Hydrology Model Data - Rating Curves	Data used from PINNEENA at the time of the assessment (i.e. prior to the release of the April 2015 updated rating curve for Warkworth gauge).
Hydrology Model Calibration	Hydrology model was calibrated to a small flood event at the Warkworth Gauge and outputs for design storm events compared to a Flood Frequency Analysis (at the Warkworth Gauge) (i.e. based on the rating curve data as per above).
Hydraulic Roughness	In channel roughness, mannings 'n', for Wollombi Brook of 0.075
Tailwater Influences	Tailwater analysis for Hunter River used long term gauging stations (Singleton, 1914 to 2005 and Liddell, 1973 to 2006) with 81 flood records presented in PINNEENA in the Log Pearson 3 (LP3) Distribution Frequency Analysis. Tailwater modelled as a static level. LP3 preferred method of analysis in PINNEENA at the time of preparation of the flood assessment.

Note: PINNEENA is a data DVD published by the NSW Government containing continuous monitoring data for surface water and groundwater systems. The DVD includes analysis outputs/methods from NSW Government including outputs from rating curves (i.e. translation of water levels during floods to flow rates).

Digital Terrain Model and Mesh Generation

LiDAR Data

Light Detection and Ranging (LiDAR) survey data was collected by Glencore on 13 April 2010. This survey captured a swath of survey points describing the land and channel system of Wollombi Brook and its tributaries. On the date of the survey the NSW DPI Water Stream Gauge on Wollombi Brook @ Warkworth recorded a water level of 0.653 metres. As the cease to flow level stated for this gauge is 0.6 metres it is understood that at the time of the LiDAR survey there was only 0.053 metres (i.e. 53 millimetres) of water depth at the gauge. As such it is considered that the LiDAR will have picked up the bed of the flow conveyance channel of the brook and its tributaries as little to no water was flowing at the time of the survey.

Surface Features

Finite element digital terrain models (FE DTMs) describe the topography of an area with a network of elements (triangles, rectangles) that are sized and distributed to best capture the local features in as much detail as possible. FE DTMs offer a means of including variable resolution and alignment of elements within the DTM in order to capture much finer detail within the local topography. As such surface features need not be lost within an FE DTM as compared to a gridded model whereby the surface features can only be included if they are of similar or larger resolution compared to the grid dimensions.

The initial digital terrain model created using the LiDAR survey data was simplified to create a triangulated mesh of the data. Checks were undertaken to ensure that the simplified landform was representative of the existing topography, with particular attention paid to hydraulically significant features such as creek channels, drains and roads. Cross checks on the volume of flood storage available with each floodplain reach as well as comparison of elevations to the raw LiDAR mesh were undertaken to check that surface features had not been removed in the development of the mesh.

There are two key bridge locations within the RMA-2 model area that have the potential to influence flood flows: Wambo Access Road Bridge; and Golden Highway Road Bridge (Cockfighter Bridge). In order to represent the behaviour of the bridges in the 2D model an assessment of the stage-discharge relationships at each of the two crossing points was undertaken. The stage-discharge relationship for each crossing was determined using HEC-RAS models. For each model a cross section was included immediately upstream and downstream of the crossing and a bridge element included between the cross sections to represent the crossing. After establishing a stage-discharge relationship for each of the crossings with the bridges, the stage-discharge relationship was reproduced in an equivalent model of the brook at each location without the bridge structure(s). The initial stage-discharge relationship was replicated in the alternate models by modifying roughness coefficients for the channel. These alternate roughness coefficients were used in the RMA-2 model at the bridge locations to reflect the stage-discharge relationship at each of the crossings.

The surface features associated with channels, overflow pathways, roads, bridge approaches, etc. are clearly visible within the mesh structure (refer to **Figure 2.4**).

Resulting Mesh

Element structures suitable to allow inflows and outflows from the model were defined at each of the seven inflow points and at the outlet of the model. The structures are only created to assist in the mathematical calculations of the model. As such any model results in these areas should be disregarded.

The lateral extents of the hydrodynamic model were determined based on the flood extent during the 1 per cent AEP flood event. This initial flood extent was used to identify elements that would not be required in the RMA-2 network, thereby allowing a further reduction in the number of elements required to simulate flood events, and a lower potential for errors and/or instabilities in the modelling to occur. The initial model mesh was extended for the extreme events (i.e. 0.5 per cent AEP flood event and higher). Both meshes were modified to model the developed scenario.

The base RMA-2 network of the existing scenario uses approximately 58,200 elements and 30,300 nodes to define the existing scenario for the 1 per cent AEP flood event modelling (refer to **Figure 2.4**). The model extends from the natural flow constriction on Wollombi Brook approximately 2 kilometres upstream of the Project Area to the confluence of Wollombi Brook with the Hunter River, approximately 6 kilometres downstream of the Project Area.

Hydrology Approach and Parameters

The 2D modelling approach for the Project is consistent with methods outlined in Australian Rainfall and Runoff Project 15 – Two Dimensional Modelling in Urban and Rural Floodplains (stage 1 and 2 report) (published November 2012). The hydrological modelling approach provides inputs to the 2D model based on a calibration using flow data.

As discussed in Chapter 2 – Catchment Representation of Australian Rainfall and Runoff (2016) (www.arr.org.au) (Ball et al., 2016), *"in situations where the interest is only on the combined hydrograph at the catchment outlet and where good flood records for current conditions are available at that point, modelling of the catchment as a single "lumped" response unit may be sufficient".* This was considered to be the case for the requirements of the Wollombi Brook Flood Assessment for the Project.

The IHACRES hydrology model (Identification of unit Hydrographs And Component flows from Rainfall, Evaporation and Streamflow data) was used to determine the design inflows into the model. The IHACRES model is a relatively simple, lumped conceptual rainfall-runoff model. Two linear stores are modelled representing quickflow and slowflow. The IHACRES model was modified following methods outlined in Post et al. (undated) to allow for applications to ungauged basins as there is limited stream flow data available for the Warkworth gauge where stream flows at this gauge have not been influenced by flooding in the Hunter River.

The IHACRES model was calibrated to observed streamflow data with Wollombi Brook at Warkworth using hourly rainfall sourced from the Bulga Coal Mine. The calibrated model was then used to create a unit hydrograph for each of the design storm events that could be used to estimate runoff responses for Wollombi Brook and the other minor upslope catchments that drain into the 2D flood model area.

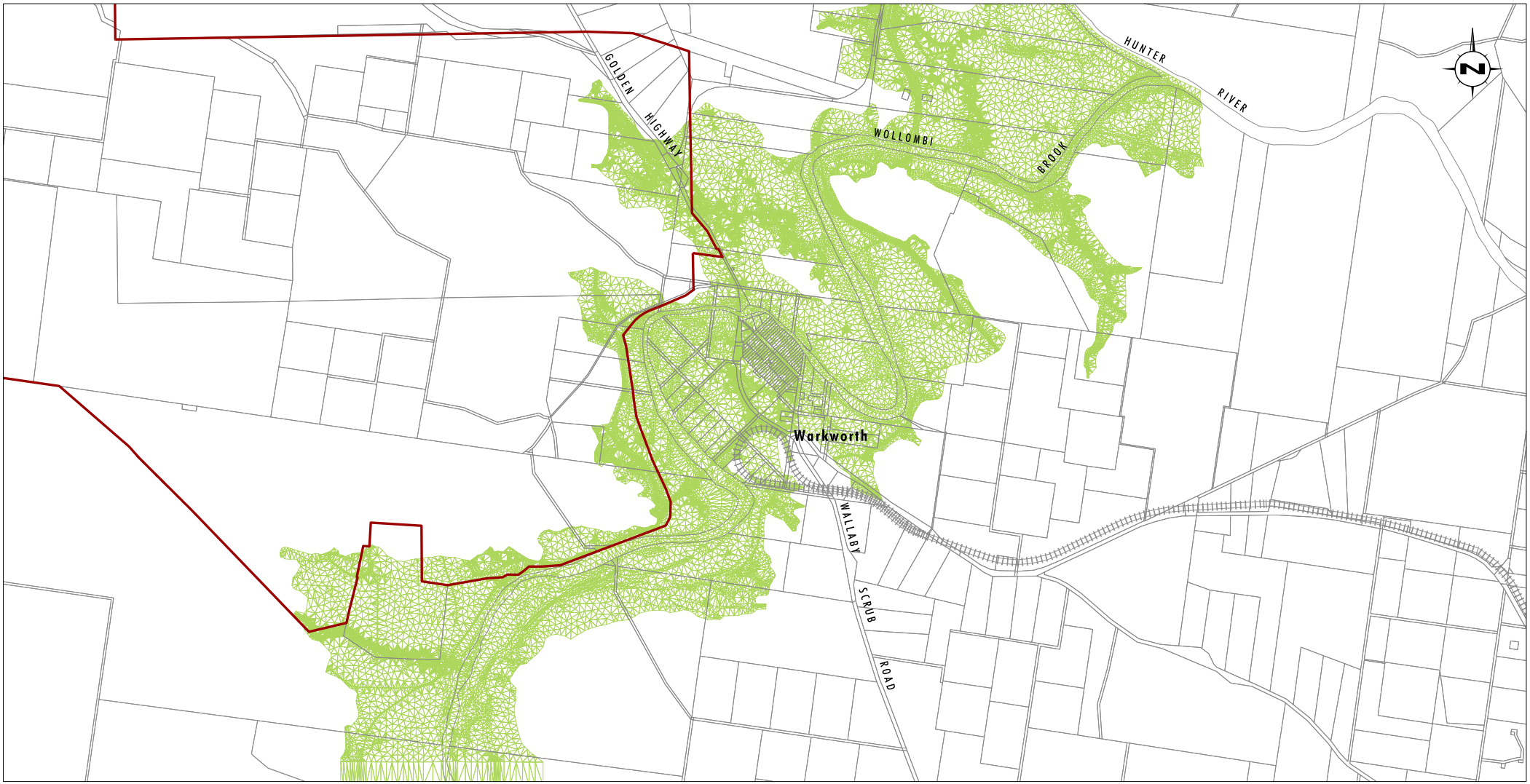
The IHACRES model was calibrated to the flow response of a flood/flow event during 1998. This flood event was selected for calibration of the hydrology model as there was limited influence by flooding in the Hunter River, good flow records at the Warkworth gauge and hourly rainfall data available.

As stated in the EIS Flood Assessment, the Warkworth gauge is influenced by flooding in the Hunter River. Similarly it was also stated in the EIS Flood Assessment that the 1998 event was used for the hydrology model calibration as there was limited influence by flooding in the Hunter River, good flow records at the Warkworth gauge and hourly rainfall data available. As such the hydrology model calibration took into consideration the influences of the Hunter River impacts on gauge data in Wollombi Brook.

The parameters used in the IHACRES model are outlined in **Table 2.13**.

Table 2.13 IHACRES Parameters

Parameter	Value
Infiltration coefficient	0.07
Quickflow coefficient	0.65
Slowflow coefficient	0.939



Data Source: LPI (2009)

0 0.5 1.0 2.0km
1:45 000

Legend

- Project Area
- RMA-2 Model

FIGURE 2.4

RMA-2 Model Domain

Outlet Conditions / Tailwater

Tailwater analysis for Hunter River used long term gauging stations (Singleton, 1914 to 2005 and Liddell, 1973 to 2006) with 81 flood records presented in PINNEENA in the Log Pearson 3 (LP3) Distribution Frequency Analysis. The tailwater for each model was modelled as a static level to present a worst case conservative flood level at the Project Area. LP3 was the preferred method of analysis in PINNEENA at the time of preparation of the flood assessment.

The outcomes of the analysis and adopted tailwater levels are presented in **Table 2.14**.

Table 2.14 Hunter River Tailwater Analysis Summary

Probability	Singleton 210001 Gauge Level (m)	Liddell 2100083 Gauge Level (m)	Interpolated Level for Confluence (m)	Converted Tailwater Level (mAHD)	Adopted Tailwater Level (mAHD)
50% AEP	5.6	8.3	6.9	49.9	54.51
10% AEP	12.1	13.8	13.0	56.0	56.0
1% AEP	19.4	18.5	18.9	61.9	59.12

Notes:

1. Adopted as is equivalent to bankfull at the confluence
2. Adopted as is highest recorded flood level on Wollombi Brook

The combination of selected tailwater and catchment flooding event probabilities were included in the modelling for the flood assessment (refer to **Table 2.15**).

Table 2.15 Model Combinations – Catchment Flooding and Tailwater Conditions (AEPs)

Catchment Flood Event	Tailwater Condition
10%	Bank full
5%	Bank full
1%	10%
0.5%	1%
0.2%	1%
PMF	1%

Hydraulic Parameters

Hydraulic Roughness

The hydraulic roughness parameters used in the RMA-2 model have been sourced from *Australian Rainfall and Runoff* (AR&R) (IEAust, 1987) and are representative of the roughness characteristics of the region. The

values of Mannings 'n' adopted were based on information gathered during site inspections and from aerial photographs. The Mannings 'n' values used in the modelling are provided in **Table 2.16**.

Table 2.16 Mannings 'n' values used in the RMA-2 Mesh

Type	Land Use	Mannings 'n'
1	Open Grassland/Pasture	0.050
2	Roads	0.030
3	Forest/Bridge crossing channel	0.100
4	Open Water	0.010
5	Wollombi Brook Creek Channel	0.075
6	Houses	1.000
7	Culvert	0.017

Influence of Marsh Elements

The RMA-2 model uses the concept of 'marsh elements' to assist in achieving a numerical solution in areas of the finite element mesh where wetting and drying occurs during the flood event. The 'marsh element' method treats the flow as an integration of both surface flow and shallow sub-surface flow. In places where the water surface elevation drops below the ground surface, rather than an element suddenly being turned off, which may cause numerical instability and poor convergence of the numerical solution, the flow is presumed to occur in a low-porosity shallow sub-surface flow zone. To implement the 'marsh element' solution, the porosity in the sub-surface zone is gradually varied over a transitional zone from the surface to sub-surface. The depth of the subsurface zone is set to be just below the anticipated lowest water level of the flood model across the solution front. This required range, referred to as the bottom elevation shift or 'slot depth' is set to be the maximum difference between the highest ground surface elevation and lowest water surface elevation across the solution front of the model.

For the RMA-2 simulations used in this report, the following values have been used to describe the marsh elements:

- bottom elevation shift (slot depth) = 11 to 12 metres
- depth range over which porosity reduces (transition range) = 0.25 metres
- effective porosity in the sub-surface zone (kappa) = 0.004.

Initial Flow Conditions

Before it can accept inflow hydrographs, the RMA-2 model requires that steady state flow conditions be established throughout the model domain. By trial and error, it was found that inflows from the subcatchments totalling approximately 340 m^3/s were required to establish these steady state conditions. These values provide a stable numerical solution for flow and water levels for use as a starting point for analysing the effect of storm event inflows. As such the initial losses for all elements within the RMA-2 model are assumed to have occurred prior to the start to the modelling period.

Critical Storm Duration

The 2D flood model was run for three flood durations for the 1% AEP flood event: 24 hour; 36 hour; and 48 hour flow events. The 36 hour storm event was found to produce the maximum flood levels within the model domain in the vicinity of the Project Area. As such the 36 hour flood duration was modelled to determine potential impacts associated with flooding.

Sensitive Analysis and Verification of Results

Sensitivity Analysis

During the model development phase sensitivity model runs were undertaken for both hydraulic roughness parameters and marsh porosity factors. Further to this sensitivity modelling of the 0.2% and 0.5% AEP flood events was undertaken to act as proxies for climate change as requested by the NSW OEH.

Hydraulic Roughness

The hydraulic roughness parameters used in the RMA-2 model have been sourced from AR&R (IEAust, 1997) and are representative of the roughness characteristics of the region. The values of Mannings 'n' adopted were based on information gathered during site inspections and from aerial photographs. The Mannings 'n' values used in the modelling are provided in **Table 2.17**.

To assess the sensitivity of the flood model to changes in hydraulic roughness the model was tested for three alternate hydraulic roughness values (i.e. Case 1, Case 2 and Case 3). These values and the base hydraulic roughness are listed in **Table 2.17** and range between -10% to +20% of the selected (i.e. base) hydraulic roughness parameters used in the Flood Assessment. The sensitivity modelling for hydraulic roughness was undertaken for the 1% AEP 48 hour flood event.

Table 2.17 Mannings 'n' values - Sensitivity Analysis

Type	Land Use	Mannings 'n'			
		Case 1 (-10%)	Base	Case 2 (+10%)	Case 3 (+20%)
1	**Open Grassland/Pasture**	0.045	0.050	0.055	0.060
2	**Roads**	0.027	0.030	0.033	0.036
3	**Forest/Bridge crossing channel**	0.090	0.100	0.110	0.120
4	**Open Water**	0.009	0.010	0.011	0.012
5	**Wollombi Brook Creek Channel**	0.068	0.075	0.083	0.090
6	**Houses**[1]	1.000	1.000	1.000	1.000
7	**Culvert**	0.015	0.017	0.019	0.020

Note 1: Due to the high roughness value used to prevent flow through buildings no changes were made to this value as part of the sensitivity analysis

Flow and stage hydrographs showing the outcomes from the sensitivity analysis described above for a cross section of the model located at the DPI Water Warkworth Stream Gauge (i.e. adjacent to the Project Area) are shown in **Charts 2.1** and **2.2**. Changing the roughness of the channel +/-10% impacted on maximum water surface elevations by up to +/- 240 mm.

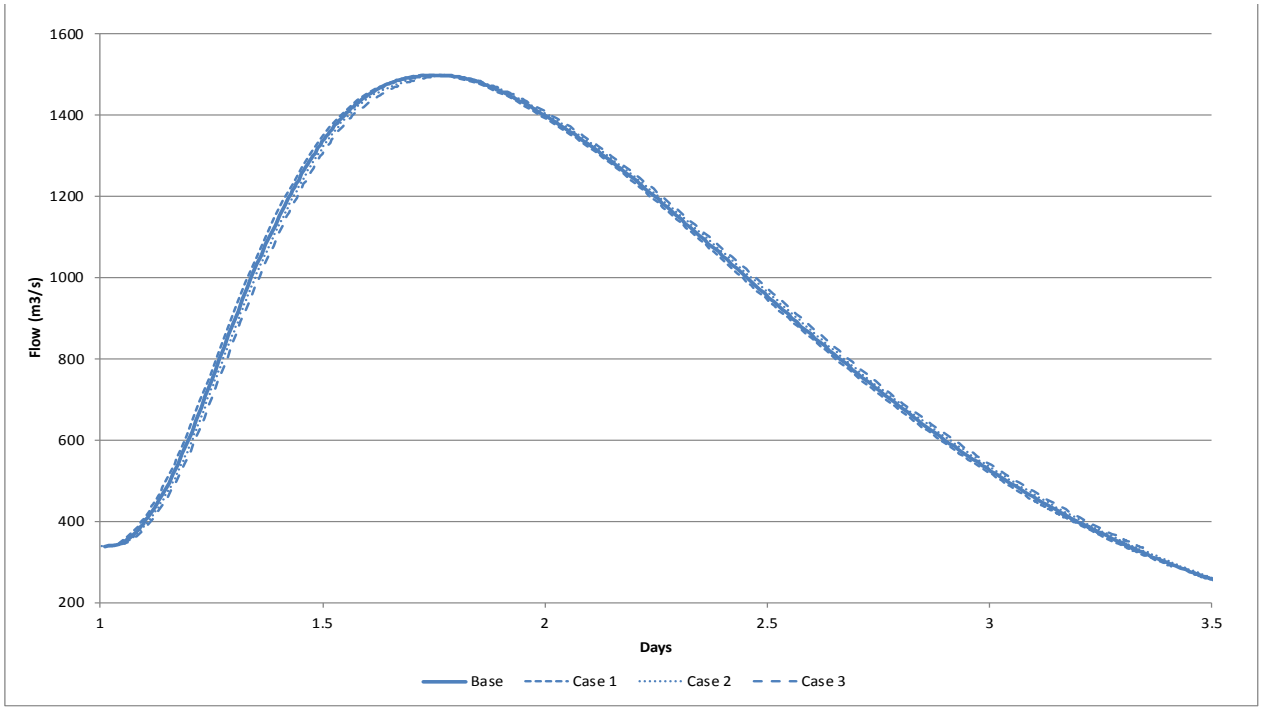


Chart 2.1 Sensitivity Analysis Results – Flow Rate

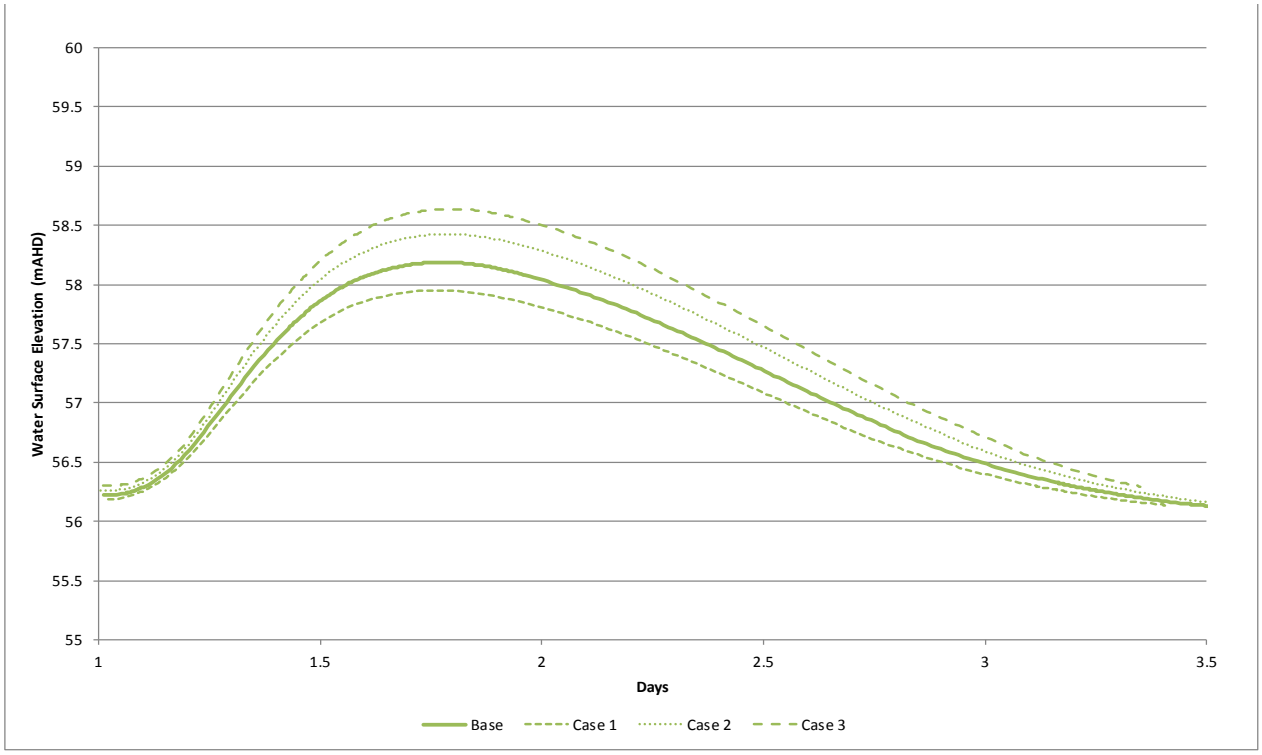


Chart 2.2 Sensitivity Analysis Results – Water Surface Elevation

Marsh Elements

The RMA-2 model uses the concept of 'marsh elements' to assist in achieving a numerical solution in areas of the finite element mesh where wetting and drying occurs during the flood event. The 'marsh element' method treats the flow as an integration of both surface flow and shallow sub-surface flow. In places where the water surface elevation drops below the ground surface, rather than an element suddenly being turned off, which may cause numerical instability and poor convergence of the numerical solution, the flow is presumed to occur in a low-porosity shallow sub-surface flow zone.

The flood model was run with different transitions zones and porosity values to determine the impact of the marsh elements on the dynamics of the flood modelling and to determine whether the flows in the subsurface zone are significant. The results indicated that changing the transition and porosity values has little effect on the outflows of the model and has an insignificant impact on the shape of the outflow hydrograph. These results demonstrate that the flow conveyance in the marsh elements is an insignificant proportion of the total flow.

Sensitivity to Climate Change

Modelling of the 1 in 200 and 1 in 500 year (i.e. 0.5% and 0.2% AEP) flood events was requested by NSW OEH in its submission to DPE to inform the preparation of the SEARs. OEH requested this modelling work to act *as proxies for assessing sensitivity to an increase in rainfall intensity of flood producing rainfall events due to climate change*.

The modelling results for flood depths, flow velocities and flood hazard categories for the 0.5% and 0.2% AEP flood events are shown on **Figures 2.5** to **2.10**.

The modelling indicates that the inundation extent within the Project Area does not change significantly between the 0.5% and 0.2% AEP flood events (refer to **Figures 2.5** and **2.6**). Similarly the modelling shows that the maximum flow velocities within the Project Area remain low (i.e. typically less than 0.5 m/s) (refer to **Figures 2.7** and **2.8**). These results are reflected in the flood hazard category analysis with only minor changes to the flood hazard categorisations within the Project Area (refer to **Figures 2.9** and **2.10**).

The above described differences between the 0.5% and 0.2% AEP flood events infer that no major changes occur in the flood behaviour in Wollombi Brook when comparing the modelling results from the two design events.

Calibration and Validation

A comparison of the flood modelling results to historical flood level data was included in the Flood Assessment and is discussed below.

In addition, a comparison of the Flood Assessment results to flood data contained in the WRL (1996 report) and the Draft WBM BMT Flood Study (2016) has been included.

Verification against Historical Flood Level Data (as included in Flood Assessment, 2016)

The modelling indicates the following peak flood elevations (i.e. design flood outputs) for Wollombi Brook at the Warkworth gauge (refer to **Table 2.18**).

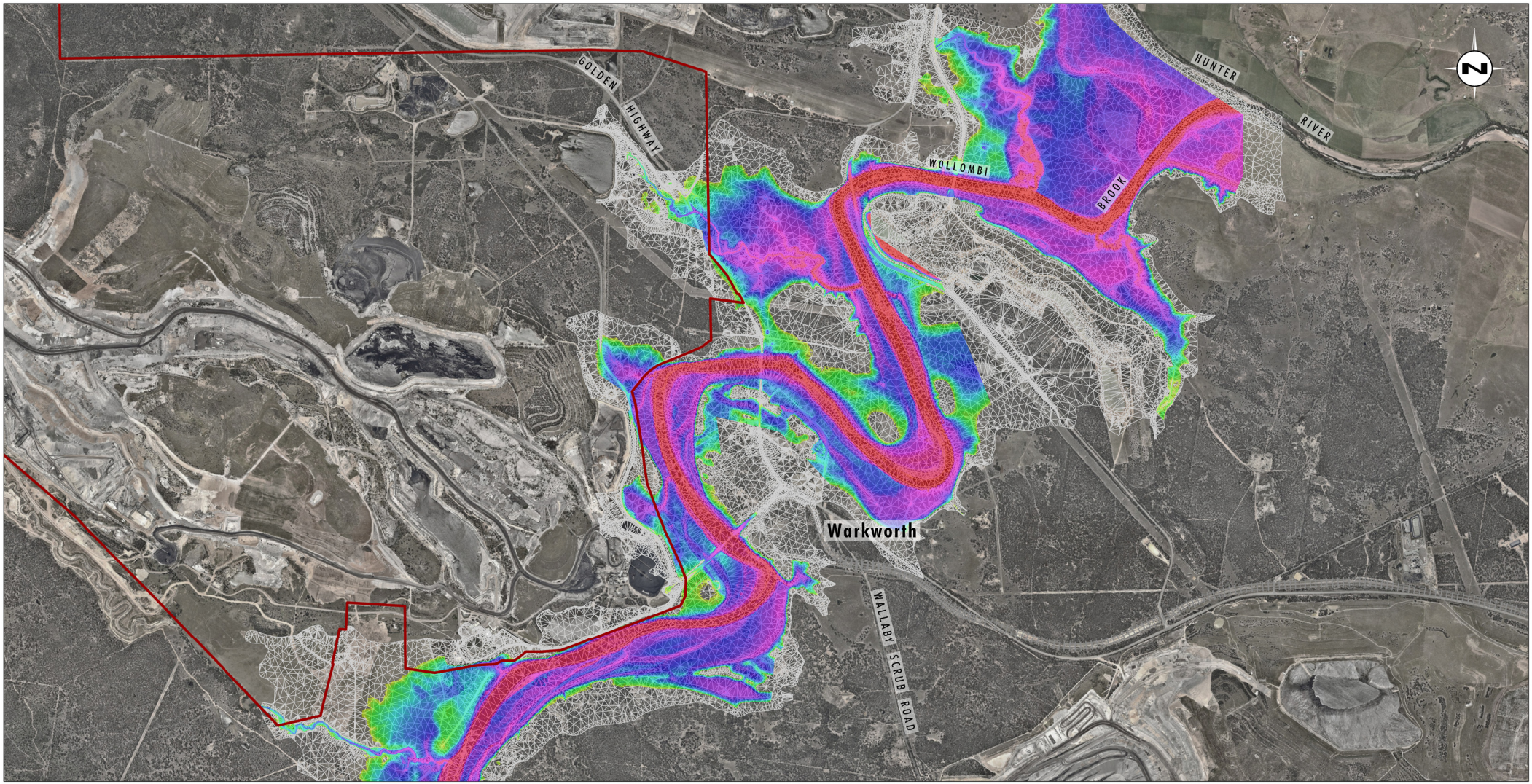


Image Source: Nearmap (Nov 2016)

0 0.5 1.0 2.0km
1:40 000

Legend

Project Area

Water Depth (metres)

12	2	0.001
8	1.5	
6	1	
4	0.5	
3	0.2	

FIGURE 2.5

Climate Change Sensitivities -
Maximum Modelled Flood Depths
0.5% AEP Flood Event

File Name (A4): R18/3509_588.dgn
20170530 9.57

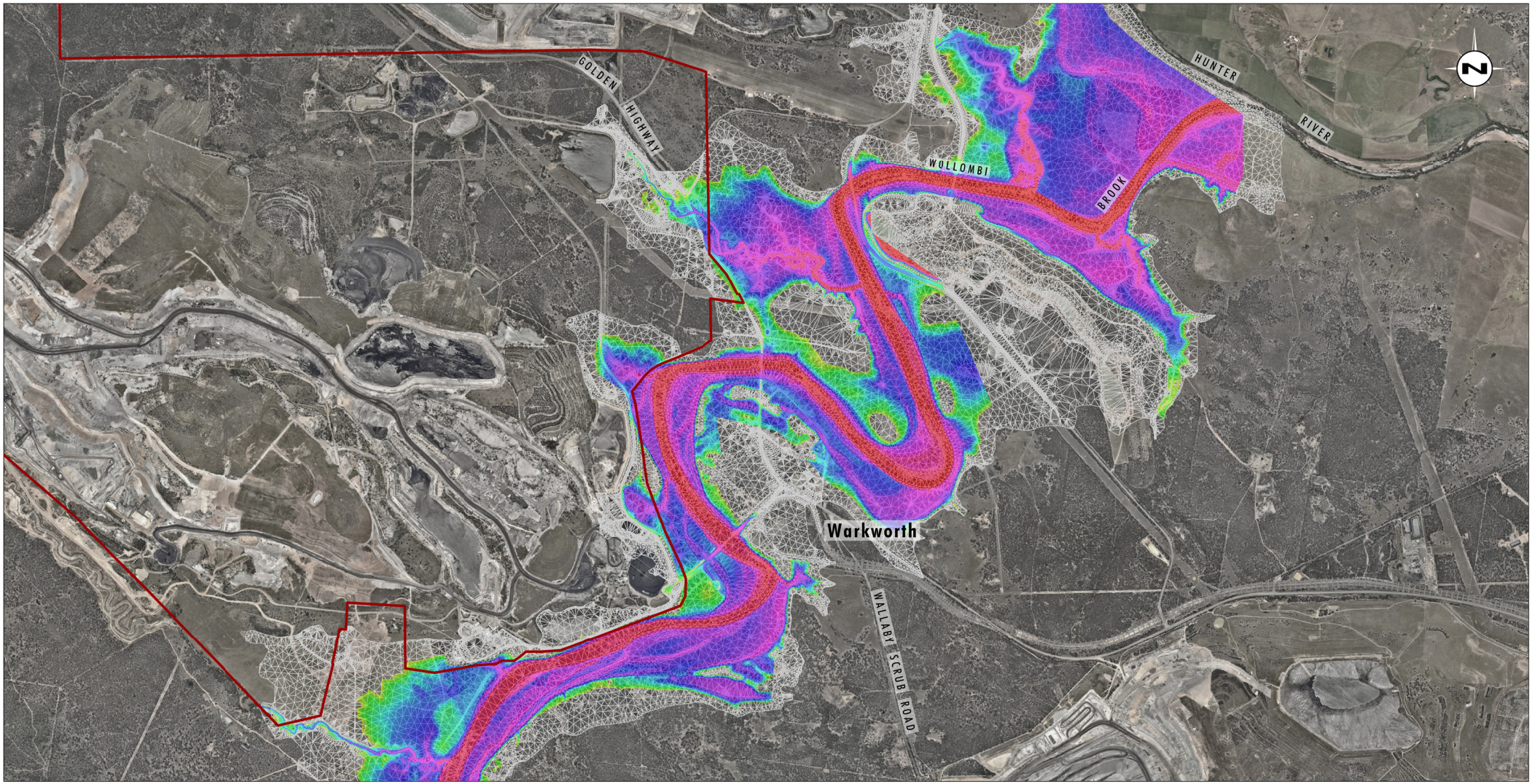


Image Source: Nearmap (Nov 2016)

0 0.5 1.0 2.0km
1:40 000

Legend

Project Area

Water Depth (metres)

12	2	0.001
8	1.5	
6	1	
4	0.5	
3	0.2	

FIGURE 2.6

Climate Change Sensitivities -
Maximum Modelled Flood Depths
0.2% AEP Flood Event

File Name (A4): R18/3509_601.dgn
20170530 9.59

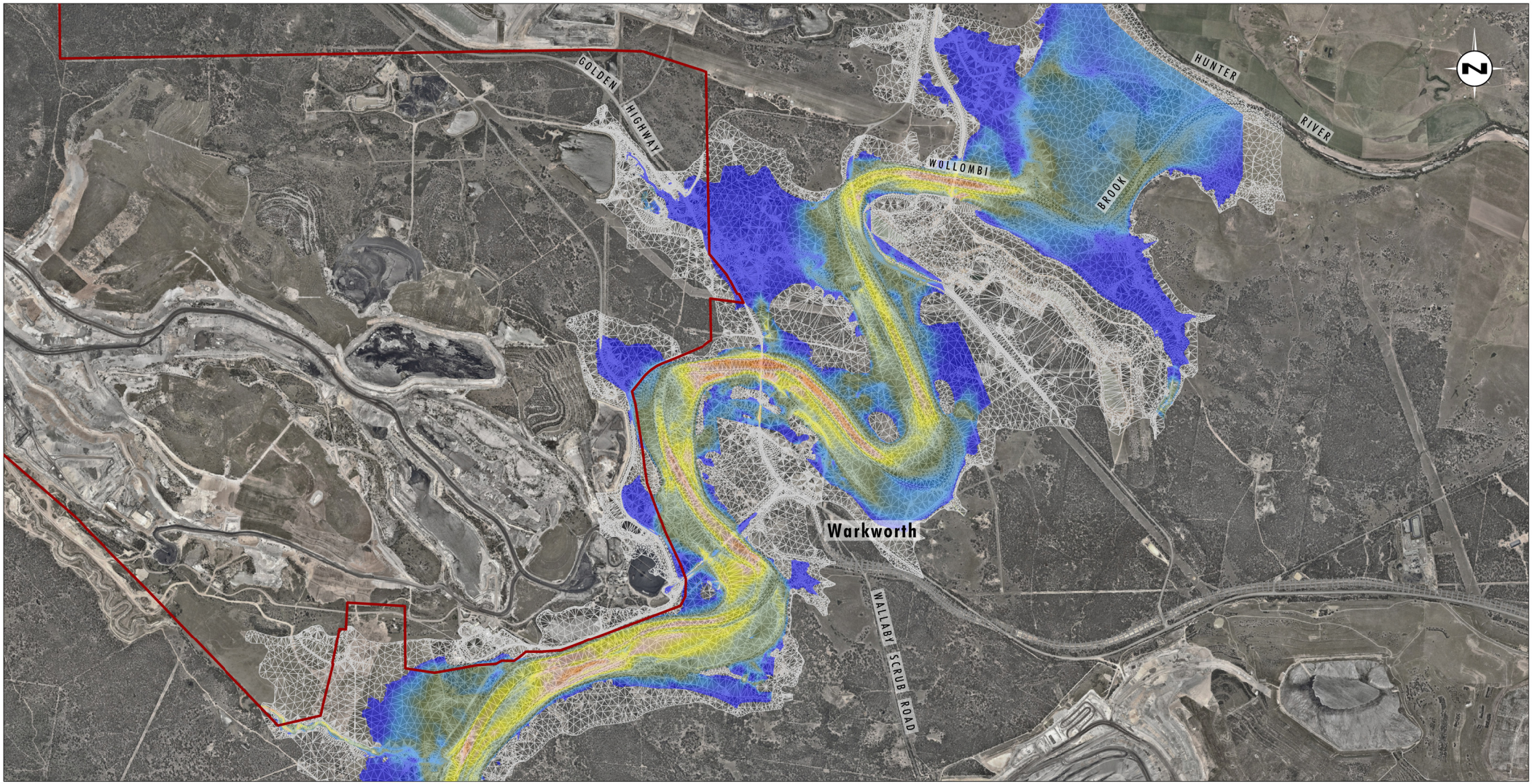


Image Source: Nearmap (Nov 2016)

0 0.5 1.0 2.0km
1:40 000

Legend

- Project Area

Flow Velocity (m/s)

5	1.25
2.25	1
2	0.75
1.75	0.5
1.5	0.25

FIGURE 2.7

Climate Change Sensitivities -
Maximum Modelled Flood Velocities
0.5% AEP Flood Event

File Name (A4): R18/3509_589.dgn
20170530 10.00

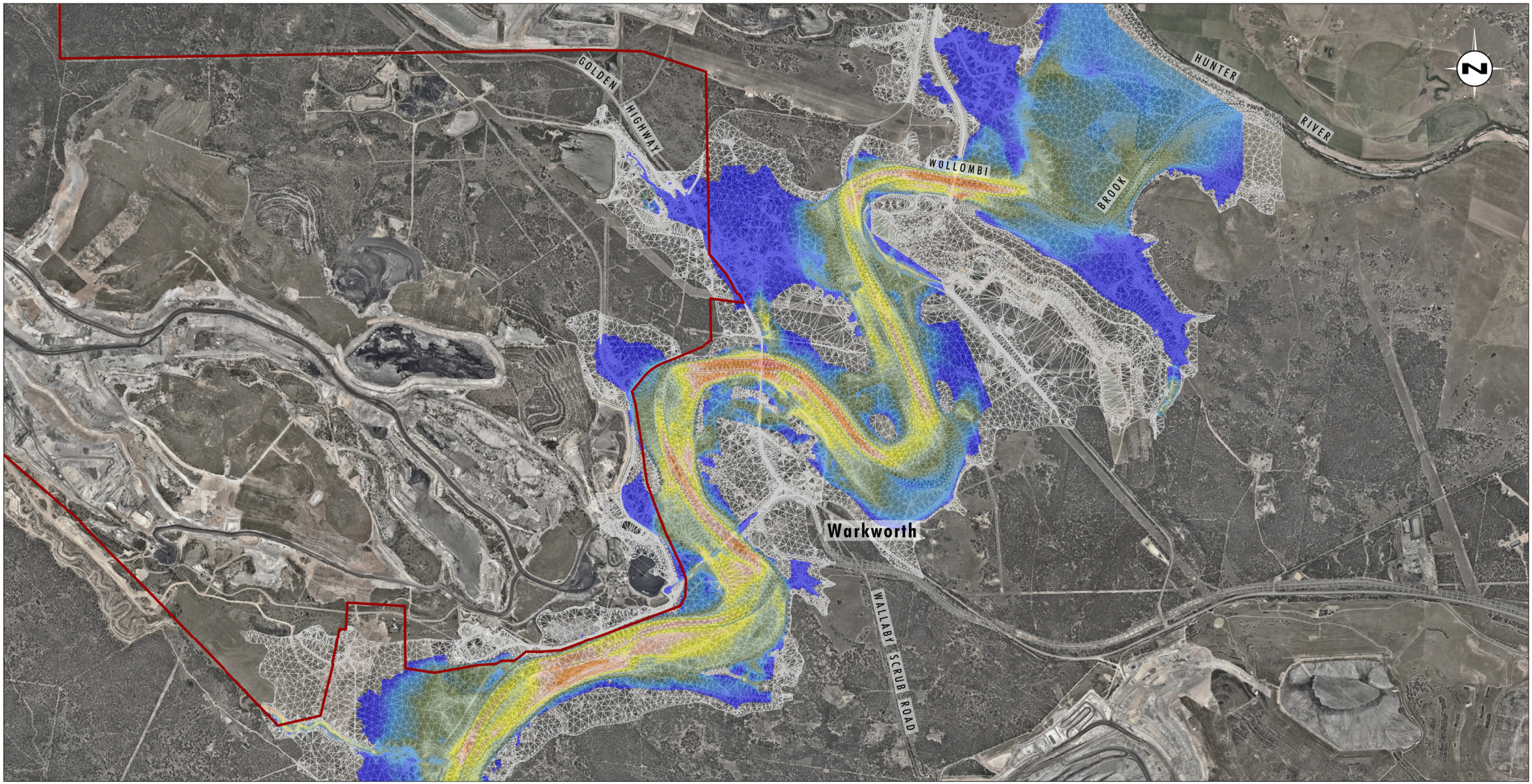


Image Source: Nearmap (Nov 2016)

0 0.5 1.0 2.0km
1:40 000

Legend

Project Area

Flow Velocity (m/s)

5	1.25
2.25	1
2	0.75
1.75	0.5
1.5	0.25

FIGURE 2.8

Climate Change Sensitivities -
Maximum Modelled Flood Velocities
0.2% AEP Flood Event

File Name (A4): R18/3509_602.dgn
20170530 10.01

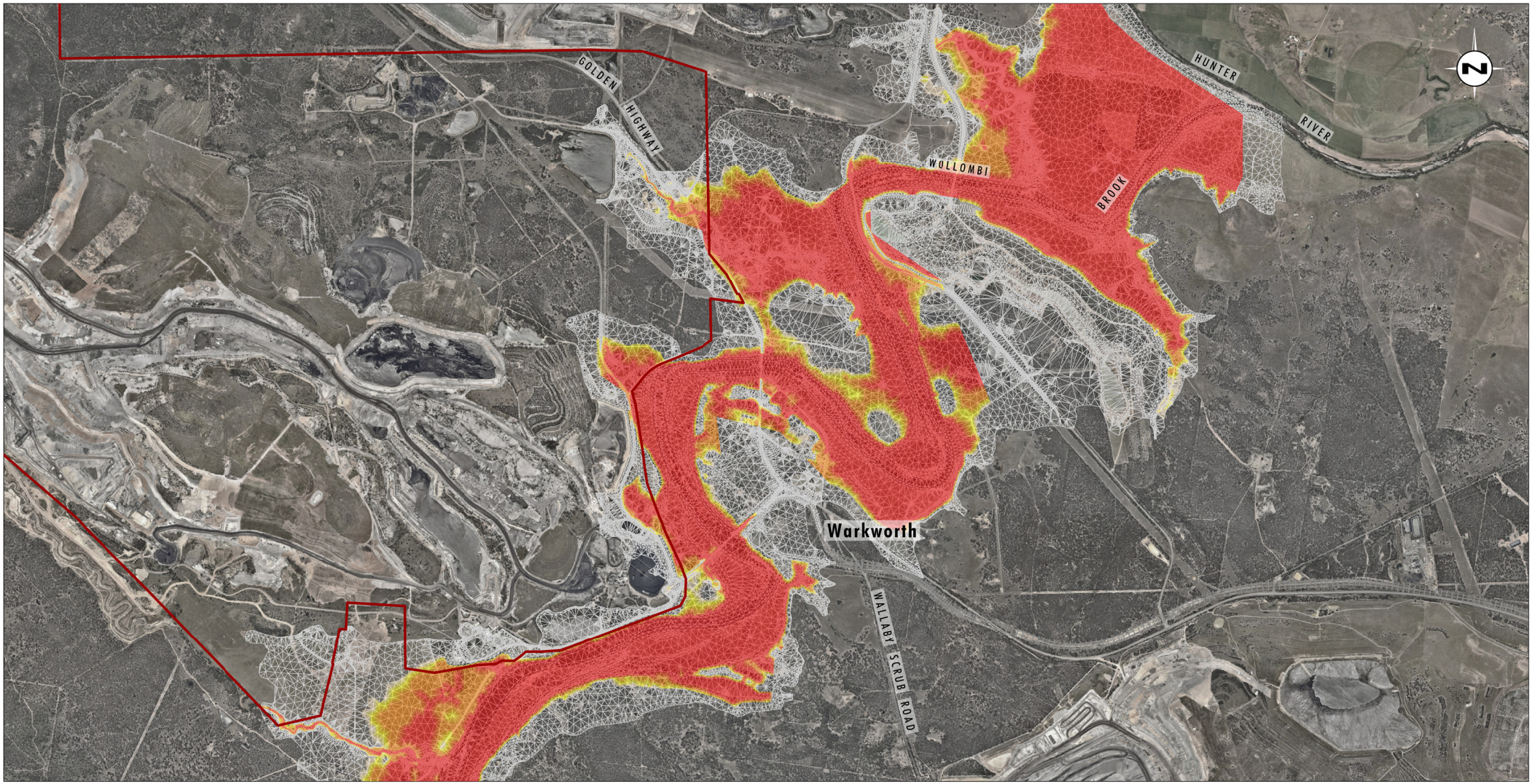


Image Source: Nearmap (Nov 2016)

0 0.5 1.0 2.0km
1:40 000

Legend

Project Area

Hazard Category

- Low Hazard - Walking and Vehicle Access
- Low Hazard - Vehicles unstable
- High Hazard - Wading unsafe
- High Hazard - Damage to light structures

FIGURE 2.9

Climate Change Sensitivities -
Maximum Modelled Flood Hazard Categories
0.5% AEP Flood Event

File Name (A4): R18/3509_590.dgn
20170530 10.02

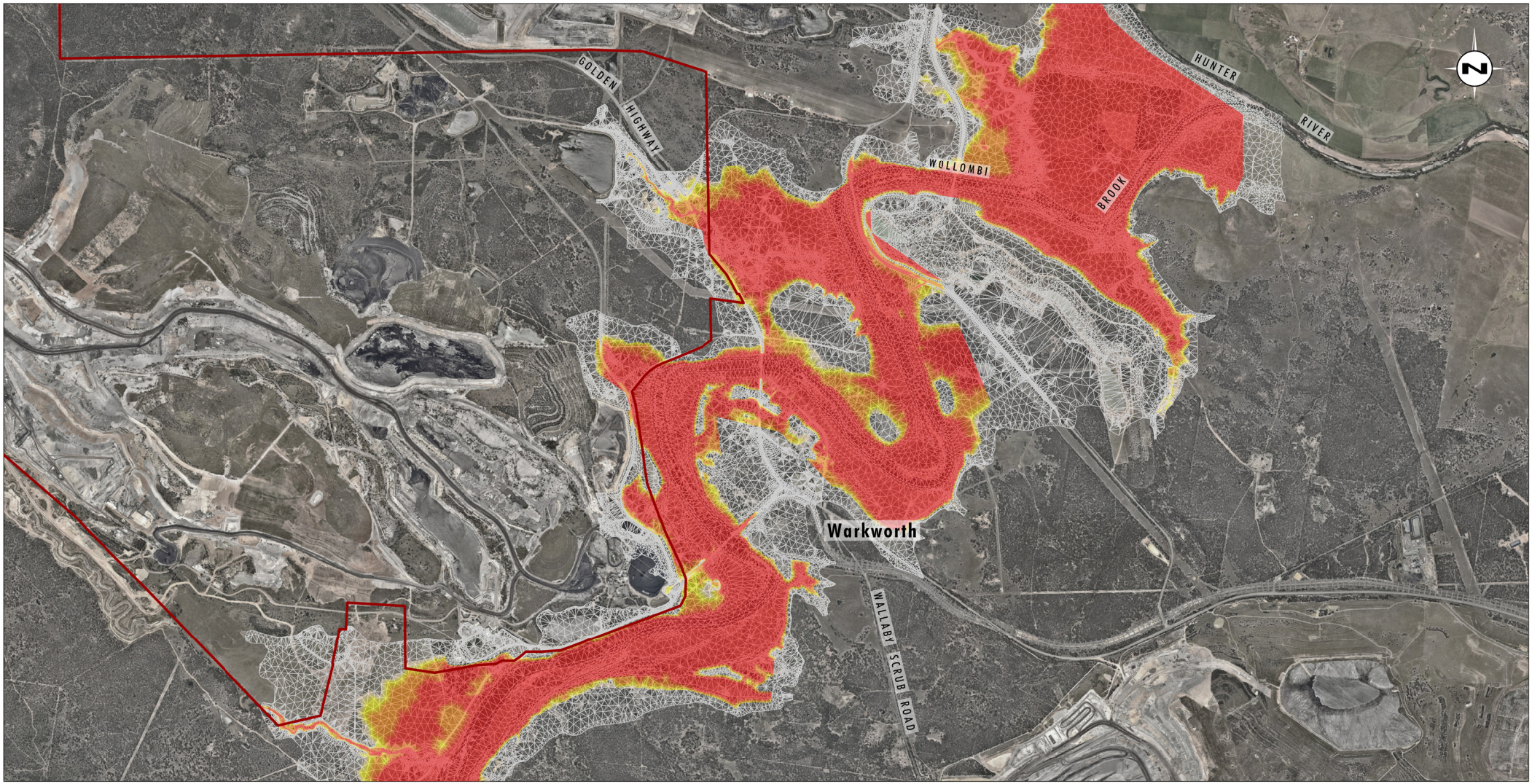


Image Source: Nearmap (Nov 2016)

0 0.5 1.0 2.0km
1:40 000

Legend

Project Area

Hazard Category

- Low Hazard - Walking and Vehicle Access
- Low Hazard - Vehicles unstable
- High Hazard - Wading unsafe
- High Hazard - Damage to light structures

FIGURE 2.10

Climate Change Sensitivities -
Maximum Modelled Flood Hazard Categories
0.2% AEP Flood Event

File Name (A4): R18/3509_603.dgn
20170530 10.03

Table 2.18 Design Flood Outputs – Peak Elevation

Flood Event	Peak Elevation (mAHD)
10% AEP	56.6
5% AEP	57.2
1% AEP	58.4
PMF	63.2

When comparing the modelled peak water levels to historical flood events the following is found:

- 10% AEP flood event modelled peak water elevation of 56.6 mAHD is similar to the flood elevations recorded in June 2007 (56.3 mAHD) and higher than those recorded in April 2015 (55.5 mAHD)
- 5% AEP flood event modelled peak water elevation of 57.2 mAHD sits mid range with the recorded flood elevations, however, does not correspond to any particular historical event record
- 1% AEP flood event modelled peak water elevation of 58.4 mAHD is lower than the 1955 recorded flood elevation of 59.3 mAHD, however it should also be noted that the gauge zero elevation, and likely as such the bed elevation, has been lowered by 1.52 metres since 1955
- PMF event modelled peak water elevation of 63.2 mAHD is higher than the maximum recorded flood elevation of 61.7 mAHD from 1949 (the 1949 event was associated with a 0.5% AEP event occurring in Wollombi Brook (Eskine 1998)).

Based on the results presented above it is considered that the flood model provides a good basis to determine the relative impacts of the Project on flood behaviour in Wollombi Brook.

Comparison to Other Flood Study Results

At the time of the preparation of the Flood Assessment there was only one available historical flood study for the downstream reaches of Wollombi Brook adjacent to the Project. The WRL flood study was published in 1996 and is described below.

Subsequent to EIS being submitted to the NSW DPE for exhibition on 8 August 2016 the NSW OEH has made United aware of the *Wollombi Brook Flood Study – Draft Report for Public Exhibition.* A copy of this study was requested from Singleton Council (dated 25 July 2016) and a comparison to the results of the Flood Assessment is included below.

The IESC Submission makes the following comment "*Specifically, flood event peak flow volumes should be compared to other studies undertaken in the vicinity of the proposed project and discrepancies full explained and justified, including why the flood volumes estimated in this study are considerably lower than those estimated in other studies on Wollombi Brook*". It is uncertain to what other studies the IESC is referring to. There are two studies in the vicinity, the most recent being the WMB BMT Draft Flood Study (not publicly available). A comparison of flow volumes for this study and the Flood Assessment is included below, however it should be noted that the Flood Assessment has higher flow rates and flood levels that in the WMB BMT Draft Flood Study.

WRL

The results from the WRL study (1996) were used in the Flood Assessment to assist in verifying the model results, inform tailwater influences from the Hunter River on flooding within Wollombi Brook, as well as providing a comparison for model parameters. This study provided data on peak flood levels at Warkworth of 61.7 mAHD in 1949 and 59.3 mAHD in 1955. These values are discussed in the discussion of historical flood levels provided in above.

The WRL study (1996) also shows a wide range in the duration of flooding at Warkworth, which is also reflected in the data for the Hunter River. The analysis in the WRL study (1996) indicates major flood durations at Warkworth ranging between 8 hours to 62 hours in duration, with an average duration of flooding of 38 hours.

The design flood levels presented for Wollombi Brook in the WRL Study (1996) are compared to the Flood Assessment outcomes in **Table 2.19**.

Table 2.19 Design Flood Outputs – Peak Elevation

Flood Event	Peak Elevation (mAHD)	
	Flood Assessment (Umwelt, 2016)	WRL (1996)
10% AEP	56.6	55.5
5% AEP	57.2	57.5
1% AEP	58.4	59.4
PMF	63.2	-[1]

Note 1: Not modelled

The Flood Assessment typically has similar but slightly lower flood levels that those reported in the WRL study (1996).

Draft WMB BMT

Table 2.20 provides a comparison of the model data for peak flows, peak flood levels and associated tailwater conditions for both the Flood Assessment and the BMT Draft Flood Study.

Table 2.20 Comparison of Results

Flood Event	Peak Flows (m3/s)		Peak Flood Levels (mAHD)		Tailwater Conditions	
	Umwelt Flood Assessment[1]	WMB BMT Flood Study	Umwelt Flood Assessment[1]	WMB BMT Flood Study	Umwelt Flood Assessment[1]	WMB BMT Flood Study
20%		426		54.2		2 yr ARI, 48.2
10%	944	553	56.6	54.6	Bank full, 54.5	2 yr ARI, 48.2
5%	1,179	717	57.2	55.2	Bank full, 54.5	20%, 51.3
1%	1,695	1,142	58.4	55.9	10%, 56.0	10%, 53.3
0.5%	1,952	1,453		56.7	1%, 59.1	5%, 55.3
0.2%	2,258			57.9	1%, 59.1	2%, 57.8
PMF	7,452		63.2		1%, 59.1	
Extreme Flood		7,146		62.8		1%, 59.8

1. Source: Table 4.1 SWA

Further discussion of the differences between the results of the Flood Assessment and WBM BMT Draft Flood Study are included below in **Table 2.21** as a high level summary of the key aspects of the Flood Assessment and BMT Draft Flood Study that are considered to influence the differences in modelled outcomes. Although it is agreed with OEH, that with the new rating curve data / analysis the Flood Assessment results are conservative, it is also considered that the flood levels presented in the BMT Draft Flood Study underestimate the potential flood levels adjacent to the Project Area and in the general Warkworth area especially in consideration of the potential tailwater levels in the Hunter River.

Table 2.21 Key Aspects and Differences in the Flood Assessment and BMT Flood Study

Key Aspects	Flood Assessment Approach	BMT Flood Study Approach	Key differences / influences on model results
Rating Curves	Data used from PINNEENA at the time of the assessment (i.e. prior to the release of the updated rating curve for Warkworth gauge).	Study included review of PINNEENA rating curve and historical data, including the recently released rating curve for the Warkworth Gauge April 2015 and estimation of a new set of rating curves for the streamflow gauges on Wollombi Brook.	BMT analysis gives lower flow rates for higher flood levels.
Hydrology Model Calibration	Hydrology model was calibrated to a small flood event at the Warkworth Gauge and outputs for design storm events compared to a Flood Frequency Analysis (at the Warkworth Gauge) (i.e. based on the rating curve data as per above).	Hydrology model was calibrated to provide outputs similar to the estimated rating curves (refer above) for three flood events (2007, 1949 and 2015).	BMT hydrograph shape is flatter (i.e. increased duration of higher flow rates) with lower peak flow rates.
Digital Terrain Data / Model Base	Triangular irregular mesh used to represent the varying scale of features associated with the channel, overbank and hydraulic features of the floodplain. Mesh orientated to represent hydraulic features. Estimated no flow in the brook at the time of LiDAR survey.	Gridded network used with 5 metre spacing. Not orientated to hydraulic features. No information of water level/flow conditions in the flood at the time of LiDAR survey.	Channel shape / capacity could be influenced by water levels in base LiDAR survey data.

Key Aspects	Flood Assessment Approach	BMT Flood Study Approach	Key differences / influences on model results
Hydraulic Roughness	In channel roughness, mannings n, for Wollombi Brook of 0.075	In channel roughness, mannings n, for Wollombi Brook in lower reaches, of 0.045. Depth varying mannings n only used for design events, not for calibration.	BMT Wollombi Brook channel (adjacent to Project Area) is smoother.
Hydraulic Calibration	Model results verified by comparison to historical flood levels (as presented in PINNEENA) and WRL (1996) flood study.	Model results calibrated to estimated rating curves (refer above).	BMT analysis gives lower flow rates for higher flood levels.
Tailwater Influences	Tailwater analysis for Hunter River used long term gauging stations (Singleton, 1914 to 2005 and Liddell, 1973 to 2006) with 81 flood records presented in PINNEENA in the Log Pearson 3 (LP3) Distribution Frequency Analysis. Tailwater modelled as a static level. LP3 preferred method of analysis in PINNEENA at the time of preparation of the flood assessment.	Tailwater analysis for the Hunter River uses data from Mason Dieu, 1993 to 2015 (13 flood records only presented in PINNEENA, although Gumbel distribution method in BMT study provides for a wider range of values to be used in the analysis). Gumbel distribution method used to determine flood frequency (Gumbel is now the preferred model of analysis). Tailwater hydrograph shape based on 2007 flood hydrograph shape.	BMT analysis provided lower tailwater levels compared to Flood Assessment. BMT analysis does not consider data from earlier major floods in the Hunter River (e.g. 1955). BMT analysis does not consider the potential for increased duration of flooding in the Hunter River (e.g. flood duration recorded at Singleton for the 1995 flood was twice as long as the flood duration recorded for the 2007 flood, although similar peak flood levels were recorded).

Note: PINNEENA is a data dvd published by the NSW Government containing continuous monitoring data for surface water and groundwater systems. The dvd includes analysis outputs/methods from NSW Government including outputs from rating curves (i.e. translation of water levels during floods to flow rates).

The flooding assessment undertaken for the EIS has been noted by OEH as conservative and appropriate for assessment purposes. It is considered that the new data that has come to light since the commencement of the Flood Assessment (i.e. new rating curve by DPI Water for Warkworth gauge and rating curve analysis/estimates undertaken for the BMT Draft Flood study) should be considered as part of the flood model updates for future design works for the proposed flood levee and highway alignments. This approach is generally consistent with the recommended conditions from OEH.

Waterfall Creek

As discussed in Section 6.2.2 of the Surface Water Assessment, dynamic flood modelling of Waterfall Creek was undertaken using XPStorm®. Flood modelling was undertaken for the pre mining landform and the Project final landform. Flood events that were simulated included the 10 per cent, 5 per cent and 1 per cent AEP flood events and the PMF event.

For the assessment, flood modelling results for the Project final landform have been compared to the pre mining landform.

The approved final landform model includes the proposed Wambo Open Cut Pit Final Void and final rehabilitated landforms for the Project. The flood modelling for all events and landforms is based on the assumption that all dams are full so as to obtain a conservative estimate of impacts on flood peaks.

XP-Storm models a watercourse as a series of nodes along a channel, connected by drainage links. Nodes are the locations at which subcatchment information may be entered into the model, including subcatchment area, slope and percentage impervious area. Drainage links are characterised by a channel length, slope, cross-section, maximum water depth, upstream and downstream channel inverts, and Mannings 'n'. The XP-Storm model layout used in the flood assessment of Waterfall Creek is shown in **Figure 2.11**.

The critical parameters used in the XP-Storm analyses were:

- Laurenson Equation S = BQ n+1

Where: S = volume of storage (m^3)

B = Storage Delay Parameter

Q = instantaneous rate of runoff (m^3/s)

n = -0.285

- Horton infiltration

Where: Maximum infiltration rate (Fo) of 25.4 mm/hr

Minimum (Asymptotic) infiltration rate of 1.27 mm/hr

Decay rate of infiltration 0.002 1/sec.

The initial and continuing loss rates are based on data obtained during field inspections of the general catchment area and are consistent with values recommended by *Australian Rainfall & Runoff* (AR&R) (IEAust, 1987).

The values of Mannings 'n' adopted are based on information gathered during site inspections for each of the catchment elements and from aerial photographs. The values used for Mannings 'n' to represent the different catchment elements are listed in **Table 2.22**.

Table 2.22 Mannings 'n' values for Different Catchment Elements

Element	Mannings 'n'
Natural Channel Sections	0.045
Pervious Catchment Areas	0.25*
Impervious Catchment Areas	0.014*

Note: * denotes Mannings 'n' for overland flow

Design rainfall data and temporal patterns were derived for the catchment area using the principles set out in Chapter 2 of AR&R (IEAust, 1987). These design rainfall intensities were translated into absolute rainfall depths for each AEP and storm duration for input into the 1D model.

Rainfall intensities derived using the processes outlined in AR&R (IEAust, 1987) are only suitable to be used for areas up to 4 km^2. For larger areas an aerial reduction factor may be used to take into account changes in rainfall intensity over larger areas. Due to the small size of the Waterfall Creek catchment area relative to the maximum ARF area of 1000 km^2 the ARF would provide a negligible reduction in the point rainfall values and hence have not been used for this assessment.

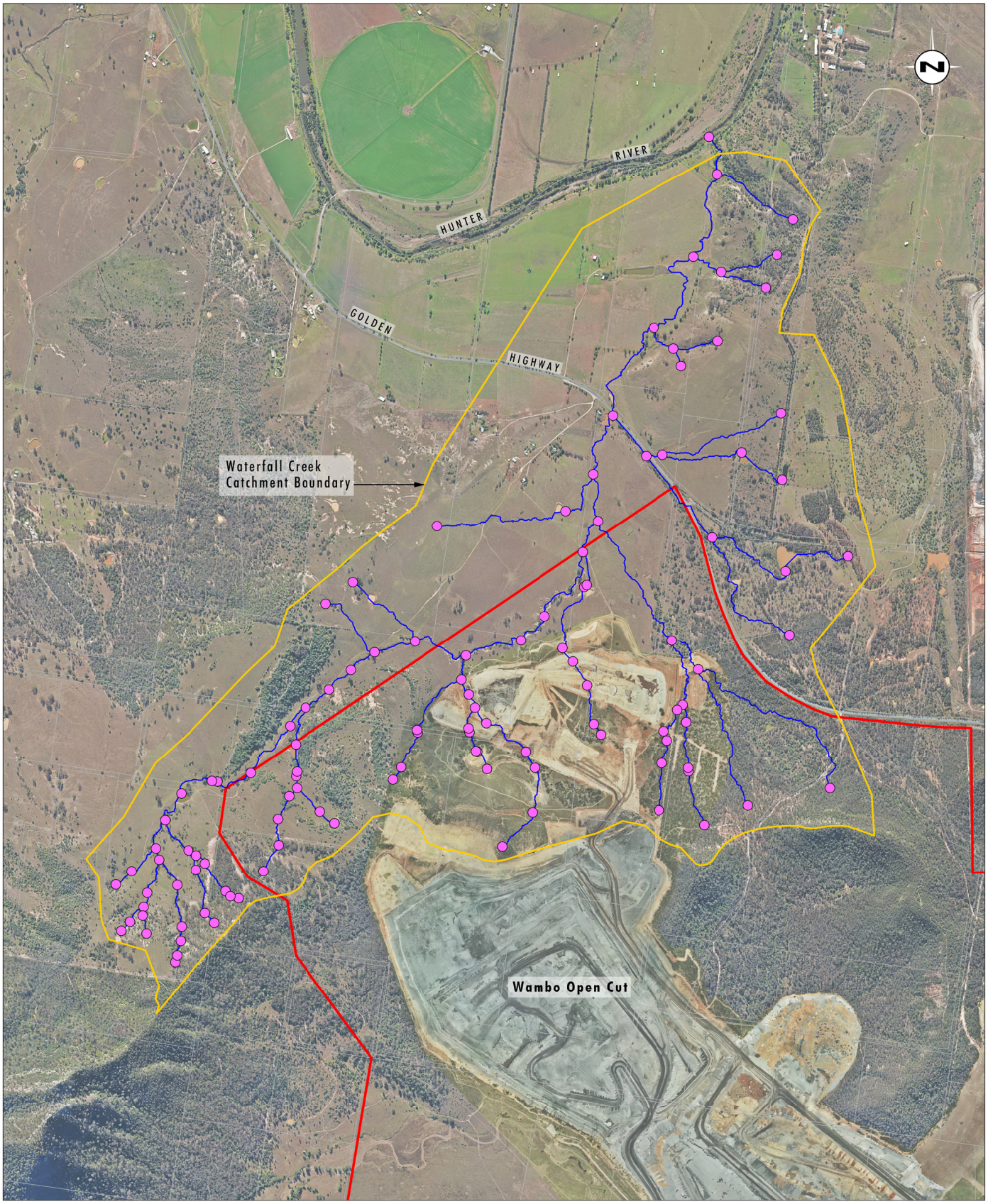


Image Source: United (2016)
Data Source: LPMA (2009)

0 0.25 0.5 1.0km
1:25 000

Legend

- Project Area
- Catchment Boundary
- Links
- Nodes

FIGURE 2.11

XP Storm Layout
Waterfall Creek Pre-mining

b. Groundwater assessment and modelling:

i. The potential for the Wambo void lake and the tailings storage facilities (TSFs) to become a recharge source for the Permian groundwater system and subsequently the alluvial aquifers and surface waters through upwards leakage.

Summary Response

In order to understand the potential likelihood and risk of the Wambo void lake and tailing storage facilities (TSF) becoming recharge sources groundwater flow modelling and analysis was conducted. The groundwater assessment identified that due to extensive depressurisation of the Permian coal measures from approved and the proposed mining, groundwater is drawn towards and into the active mine areas. The proposed United final void acts as a dominant groundwater sink, drawing in groundwater from the Permian coal measures and all saturated spoil at the site. The final void will not become a recharge source to any aquifers.

As part of the Project, one new TSF is proposed, which is located within a compartment of the South Bates open cut, part of the current Wambo open cut. The Project will also utilise the currently approved Homestead TSF and Main TSF. The maximum fill level for the proposed South Bates TSF is approximately 50 metres below surface and 40 metres below the base of alluvium. The TSF will only be utilised during active mine operations, therefore current groundwater conditions of depressurised Permian coal measures are expected to be maintained over the life of the TSF. It is therefore considered unlikely that water associated with the TSF would interact with the alluvium along North Wambo Creek Diversion following capping of the tailings; there will be no rainfall or surface inflows to the TSF and therefore no recharge opportunities.

Post closure, water surrounding the proposed TSF and in-pit spoil will flow towards the final voids and remain contained within the mine area. Therefore, there is minimal risk of groundwater within the in-pit spoil and proposed final voids influencing stratigraphy outside of the mine area post closure.

Based on geochemistry assessment, during operation the waste rock and tailings are unlikely to cause adverse changes in groundwater quality, due to low AMD potential. The total PAF or PAF-UC material that remains onsite as CHPP reject is potentially a maximum of 0.35 per cent of the overall volume of material handled during mining operations.

The vast bulk of overburden, interburden and floor materials are unlikely to be acid producing or release significant salinity and will be acid consuming. This is consistent with the current experience within the Project Area and as most of the overburden material is acid consuming, the operational practice of rapid burial and mixing of any potential acid forming (PAF) materials with overburden is expected to be sufficient to control any potential for acid generation.

Detailed Response

In order to understand the potential likelihood and risk of the Wambo void lake and tailing storage facilities (TSFs) becoming recharge sources further groundwater flow modelling and analysis was conducted. The findings of this further modelling and analysis are outlined below.

Groundwater Flow

The flow of groundwater stored within waste rock used to infill the mined area and the influence of TSF's was represented within the numerical model developed for the GIA. The representation of waste rock and the TSF's within the model is discussed in Appendix B of the GIA. The groundwater assessment identified that due to extensive depressurisation of the Permian coal measures from approved and the proposed mining, groundwater is drawn towards and into the active mine areas. The extent of cumulative drawdown is presented in Figure 7-13 to Figure 7-18 of the GIA report.

Groundwater Flow

The flow of groundwater stored within waste rock used to infill the mined area and the influence of TSF's was represented within the numerical model developed for the GIA. The representation of waste rock and the TSF's within the model is discussed in Appendix B of the GIA. The groundwater assessment identified that due to extensive depressurisation of the Permian coal measures from approved and the proposed mining, groundwater is drawn towards and into the active mine areas. The extent of cumulative drawdown is presented in Figure 7-13 to Figure 7-18 of the GIA report.

Recharge Potential from Wambo Void Lake

Focusing on the Wambo void lake component of the submission, groundwater flow path modelling using Mod-PATH3DU (Papadopulos, 2014) was utilised to simulate groundwater movement in relation to the proposed final voids post mining. The predicted flow pathways originating from the shallow overburden and alluvium are presented in Figure 24 of **Appendix 2**, and the deeper groundwater flow pathways (i.e. Permian coal measures and in-pit spoil) are shown in Figure 25 of **Appendix 2**. The pathlines for alluvium from the start of recovery to the end are presented in the one figure. Due to the greater number and length of the flow pathlines for the Permian coal measures, the figure has been divided into four segments to show the temporal development of the flow pathline over the full recovery period.

As shown within Figure 24 of **Appendix 2**, alluvial groundwater flow largely follows the direction of stream flow and, in areas, discharges to the stream. Surrounding the mine area, shallow groundwater flows towards the mine disturbance area. Figure 25 of **Appendix 2** shows the groundwater flow through undisturbed Permian coal measures (i.e. surrounding the mine and beneath the mined strata) and in-pit spoil. The growth of the flow pathways is presented from the commencement of the recovery model up to 10, 50, 100 and 1000 years post mining. As shown in Figure 25 of **Appendix 2**, the proposed United final void acts as a dominant groundwater sink, drawing in groundwater from the Permian coal measures and all saturated spoil at the site. To the northwest of the mine area, Figure 25 of **Appendix 2** shows flow within the Permian coal measures and deep spoil flowing in a northwest then north-easterly direction, towards HVO South. This trend is not observed in the shallower strata in Figure 24 of **Appendix 2**, so does not reflect a potential source to other aquifers. However, it does show the influence of the HVO South future final void design (part of another mining operation (unrelated owner) to the north and not part of this Project).

Recharge Potential for TSFs

As part of the Project, one new TSF is proposed, which is located within a compartment of the South Bates open cut. The Project will also utilise the currently approved Homestead TSF and Main TSF (refer to **Figure 2.12**). The South Bates TSF is proposed to be filled to a maximum elevation of 41 mAHD. The closest receptor to the proposed South Bates TSF is North Wambo Creek, which is located approximately 150 metres to the south. Bore GW19 intersects the alluvium between the proposed South Bates TSF and North Wambo Creek, and GW20 (VWP) was installed approximately 700 metres to the southeast. Bore GW19 recorded sands and gravels to a depth of 6.5 metres, and conglomerates present to 8 metres depth. VWP GW20 recorded sands, gravels and clays to a depth of 8.1 metres. This indicates that permeable alluvial stratigraphy occurs to a depth of around 8 metres (83 mAHD), which is underlain by lower

permeability Permian coal measures (i.e. siltstone and sandstone). Another bore (P4) is also present approximately 900 metres south-east of the proposed South Bates TSF, and is understood to be screened within alluvium to a depth of 5.5 metres. Water level monitoring at GW19 and P4 indicate the alluvium is unsaturated within this area. Results from nearby bores intersecting the weathered overburden (GW18 and GW21) show unsaturated conditions.

The maximum fill level for the proposed South Bates TSF is approximately 50 metres below surface and 40 metres below the base of alluvium. The TSF will only be utilised during active mine operations, therefore current groundwater conditions of depressurised Permian coal measures are expected to be maintained over the life of the TSF. It is therefore considered unlikely that water associated with the TSF would interact with the alluvium along North Wambo Creek following capping of the tailings; there will be no rainfall or surface inflows to the TSF and therefore no recharge opportunities. The Mod-PATH3DU recovery modelling presented in Figure 24 and Figure 25 of **Appendix 2** also shows that post closure, water surrounding the proposed TSF will flow towards the final voids and remain contained within the mine area.

In order to monitor these conditions and identify any unforeseen changes early, the proposed groundwater monitoring program has been updated. As outlined within Part A of the RTS (Umwelt 2017), the proposed monitoring program includes regular monitoring at bores P4 and GW18 to GW20.

Conclusions

The Mod-PATH3DU recovery modelling presented in Figure 24 and Figure 25 of **Appendix 2** shows that post closure, water surrounding the proposed TSF and in-pit spoil will flow towards the final voids and remain contained within the mine area. Therefore, there is minimal risk of groundwater within the in-pit spoil and proposed final voids influencing stratigraphy outside of the mine area post closure. Based on the available data and the *United Wambo Open Cut Coal Mine Project Waste Rock/Tailings Geochemical Characterisation and Acid & Metalliferous Drainage Assessment* undertaken by GeoTerra (2017), during operation the waste rock and tailings are unlikely to cause adverse changes in groundwater quality, due to low AMD potential.

Overall, the overburden material is considered as NAF, with a low likelihood of AMD generation. GeoTerra (2017) found the existing tailings at Homestead TSF were NAF, and had a low likelihood of AMD generation. Results for core samples from the CHPP washability trials and CHPP rejects indicate low to moderate ANC, with most samples classified as NAF. Some samples for certain coal seams were classified as PAF or PAF-UC, with a low to moderate acid production potential. These seams make up approximately 15.5% of the total coal extracted as part of the Project (GeoTerra 2017) which is then washed and transported off site. However, these results are considered to represent a 'worst case' scenario as they are based on laboratory conditions. The total PAF or PAF-UC material that remains onsite as CHPP reject is very small, being potentially a maximum of 0.35 per cent of the overall volume of material handled during mining operations.

In addition, the vast bulk of overburden, interburden and floor materials represented by the samples tested are unlikely to be acid producing or release significant salinity and will be acid consuming. This is consistent with the current experience within the Project Area and as most of the overburden material is acid consuming, the operational practice of rapid burial and mixing of any PAF materials with overburden is expected to be sufficient to control any potential for acid generation. The volume of acid consuming material that will be emplaced is vast and will significantly out-weigh the PAF materials emplaced on site. As discussed above, the total PAF or PAF-UC material that remains onsite is very small at a maximum of 0.35 per cent.

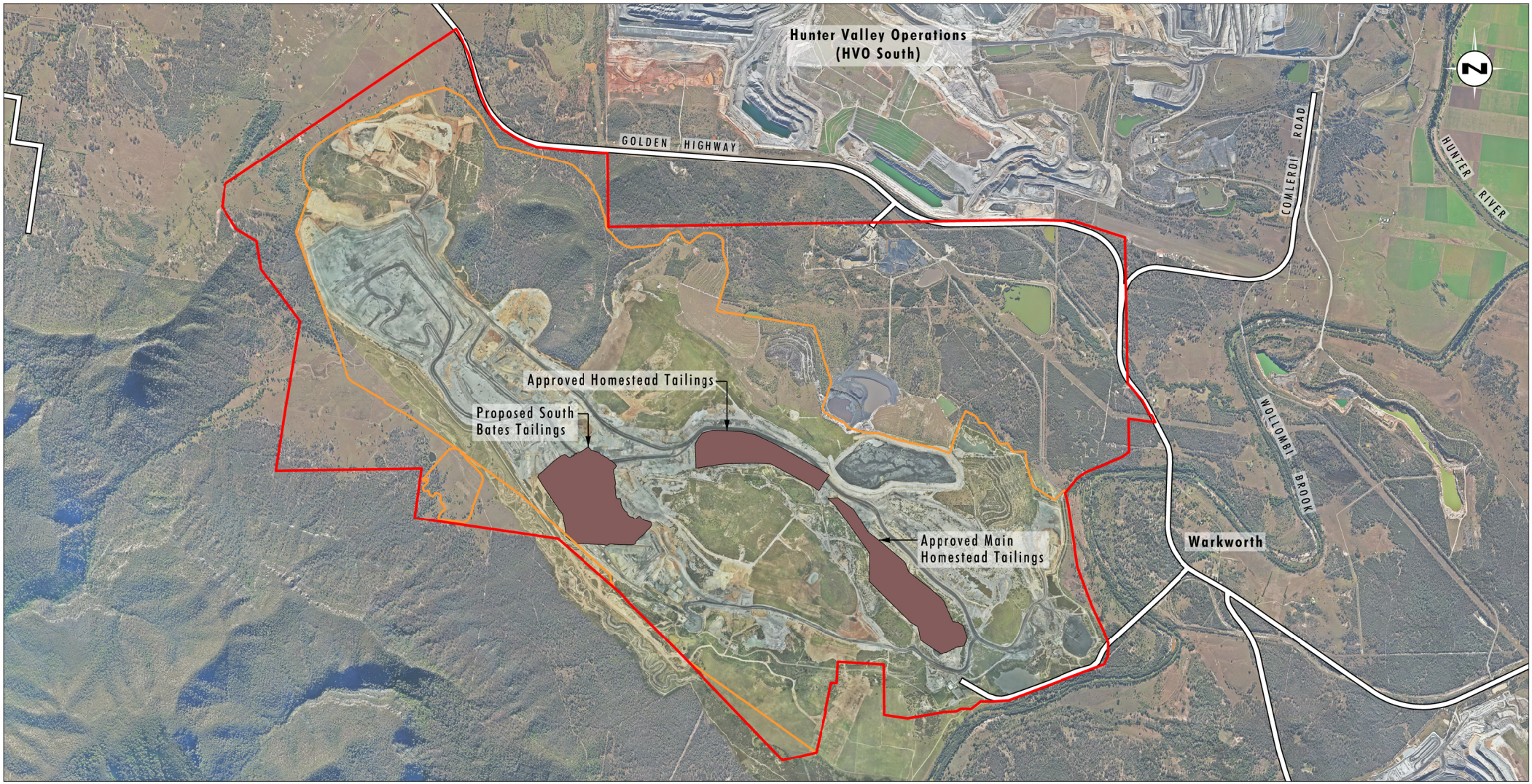


Image Source: United (2016)
Data Source: Glencore (2015)

0 1.0 2.0 2.5km
1:50 000

Legend

- Project Area
- Approved Wambo Surface Development Area
- Approved and Proposed Tailings Storage Facilities

FIGURE 2.12

Conceptual Tailings Storage Facilities

File Name (A4): R18/3509_591.dgn
20170530 10.05

To mitigate potential impacts due to PAF and PAF-UC results for certain coal seams, a tailings management plan will be developed for the Project. The plan will include monitoring and management of tailings slurry to help maintain NAF conditions within the proposed South Bates TSF. The plan will draw on findings by GeoTerra (2017) and be prepared in consultation with relevant regulators.

Based on recommendations from GeoTerra (2017), ongoing monitoring and testing will be conducted to order to detect any changes in these conditions over the life of the Project. This includes water quality monitoring for EC, pH and key AMD indicators. These include sulphate and key metals (Al, As, Co, Cu, Fe, Mn, Ni, Se and Zn), which are already captured within the proposed monitoring program for the Project. The proposed monitoring network was also updated (Part A RTS) to include additional bores within the regolith and spoil around the Project and proposed South Bates TSF. The bores were positioned to enable assessment of groundwater levels, flow directions and water quality, to be monitored on a regular basis for early detection of groundwater quality changes. These mitigation measures will be captured within the Project specific WMP plan.

Identification of any changes or long term trends in groundwater quality outside the predicted impacts will result in an investigation to determine if the trend is a result of the Project operations. If impacts are identified, management strategies will be implemented to address the identified issues in accordance with a TARP process (T – trigger; A – Action; R – response; P – Plan) to be developed for the Project.

ii. Use of the United Collieries underground workings as a water storage facility and the potential impact this could have on groundwater quality.

Summary Response

The existing United underground mine is currently used as a water storage facility and the WMS plans to continue this use as part of the Project. Excess water will be pumped underground and water extracted from the underground storage as needed for use on the site. Both United and Wambo Mines have been using water extracted from the United underground workings as part of normal mining operations over a number of years. This is common practice within previous underground workings in the Hunter Valley.

The underground workings are considered to be a good option for storing mine water. Regardless of United's plans for the ongoing use of the voids for water storage, the previous underground workings would naturally fill with water from coal seams over time and would therefore hold similar quality water.

The use of the voids to store water was considered as part of the groundwater assessment which found that the storage could be undertaken without resulting in the discharge of poor quality groundwater to the alluvial aquifers.

Building a surface storage to contain the water above ground would result in greater impacts including increased ground disturbance and/or limiting resource extraction to accommodate a significantly sized water storage. Using the existing underground workings for water storage is considered by United to present a better overall environmental outcome than storing the water on the surface.

Detailed Response

The United Underground Mine (United Underground) was mined into the Arrowfield Seam and has been inactive since 2010. The United Underground is beneath the North Wambo Underground, which intersects the Wambo seam (refer to Figure 26 of **Appendix 2**). The floor of the United Underground occurs at an elevation of around -222mAHD, while the floor of the North Wambo Underground occurs around -49mAHD.

Groundwater modelling has found that the United Underground workings can be used as water storage without causing discharge of poor quality groundwater to the alluvial aquifers.

Since 2010, groundwater levels within the inactive United Underground have naturally been recovering, to an elevation of around -127mAHD. Due to the position of the two underground mines, investigations into the interaction between recovered groundwater levels in United Underground and North Wambo Underground have been conducted. These investigations demonstrated that temporary storage of water within the United Underground is possible, with appropriate management controls to be implemented to avoid interaction issues with the Wambo underground. The Woodlands Hill Underground has also been approved, which will intersect the Woodlands Hill Seam immediately above the United Underground. From a groundwater perspective, due to the restriction on maximum fill elevation, the stored water would not form any hydraulic connection with the alluvial aquifer.

iii. The potential influence of faults (i.e. to act as either barriers or conduits) on groundwater flow within the groundwater model domain.

Summary Response

Numerous hydrogeological and geotechnical assessments have been conducted across the site over its long history. Faults have been intersected in mine workings across Wambo and United. Faults are generally orientated in a north-south or northeast-southwest direction. North-south trending faults are generally high angle faults with displacements of less than 2 metres. Northeast trending faults are generally low angle thrust faults with displacements of up to 7.5 metres.

The numerical model developed for the Project uses the 'effective porous media approach', whereby the permeability and storage imparted from joints and fractures is represented as a porous media. Consequently, secondary porosity features within the Permian stratigraphy are captured by the hydraulic properties, derived from available field data and calibration against observed groundwater trends.

The groundwater model is capable of predicting impacts due to mining, as evidenced by the good measure of fit between observed and modelled groundwater levels, which includes replicating localised drawdown responses to historic mining at Wambo and United.

Previous experience in the area demonstrates that structural changes due to fault displacement can influence flow directions; however, the faults themselves are not acting as conduits enhancing groundwater flow. The structural influence of the faults on groundwater flow is reflected within the model layers. The model layers were developed based on detailed site geological models and therefore capture localised displacement of the Permian stratigraphy.

In summary, the groundwater model appropriately considered the influence of faults and calibration of the model has shown that it is capable of accurately predicting the impacts of the Project.

Detailed Response

As outlined within Section 4.3 of the GIA, the Permian coal measures are stratified (layered) sequences that have undergone deformation resulting in strata dipping in a general south-westerly direction within the Project Area. Regionally, the coal measures are influenced by large fold structures, including the Muswellbrook Anticline and the Bayswater Syncline, which occur east of the Project Area and trend in a north to north-west direction.

Numerous hydrogeological and geotechnical assessments have been conducted across the site over its long history, including reports by AGC (1989), BHP Engineering (1990), CCB (1999 and 2004), Harrison (1999) and HLA EnviroScience's (1995). As outlined within the reports, faults have been intersected in mine workings across Wambo and United. Faults are generally orientated in a north-south or northeast-southwest direction (refer to Figure 4-3 of GIA). North-south trending faults are generally high angle faults with displacements of less than 2 metres. Northeast trending faults are generally low angle thrust faults with displacements of up to 7.5 metres. BHP Engineering (1990) conducted a regional aeromagnetic survey of the region and concluded that no faults occur along major rivers or drainage features.

A site geotechnical assessment conducted by Douglas Partners (1995), outlines the natural discontinuities for the Permian Coal Measures. According to the report, fracture spacing within siltstone and competent sandstone can range between 0.1 metre and 0.8 metre, for low to medium strength sandstone it can range between 0.5 metre and over 1 metre. Cleating within the coal seams is well developed, and fracture spacing ranges between less than 0.1 metre and 0.2 metre. Joint dips occur at sub-vertical angles of 70^{o} to 80^{o}, with lateral and vertical continuity of the joints ranging from less than 1 metre to over 10 metres (Douglas Partners 1995).

The numerical model developed for the Project uses the 'effective porous media approach', whereby the permeability and storage imparted from joints and fractures is represented as a porous media. Consequently, secondary porosity features within the Permian stratigraphy are captured by the hydraulic properties, derived from available field data and calibration against observed groundwater trends. Ultimately all numerical models represent complex geological systems in a simplified manner, and whilst knowledge of small scale details remains useful, it often cannot be represented realistically within models. However, the groundwater model is capable of predicting impacts due to mining, as evidenced by the good measure of fit between observed and modelled groundwater levels, which includes replicating localised drawdown responses to historic mining at Wambo and United. As outlined in the GIA, the transient calibration achieved a 3.14% scaled root mean square error, which is well within the acceptable limits recommended by the Australia groundwater modelling guidelines (Barnett *et al*, 2012).

Drill logs around the Hunter Valley Cross Fault indicate a maximum displacement of approximately 10 metres, with no details documented about increased groundwater flows within the vicinity of the fault. The Redmanvale Fault is a large reverse fault, which has a throw of about 20 metres downthrown to the south (CCB 1999). The location of Redmanvale Fault is inferred to occur over 2.5 km south of the Project Area. Work is currently being undertaken by Wambo to assess the alignment of the Redmanvale Fault in relation to currently approved operations at the South Bates Underground. At the Wollemi Boxcut, a fault zone consisting of several horst and graben structures with individual throws of up to 8 metres has been identified. Figure 27 of **Appendix 2** shows the northern highwall at the historic Wollombi Mine, with water visible where spoil material overlies a downthrown section of the *in situ* strata. While water is visible at this low-point, it is not visible within the fault zone. Water is also not present within the fault zone along the southern highwall of Wollombi Mine (refer to Figure 28 of **Appendix 2**). This demonstrates that structural changes due to fault displacement can influence flow directions; however, the faults themselves are not acting as conduits enhancing groundwater flow. The structural influence of the faults on groundwater flow is reflected within the model layers. The model layers were developed based on detailed site geological models and therefore capture localised displacement of the Permian stratigraphy.

Two north-east to south-west trending dykes have also been mapped at site known as the Hunter Valley Dyke and Tank Dyke. The Hunter Valley Dyke occurs approximately 600 metres north of the Project Area (Wambo Open Cut), while Tank Dyke is mapped across the existing Wambo Open Cut. The Hunter Valley Dyke extends for approximately 16 km and ranges between 5 metres and 20 metres in thickness (Mackie 2009). Mackie (2009) reports that the dykes are relatively impermeable over significant strike lengths and can act as barriers to groundwater flow. Hydraulic parameters are not available for the dykes mapped at site. Therefore, in the absence of supporting data the numerical groundwater model did not include low permeability zones to represent dykes. This ensured the predicted drawdown was conservative as it could extend further than possible if it intersected a relatively impermeable dyke.

c. Groundwater dependent ecosystems:

i. Potential combined effects on GDEs due to groundwater drawdown and a reduction in surface water flows. For example, the effects of reduced baseflow on low-flow conditions and aquatic biota in Wollombi Brook.

ii. Characterisation of GDEs (including stygofauna) in the Hunter River alluvium where the proposed project is predicted to cause up to 10m of groundwater drawdown.

Summary Response

The potential GDEs in the vicinity of the Project Area that could be influenced by the Project were identified, mapped and assessed in the EIS. The EIS assessment found that no significant impacts on GDEs were predicted as a result of the Project. This assessment finding has not changed with the further work undertaken to address the IESC comments.

In regard to the potential impacts of changes to surface water flows on GDEs outside the Project disturbance footprint, the majority of the GDEs identified are associated with the floodplain and associated alluvial areas of Wollombi Brook and the Hunter River. No significant impacts on GDEs or aquatic biota associated with changes to surface water flows within Wollombi Brook are predicted.

In regard to impacts on alluvial zones where GDEs may occur, the Project design incorporates offset distances to Wollombi Brook (approximately 370 metres) and the Hunter River (approximately 1.7 kilometres) which exceed the 200 metre offsets recommended in the NSW Aquifer Interference Policy (AIP) so that impacts to alluvial systems are minimised as far as possible.

The Project is not predicted to cause up to 10 metres of groundwater drawdown within saturated alluvium as inferred in the IESC comment. The cumulative drawdown within saturated alluvium along the Hunter River is generally between 1 metre and 2 metres. The existing HVO South (refer to **Figure 1.2**) operations occur between the Project Area and the Hunter River to the north. The cumulative impacts from approved mining at HVO South, Wambo and MTW have a greater influence on the drawdown within saturated alluvium along the Hunter River.

In response to the IESC comments additional stygofauna surveys have been completed in the Hunter River alluvium. This additional survey and assessment found that stygofauna exist in very low diversity within the alluvial aquifer of the Hunter River and are absent at the sites surveyed within the Wollombi Brook Alluvium. The predicted drawdown of the Hunter alluvium is predicted to have a minimal, local impact on the stygofauna community due to poorly developed biodiversity, the large extent of the alluvium and the connection with the Hunter River which will aid in long term recolonisation of impacted zones. The potential impact on the stygofauna community in the area of drawdown will be a small loss of habitat associated with the dropping of water levels and a change in flow direction between the surface water and groundwater. A risk assessment ranked ecological risk to sites where stygofauna were present as low value/low risk (refer to Part A of the RTS). The remaining bores which did not record stygofauna were ranked as low value/low risk.

Detailed Response

As discussed in the EIS, the following vegetation types occurring outside the additional disturbance area but in proximity to the Project have the potential to be at least partially groundwater-dependent:

- Central Hunter Swamp Oak Forest
- Hunter Floodplain Red Gum Woodland Complex
- Hunter Valley River Oak Forest
- River Flat Eucalypt Forest
- stands of individual river red gum trees (*Eucalyptus camaldulensis*)
- Warkworth Sands Woodland.

The area of Hunter River alluvium where some drawdown is predicted consists of areas that have previously been highly disturbed by historical agricultural activities and no GDEs have been identified.

Potential drawdown is predicted to be relatively limited in area and impacts upon only a small portion of possible Central Hunter Swamp Oak Forest and possibly a small number of River Red Gum trees. Further discussion of the predicted groundwater drawdown and interactions with GDEs and stygofauna are provided below.

As outlined within the GIA, the predicted drawdowns presented in the GIA are considered conservative. To provide further definition of the interaction of the Project with areas where GDEs (outside of stygofauna) may occur, further analysis of the predicted drawdown of the saturated alluvial and shallow overburden outside the mining footprint has been undertaken. Figure 22 of **Appendix 2** shows the drawdown attributable to the Project only within the saturated alluvium and shallow overburden. As presented in Figure 22 and Figure 23 of **Appendix 2**, cumulative drawdown within saturated alluvium along the Hunter River is generally between 1 metre and 2 metres. The Project is not predicted to cause up to 10 metres of groundwater drawdown within saturated alluvium.

The GIA (refer to Appendix 12 of the EIS) considered impacts on potential GDEs and assessed the potential for groundwater impacts to occur in the areas occupied by the potential GDEs. The assessment identified two areas of GDEs within the zone of cumulative drawdown that were predicted to be impacted (which were labelled for the purpose of the GIA as GDE1 and GDE2). The predicted impacts on these areas are discussed below. The GIA also found that the predicted groundwater drawdown would not affect Wollombi National Park which is located to the west of the Project Area.

As outlined in Section 6.9.4.1 of the EIS, approximately 1 metre in groundwater level decline is predicted at GDE2 due to cumulative impacts from mining (approved mining and the Project). The decline in groundwater levels at GDE2 is along the fringes of Wollombi Brook. This drawdown is relatively limited in area and impacts upon only a small portion of possible Hunter Valley River Oak Forest and possibly a small number of River Red Gum trees. Both of these species have a dependency on groundwater, but both also have a high degree of drought tolerance, particularly River Red Gum. The vegetation communities in which they occur are highly disturbed from historical land uses (primarily agricultural practices) and are affected by substantial weed establishment. It is expected that the impacts resulting from the drawdown will be negligible on these species and the vegetation communities in which they occur. Hunter Valley River Oak Forest and River Red Gums are not listed under the EPBC Act.

At GDE1 groundwater levels are predicted to decline more significantly with mining (approved mining and the Project). The alluvium near GDE1 is predicted in the groundwater modelling to become largely unsaturated due to cumulative impacts from approved mining at HVO South, Wambo and MTW (refer to Appendix 13 of the EIS). This desaturation occurs due to the existing approved mining, without the Project. Based on the conceptual timing of the Project, the Project may result in this effect occurring approximately one year earlier, however, this depends on a range of factors and the timing of any approval for the Project and is highly uncertain. Therefore, the Project is not considered likely to result in impacts beyond those currently approved for GDE1.

As outlined within the GIA (Section 3.4 and Section 5.3), groundwater level data indicates the alluvial aquifer obtains 'focussed' recharge from stream flow, as well as 'diffuse' recharge from rainfall. A minor proportion of recharge to the alluvium also occurs from upward seepage from the underlying Permian coal measures. However, due to the poorer quality water within the Permian coal measures, upward leakage can increase the salinity of the alluvial aquifer. As outlined within the stygofauna report (Appendix E of the GIA), stygofauna species diversity was noticeably reduced or absent where alluvial groundwater became brackish to saline (i.e. EC of over 1779µS/cm). Therefore, stygofauna populations are largely localised along streams and riparian areas. Figure 22 of **Appendix 2** shows the extent of drawdown in saturated alluvium

due to the Project alone is restricted to isolated areas, away from stream embankments and riparian zones. The figure shows the Project contributes no additional drawdown to saturated alluvium along Wollombi Brook, and less than 2.5 metres of drawdown within an area of alluvium south of the Hunter River.

It should be noted that the numerical model represented natural climatic and streamflow variability through the model input files. Rainfall was replicated in the recharge package by using historical rainfall averaged over a quarterly period (i.e. December to March quarter) effectively representing seasonal changes. The model also represented the interaction of the aquifers with the perennial rivers (i.e. Wollombi Brook and Hunter River) through the river package. The river stage heights were represented in the model based on historical measured stream levels at government stream gauge stations. Observed stream gauge heights were replicated within the historical model, and were also used within the predictive model to represent natural variability, including quarters with historically low flow conditions.

Further assessment of stygofauna was undertaken and details provided in Question 2 below.

In regard to potential impacts of changes to surface water flows on GDEs outside the Project disturbance footprint, as outlined in Section 6.8.1 of the EIS, the majority of the GDEs identified are associated with the floodplain and associated alluvial areas of Wollombi Brook and the Hunter River. GDEs have been identified along the downstream reaches of Redbank Creek adjacent to the confluence with Wollombi Brook and located within the flood prone lands associated with Wollombi Brook. As such potential impacts on GDEs will primarily be influenced by changes in flows in Wollombi Brook and the Hunter River as opposed to their ephemeral tributaries. Analysis of the flow duration curve for Wollombi Brook indicates that the predicted changes to annual flow volumes are small on a regional scale. On this basis, no significant impacts on GDEs associated with changes to surface water flows within Wollombi Brook are predicted. Analysis of the flow duration curve for the Hunter River indicates that the predicted changes to annual flow volumes are negligible on a regional scale in the Hunter River. The Project is consequently considered unlikely to result in impacts on ecosystems, including GDEs.

d. Impacts arising from leaching from TSFs and materials used in the final landforms.

Summary Response

The Project proposes to utilise existing and approved tailings storage facilities at Wambo, including the approved Homestead and Main Homestead tailings storage facilities. In addition, the Project will utilise the South Bates void for tailings storage once required.

Metals generally become more water soluble under acidic conditions and therefore consideration of the potential for acid generation from emplaced material (e.g. overburden) is important to assess this theoretical risk. The vast bulk of overburden, interburden and floor materials are unlikely to be acid producing or release significant salinity and will be acid consuming. The total PAF or PAF-UC material that remains onsite as CHPP reject is very small, being potentially a maximum of 0.35 per cent of the overall volume of material handled during mining operations. These findings are consistent with the current experience within the Project Area and as most of the overburden material is acid consuming, the operational practice of rapid burial and mixing of any PAF materials with overburden is expected to be sufficient to control any potential for acid generation.

It is important to note that the TSF seepage makes up only a minor fraction of the total mine water balance and will be contained within the mine water system and prioritised for re-use on the site. Any water mixed with TSF seepage would only be released under controlled conditions and in the circumstances where the relevant NSW Government imposed water discharge quality criteria are met. Based on the leachate results and the AMD potential, seepage is unlikely to impact on the water quality in the mine water management system and final void. Therefore, the risk of impact associated with leachate from the TSFs and material used in the final landforms is low.

Post mining the United final void will act as a long-term groundwater sink and groundwater seepage from the site, including any seepage from encapsulated TSF areas, will report to the void and therefore does not have the potential to result in impacts on the surrounding environment.

Detailed Response

The Project proposes to utilise existing and approved tailings storage facilities at Wambo, including the approved Homestead and Main Homestead tailings storage facilities. In addition, the Project will utilise the South Bates void for tailings storage once required. Other mine voids or suitable locations within the open cut mining footprint may be used as tailings storage over the life of the Project if feasible.

Tailings, which consist of fine residual waste material (coal, clay, sand, silt, etc.) separated in the coal preparation process, are placed in the open cut voids and capped with overburden and coarse rejects over the life of the Project. That is, tailings are contained within the site. The only risk arises as a result of tailings storages filling in extreme rainfall events and overtopping, however, management procedures are in place which limit water volume (e.g. freeboard allowances on pits) making this very unlikely to occur. It is important to note that the TSF seepage makes up only a minor fraction of the total mine water balance and will be contained within the mine water system and prioritised for re-use on the site. Any water mixed with TSF seepage would only be released under controlled conditions and in the circumstances where the relevant NSW Government imposed water discharge quality criteria are met. Based on the leachate results and the AMD potential, seepage is unlikely to impact on the water quality in the mine water management system and final void.

The tailings storage facilities on site will be filled capped and shaped to the conceptual final landform plan. The primary objective of the capping design will be to minimise the potential for exposure of potentially environmentally sensitive tailings material in the rehabilitated landform and prevent the occurrence of spontaneous combustion. Following capping, these areas will be revegetated in accordance with the rehabilitation strategy.

To promote the geotechnical stability of capped tailings emplacement areas and avoid the potential sterilisation of land in the post-mining landform, dewatering strategies will be incorporated into the design of the proposed tailings facilities. The aim of the strategy will be to progressively dewater the tailings facilities and promote the consolidation of material throughout the tailings profile. Water extracted from the process will be re-utilised for on-site purposes such as the processing of coal or for dust suppression.

Capping of Wambo's existing tailings storage facilities (North East and Hunter) will be completed by Wambo prior to the Project placing overburden in these areas.

In regard to groundwater risks post closure, the Mod-PATH3DU groundwater recovery modelling presented in Figure 24 and Figure 25 of **Appendix 2** shows that post closure, water surrounding the proposed TSF and in-pit spoil will flow towards the final voids and remain contained within the mine area.

Geochemical tests and analysis were conducted by GeoTerra (2017) (refer to **Appendix 3**) for waste rock and tailings. In addition, GeoTerra (2017) assessed the acid mine drainage (AMD) potential of the overburden and tailings materials associated with the Project. This included leachate analysis of waste rock and tailings material to understand potential impacts on groundwater quality. Findings from the geochemical analysis are summarised below, with the full report also included as **Appendix 3**.

Leachate Analysis

GeoTerra (2017) analysed the quality of leachate generated by samples of waste rock and tailings, with the results summarised in **Table 2.23**. The results are compared against water quality data for bores that intersect shallow overburden upstream of the site (P202 and P206), as well as the ANZECC (2000) guidelines for stock water and fresh water aquatic ecosystem (slightly-moderately disturbed systems).

Table 2.23 Summary of leachate water quality

Analyte	Unit	Waste rock leachate	Tailings leachate	Shallow overburden (P202 and P206)	ANZECC (2000) Fresh Water Aquatic‡	ANZECC (2000) Stock Water‡
pH	pH unit	7.98 – **9.16**	6.69 – **8.83**	6.35 – 8.6*	6.0 – 8.5	-
EC	µS/cm	339 - 998	335 – 7,220	213 – 10,520*	120-300	-
Sulphate	mg/L	12 – 130	9 – **910**	14.3 – 193*	-	1,000 – 2,400
Aluminium (d)	mg/L	0.02 – **0.32**	<0.01 – **0.05**	<0.01 – 0.01†	0.055	5
Arsenic (d)	mg/L	<0.01 – **0.32**×	<0.01 – **0.03**	0.001 – 0.002†	As (III) 0.024 As (V) 0.013	0.5
Cadmium (d)	mg/L	<0.0002	<0.0002	<0.0001†	0.0002	0.01
Chromium (d)	mg/L	<0.01	<0.01	<0.001	CrIII – ID Cr(VI) 0.001	1
Copper (d)	mg/L	<0.001 – 0.005	0.001 – 0.004	<0.5 – 2.7†	0.0014	1 (cattle)
Cobalt (d)	mg/L	<0.01	<0.01	<0.001	-	1
Iron (d)	mg/L	<0.01 – 0.36	<0.01 – 0.01	<0.05 – 0.45†	-	-
Lead (d)	mg/L	<0.001	<0.001	<0.001†	0.0034	0.1
Manganese (d)	mg/L	<0.01	<0.01	0.001 – 0.053†	1.9	-
Nickel (d)	mg/L	<0.01	<0.01 – 0.02	<0.005 – 0.035†	0.011	1
Selenium (d)	mg/L	<0.01 – **0.03**	<0.01	<0.01†	Total – 0.011 Sel IV - ID	**0.02**
Strontium (d)	mg/L	0.001 – 0.019	0.063 – 0.29	-	-	-

Analyte	Unit	Waste rock leachate	Tailings leachate	Shallow overburden (P202 and P206)	ANZECC (2000) Fresh Water Aquatic‡	ANZECC (2000) Stock Water‡
Zinc (d)	mg/L	<0.001 – 0.015	0.002 – 0.006	<0.005 – 0.035†	0.008	20

Notes:

(d) dissolved metals

* P202 and P206 EC and pH range based on historic data from around 2003 to 2016

† P202 and P206 metals based on available data collected in 2015 and 2016

‡ NB: ANZECC metals trigger process generally relate initially to detection of total, then dissolved concentrations, but can vary for individual analytes

× Elevated arsenic results were generated by laboratory testing methods (see discussion below)

The elevated arsenic was present within samples between 157 and 190.4mbgl from one borehole. The elevated results are in part a result of the laboratory testing methodology where crushed core samples are mixed with a 1:2 ratio of distilled water prior to testing the leachate after the pH / EC had stabilised (after approximately a week). The geochemical specialist engaged for the Project has advised that in reality the field water / solid ratio will be much higher, with higher dilution, and there will be much more mixing within the overburden rock which does not contain elevated levels of arsenic. Also given that these elevated results were only present in one borehole, the overall leachate discharge water quality will not be as high in arsenic. The geochemical specialist has also noted that arsenic is not generally observed as a discharge component of concern in the Hunter Valley.

The elevated aluminium highlighted in **Table 2.21** is principally due to <45 micron flakes of aluminosilicate clays being dissolved in the acid used in the laboratory sample preparation process, and would not be elevated in the field situation. Analysis of water samples leached through the waste rock material indicates the material produces water with an alkaline pH (7.98 – 9.16) and fresh to brackish salinity (339 µS/cm - 998 µS/cm). Leachate analysis for tailings indicates neutral to alkaline pH (6.69 – 8.83) and fresh to moderately saline (335 µS/cm – 7,220 µS/cm) water quality. When these results are compared with the *in-situ* groundwater from the shallow overburden it indicates the mine wastes are of a similar pH, or slightly more alkaline, and are less saline.

The leachate samples from the mine wastes were also analysed for dissolved metals. Leachate analysis for the waste rock and tailings material indicates that concentrations of most dissolved metals (Cd, Cr, Cu, Co, Fe, Pb, Ni and Zn) are within the range observed within the shallow overburden material. Sulphate concentrations within the tailings leachate can be higher than recorded for the shallow overburden. Both the waste rock and tailings record dissolved aluminium and arsenic concentrations above observed concentrations for the shallow overburden. In addition, dissolved selenium concentrations within the waste rock can be higher than recorded for the shallow overburden.

Part A of the RTS compared the extensive groundwater and surface water quality data against relevant guidelines (i.e. ANZECC). As outlined in the RTS, all surface water and groundwater units are too saline for fresh water aquatic ecosystems according to the criteria proposed by ANZECC (2000) of 120µS/cm to 300µS/cm EC. In addition to salinity, the maximum observed concentrations of total aluminium and zinc within all groundwater units (i.e. Permian coal measures and alluvium) also exceeded the ANZECC (2000) guidelines fresh water aquatic ecosystems.

While the Permian and alluvial groundwater is not suitable for fresh water aquatic ecosystems, alluvial groundwater is suitable for stock water supply. As presented in **Table 2.21**, waste rock leachate recorded a peak selenium concentration of 0.03mg/L, which exceeds the ANZECC (2000) trigger for stock water. It should be noted that this may be an isolated reading, as only one leachate sample recorded a concentration above the limit of reporting (<0.01).

Metals concentrations of waste rock and tailings leachate under laboratory conditions were recorded above baseline levels (i.e. Al, As and Se). However, these results are considered to represent a 'worst case' scenario, as they assume acidic conditions and do not account for buffering from the bulk material and natural mixing with rainfall captured within the mine water management system. Overall, the results indicate the waste rock leachate will have low salinity and is not likely to generate acidic leachate.

As discussed earlier, the Mod-PATH3DU recovery model results also indicate that there is minimal risk of groundwater within the spoil and proposed final voids recharging stratigraphy outside of the mine area. However, for greater assurance, monitoring and management of AMD will be undertaken to avoid mobilisation of metals and sulphate. The section below summarises the results of geochemical analyses and AMD potential within the Project Area based on work by GeoTerra (2017).

The management of acid rock drainage potential is discussed in Section 6.13.4.1 of the EIS. Should PAF material be identified, the following management strategies will be considered for PAF material where operational blending is not sufficiently effective:

- placement of PAF material in thin layers of no more than 5 metres with traffic compaction and immediate over-dumping with non-acid forming (NAF) spoil
- avoid placing PAF material within 5 metres of the natural ground level in out-of-pit emplacement areas to isolate it from any water flow along the interface between the overburden and natural ground
- mixing of acid neutralising materials (limestone and/or high ANC NAF overburden and interburden) with PAF material to increase lag times before onset of acid conditions
- selective placement of PAF material at least 100 metres back from the outer perimeter of the emplacement area with a thick (not less than 20 metre) outer zone of NAF materials (preferably high ANC material) and incorporate strategies to limit oxygen transfer to and fluctuating moisture conditions in PAF materials
- selective placement of PAF materials in-pit below the long term recovery water table to allow inundation at closure and prevent long term exposure to atmospheric oxidation.

A program of routine sampling and testing of the overburden/interburden material identified as being PAF will be carried out during operations to better define the AMD potential and variability of rejects. A program of routine sampling and testing of seepage and runoff from pit walls and floors, overburden emplacements, ROM stockpiles and washery waste disposal areas where the testing has identified a risk of ARD will also be carried out to check for ARD generation, assess the performance of management strategies, and determine and/or refine non-acid forming/potentially acid forming blending ratios and limestone treatment requirements (if required). The need for ongoing monitoring will be reviewed periodically should the testing and monitoring indicate negligible risk of ARD with the management practices above being implemented.

Considering the substantial volumes of acid consuming material that will be mined and emplaced by the Project, the overall risk associated with the small areas of PAF material is considered low.

The total PAF or PAF-UC material that remains onsite as CHPP reject is very small, being potentially a maximum of 0.35 per cent of the overall volume of material handled during mining operations.This risk is further mitigated by the proposed implementation of the above management strategies.

AMD Potential

Overburden

The study by GeoTerra (2017) found that the overburden material, comprising sandstone, siltstone, conglomerate and tuff, contains around 2.8 per cent of acid neutralising calcium carbonate ($CaCO_3$). The overburden comprises between 0.010 per cent - 0.41 per cent of total sulphur (TS), which gives a negative net acid producing potential (NAPP) and is classified as non-acid forming (NAF). Two of the more carbonaceous samples recorded TS of over 0.05 percent; however, CrS was below 0.05 percent and NAPP negative, giving a NAF classification.

The waste rock material was also tested for dispersivity; sodicity and erosion potential by GeoTerra (2017) (refer to **Appendix 3**). The sandstone and siltstone material was found to be sodic with an exchangeable sodium percentage (ESP) of between 4.2 per cent and 25.5 per cent. Fresh sandstone and siltstone material was generally non-dispersive; however, the more carbonaceous siltstones were found to be moderately to strongly dispersive. Results for the clay rich tuff material indicated strongly dispersive and very strongly sodic properties, with an ESP of 87.5 per cent. These results will be considered during development of the SWMP and sediment controls.

Tailings

Analysis of tailings material included testing of samples from the existing Homestead tailings storage facility (TSF), as well as core samples tested for CHPP washability and tailings rejects. Tailings within the existing Homestead TSF contain a low proportion of calcium carbonate, TS concentration of between 0.1 per cent - 0.13 per cent and CrS of between 0.015 per cent - 0.046 per cent These results indicate a negative NAPP and NAF conditions for the Homestead TSF tailings material.

Core samples tested after CHPP washability trials recorded variable results based on the different coal seams tested. Samples from the Woodlands Hill, Warkworth and Mt Arthur seams recorded TS of less than 0.05 per cent and were classified as NAF by GeoTerra (2017). Samples from the Glen Munro, Piercefield and Vaux seams were classified as Potentially Acid Forming (PAF) - Uncertain (US), with TS of between 0.075 per cent - 0.17 per cent and CrS of between 0.053 per cent - 0.111 per cent Results for the Blakefield Seam core sample indicate TS of 0.72 per cent and CrS of 0.674 per cent resulting in a positive NAPP reading and PAF classification.

CHPP rejects derived from the Woodlands Hill, Warkworth and Mt Arthur seams recorded TS of less than 0.05 per cent and were classified as NAF. CHPP reject samples from Piercefield and Vaux seams recorded a TS of over 0.05 per cent and CrS of over 0.05 per cent but due to the ANC, maintained a negative NAPP and were classified as NAF. Samples from Blakefield Seam and the overlying Unnamed E Seam recorded a TS of over 0.05 per cent and CrS of over 0.05 per cent resulting in a positive NAPP reading and PAF classification.

Overall, the overburden material is considered as NAF, with a low likelihood of AMD generation. GeoTerra (2017) found the existing tailings at Homestead TSF were NAF, and had a low likelihood of AMD generation. Results for core samples from the CHPP washability trials and CHPP rejects indicate low to moderate ANC, with most samples classified as NAF. Some samples for certain coal seams were classified as PAF or PAF-UC, with a low to moderate acid production potential. These seams make up approximately 15.5% of the total coal extracted as part of the Project (GeoTerra 2017) which is then washed and transported off site. The total PAF or PAF-UC material that remains onsite as CHPP reject is potentially a maximum of 0.35 per cent of the overall volume of material handled during mining operations.

However, these results are considered to represent a 'worst case' scenario, as they are based on laboratory conditions. Additional dilution is likely to occur in the field due to mixing with rainfall and clean surface water runoff.

In addition, as discussed above, the vast bulk of overburden, interburden and floor materials represented by the samples tested are unlikely to be acid producing or release significant salinity and will be acid consuming. This is consistent with the current experience within the Project Area and as most of the overburden material is acid consuming, the operational practice of rapid burial and mixing of any PAF materials with overburden is expected to be sufficient to control any potential for acid generation.

To mitigate potential impacts due to PAF and PAF-UC results for certain coal seams, a tailings management plan will be developed for the Project. The plan will include monitoring and management of tailings slurry to help maintain NAF conditions within the proposed South Bates TSF. The plan will draw on findings by GeoTerra (2017) and be prepared in consultation with relevant regulators.

Based on recommendations from GeoTerra (2017), ongoing monitoring and testing will be conducted to order to detect any changes in these conditions over the life of the Project. This includes water quality monitoring for EC, pH and key AMD indicators. These include sulphate and key metals (Al, As, Co, Cu, Fe, Mn, Ni, Se and Zn), which are already captured within the proposed monitoring program for the Project. The GeoTerra report is provided in **Appendix 3**. The proposed monitoring network was also updated (Part A RTS) to include additional bores within the regolith and spoil around the Project and proposed South Bates TSF. The bores were positioned to enable assessment of groundwater levels, flow directions and water quality, to be monitored on a regular basis for early detection of groundwater quality changes. These mitigation measures will be captured within the Project specific WMP plan.

It is important to note that the TSF seepage makes up only a minor fraction of the total mine water balance and will be contained within the mine water system and prioritised for re-use on the site. Any water mixed with TSF seepage would only be released under controlled conditions and in the circumstances where the relevant NSW Government imposed water discharge quality criteria are met. As discussed earlier, Mod-PATH3DU recovery model results (Figure 24 and Figure 25 of **Appendix 2**) show that there is minimal risk of groundwater within the mine area recharging stratigraphy outside of the mine area. Based on the leachate results and the AMD potential, seepage is unlikely to impact on the water quality in the mine water management system and final void.

2.2 Question 2

Question 2: If not, what is a reasonable assessment of the likelihood, extent and significance of impacts on these water resources and water dependent ecosystems?

13. In addition to the responses provided in Question 1, the following would enable assessment of the impacts of the proposed project:

a. The surface water modelling could be improved by:

i. Estimating flood hydrographs using a runoff routing model as recommended by Australian Rainfall and Runoff (Ball *et al.* 2016).

ii. Discussing the limitations and assumptions of the selected modelling approach and the data used in the models.

iii. Presenting model results against the 2D hydraulic mesh model boundary and aerial photography to facilitate interpretation.

Summary Response

Potential impacts on flood behaviour were assessed in the EIS for Wollombi Brook and Waterfall Creek. A Flood Assessment Report is included as an appendix to the Surface Water Assessment.

The 2D modelling approach for the Project is consistent with methods outlined in Australian Rainfall and Runoff Project 15 – Two Dimensional Modelling in Urban and Rural Floodplains (stage 1 and 2 report) (published November 2012). The hydrological modelling approach provides inputs to the 2D model based on a calibration using flow data.

As discussed in Chapter 2 – Catchment Representation of Australian Rainfall and Runoff (2016) (www.arr.org.au) (Ball et al., 2016), "*in situations where the interest is only on the combined hydrograph at the catchment outlet and where good flood records for current conditions are available at that point, modelling of the catchment as a single "lumped" response unit may be sufficient*". This was considered to be the case for the requirements of the Wollombi Brook Flood Assessment for the Project.

Further information on the modelling approach including limitations and assumptions was included in the response to Question 1.

It is also noted that the flooding assessment undertaken for the EIS has been accepted by the NSW Office of Environment and Heritage (OEH) and identified as being conservative.

The results of the modelling were presented in a series of figures for the 10%, 5% and 1% AEP flood and the PMF event in the Flood Assessment Report. As requested by the IESC, additional figures have been produced presenting the model results against the 2D hydraulic mesh and aerial photograph at a larger scale.

Detailed Response

A detailed response on the flood modelling is provided for Question 1 above.

The results of the modelling were presented in a series of figures for the 10%, 5% and 1% AEP flood and the PMF event in the Flood Assessment Report. **Appendix 1** contains the figures reproduced, as requested, and presented against the 2D hydraulic mesh and aerial photograph at a larger scale, as follows:

- **Figures 1** to **3** – Flood planning information
- **Figures 4** to **15** – Maximum modelled flood depths and modelled changes with the Project
- **Figures 16** to **27** – Maximum modelled flow velocities and modelled changes with the Project
- **Figures 28** to **34** – Maximum modelled flood hazard categories and modelled changes with the Project.

b. A systematic approach to identifying GDEs and application of techniques outlined in the GDE Toolbox (Richardson *et al.* 2011) would improve the assessment of potential impacts on GDEs. Additional suggestions include:

a. Further surveys of GDEs which may include remote sensing to identify spatial and temporal variations in groundwater dependent vegetation (Barron *et al.* 2014), especially along the Hunter River to the north of the project. Additional stygofauna sampling should also be considered in this area.

b. Discussion of how the predicted drawdown will affect the ability of GDEs to continue to access and utilise groundwater.

Summary Response

As discussed in the EIS, potential GDEs have been identified in proximity to the Project Area primarily associated with riparian vegetation along the main watercourses. The process for identifying these potential GDEs covered the full extent of the potential affection area for groundwater and it is considered that all relevant GDEs that have the potential to be impacted by the Project and that therefore require assessment have been identified and considered. The EIS undertook an assessment of potential impacts on GDEs considering direct mining impacts, surface water impacts and groundwater impacts. The groundwater impact assessment determined the potential drawdown impacts associated with the Project and other mining operations at GDEs.

The potential GDEs in the vicinity of the Project Area that could be influenced by the Project were identified, mapped and assessed in the EIS. The EIS assessment found that no significant impacts on GDEs were predicted as a result of the Project. This assessment finding has not changed with the further work undertaken to address the IESC comments.

The area of Hunter River alluvium where some drawdown is predicted due to the Project consists of modified vegetation and no GDEs have been identified. No remote sensing surveys are considered necessary.

As requested by the IESC additional stygofauna surveys have been completed in the Hunter River alluvium. The survey and assessment found that stygofauna exist in very low diversity within the alluvial aquifer of the Hunter River and are absent at the sites surveyed within the Wollombi Brook Alluvium. The predicted drawdown of the Hunter alluvium is predicted to have a minimal, local impact on the stygofauna community due to poorly developed biodiversity, the large extent of the alluvium and the connection with the Hunter River which will aid in long term recolonisation of impacted zones. The potential impact on the stygofauna community in the area of drawdown will be a small loss of habitat associated with the dropping of water levels and a change in flow direction between the surface water and groundwater. A risk assessment ranked ecological risk to sites where stygofauna were present as low value/low risk (refer to Part A of the RTS). The remaining bores which did not record stygofauna were ranked as low value/low risk.

Detailed Response

As discussed above, Section 6.9.4.1 of the EIS outlines the identification of potential GDEs within the Project Area. The area of Hunter River alluvium where some drawdown is predicted due to the Project consists of modified vegetation and no GDEs have been identified. No remote sensing surveys are considered necessary.

Additional stygofauna surveys have been completed in the Hunter River alluvium. The report found that stygofauna exist in very low diversity within the alluvial aquifer of the Hunter River and are absent at the sites surveyed within the Wollombi Brook Alluvium.

The results of the additional survey indicate that the subterranean ecosystem within the Wollombi Brook Alluvium downstream of the Project Area is unlikely to be impacted by the predicted drawdown levels due to the lack of fauna within the alluvium.

The predicted drawdown of the Hunter alluvium is also predicted to have a minimal, local impact on the stygofauna community due to poorly developed biodiversity, the large extent of the alluvium and the connection with the Hunter River which will aid in long term recolonisation of impacted zones. The potential impact on the stygofauna community in the area of drawdown will be a small loss of habitat associated with the dropping of water levels and a change in flow direction between the surface water and groundwater.

A risk assessment ranked ecological risk to sites where stygofauna were present as low value/low risk (refer to Part A of the RTS). The remaining bores which did not record stygofauna were ranked as low value/low risk.

The groundwater impact assessment (refer to Appendix 12 of the EIS) considered these potential GDEs and assessed the potential for groundwater impacts to occur in the areas occupied by these potential GDEs. The assessment identified two areas within the zone of cumulative drawdown that were labelled for the purpose of the groundwater impact assessment as GDE1 and GDE2. Potential GDEs occurring at GDE1 include areas of Central Hunter Swamp Oak Forest and a small number of River Red Gum trees along Redbank Creek, areas of Hunter Valley River Oak Forest, some River Red Gum trees and Hunter Floodplain Redgum Woodland Complex along Wollombi Brook. Potential GDEs occurring at GDE2 include areas of Hunter Valley River Oak Forest.

Around 1 metre in groundwater level decline is predicted at GDE2 due to cumulative impacts from mining (approved mining and the Project). The decline in groundwater levels at GDE2 is along the fringes of Wollombi Brook. This drawdown is relatively limited in area and impacts upon only a small portion of possible Hunter Valley River Oak Forest and possibly a small number of River Red Gum trees. Both of these species may have a dependency on groundwater, but both also have a high degree of drought tolerance, particularly River Red Gum. The vegetation communities in which they occur are highly disturbed from historical land uses (primarily agricultural practices) and are affected by substantial weed establishment. It is expected that the impacts resulting from the drawdown will be negligible on these species and the vegetation communities in which they occur. Hunter Valley River Oak Forest is not listed under the *Environment Projection and Biodiversity Conservation Act 1999* (EPBC Act) or *Threatened Species Conservation Act 1995* (TSC Acts). However, River Red Gums are listed under the TSC Act as an endangered population in the Hunter Catchment. The anticipated potential impact on these trees would not be significant in terms of the impact on the endangered population. It is likely that predicted drawdown will only occur during prolonged dry periods as permeability in alluvium should mean the alluvium recharges faster than any loss associated with depressurisation.

At GDE1 groundwater levels are predicted to decline more significantly with mining (approved mining and the Project). The alluvium near GDE1 is predicted in the groundwater modelling to become largely unsaturated due to cumulative impacts from approved mining at HVO South, Wambo and Mount Thorley Warkworth. This desaturation is due to the existing approved mining, without the Project. Based on the conceptual timing of the Project, the Project may result in this effect occurring approximately one year earlier; however, this depends on a range of factors and the timing of any approval for the Project and is highly uncertain. Therefore, the Project is not considered likely to result in impacts beyond those currently approved for GDE1.

In terms of impacts on surface water flows that may impact on GDEs the changes to surface water flows are not considered likely to significantly impact on the water availability for GDEs.

The groundwater impact assessment also found that the predicted groundwater drawdown would not affect Wollombi National Park which is located to the west of the Project Area.

2.3 Question 3

Question 3: Has the applicant provided reasonable strategies to avoid, mitigate or reduce the likelihood, extent and significance of impacts? And if not, why are the strategies unsatisfactory?

14. The proposed strategies were not able to be assessed due to the lack of information provided on these strategies in the assessment documentation. The water management plan (WMP) is the central element of the proposed mitigation and management measures. This document has not been finalised and was not provided with the assessment documentation. Therefore the IESC is unable to determine if the proposed strategies are reasonable.

Summary Response

As discussed with and acknowledged by both DoEE and DPE, the NSW process requires the preparation of a fully detailed Water Management Plan for a Project as an approval condition and not as part of the assessment process. The EIS did, however, outline in detail the water management strategies and commitments that have been made for the Project. The EIS also committed to the development of, and provided detail on the proposed content of, the Water Management Plan for the Project.

The water management system for the Project (Project WMS) has been designed in accordance with relevant government standards to limit potential impacts on downstream water resources by: containing mine water; managing runoff from disturbed areas; and undertaking all discharges in accordance with environmental protection licences and legislation.

The Project WMS has been designed to convey clean water around mining operations and segregate, store and reuse mine-impacted water to minimise adverse effects on water quality from mining operations to downstream waterways.

The Project exists within a well-regulated system that has been designed to provide for the sustainable management of the State's water resources. The design and management of the WMS has and will be undertaken in a manner that meets these legislative requirements, resulting in the WMS contributing to the achievement of this sustainable management of water.

Further discussion of the approach to water management for the Project is provided in the detailed response.

Detailed Response

As discussed with and acknowledged by both DoEE and DPE, the NSW process requires the preparation of a fully detailed Water Management Plan for a Project as an approval condition and not as part of the assessment process. The EIS did, however, outline in detail the water management strategies and

commitments that have been made for the Project. The EIS also committed to the development of, and provided detail on the proposed content of, the Water Management Plan for the Project. These commitments are reproduced and discussed further in the sections below. The existing WMPs which will form the basis for ongoing water management for the Project can be accessed here:

Wambo: https://www.peabodyenergy.com/Operations/Australia-Mining/New-South-Wales-Mining/Wambo-Underground-Mine/Approvals,-Plans-Reports

United: http://www.unitedproject.com.au/en/publications/Pages/management-plans.aspx

In terms of the design of the Project, the Project has been designed to maximise resource recovery and operational efficiencies between the proposed United Open Cut and the existing Wambo Open Cut whilst aiming to minimise environmental and social impacts. A number of design changes were implemented during the early stages of designing the Project that ameliorated the impacts of the Project. This has included a range of impact avoidance measures being incorporated into the Project design including measures to minimise the disturbance footprint (e.g. avoidance of impacts on the critically endangered weeping myall community) and efficiently manage water resources (e.g. water sharing with Wambo), create an improved final landform and address a range of issues raised by Project stakeholders.

As discussed in the Surface Water Assessment (refer to Appendix 11 of the EIS), a range of key factors were considered as part of Project development and associated studies to minimise the potential for the Project to impact on water resources. These factors comprise measures to both avoid and mitigate impacts and include:

- The management of impacts from the Project within the regime established by NSW water and pollution control legislation, which provides for sustainable water take from water sources, management of water quality to meet discharge quality criteria and associated management of salt loads within sustainable targets by managing water discharges to the environment.

- By maintaining substantial buffer distances to Wollombi Brook (approximately 370 metres) and the Hunter River (approximately 1.7 kilometres) which exceeds the recommended minimum 200 metre offset in the NSW Aquifer Interference Policy.

- Design of the water management system to meet NSW legislative requirements and relevant guidelines (e.g. guidelines for treatment of runoff from disturbed areas).

- Minimisation of works within the flood prone areas of Wollombi Brook to minimise the potential to impact on flood behaviour.

- Maximised water recycling and sharing across the integrated WMS to minimise import of water to the complex and to minimise discharges of excess water from the complex.

The water management system for the Project (Project WMS) has been designed in accordance with relevant government standards to limit potential impacts on downstream water resources by: containing mine water; managing runoff from disturbed areas; and undertaking all discharges in accordance with environmental protection licences and legislation.

The Project WMS has been designed to convey clean water around mining operations and segregate, store and reuse mine-impacted water to minimise adverse effects on water quality from mining operations to downstream waterways.

As discussed in the EIS, it is proposed to integrate water management for the Project with the Wambo WMS to maximise water sharing and reuse, limiting the potential impacts of the Project on downstream

water quality by managing water that has the potential to cause environmental harm. In conjunction with the proposed WMS, a series of erosion and sediment control measures will be utilised during construction, operation and rehabilitation phases of the Project to manage water quality. Refer to the Surface Water Assessment for the Project (Appendix 11 of the EIS) for further details.

Further details describing the NSW regulatory context, existing water management systems, the Project water management strategy, water management plan, monitoring and reporting are included below.

Regulatory Context

The Project exists within a well-regulated system that has been designed to provide for the sustainable management of the State's water resources. The design and management of the WMS has and will be undertaken in a manner that meets these legislative requirements, resulting in the WMS contributing to the achievement of this sustainable management of water. This includes:

- licensing of allowable water take with consideration of environmental flow requirements of watercourses and the needs of other water users

- control of water pollution, including management of sustainable salt loads associated with all water sources, including mine water discharges

- guidelines that govern the appropriate design of water management systems for mines to provide for appropriate water quality in accordance with EPL requirements.

There are two key acts that provide the regulatory framework for water use and management in NSW. These acts are the *Water Management Act 2000* (WM Act) and the *Water Act 1912* regulated by DPI Water. Pollution of water is regulated by the *Protection of the Environment Operations Act 1997* (POEO Act). The POEO Act is the key piece of environment protection legislation administered by the NSW Environment Protection Authority (EPA).

The objective of the WM Act is the sustainable and integrated management of water in NSW and is based on the concept of ecologically sustainable development. The WM Act defines water access and water sharing strategies within NSW. The WM Act also supersedes the provisions of the *Water Act 1912* in regard to water take when a water sharing plan (WSP) is in place and in regards to works adjacent to or within watercourses.

As part of the WM Act, WSPs have been developed across NSW to protect the health of rivers, whilst at the same time securing sustainable access to water for all users. The WSP's specify maximum water extractions and allocations. By complying with the requirements of the WSP's, water take will be within the sustainable yield for the water system as determined by the NSW government. This in turn provides for sustainable environmental flows within the water systems.

The *Water Sharing Plan for the Hunter Unregulated and Alluvial Water Sources* 2009 applies to watercourses in the vicinity of the Project Area and alluvial groundwaters. The catchment of Wollombi Brook is located within the Lower Wollombi Water Source and the catchment of Waterfall Creek is located within the Jerrys Water Source. As Wollombi Brook, its sub catchments, and Waterfall Creek are covered by WSPs, water take from surface and alluvial waters in and adjacent to the Project Area is governed by the WM Act.

Extractions from the Hunter River, including the Hunter River alluvials, are managed under the *Hunter Regulated River Water Sharing Plan 2004* and also covered by the WM Act. The porous hard rock units (coal and Triassic sandstones) are covered under the Water Sharing Plan for the *North Coast Fractured and Porous Rock Groundwater Sources 2016* (North Coast Fractured and Porous Rock WSP).

All water extraction in NSW, apart from some exemptions for government authorities and basic landholder rights extractions, must be authorised by a water licence. Harvestable rights, which are a Basic Landholder Right under the WM Act, allow a landholder to capture and use up to 10 per cent of the average regional runoff from a landholding. Basic Landholder Rights are exempt from licensing requirements.

Each water licence, referred to under the WSP system as a Water Access Licence (WAL), specifies a share component. The share components of specific purpose licences such as local water utility, major utility and domestic and stock are expressed as a number in megalitres per year. The share components of high security, general security and supplementary WALs are expressed as a number of unit shares for the water source. The value of each unit share is subject to Available Water Determinations (AWDs) as specified by DPI Water.

As discussed above, the design of the WMS has been undertaken in a manner that meets these legislative requirements. The WMS will also be managed throughout the life of the operation to comply with these legislative requirements. The effective design and management of the WMS will provide for the sustainable management of water by the Project in accordance with NSW Government requirements.

Existing Water Management Systems

Both United and Wambo mines have extensive WMSs in place which include mine dewatering systems, water storages, sedimentation and retention basins, and water diversions and catch drains. Both WMSs have similar key objectives. The key objectives as listed in the United Water Management Plan are presented below:

- prevent the contamination of clean water by mining activities
- segregate clean waters away from active mining areas to reduce the volume of mine affected water requiring subsequent storage and treatment
- minimise the discharge of pollutants from mining affected areas into the environment
- quantify the water used, stored and imported/exported
- maximise recycling and water sharing opportunities.

The water management strategies currently employed at both United and Wambo to avoid, mitigate and manage potential impacts on surface water are outlined in the approved water management plans for the operations. The approved water management and associated plans for the existing operations outline the following:

- current water management systems
- water quality monitoring programs
- water balance
- reporting mechanisms.

The Project will have the effect of increasing the disturbance area associated with mining. The existing WMSs will therefore need to be extended and modified as part of the Project.

Water Management Strategy for the Project

The water management strategy for the Project has been designed to integrate water management of the Project with the existing water management systems of the United and Wambo Mines. The strategy includes the separation of clean and dirty water, seeking to prevent the contamination of clean water by mining activities and managing compliance with statutory obligations.

For the Project, three categories of water will be managed, each with different potential for water quality impacts, namely:

- Clean water - Runoff from undisturbed areas or rehabilitated areas where vegetation is fully established, and where the water quality is suitable for release/discharge, and raw water imported under licence.

- Dirty water - Runoff from disturbed areas, such as active overburden emplacement areas or overburden emplacement areas where vegetation is not fully established. These areas have the potential for elevated TSS.

- Mine water - Mine water, being water exposed to coal or used in coal processing and runoff within MIAs, including groundwater that seeps into the open cut pit. This water quality is typically at a higher level of salinity.

The target design criteria for the three categories of water are summarised in **Table 2.24**.

Table 2.24 Design Criteria Components of the WMS

Water Category	Water Description	Target Design Criteria
Clean	Runoff from undisturbed or established rehabilitated areas	Intercept, convey and/or release, where practicable, to downstream environment.
Dirty (Sediment Laden Water)	Runoff from disturbed areas	Managed in line with the Blue Book (Managing Urban Stormwater: Soils and Construction Volumes 1 and 2E).
Mine	Runoff from areas exposed to coal, groundwater inflow or water used in coal processing or from coal stockpile areas	Mine water storages to have sufficient freeboard to contain runoff for events up to and including the 1 per cent 24 hour AEP (annual exceedance probability) storm event.

Dirty water and mine water will be utilised preferentially to meet the water needs for the Project and Wambo underground mining operations. This will minimise the demand for importing raw/clean water into the site. In addition, excess water that cannot be utilised will be discharged in accordance with the EPL and HRSTS.

Raw water supply and wastewater treatment and disposal practices for the Project will be the same as for the existing operations.

As described above, the intent of the WMS is to convey clean water around the mining operations or, when runoff water from rehabilitated areas becomes clean (in accordance with the site specific trigger values

listed in the Surface Water Management Plan), enable the runoff from these rehabilitated areas to flow directly to the downstream environment instead of being managed as part of the water management system.

Dirty water (i.e. runoff from disturbed areas outside the mining pit and infrastructure areas, such as overburden emplacement areas (both active and under rehabilitation) captured in the sediment dams) is pumped to the mine water management system. Mine water (i.e. runoff from areas exposed to coal or water used in coal processing or from coal stockpile areas, refer to **Table 2.24**) is also managed as part of the mine water management system. Pollution in NSW is regulated by the POEO Act with discharges from the mine water management system required to be licensed by an EPL if the discharge would otherwise constitute a pollution of waters (section 120 of the POEO Act). The Wambo EPL allows discharge to the environment from the mining operations with limits on water quality and volumes, and in accordance with the HRSTS regulation.

Any surplus water in the mine water management system will be either reused on site or discharged in accordance with the EPL and the existing approval.

Water Management Plan

As noted by the IESC, a fully detailed WMP for the Project has not been prepared as yet, however, the key components of the WMS and the proposed management strategies that will be documented in the WMP were described in detail in the EIS and the Surface Water Assessment that formed an appendix to the EIS. If the Project is approved, the development consent will include a requirement to prepare and implement a WMP that meets the requirements of the development consent and which will incorporate the commitments made in the EIS. The NSW Government has published draft model conditions relevant to open cut and underground mining operations, which includes conditions in relation to the contents of a WMP. This results in a good understanding of what the WMP to be prepared will address and the need to prepare with WMP in consultation with relevant NSW Government agencies and have it approved by DPE prior to implementation ensures it will be prepared to a high standard and outline the required management controls.

As outlined in Section 6.8 of the EIS, the Project WMP will guide the overall management of water as part of the Project. The WMP will also discuss the integration of the water management of the Project with water management at Wambo. The EIS committed that the WMP will include:

- a water balance including details of water supply, use, management and transfers
- an Erosion and Sediment Control Plan which describes the control measures that will be implemented for all works as part of the Project to manage erosion and sedimentation. This Plan will be consistent with the requirements of Managing Urban Stormwater: Soils and Construction – Volume 1 and Volume 2E Mines and Quarries, or its latest version
- a Surface Water Management Plan, including:
    - relevant baseline data on channel stability and water quality
    - a description of the water management system on site including design objectives and performance criteria
    - trigger levels for investigating any potentially adverse impacts
    - a surface water monitoring program including designation of monitoring locations, parameters and frequency (based on the commitments to monitoring made in the EIS and RTS).

- a Groundwater Management Plan, including:
    - a groundwater monitoring program (based on the commitments to monitoring made in the EIS and RTS)
    - trigger levels for water quality and water levels for investigating any potentially adverse impacts.

The WMP for the Project, which will address the management of the open cut operations, will be integrated with the WMP for Wambo which addresses the Wambo Underground, CHPP and train loading facility.

There will be erosion and sediment control measures implemented for all works as part of the Project including during both the construction and operation phases. These measures will be implemented in accordance with the relevant volumes of the Blue Book (Volumes 1 and 2) including:

- Landcom 2004. Managing Urban Stormwater – Soils and Construction, Volume 1, 4th Edition.
- Department of Environment and Climate Change (DECCa) 2008. Managing Urban Stormwater – Soils and Construction, Volume 2A – Installation of Services.
- Department of Environment and Climate Change (DECCb) 2008. Managing Urban Stormwater – Soils and Construction, 2C – Unsealed Roads.
- Department of Environment and Climate Change (DECCc) 2008. Managing Urban Stormwater – Soils and Construction, 2D – Main Road Construction.
- Department of Environment and Climate Change (DECCd) 2008. Managing Urban Stormwater – Soils and Construction, Volume 2E – Mines and Quarries.

Further details of the commitments made in regard to proposed approach to ongoing surface water monitoring and management are provided in Appendix 11 of the EIS.

Monitoring

Surface water quality monitoring is currently undertaken for both United and Wambo mines within the Project Area and at 19 various upstream and downstream locations on the creeks located near the Project Area. United and Wambo have a combined groundwater monitoring network that comprises 77 bores and 24 vibrating wire piezometers (VWPs), of which 27 bores and 11 VWPs (55 sensors) are currently monitored as part of ongoing groundwater monitoring programs.

Commitments relating to the water monitoring program for the Project were made in the EIS, with further monitoring committed to as part of this RTS process. The monitoring programs for the Project have incorporated, where appropriate, the existing monitoring data, methods, frequency and locations in the current NSW Government approved United and Wambo monitoring programs and then added further monitoring locations and parameters to provide appropriate monitoring coverage to monitor the ongoing water management performance of the Project.

Surface water quality parameters monitored in watercourses upstream and downstream of the Project Area will include monthly sampling of pH, electrical conductivity, total suspended solids and total dissolved solids. The proposed surface water monitoring programs will continue over the life of the Project and the requirements will be described in the Project WMP.

The surface water monitoring program will include:

- monitoring of the existing surface water quality upstream and downstream of the Project Area (using the water quality parameters, frequency of sampling and water quality triggers currently approved for the existing approved operations)

- monitoring of water quality within the WMS for pH, electrical conductivity, total suspended solids, total dissolved solids, oil and grease and for a suite of metals, metalloids and ions. This will include monitoring within, downstream and, where possible, upstream of the Project Area

- monitoring of water quality during HRSTS discharge events as set out in the Wambo EPL

- ongoing review and monitoring of the performance of erosion and sediment controls implemented as part of the Project.

The surface water monitoring program will monitor for any potential impacts on water resources and measure the effectiveness of the mitigation measures.

The WMP will also include details on how and when groundwater will be monitored across the Project Area and surrounds. It is proposed the existing groundwater monitoring programs will be continued and revised as required throughout the life of the Project. As outlined in the RTS – Part A, United has committed to the installation of additional monitoring bores in order to provide that the groundwater monitoring network covers all key groundwater bearing units and all appropriate monitoring parameters. Groundwater monitoring will include:

- monthly to bi-monthly water levels

- monthly to bi-monthly field water quality

- annual comprehensive water quality analysis at selected bores, including pH, electrical conductivity (EC), total dissolved solids (TDS), major ions (Ca, Cl, K, Na, Mg and SO_4), hardness, bicarbonate and nitrate

- quarterly comprehensive water quality analysis at new proposed bores and selected existing bores for two years, after which time the frequency of sampling will be reviewed

- monitoring of water levels and flows from key private bores within, and adjacent to, the zone of depressurisation, in consultation with adjacent landholders.

The monitoring program will also include a program of periodically sampling stygofauna in consideration of the recommendations of the Stygofauna Assessment completed for the Project. The proposed monitoring program has been established where accessible and in consideration of the potential for groundwater impacts on GDEs so that appropriate monitoring is in place for groundwater in relation to GDEs. This includes consideration of the construction of proposed bores to include screens suitable for full stygofauna sampling.

The preliminary site specific surface water triggers are listed in **Table 2.2** in this document in response to Question 1. The site specific surface water triggers will be included in the WMP and will include trigger levels for water quality and water levels. The aim of the trigger levels is to provide mine management with an early warning mechanism that identifies water quality trends departing from historical values. The site specific triggers for the relevant monitoring aspects and variables will be subject to refinement as part of the development of the detailed WMP. The methods used to determine site specific triggers/impact assessment criteria will include ANZECC Guidelines (2000) and published guidelines from the NSW DPI Water, OEH and EPA.

Should monitoring indicate that changes in groundwater levels and quality, or changes in surface waters, are more extensive or significant than predicted, appropriate actions will be implemented which may include further mitigation measures determined in consultation with relevant government agencies.

Reporting

As per the commitment made in the EIS, a summary of water monitoring results will be provided in the Annual Review for the Project which is provided to all relevant government agencies and made available on the United website for review by the community. The reporting of surface water and groundwater in the Annual Review will comply with the NSW Government reporting guidelines for Annual Reviews and will include:

- a summary of water taken by the operation in the previous year
- a summary of monitoring results
- details of any discharges
- salinity trading scheme credit usage
- any other matters outlined in the WMP.

Reporting of water monitoring data will also occur in accordance with EPL requirements.

2.4 Question 4

Question 4: Are there further strategies the IESC would recommend to avoid, mitigate or reduce the likelihood, extent and significance of impacts on water resources? And if so, why?

15. Noting the response to Question 3, strategies that could be considered include:

a. Use of water treatment technologies to improve the quality of discharge waters given exceedances of ANZECC guidelines have been observed in the water management system.

b. Regular validation and review of the water balance, groundwater and surface water models including independent peer review. Uncertainty analysis of the groundwater model has highlighted that the predicted impacts could vary considerably (e.g. higher hydraulic conductivity rates would reduce surface water flows (EIS, Appendix B of Appendix 12, pp. 40-41)). Therefore improving confidence in the modelling outputs is important. It is noted that some layers of the groundwater model may not contain calibration targets. As part of the validation process, data should be obtained for these layers. Validation should occur promptly once data is available. The proponent has committed to reviewing the groundwater model every 5 years (EIS, Appendix 12, p. 116), however this could be done more frequently and should be done if validation indicates that observed drawdowns are inconsistent with predicted drawdown.

c. Management actions based on trigger systems need to be clearly articulated and presented for all potential impacts.

Summary Response

Treatment methods used within the WMS include management of different water qualities (i.e. clean, dirty and mine water) and use of settling technologies for removal of sediment loads. There are no other treatment technologies currently proposed to be implemented as part of the Project as they are not considered necessary to meet the objective of sustainably managing water in accordance with NSW Government requirements. The water treatment on the site, i.e. containment and settling, meets the water quality discharge requirements for the HRSTS and EPL and no water which does not meet these requirements will be discharged from the site.

A WMP will be prepared for the Project, in consultation with DPE and DPI Water, and will account for reporting and assessment requirements for active approved operations. This includes annual review of monitoring data against water balance, surface water and groundwater modelling predictions.

The WMP will include a prescriptive Trigger Action Response Plan (TARP). Surface water and groundwater monitoring data will be compared against the prescribed trigger thresholds relevant for each monitoring location and parameter. When surface water and groundwater monitoring results are compared to the water quality trigger thresholds:

- if results do not exceed the trigger thresholds for the relevant monitoring location, then no further action is required
- if results exceed the water quality thresholds, an investigation and response will be initiated.

The WMP will include a prescriptive TARP if groundwater quality impacts around TSF's and the final voids are detected. In addition, a TARP process will be established for alluvial aquifers, private users and watercourses if impacted as a result of the Project.

Detailed Response

Surface Water

The response to Question 3 above outlines the water management strategies for the Project. As outlined above, a number of design changes were implemented during the early stages of designing the Project that ameliorated the impacts of the Project. This has included a range of impact avoidance measures being incorporated into the Project design including measures to minimise the disturbance footprint, efficiently manage water resources, create an improved final landform and address a range of issues raised by Project stakeholders. Treatment methods used within the WMS include management of different water qualities (i.e. clean, dirty and mine water) and use of settling technologies for removal of sediment loads. There are no other treatment technologies currently proposed to be implemented as part of the Project as they are not considered necessary to meet the objective of sustainably managing water in accordance with NSW Government requirements. Additional water treatment methods, e.g. reverse osmosis / filtration plants, are typically expensive and produce concentrated waste streams which create their own management issues. The water treatment on the site, i.e. containment and settling, meets the water quality discharge requirements for the HRSTS and EPL and no water which does not meet these requirements will be discharged from the site. Further discussion on water quality within the WMS is included in the response to Question 1.

The performance of the surface water management system for the Project will be subject to regular validation through review of monitoring data and comparison of any measured impacts to the predicted impacts in the EIS. An annual review of the site water balance will also be undertaken. The outcomes of these annual reviews will be provided in an Annual Review which will be provided to relevant regulators and made available to the public via the United website

The WMP will include a prescriptive Trigger Action Response Plan (TARP). Surface water monitoring data will be compared against the prescribed trigger thresholds relevant for each monitoring location and parameter. When surface water monitoring results are compared to the water quality trigger thresholds:

- if results do not exceed the trigger thresholds for the relevant monitoring location, then no further action is required

- if results exceed the water quality thresholds, an investigation and response will be initiated.

The surface water impact investigation and response process will be initiated in the event that trigger thresholds or values are exceeded. The administering authority may be notified and the relevant data set will be reviewed by a suitably qualified specialist who will determine if further investigation is necessary. Investigations and responses will be entirely dependent on the particulars of the trigger exceedance. Additional management controls to minimise or avoid impacts will be implemented as required as part of the TARP process.

Groundwater

The numerical groundwater model was calibrated to 301 monitoring points, which is considered an extensive dataset for model calibration. Linear analysis of the transient (1970 to 2015) model was undertaken to quantify the benefit of the calibration process on addressing uncertainty, as well as quantify the data worth of the observation targets used. The analysis highlighted the complex nature of the groundwater regime and subsequent model representation. Hydraulic conductivity was found to be the parameter which contributed most to the calibration solution. Hydraulic properties were calibrated based on extensive field data, which was available for nearly all model layers, as presented in Figure B-11 of Appendix B of the GIA. Field hydraulic conductivity data was available for most units represented within the groundwater model, and on the rare occasions where data was not available, a conservative estimate, based on parameters used for similar strata, was used. Additional data is not considered essential, as sensitivity and uncertainty analysis was used to determine the influence of parameter variability on the model predictions.

Sensitivity analysis (Section B5.2 of Appendix B of GIA) indicated that increasing hydraulic conductivity of all geological units did not cause an increase in the extent of drawdown within the target coal seam (Vaux Seam). However, the increase in conductivity for all units could increase 'water-take' from Wollombi Brook alluvium by a peak of 211ML/year, and by a peak of 124ML/year for Hunter River alluvium. Uncertainty analysis highlights that an increase in hydraulic conductivity for all units is unlikely, with lower peak predicted takes. Under the 97.7th percentile, the uncertainty analysis predicts up to 109ML/year of peak take from Wollombi Brook alluvium and up to 103ML/year of peak take from the Hunter River alluvium. These outcomes have a low likelihood of occurring given they are at the extreme end of the impact range predicted. In addition, the extent of drawdown indicates that the base case model adequately captures the extent of potential impact. The magnitude of the predicted 'water take' also relates to increases in recharge through the more permeable model layers.

A WMP will be prepared for the Project, in consultation with DPE and DPI Water, and will account for reporting and assessment requirements for active approved operations. This includes annual review of monitoring data to compare groundwater levels to rainfall and identify trends. The validity of the model predictions will be assessed on a more frequent, three yearly basis, and if the data indicates significant divergence from the model predictions, an updated groundwater model would be constructed for simulation of mining.

The WMP will include a prescriptive TARP if groundwater quality impacts around TSF's and the final voids are detected. In addition, a TARP process will be established for alluvial aquifers, private users and watercourses if impacted as a result of the Project.

Numerical groundwater modelling predicts groundwater within the mine area will be drawn towards active operations and the proposed final voids. Therefore, recharge of groundwater from the mine area to water resources and groundwater dependent ecosystems is not predicted. However, in order to provide greater assurance of early detection of any groundwater quality changes due to waste rock leachate and tailings storage, the proposed monitoring program has been updated to include additional bores within the regolith and spoil. The bores have been positioned to enable assessment of groundwater levels, flow directions and water quality, which will be monitored on a regular basis, as outlined within Part A of the RTS.

The EIS and the RTS have made commitments in relation to the groundwater monitoring program that will be implemented for the Project. These commitments will be incorporated into the Groundwater Monitoring Program that will be prepared in consultation with relevant government agencies. This Program will include full details on how and when groundwater will be monitored across the Project Area and surrounds. In addition, periodic sampling and testing for stygofauna will be captured within the groundwater monitoring program to supplement work completed as part of the Project EIS.

The groundwater relevant TARPs will involve the following workflow for trigger investigation. Groundwater monitoring data will be compared against the prescribed groundwater level trigger thresholds relevant to the specific bores. When groundwater level monitoring results are compared to the groundwater level trigger thresholds:

- if results do not exceed the level trigger thresholds for the relevant bore, then no further action is required; or

- if results exceed the level thresholds, an investigation and response will be initiated.

The groundwater impact investigation and response process will be initiated in the event that trigger thresholds or values are exceeded. The administering authority may be notified and the relevant data set will be reviewed by a suitably qualified specialist who will determine if further investigation is necessary. Investigations and responses will be entirely dependent on the particulars of the trigger exceedance (or complaint), but as a minimum, they should aim to:

- identify an exceedance:
    - verify the results by re-sampling / re-measuring
- define the exceedance:
    - location of bore and date of the sample / measurement / logged data point
    - the exceedance result itself, comparison against trigger thresholds and values
- identify the cause:
    - non-mining causes may include sampling / measurement error, climatic influences, natural variation (e.g. comparison against historical datasets)
    - mining related causes may include mine seepage / dewatering, contaminant spills, etc.

- assess the environmental impact:
    - has the exceedance resulted in any unauthorised environmental harm and associated environmental impact?
- identify actions required / taken to prevent environmental harm:
    - what actions (if any) are required to minimise / mitigate / manage the impacts associated with the unauthorised environmental harm?; and
    - what additional measures (if any) are required to be implemented to aid the prevention of further occurrences of the unauthorised harm and associated environmental impact?

2.5 Question 5

Question 5: Does the EIS provide a reasonable assessment of the potential for discharges (including salt) to nearby watercourses and alluvial groundwater systems and the significance of any resulting impacts on water quality and the downstream environment? If not, what additional information would be required to provide a reasonable assessment of these matters?

16. No. Some potential discharge sources and pathways have not been fully examined in the assessment documentation. Further consideration is required for:

a. Wambo void lake which could become a recharge source for the groundwater systems, as discussed in response to Question 1.

Summary Response

In order to provide a more detailed understanding of the potential likelihood and risk of the Wambo void lake becoming a recharge source, further groundwater flow modelling and analysis was conducted.

This further assessment found that due to extensive depressurisation of the Permian coal measures from approved and the proposed mining, groundwater is drawn towards and into the active mine areas. The proposed United final void acts as a dominant groundwater sink, drawing in groundwater from the Permian coal measures and all saturated spoil at the site.

Post closure, water surrounding the proposed TSF and in-pit spoil will flow towards the final voids and remain contained within the mine area. Therefore, there is minimal risk of groundwater within the in-pit spoil and proposed final voids influencing stratigraphy outside of the mine area post closure.

The final void will not become a recharge source to any aquifers.

Item a. is addressed in the response to Question 1.

b. Possible spillages from the water management system.

Detailed Response

As discussed in detail above, the WMS for the Project has been designed to contain mine water for reuse on the site. Mine water storages have been designed to have sufficient freeboard to contain runoff for events up to and including the 1 per cent 24 hour AEP (annual exceedance probability) storm event. The risk of spill from the mine water management system is limited as freeboard requirements are met by ceasing pumping water to these dams, and instead pumping to the pit/underground voids, when surplus mine water occurs.

In regard to the dirty water system (or sediment laden water system) it has been designed to provide for treatment of the water in accordance with relevant guidelines prior to any releases occurring. The applicable design criteria have been established by the NSW Government specifically for sediment control at mining operations. This means that any water that spills from the system have been treated prior to spills occurring.

Water will be managed and transferred across the United / Wambo complex to maximise water recycling. When excess water occurs, United and Wambo propose to continue to discharge surplus water in accordance with current approvals and licences. The quality of such discharges will be in accordance with the current EPLs and consistent with the provisions of the HRSTS. Discharges from the Project will be monitored prior to release to ensure compliance with the requirements of the HRSTS and in accordance with the EPL conditions.

The surface water monitoring programs have been in place at United and Wambo for a number of years and were developed based on the management of risk to downstream water quality posed by the existing operations. It is considered that the Project will not change the specific risks to water quality compared to the existing operations.

The highest risks to downstream surface water quality as a result of the Project are summarised in **Table 2.25**. **Table 2.25** identifies the water management control category which is proposed to manage the risk.

Table 2.25 Preliminary Risk Assessment - Surface Water Quality

Aspect	Water Management Control Category	Risk to Environment	Comment
Discharge of mine water	Mine	Low	Mine water storages to have sufficient freeboard to contain runoff for events up to and including the 1 per cent 24 hour AEP (annual exceedance probability) storm event. Surplus water is used in Wambo Underground Operations, stored in the United underground or the open cut pits or discharged via EPL and HRSTS.
Overflow/failure of sediment pond (dirty water)	Dirty (Sediment Laden)	Low - Medium	Numerous sediment dams are required due to complexity of mine site. Sediment dams are managed in line with the Blue Book and designed to manage runoff from the 5 day, 95th percentile rainfall event. Some sediment dams have secondary containment measures downstream. Elevated TSS is primary risk.
Spillage of tailings	Mine	Low	It is proposed that tailings will be disposed of on site within in pit tailings storages. Risk only arises as a result of tailings storages filling in extreme events and overtopping, however, management procedures are in place which limit water volume (e.g. freeboard allowances on pits) making this very unlikely to occur.

The higher risks (low to medium level) outlined in **Table 2.25** are associated with the dirty water management system where the risk is associated with overflow from sediment dams during rainfall events above the design criteria specified in the Blue Book. These design criteria have been established by the NSW Government specifically for sediment control at mining operations. The risk of spill from the mine water management system is limited as freeboard requirements are met by ceasing pumping water to these dams, and instead pumping to the pit/underground voids, when surplus mine water occurs.

Based on the preliminary risk assessment and considering the controls to be implemented as part of the Project design, the primary monitoring parameter for mining impacts in regard to potential impacts on downstream water quality is TSS. Both the United and Wambo operations also monitor pH, EC and TDS so that overall changes to water quality in downstream creek systems associated with the mining operations, including release of runoff from rehabilitated landforms, are monitored for potential impacts.

The routine site water quality monitoring programs will be updated for proposed and selected bores to include pH, EC, acidity/alkalinity, sulfate , AL, As, Co, Cu, Fe, Mn, Ni and ZN on a quarterly basis for two years, after which time the frequency of sampling will be reviewed.

Based on the findings of the geochemistry assessment it is considered that metals are more likely to be present as solids, as opposed to dissolved, and as such monitoring of TSS provides a good indicator of risks to the downstream environment.

The Joint Venture has committed to additional monitoring of metals/metalloids within both the WMS and the downstream receiving environment, as well as setting triggers for pH (i.e. increased risk of mobilisation of metals). The additional monitoring is outlined in the response to Question 4.

In addition, the *geochemical assessment undertaken by* GeoTerra (2017) (refer to **Appendix 3**) was to enable understanding of the historic and potential future waste rock and tailings geochemistry, as well as the acid and metalliferous drainage (AMD) potential of the overburden, coal, pit flood rock, tailings and coarse reject materials associated with the Project.

As discussed earlier in this report, the GeoTerra report concluded that the “vast bulk” of waste emplacement tested was NAF and also concluded that AMD is not anticipated to be an issue of concern for the Project. The geochemistry report recommends that on-going monitoring of the leachate generated from the waste emplacements should include pH, salinity (EC), TSS, sulphate and acidity/alkalinity, with follow up elemental testing if any low pH conditions are detected to ensure that key water quality parameters remain within appropriate criteria.

As outlined in Section 9.2.6 of the Surface Water Assessment, the process of detailed design, construction and monitoring/maintenance of the proposed WMS during the operational phase is intended to reduce the risks associated with unplanned spillages or other unforeseen circumstances with potential to result in unexpected environmental impacts. That is, the concept design of the system has been completed considering the range of potentially relevant environmental factors and variables, reducing the risk of the implemented system not performing as planned.

The WMP will include plans to respond to any exceedances of the performance criteria, and mitigate and/or offset any adverse surface water impacts of the development. This will include, for the operational phase of the Project, the hazards to be managed, incident management processes, notification procedures, and other key information to address incidents. Further contingency measures to address potential surface water impacts are outlined in the Surface Water Assessment.

As outlined in Section 6.3.2.1 of the Surface Water Assessment, the purpose of the sediment dams within the dirty water management system is to manage runoff from disturbed areas. The dirty water management system will be designed in accordance with *Managing Urban Stormwater: Soils and Construction* (the Blue Book), *Volumes 1* and *2E - Mines and Quarries* (Landcom 2004 and DECC 2008) to manage runoff from the 5 day, 95th percentile rainfall event. The selected design criteria is in excess of the minimum recommended design criteria for sediment dams as outlined in Volume 2E of the Blue Book (DECC, 2008). Volume 2E of the Blue Book (DECC, 2008) indicates that for the 95th percentile design storm event the indicative average annual sediment basin overflow frequency will be 1 to 2 spills per year.

Mine water is contained within systems designed to a higher design criteria than the dirty water system. The design criteria for mine water is to convey runoff from and to provide sufficient freeboard to contain runoff from the 1 per cent AEP 24 hour storm event within the mine water storage dams. Mine water can also be stored in the United underground and, if required, in extreme events, within the open cut pits.

The receiving waters in the event of spillages are listed in **Table 2.26**.

Table 2.26 Potential Receiving Points for Spills from Sediment Dams

Dam Name	Spills To
W1	North Wambo Creek
W3	North Wambo Creek
W4	North Wambo Creek
W5	Dirty WMS (W4)
W6	North Wambo Creek
W7	North Wambo Creek
W8	Wollombi Brook
W9	Dirty WMS (W1)
W10	Dirty WMS (W4)
M1	Waterfall Creek
M3	North Wambo Creek
M4	North Wambo Creek
M5	North Wambo Creek
M6	North Wambo Creek
U1	Clean water management system (C3 – Redbank Creek)
U2	Wollombi Brook
U3	Mine WMS (United Pit)
U4	Mine WMS (United Pit)
U5	Dirty WMS (U4)

Water will be managed and transferred across the United / Wambo complex to maximise water recycling. When excess water occurs, United and Wambo propose to continue to discharge surplus water in accordance with current approvals and licences. The quality of such discharges will be in accordance with the current EPLs and consistent with the provisions of the HRSTS.

Discharges from the Project will be monitored prior to release to ensure compliance with the requirements of the HRSTS and in accordance with the EPL conditions.

The Joint Venture parties will manage water resources within the Project Area in accordance with the Project site Water Management Plan, site EPLs and the requirements of the HRSTS.

c. The potential for water from tailings dewatering to be a contaminant source when it is reused.

Summary Response

Reuse of tailings decant water within the WMS for both United and Wambo mines has been undertaken throughout the operation of these mines. This water 'source' is incorporated as part of the mine water collected at the site, consistent with water management practices for coal mines in the Hunter Valley. The collected mine water is reused within the mining area and based on the quality of the mine water the risk of contamination is considered low. As discussed in earlier responses, a geochemistry assessment has been completed for the Project and has found that as the vast majority of material to be mined is acid consuming, the risk associated with any small areas of PAF material (including any that reports to tailings), is low.

Tailings are disposed of on site within in pit tailings storages. The risk of tailings flowing into the environment is considered low. Risk only arises as a result of tailings storages filling in extreme rainfall events and overtopping, however, management procedures are in place which limit water volume (e.g. freeboard allowances on pits) making this very unlikely to occur.

Detailed Response

Reuse of tailings decant water within the WMS for both United and Wambo mines has been undertaken throughout the operation of these mines. This water 'source' is not separated within the WMS, which is consistent with water management practices for coal mines in the Hunter Valley. The general water quality monitoring within the WMS (mine water) is considered representative of the water quality to be expected with reuse of tailings decant water.

As outlined above, tailings are disposed of on site within in pit tailings storages. The risk of tailings flowing into the environment is considered low. Risk only arises as a result of tailings storages filling in extreme rainfall events and overtopping, however, management procedures are in place which limit water volume (e.g. freeboard allowances on pits) making this very unlikely to occur.

The GeoTerra geochemical report for the Project (refer to **Appendix 3**) enables understanding of the historic and potential future waste rock and tailings geochemistry, as well as the AMD potential of the overburden, coal, pit flood rock, tailings and coarse reject materials associated with the Project. As discussed above, the report concluded that the potential tailings from the Project are likely to be NAF and should not require any special handling for AMD control.

As PAF material was identified from the Unnamed E and Blakefield Seam rejects, there is a potential for dissolved metals to be contained in the stored water within and seepage from the reject emplacement, and as a result, the rejects from these seams should be blended with non-PAF material that will provide buffering capacity to neutralise the potential for impacts. As discussed in Section 6.13.4.1 of the EIS, further

investigation will be undertaken during operations to confirm any potential for acid forming material, confirm the appropriate approach to management of this material and to demonstrate the effectiveness of the management techniques proposed.

Past experience with similar reject emplacements and similar AMD characteristics in the Hunter Valley indicates that dilution from rainfall infiltration and surface water mixing are likely to occur in the field, and as a result, the 'field' dissolved metal concentration in discharge from the reject emplacements are unlikely to present significant bulk discharge surface water quality environmental issues.

d. Characterisation of metals, nutrients and organics in water discharged at the licenced discharge point on Wollombi Brook.

Summary Response

The WMS is designed to contain mine water and not allow this to be discharged in to the surrounding environment except via the Wambo licensed discharge point in accordance with the Wambo EPL, the provisions of the HRSTS and the POEO Act. All monitoring of discharges are undertaken in accordance with the existing approvals.

No changes to these existing discharge arrangements are proposed as part of the development application for this Project and as this discharge arrangement is already approved and operational, no further assessment of this issue is required for the Project.

Detailed Response

As described above, the intent of the WMS is to convey clean water around the mining operations or, when runoff water from the rehabilitated areas becomes clean, enable runoff from these rehabilitated areas to flow directly to the downstream environment instead of being managed as part of the WMS.

Dirty water (i.e. runoff from disturbed areas outside the mining pit and infrastructure areas, such as overburden emplacement areas (both active and under rehabilitation) captured in the sediment dams) is pumped to the mine water management system. Mine water (i.e. runoff from areas exposed to coal, groundwater inflows and water used in coal processing or from coal stockpile areas) is also managed as part of the mine water management system. The WMS is therefore designed to contain any dirty or mine water and not allow this to be discharged in to the surrounding environment.

Discharges from the site are currently undertaken via the licensed discharge point in accordance with the current project approvals / development consents and Wambo EPL, the provisions of the HRSTS and the POEO Act. No changes to these existing discharge arrangements are proposed as part of the development application for this Project and as this discharge arrangement is already approved and operational, no further assessment of this issue is required for the Project.

All monitoring of discharges are undertaken in accordance with the existing approvals.

2.6 Question 6

Question 6: In addition to the proposed monitoring and management regime recommendations in the EIS, does the IESC recommend additional monitoring and management measures to minimise the risks of the project to water resources and water dependent ecosystems? If yes, what are they?

20. Yes. The IESC suggests the following further monitoring and management actions be considered, in addition to those highlighted in the response to previous questions:

a. Design and implementation of monitoring programs (including installation of additional monitoring bores) capable of early detection of groundwater and surface water contamination from the Wambo void lake, the TSFs and the final landforms.

Summary Response

In order to provide greater assurance of early detection of any groundwater quality changes due to waste rock leachate and tailings storage, the proposed monitoring program for the Project has been updated to include additional bores within the regolith and spoil.

The positions of the proposed additional bores have been selected to enable assessment of groundwater levels and flow directions. Water quality data will also be collected and tested for a suite of analytes in order to identify any changes in groundwater quality.

As discussed in the EIS, a specific WMP will be prepared for the Project, in consultation with DPE, DPI Water and DoEE. The WMP will include a prescriptive Trigger Action Response Plan (TARP) if groundwater quality impacts around TSF's and the final voids are detected or if surface water impacts are predicted in the surrounding environment.

Detailed Response

Numerical groundwater modelling predicts groundwater within the mine area will be drawn towards active operations and the proposed final voids. Therefore, recharge of groundwater from the mine area to water resources and groundwater dependent ecosystems is not predicted.

In order to provide greater assurance of early detection of any groundwater quality changes due to waste rock leachate and tailings storage, the proposed monitoring program has been updated to include additional bores within the regolith and spoil (refer to Part A of the RTS). The bores have been positioned to enable assessment of groundwater levels and flow directions. Water quality data will also be collected and tested for a suite of analytes in order to identify any changes in groundwater quality.

As discussed above and committed to in the EIS, a specific WMP will be prepared for the Project, in consultation with DPE, DPI Water and DoEE. The WMP will include a prescriptive Trigger Action Response Plan (TARP) if groundwater quality impacts around TSF's and the final voids are detected or if surface water impacts are predicted in the surrounding environment. In addition TARP processes will also be developed for alluvial aquifers, private users and watercourses if impacted as a result of the Project.

The Project surface water and groundwater monitoring program will also include full details on how and when monitoring will occur across the Project Area and surrounds. In addition, sampling and testing for stygofauna will be captured within the groundwater monitoring program to supplement work completed as part of the Project EIS.

b. Additional groundwater monitoring bores to the north and northwest of the proposed project site both in the Hunter River alluvium and between the mine and the alluvium, and to the southwest of the proposed project, near Wollemi National Park. These bores would allow potential impacts to be better monitored near these sensitive locations and would provide further data for model validation.

Summary Response

As discussed earlier in this response, the Project occurs within an existing mining area (refer to **Figure 1.2**) therefore an extensive groundwater monitoring regime is in place. This includes monitoring by both United and Wambo, and monitoring by other nearby mining operations.

Although an extensive monitoring program is already in place, as an outcome of the groundwater assessment process some further monitoring locations have been proposed. Further, in response to the IESC comments, in order to provide greater assurance of early detection of any impacts within the Hunter River alluvium and shallow overburden north of the Wambo Open Cut, a series of additional monitoring points has been proposed. The network has also been expanded to the south-west of the Project area in order to detect changes in groundwater level and quality at the southern extent of the Project plan. This includes utilisation of existing bores around the proposed South Bates TSF.

Detailed Response

The Project Area exists within a locality dominated by mining and is surrounded by other mining operations, including Wambo's underground operations and Coal and Allied's HVO and their associated mine owned land. Several other mines are located further south including Mount Thorley Warkworth and Bulga Mine. Each of these mines have an existing influence on the water resources surrounding the Project Area and undertaken extensive monitoring.

In order to provide greater assurance of early detection of any impacts within the Hunter River alluvium and shallow overburden north of the Wambo Open Cut, a series of additional monitoring points has been proposed (refer to Part A of the RTS). The network has also been expanded to the south-west of the Project area in order to detect changes in groundwater level and quality at the southern extent of the Project plan. This includes utilisation of existing bores around the proposed South Bates TSF.

Ongoing groundwater management and mitigation measures for the Project will be outlined within the groundwater monitoring program. The groundwater monitoring program will be developed in consultation with DPE and DPI Water following Project approval, and will outline clear commitments to management and mitigation measures.

The validity of the groundwater model predictions will be assessed on a three yearly basis, and if the data indicates significant divergence from the model predictions, an updated groundwater model would be constructed for simulation of mining.

c. Further monitoring of surface water and groundwater levels, and ecosystem health at the location identified as GDE 1. These measures would improve the understanding of this ecosystem, and allow a management plan to be formulated to monitor and manage drawdown and prevent complete dewatering of the alluvial aquifer at this location. These actions could be done in co-operation with Hunter Valley Operations South.

Summary Response

The alluvium near GDE1 is predicted in the groundwater modelling to become largely unsaturated due to cumulative impacts from approved mining at HVO South, Wambo and Mount Thorley Warkworth. This desaturation occurs due to the existing approved mining (primarily HVO South) without the Project.

The Project may result in this effect occurring approximately one year earlier, however, this depends on a range of factors and the timing of any approval for the Project and is highly uncertain. Therefore, the Project is not considered likely to result in impacts beyond those currently approved for GDE1 and the proposed monitoring approach is considered appropriate.

Detailed Response

The location of GDE 1 is on land owned by HVO and the Joint Venture does not have access to this area. Monitoring point P413 has been included within the monitoring program to enable monitoring of groundwater conditions along Redbank Creek, as close to GDE1 as practicable.

The alluvium near GDE1 is predicted in the groundwater modelling to become largely unsaturated due to cumulative impacts from approved mining at HVO South, Wambo and Mount Thorley Warkworth. This desaturation occurs due to the existing approved mining (primarily HVO South) without the Project. Based on the conceptual timing of the Project, the Project may result in this effect occurring approximately one year earlier, however, this depends on a range of factors and the timing of any approval for the Project and is highly uncertain. Therefore, the Project is not considered likely to result in impacts beyond those currently approved for GDE1 and the proposed monitoring approach is considered appropriate.

d. Monitoring of metals in the surface water management system (currently only undertaken by United Collieries annually) should be increased in frequency (e.g. monthly). The proposal to only sample for metals when a pH trigger is initiated would require in-depth knowledge of potentially leachable metals and their solubility characteristics under a range of conditions, which has not been demonstrated in the assessment documentation. Additionally, exceedances of the ANZECC guidelines for metals have been observed in the water storages (EIS, Appendix 11, p. 25), highlighting the need to monitor for metals as this water may be discharged to adjacent waterways, potentially impacting water quality and possibly GDEs. Metals and organics (as toxicants and stressors) monitoring should also be undertaken in receiving waterways as proposed in the EIS (EIS, Appendix 11, p. 89).

Summary Response

In addition to the existing monitoring, monitoring of rejects, overburden and water quality will be undertaken to enable assessment and management of any potential downstream water quality impacts. Monitoring of water quality within the WMS will include pH, electrical conductivity, total suspended solids, total dissolved solids, oil and grease and for a suite of metals, metalloids and ions. This will include monitoring within, downstream and, where possible, upstream of the Project Area on a regular basis.

Detailed Response

Historical and more recent water quality data has been reviewed and an analysis provided in **Appendix 1** with the key outcomes discussed in Question 1. This review has been used to provide advice on the proposed monitoring approach for the Project. Details of the proposed monitoring are detailed in the response to Question 3 (Item 14) and include the following:

- monitoring of the existing surface water quality upstream and downstream of the Project Area (using the water quality parameters, frequency of sampling and water quality triggers currently approved for the existing approved operations)
- monitoring of water quality within the WMS for pH, electrical conductivity, total suspended solids, total dissolved solids, oil and grease and for a suite of metals, metalloids and ions. This will include monitoring within, downstream and, where possible, upstream of the Project Area
- monitoring of water quality during HRSTS discharge events as set out in the Wambo EPL
- ongoing review and monitoring of the performance of erosion and sediment controls implemented as part of the Project.

In addition to the existing monitoring, monitoring of rejects, overburden and water quality will be undertaken to effectively manage potential AMD issues arising from emplacement of PAF materials.

Site specific water quality triggers have been developed for Wollombi Brook and these will be incorporated into the WMP to be developed to facilitate assessment of any water quality impacts as a result of the Project. The preliminary site specific triggers are listed in **Table 2.2** in this document in response to Question 1.

e. Refinement of the proposed trigger schemes for surface water and groundwater quality and groundwater levels to improve the ability of these schemes to promptly detect change. This includes:

i. Discussion of the derivation of the surface water quality triggers and confirmation that these are consistent with the ANZECC methodology.

ii. Groundwater quality data should be compared with trigger values when data becomes available rather than annually as currently proposed (EIS, Appendix 12, p. 116) and the temporal scale of sampling increased to three-monthly. The proposed use by the proponent of a control chart approach to developing triggers would require considerable baseline data and a high sampling frequency. It may also lead to issues with gradual changes not being detected if a moving baseline is used. Derivation of triggers based on the ANZECC methodology (i.e. 80$_{th}$ percentile from reference conditions for physicochemical parameters) could be more appropriate. Proposed control charting may be a useful tool during the investigative phase following trigger initiation.

iii. The trigger for groundwater drawdown outside the predicted zone of impact needs to consider that using a moving 24-month average as currently proposed (EIS, Appendix 12, p. 116) may allow a gradual decline in water levels to go undetected. Management measures would then not be implemented.

Summary Response

Existing surface water quality triggers are in place at United and Wambo. It is proposed to update and review the site-specific water quality triggers as part of the development of the Project Water Management Plan and preliminary triggers were provided in the response to Question 1 including derivation of triggers based on ANZECC where appropriate. This will include review of additional water quality data to inform the development of site specific triggers for other analytes. Water quality triggers for the Project will be used to implement TARPs aimed at protecting the environment and identifying any unforeseen impacts on downstream water quality.

In regard to groundwater, specific triggers for each bore are proposed as this will give a more representative indication of groundwater changes on a localised scale than the use of reference conditions. A percentile or standard deviation approach will be adopted in the establishment of the trigger levels and the proposed control chart approach will enable immediate (i.e. quarterly) detection of any adverse changes.

In order to identify potential gradual declines in water levels that may not be detected by the trigger, the long-term trends in groundwater levels will be reviewed as part of the Annual Review to identify any potential impacts due to the Project.

Detailed Response

Discussion of the derivation of the surface water quality triggers and comparison against ANZECC guidelines is provided in the response to Question 1.

In regard to groundwater, a review of data indicates the groundwater conditions vary between bores due to variations in geology, bore construction, recharge sources (i.e. closer to stream) and location. Therefore, specific triggers for each bore would give a more representative indication of groundwater changes on a localised scale than the use of reference conditions.

The historic and baseline data (for proposed bores) will be reviewed by a qualified hydrogeologist in order to establish suitable trigger levels for the Project. Dependent on the distribution of data, a percentile or standard deviation approach will be adopted in the establishment of the trigger levels. Consideration will also be made for existing trigger levels established for already approved site operations. The control chart approach will enable immediate (i.e. quarterly) detection of any adverse changes. In addition, annual review of the results against historical trends will enable identification of any long-term impacts as a result of the Project.

The numerical modelling indicates that groundwater levels will fall within a zone around the proposed mining areas. As outlined in Section 10.3.2 of the GIA, in order to identify significant deviations from the model predictions, an annual review will be conducted by an experienced hydrogeologist to compare the measured groundwater levels with the model predicted levels. For monitoring bores outside of the predicted drawdown extent, the percentile approach was proposed within Section 10.3.2 of the GIA. The initial trigger will be established based on the 5th percentile of baseline data. Where no triggers occur over the reporting period, the trigger will be updated based on the last 24 months of data. This approach was proposed as it helps account for natural variability and landholder bore usage. In order to identify potential gradual declines in water levels that may not be detected by the trigger, the long-term trends in groundwater levels will be reviewed as part of the Annual Review to identify any potential impacts due to the Project.

The WMP will include a prescriptive TARP for impacts on alluvial aquifers and private users, as well as rehabilitation measures for watercourses impacted as a result of the Project. The Project groundwater monitoring program will also include full details on how and when groundwater will be monitored across the Project Area and surrounds.

The groundwater monitoring program will incorporate existing United and Wambo groundwater monitoring points, and will expand the network to include additional monitoring points within the alluvium, shallow regolith and coal measures. This will ensure all key groundwater bearing units are monitored in the long-term. The proposed network and additional bores have been chosen to enable assessment of groundwater levels and flow directions, which will be monitored on a quarterly basis. In order to obtain seasonal baseline data, water quality analysis will be conducted at the proposed bores on a quarterly basis for two years, after which time the frequency of sampling will be reviewed.

The proposed monitoring network for the Project and existing operations at United and Wambo is detailed within the response to Question 1 and shown in **Figure 2.13**. The proposed design also incorporates recommendations from a peer review conducted by Dr Frans Kalf for a transect of monitoring points to the Hunter River alluvium, represented with proposed bores P408, P409 and P414. Following consultation with DPI Water and review of accessibility, the finalised Project monitoring program will be presented within the groundwater monitoring program.

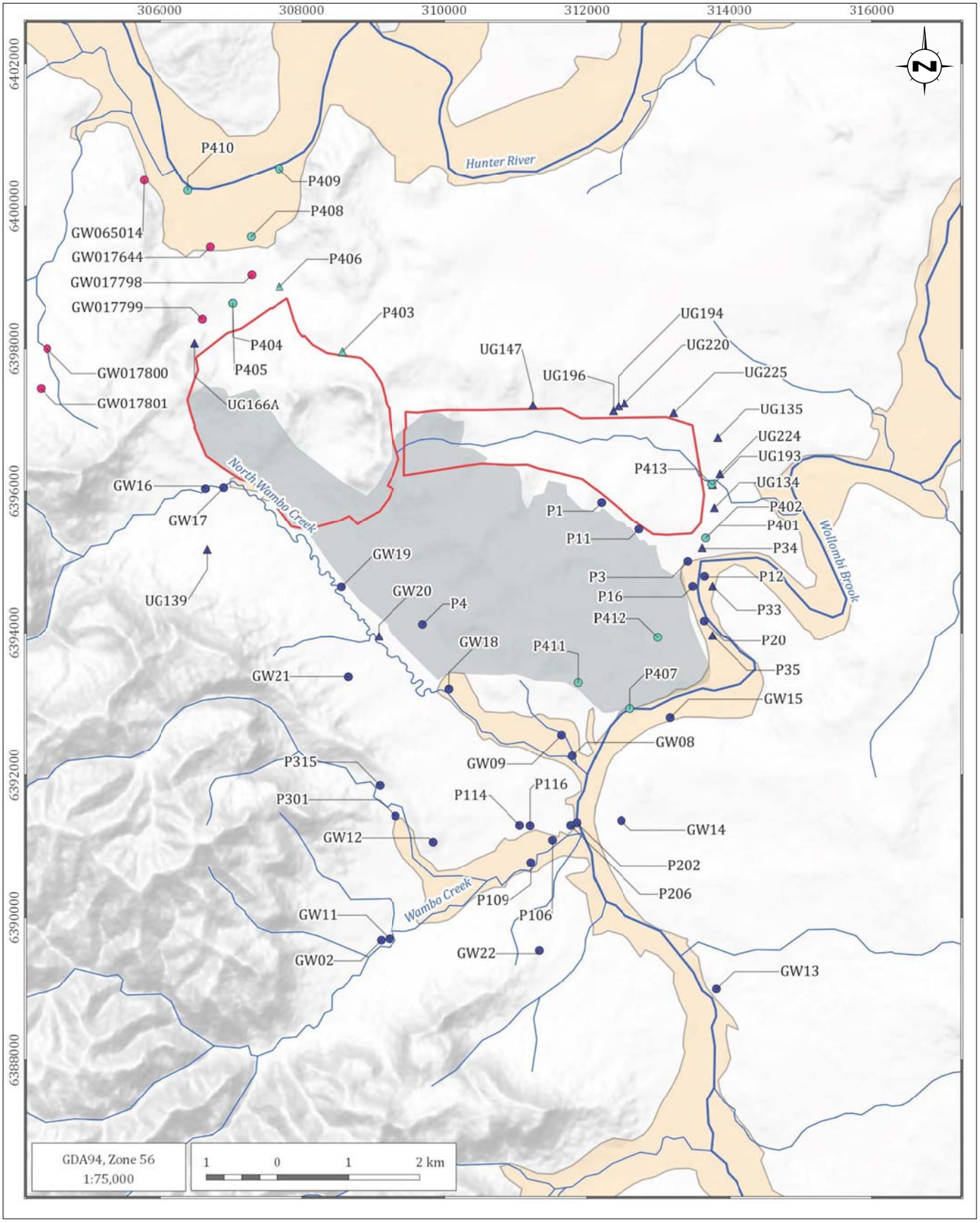


Image Source: AGE Groundwater and Environmental (2016)

Legend

- Proposed extraction area
- Existing mine disturbance area
- Major drainage
- Minor drainage
- Quaternary alluvium (1:25k AGE)
- Monitoring bore (Existing)
- Monitoring bore (Proposed)
- Monitoring bore (Registered)
- VWP (Existing)
- VWP (Proposed)

FIGURE 2.13

Proposed Groundwater Monitoring Network

f. Measurable triggers, based on robust statistical analyses, should be developed in advanced for identifying significant deviations in groundwater levels from baseline or model predictions. These should be used in addition to the judgement of an expert independent hydrogeologist.

Summary Response

Historic data and trigger levels are currently in place for existing approved operations. It is proposed to update and review the site specific water quality triggers as part of the development of the Project WMP.

The establishment of triggers will be conducted as part of the Project WMP process, which will involve consultation and approval from relevant State regulatory bodies.

Detailed Response

Historic data and trigger levels are currently in place for existing approved operations, as outlined in Question 1. It is proposed to update and review the site specific water quality triggers as part of the development of the Project WMP. In addition, bores proposed for the Project will be installed prior to commencement of any mining of areas beyond that currently approved.

Long-term historic water quality data is available for all existing bores included within the updated network. In order to gain an understanding of seasonal trends in the proposed bores, water quality analysis will be conducted on a quarterly basis for two years, after which time the frequency of sampling will be reviewed. The water quality data will be reviewed by an experienced hydrogeologist in order to establish suitable trigger levels for the Project. The establishment of triggers will be conducted as part of the Project WMP process, which will involve consultation and approval from relevant State regulatory bodies.

g. Automated loggers should be downloaded more frequently, currently proposed to be six-monthly, to reduce the potential for data loss and to improve the capability of the proposed trigger system. Three-monthly sampling of groundwater quality would improve the ability to detect and address changes in water quality.

Summary Response

The proposed monitoring program will include download of automated loggers on a more frequent, three monthly basis.

Detailed Response

As outlined within Part A of the RTS, the proposed monitoring program will include download of automated loggers on a more frequent, three monthly basis. Comprehensive groundwater quality monitoring at United and Wambo is conducted on an annual basis and for variable analytes. The proposed monitoring program ensures uniform testing of analytes and at a more frequent six monthly basis for existing bores. In addition,

proposed new bores and selected bores around the proposed South Bates TSF (i.e. P4, GW18 and GW19) will be monitored on a quarterly basis for two years, after which time the frequency of sampling will be reviewed.

h. Selection of appropriate groups of upstream and downstream sampling locations to be used for identifying the potential impacts of discharge on downstream environments. These should be located within the same reach where possible and the downstream location should not be affected by discharge from other mining operations. Contextual information about the proposed monitoring sites and justification of the selection should be provided.

Summary Response

The existing monitoring locations have been designed in consultation with relevant agencies and have been selected based on the location of other mines and discharge locations. These locations are planned to be used for the Project.

The monitoring locations include sites that are upstream, mid-stream and downstream of the Project Area and various operational components of both Wambo and United mines along Wollombi Brook. In addition, monitoring locations are in place upstream of the mining operations on North Wambo Creek, Stony Creek, South Wambo Creek and Wambo Creek. There are no monitoring locations upstream of the operations on Waterfall Creek or Redbank Creek as the mining operations include the headwaters of these catchment areas.

The monitoring program also includes sites downstream of the Project on the ephemeral watercourses of Wambo Creek, North Wambo Creek, Waterfall Creek and Redbank Creek. The upstream, downstream and, where present, mid-stream monitoring locations are located in different reaches and are not influenced, between monitoring sites, by mining operations other than United or Wambo coal mines.

Detailed Response

During periods of water surplus, water will be discharged via the Wambo discharge point (refer to **Figure 2.14**) in accordance with the EPL and HRSTS. This discharge arrangement is approved and no changes to this current approval are proposed as part of the development application for the Project.

The Project proposes to continue to discharge surplus water from the WMS in accordance with existing approvals and no changes are proposed to the current discharge approvals as part of the Development Application for this Project.

The existing monitoring locations have been designed in consultation with relevant agencies and have been selected based on the location of other mines and discharge locations. The monitoring locations include sites that are upstream, mid-stream and downstream of the Project Area and various operational components of both Wambo and United mines along Wollombi Brook. In addition, monitoring locations are in place upstream of the mining operations on North Wambo Creek, Stony Creek, South Wambo Creek and Wambo Creek. There are no monitoring locations upstream of the operations on Waterfall Creek or Redbank Creek as the mining operations include the headwaters of these catchment areas. The monitoring program also includes sites downstream of the Project on the ephemeral watercourses of Wambo Creek, North Wambo Creek, Waterfall Creek and Redbank Creek.

The upstream, downstream and, where present, mid-stream monitoring locations are located in different reaches and are not influenced, between monitoring sites, by mining operations other than United or Wambo coal mines.

Based on monitoring locations being in place for all relevant locations for the Project, there are no proposed changes to the surface water quality monitoring locations proposed as part of the Project.

The quality of such discharges will be in accordance with EPL limits and consistent with the provisions of the HRSTS. Discharges from the WMS will be monitored prior to release to ensure compliance with the requirements of the HRSTS. With these measures in place and considering the management of cumulative salt loads under the HRSTS, discharges of water from the Project are not considered likely to result in significant cumulative impacts on downstream environments.

Further details of the monitoring locations will be included in the WMP for the Project.

21. Commitments for surface and groundwater monitoring should be presented as part of a water monitoring plan and should be consistent with the National Water Quality Management Strategy.

Summary Response

A Project specific water monitoring plan will be prepared in consultation with DPE, DPI Water, DoEE and with reference to relevant industry standards which are consistent with the National Water Quality Management Strategy.

Detailed Response

A Project specific water monitoring plan will be prepared in consultation with DPE, DPI Water, DoEE and with reference to relevant industry standards, including:

- *Australian guidelines for water quality monitoring and reporting,* Australian and New Zealand Environment and Conservation Council & Agriculture and Resource Management Council of Australia and New Zealand, October 2000 (ANZECC Guidelines)

- The Australian/New Zealand Standard Water quality – Sampling, Part 1: *Guidance on the design of sampling programs, sampling techniques and the preservation and handling of samples* (AS/NZS 5667.1:1998)

- The Australian/New Zealand Standard Water quality – Sampling, Part 11: *Guidance on sampling of groundwaters* (AS/NZS 5667.11:1998).

The NSW Water Quality and River Flow Objectives (NSW Office of Environment and Heritage (OEH), 2006) are the agreed environmental values and long-term goals for NSW's surface waters. The objectives are consistent with the agreed national framework for assessing water quality as set out in the Australian and New Zealand Guidelines for Fresh and Marine Water Quality Guidelines (2000) (ANZECC Guidelines). It should be noted that both the above guidelines were developed to be consistent with the requirements of the National Water Quality Management Strategy.

22. The Northern Sydney Basin, which includes the Hunter Subregion, has been identified as a Bioregional Assessment priority region. Data and relevant information from the proposed project should be made accessible to this Bioregional Assessment and related research projects.

Glencore, United's parent company, has already provided data and relevant information for this Bioregional Assessment, and is willing to continue to provide relevant data and information on request.

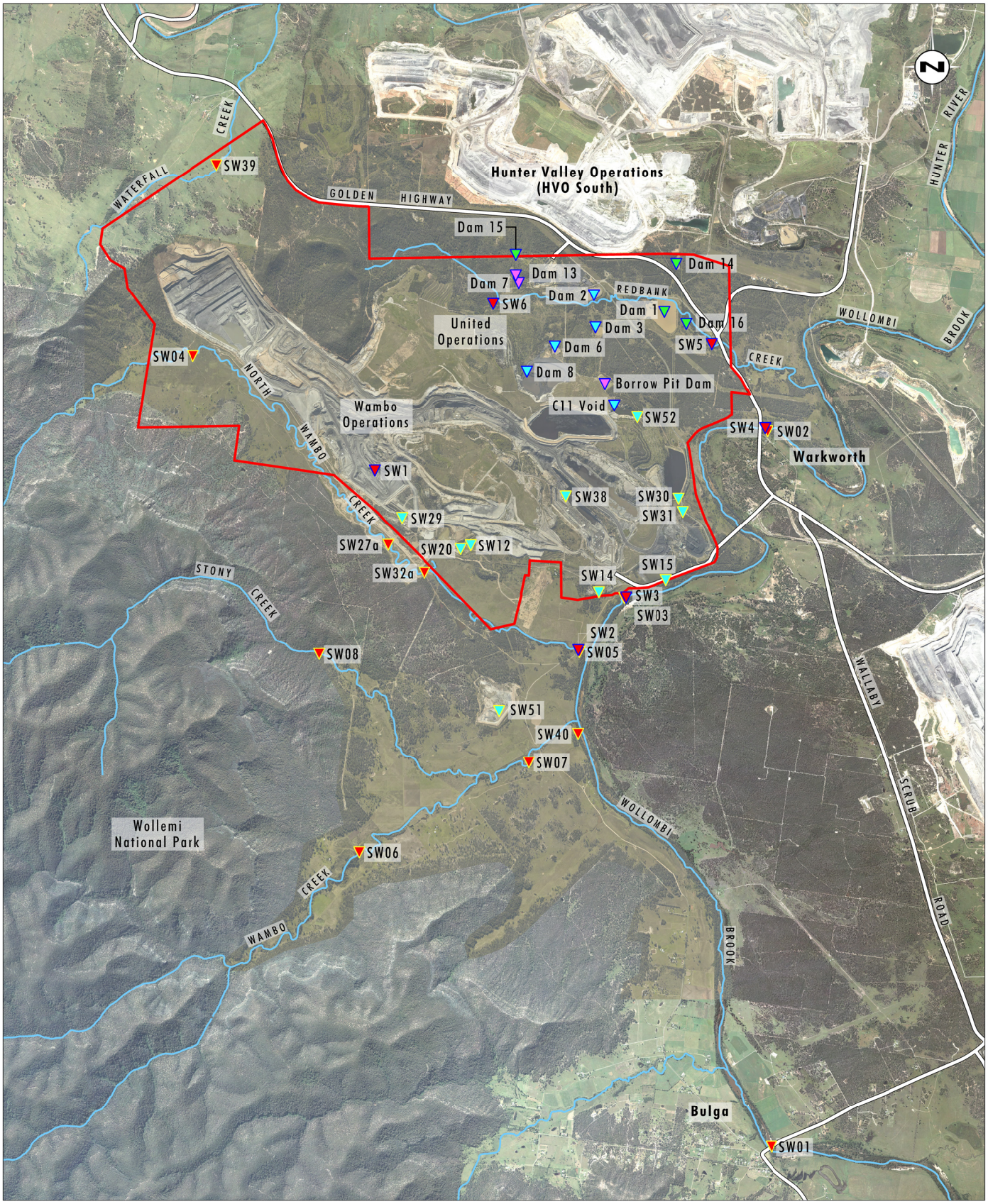


Image Source: United (2015)
Data Source: Glencore (2015), Peabody Energy (2015)

Legend

- Project Area
- United Receiving Water
- United Mine Water
- United Dirty Water
- United Clean Water
- Wambo Receiving Water
- Wambo Mine Water

FIGURE 2.14

Existing Surface Water Quality Monitoring Locations

File Name (A4): R11/3509_182.dgn
20170530 11.37

3.0 Biodiversity

As discussed in **Section 1.2**, United has revised the additional disturbance footprint for the Project as part of its ongoing refinement of the Project design. This refinement has resulted in a reduction in the additional disturbance footprint by approximately 37 hectares as shown on **Figure 1.5**. This reduction in the additional disturbance footprint has resulted in the following reductions in impacts of the Project:

- avoidance of impacts on 19.2 hectares of vegetation conforming to the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) listed Central Hunter Valley Eucalypt Forest and Woodland Critically Endangered Ecological Community (CEEC)
- avoidance of impacts on 27.1 hectares of native woodland vegetation and fauna habitat
- avoidance of impacts on 7.9 hectares of native grassland vegetation.

As also discussed in **Section 1.2**, since the lodgement of the EIS for public exhibition the Joint Venture has been undertaking ongoing investigations to identify and secure additional biodiversity offsets for the Project. As an outcome of these ongoing investigations the area of the Wambo Offset site has been increased from approximately 56 hectares to approximately 338 hectares. The site is proximate to the additional disturbance area for the Project and provides a local offset. The site contains approximately 150 hectares of CEEC and another approximately 48 hectares of land (including areas of derived native grassland created by historic land clearing) that will be regenerated to CEEC. In total, the offset site will provide approximately 200 hectares of offset for the CEEC.

As outlined in the EIS, from a biodiversity perspective the Project was planned to be assessed under the UHSA following the UHSA Interim Policy (DP&I 2012). United was advised by OEH to undertake the assessment under the UHSA Interim Policy as outlined in OEH's letter to DPE dated 24 July 2015 and included as Attachment 2 to the SEARs. Based on advice from OEH during the preparation of the assessment, it was understood by United that the UHSA process was planned to be finalised and the UHSA Biodiversity Plan would be in place prior the public exhibition of the EIS for the Project. However, this was not the case and the Draft UHSA Biodiversity Plan has not as yet been publicly exhibited and is therefore not in place.

Following OEH's directions, a 'Statement of Consistency' report was prepared as part of the EIS to assess the impacts of the Project on biodiversity in line with the Biodiversity Certification Assessment Methodology (BCAM). The Statement of Consistency report also outlined the proposed offsetting framework for the Project. The report also addressed other relevant matters raised in the SEARs provided initially on 27 July 2015 and revised on 15 December 2015.

While, it remains available for the Project to continue to be assessed under the UHSA Interim Policy (DP&I 2012), the lack of a finalised UHSA Biodiversity Plan provides some uncertainty regarding outcomes for both United and the community. The community has not, as yet, been provided the opportunity to comment on the Draft UHSA Biodiversity Plan as it has not yet been publicly exhibited. This point was raised in a number of submissions by non-government organisations and the community.

In the absence of a final UHSA Biodiversity Plan and to provide certainty for the progression of the approval process for the Project, in addition to the UHSA assessment provided as part of the EIS, an assessment has been completed for the Project under the NSW Biodiversity Offsets Policy for Major Projects which incorporates the NSW Framework for Biodiversity Assessment (FBA) which is current NSW Government policy and is an alternative biodiversity assessment path available for the Project. While the OEH letter

discussed above referred to the UHSA process, the SEARs themselves included flexibility to undertake the biodiversity assessment under the FBA as outlined on page 4 of the revised SEARs:

- ***Biodiversity*** *– including an assessment of the likely biodiversity impacts of the development, having regard to the NSW Biodiversity Offsets Policy for Major Projects, OEH's requirements (see Attachment 2) and Department of Environment's requirements (see Attachment 3).*

The Biodiversity Assessment Report (BAR) (FBA report) prepared for the Project is provided as **Appendix 4**.

Notwithstanding the above, the OEH submission asked several questions in regard to the UHSA assessment and some NGO and community submissions also raised issues that required a response. There have also been changes to the Project that affect the UHSA assessment outcomes including a reduction in disturbance area and increase in offset areas since the EIS was publicly exhibited. To ensure the UHSA assessment process is complete, this report provides a response to these issues in addition to providing the FBA assessment.

3.1 Updated UHSA Credit Outcomes

As outlined in **Section 1.2**, the additional disturbance area for the Project has been revised and as discussed in **Section 3.3** the OEH submission required some minor changes to the BCAM assessment undertaken as part of the preparation of the EIS. The revision to the additional disturbance area has resulted in a change to the impacts that were presented in the EIS. **Table 3.1** provides the revised UHSA BCAM credit requirements. These include revising the overstorey regeneration score for the grasslands in response to comments from OEH (refer to **Section 3.3**). These credits have also applied the 50 per cent discount applicable to derived native grasslands (DNG) that are not part of the Central Hunter Valley CEEC, for which no discounting applies.

Table 3.1 Revised UHSA BCAM Credit Requirements

Vegetation zone details	Vegetation zone area (ha)	Total Number of Credits
HU812 - Moderate/Good **Forest Red Gum grassy open forest on floodplains of the lower Hunter**	0.29	14
HU816 - Moderate/Good_Plantation/Rehabilitation **Spotted Gum - Narrow-leaved Ironbark shrub - grass open forest of the central and lower Hunter**	29.42	1,041
HU869 - Moderate/Good **Grey Box - Slaty Box shrub - grass woodland on sandstone slopes of the upper Hunter and Sydney Basin**	1.56	59
HU905 - Moderate/Good **Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter**	149.28	6,038
HU905 - Moderate/Good_Regeneration **Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter**	26.55	976
HU905 - Moderate/Good_Cooba Open Shrubland **Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter**	80.45	1,923
HU905 - Low_Derived Native Grassland **Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter**	93.81	1,005
HU906 - Moderate/Good **Bull Oak grassy woodland of the central Hunter Valley**	117.67	4,870
HU945 - Moderate/Good **Swamp Oak - Weeping Grass grassy riparian forest of the Hunter Valley**	31.61	1,248

Vegetation zone details	Vegetation zone area (ha)	Total Number of Credits
HU905_Moderate/Good_Thinned Canopy **Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter**	0.08	3
Totals	**530.72**	**17,177**

As discussed above, the UHSA process has not yet been finalised and therefore the final UHSA Biodiversity Plan is not available. In the absence of this document the offsetting rules that apply to the UHSA assessment for the Project were provided by OEH and these rules were used to assess the then proposed offsets in the EIS. Since that time OEH has advised of changes in some of the draft rules used in the assessment including a change in the proportion of the credit requirement for the CEEC that can be generated by mine rehabilitation, capping this at 15 per cent of the total credits for the CEEC. Mine rehabilitation has also been capped at 25 per cent for all other values requiring offset.

The change in cap on the rehabilitation contribution for the CEEC has resulted in United changing the approach to the use of ecological rehabilitation as part of the rehabilitation strategy for the Project. As outlined in the EIS, 878 hectares of ecological rehabilitation is proposed. In the EIS and based on the UHSA rules being used at that time, all of this was planned to be CEEC; that is 878 hectares of CEEC. With the revised cap, the area of CEEC mine rehabilitation for the Project available to be used in the offset strategy is 226 hectares. The remaining area of ecological rehabilitation (652 hectares) is instead available to focus on the other communities that are also required to be offset for the Project. However, it is noted that due to the caps imposed, not all of the proposed ecological rehabilitation is currently allocated to meet offset requirements and therefore the total area of ecological rehabilitation may be reduced should these draft rules remain unchanged.

Based on the current draft rules, a total of 616.5 hectares of ecological rehabilitation is able to be used as part of the offset strategy. Rehabilitation that meets the criteria of ecological rehabilitation for use in a biodiversity offset strategy is more expensive to establish, and also more complex to achieve than other areas of native vegetation rehabilitation or pasture. Due to this additional cost, the area of ecological rehabilitation may be capped based on the total number of offsets credits that can be achieved. The final make-up of the ecological rehabilitation as part of the Project will be based on the final offset rules that are applied.

As discussed in **Section 1.2**, the offsets secured for the Project have also increased since the EIS was publicly exhibited. Taking into account the reduced disturbance, changes in offsetting rules and increased offset area for the Project, the overall UHSA offsetting outcomes for the Project are provided in **Table 3.2**.

Table 3.2 Final Offset Credit Outcome based on Draft UHSA Offsetting Rules

Impacted Biometric Vegetation Type (BVT)	Credits Required (Impact)	Credits Allocated (Offset)	Remaining Requirements	Further Information
HU812 - Forest Red Gum Grassy Open Forest on Floodplains of the Lower Hunter	14	14	0	• 14 credits of HU812 at Mangrove Offset Site (like-for-like rules – same Plant Community Type (PCT)).
HU816 - Spotted Gum - Narrow-leaved Ironbark shrub - grass open forest of the central and lower Hunter	999	251	748	• 251 credits from mine rehabilitation (contributing 25% of offset for HU816 as *Central Hunter Ironbark – Spotted Gum – Grey Box Forest EEC*).
HU869 - Grey Box - Slaty Box shrub - grass woodland on sandstone slopes of the upper Hunter and Sydney Basin	16	16	0	• 16 credits of HU868 at Highfields Offset Site (like-for-like rules - same vegetation class where the per cent cleared is greater or equal to HU869).
HU905 - Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter	3183	2527	656	• 1732 credits of HU905 at Mangrove Offset Site (like-for-like rules – same PCT). • 795 credits from mine rehabilitation (contributing 25% of offset for HU905 as *Central Hunter Grey Box – Ironbark Woodland in the NSW North Coast and Sydney Basin Bioregions EEC*).

Impacted Biometric Vegetation Type (BVT)	Credits Required (Impact)	Credits Allocated (Offset)	Remaining Requirements	Further Information
HU906 - Bull Oak grassy woodland of the central Hunter Valley	4448	4448	0	• 3592 credits of HU730 at Highfields Offset Site (like-for-like rules – same vegetation class with per cent cleared equal or greater than HU906). • 20 credits of HU714 at Highfields Offset Site (variation rules - same formation where the per cent cleared is greater or equal to HU906). • 836 credits from mine rehabilitation (contributing 19% of offset for HU906).
HU945 - Swamp Oak - Weeping Grass grassy riparian forest of the Hunter Valley	1248	1248	0	• 1248 credits of HU812 at Mangrove Offset Site (variation rules - same formation where the per cent cleared is greater or equal to HU945^).
Central Hunter Valley Eucalypt Forest and Woodland CEEC **(comprising portions of HU816, HU869, HU905 and HU906)**	7268	4275	2993	• 3186 credits of *Central Hunter Valley Eucalypt Forest and Woodland CEEC* at Wambo Offset Site (like-for-like – CEEC under the EPBC Act). • 1089 credits from mine rehabilitation restoring CEEC (contributing 15% of offset for *Central Hunter Valley Eucalypt Forest and Woodland CEEC*).

Impacted Biometric Vegetation Type (BVT)	Credits Required (Impact)	Credits Allocated (Offset)	Remaining Requirements	Further Information
Total Ecosystem Credits Remaining			**4397**	
southern myotis (*Myotis macropus*)	562	21	541	• 21 credits of potential southern myotis roosting habitat at Mangrove Offset Site.
Total Species Credits Remaining			**541**	

^ VIS database quotes 0% cleared for HU812 across the Hunter/Central Rivers CMA. This is likely due to an error/omission of data in the database. Known per cent cleared for HU812 is quoted as around 98% in Peake (2006) and over 90% in the NSW Scientific Committee's Final Determination for Hunter Floodplain Red Gum Woodland in the NSW North Coast and Sydney Basin Bioregions EEC (NSWSC 2011c).

As outlined in **Table 3.2** there are some remaining credits that are not addressed by the existing offset package and further offsets will be required. As discussed in the EIS and earlier in this RTS, United is undertaking further investigations to secure the remaining required offsets for the Project and may use a range of different offsetting options. Broadly, these may include:

- land-based offset sites
- securing required credits through the open credit market
- contributing money to supplementary measures in accordance with relevant conservation or recovery actions and/or
- payments to an offsets fund.

3.1.1 Wambo Offset Site and Underground Mining

The South Bates Extension Modification proposes to extend longwall panel mining in the Wambo Coal Mine Whybrow Seam to the northwest of the previously approved South Bates Underground Mine. Parts of the proposed longwalls occur under the proposed Wambo Offset Site. As discussed below the potential impacts of this mining activity (if approved) have been assessed (FloraSearch 2017) and were considered unlikely to result in a measurable impact on the quality of the native vegetation and habitats in the proposed BioBank site.

BioBank sites can be established in areas where mining leases exist and mining may occur. There is also precedent for establishment of biodiversity offset sites above underground mining areas where the surface impacts and resultant impacts on biodiversity are low, such as at Glencore's Ulan coal mine. Given the high conservation value offered by the large area of CEEC at the Wambo Offset site, the establishment of an offset site at this location is considered an appropriate outcome.

Further detailed assessment of the potential subsidence impacts associated with any future application to mine under this area will be undertaken as part of the approval process for that development application, however, a summary of the key findings of the assessments completed are provide below.

Potential impacts to native vegetation and habitats as a result of the longwall mining underneath the Wambo BioBank

Site may include subsidence of the land surface, which results in soil cracking, ponding of water, and bedrock cracking in streambeds leading to potential diversion of surface water flows to sub-surface fracture networks (FloraSearch 2017). Mine subsidence effects on the surface are expected to vary according to the depth of cover above the coal seam and surface features such as steep narrow ridge lines (FloraSearch 2017). Surface cracking of soils may potentially occur over the lower flat areas of the site, however would likely be less prevalent as depth of cover increases towards the southern escarpment to the west of the proposed Wambo Offset Site (FloraSearch 2017).

Overall, the flora impact assessment (FloraSearch 2017) considered it unlikely for vegetation within areas of the proposed Wambo Offset Site to be adversely affected by soil cracking due to mine subsidence. It was noted, however, that some woodland areas may be affected by ponding and minor effects to riparian vegetation along the upper reaches of North Wambo Creek. The assessment concluded that it is considered unlikely that these impacts will result in a measurable impact to the quality of the native vegetation and habitats in the proposed Wambo Offset Site under a BioBanking scenario.

3.2 Department of Planning and Environment

A key issue raised in submissions relates to biodiversity impacts and the Upper Hunter Strategic Assessment. The OEH submission identifies areas which must be addressed in the RTS

The issues raised in the submissions relating to biodiversity area are addressed throughout this section of this RTS. The OEH submission is addressed in **Section 3.3**.

Provide information on the existing offset requirements for the United Mine and the Wambo Mine and how these are being considered in the current biodiversity offsets strategy.

The existing offsets owned and managed by Wambo will be unaffected by the Project and Wambo will remain responsible for these existing offsets.

In regard to the development consent for the former United underground mine, Schedule 4, condition 45 of DA-410-11-2003-i, required the establishment of at least 18.5 hectares of compensatory habitat on the surface colliery holding to the satisfaction of the Director-General, to replace the woodland vegetation removed for the United underground mine development.

In accordance with condition 45, a 30 hectare portion of land in the north west corner of the surface colliery holding was established under a management plan as a Compensatory Habitat Area (refer to **Figure 3.1**). The Compensatory Habitat Area is located in the north west corner of the United surface colliery holding and is bordered to the west by land owned by neighbouring Wambo Mine Complex (Wambo), to the north by land owned by Coal and Allied's Hunter Valley Operations (HVO). Unmined land within the United colliery holding exists to the east and south of the Compensatory Habitat Area boundaries. The Compensatory Habitat Area is not subject to any long-term conservation mechanisms and occurs within the disturbance area for the Project.

To replace the existing compensatory habitat area, United proposes to use 18.5 ha of a proposed offset site to address the requirements of DA-410-11-2003-i and will secure this area under a biobank agreement providing in-perpetuity conservation. It is also noted that credits have been generated for the impacts in this area so the impacts on this area are considered in the offset calculations for the Project.

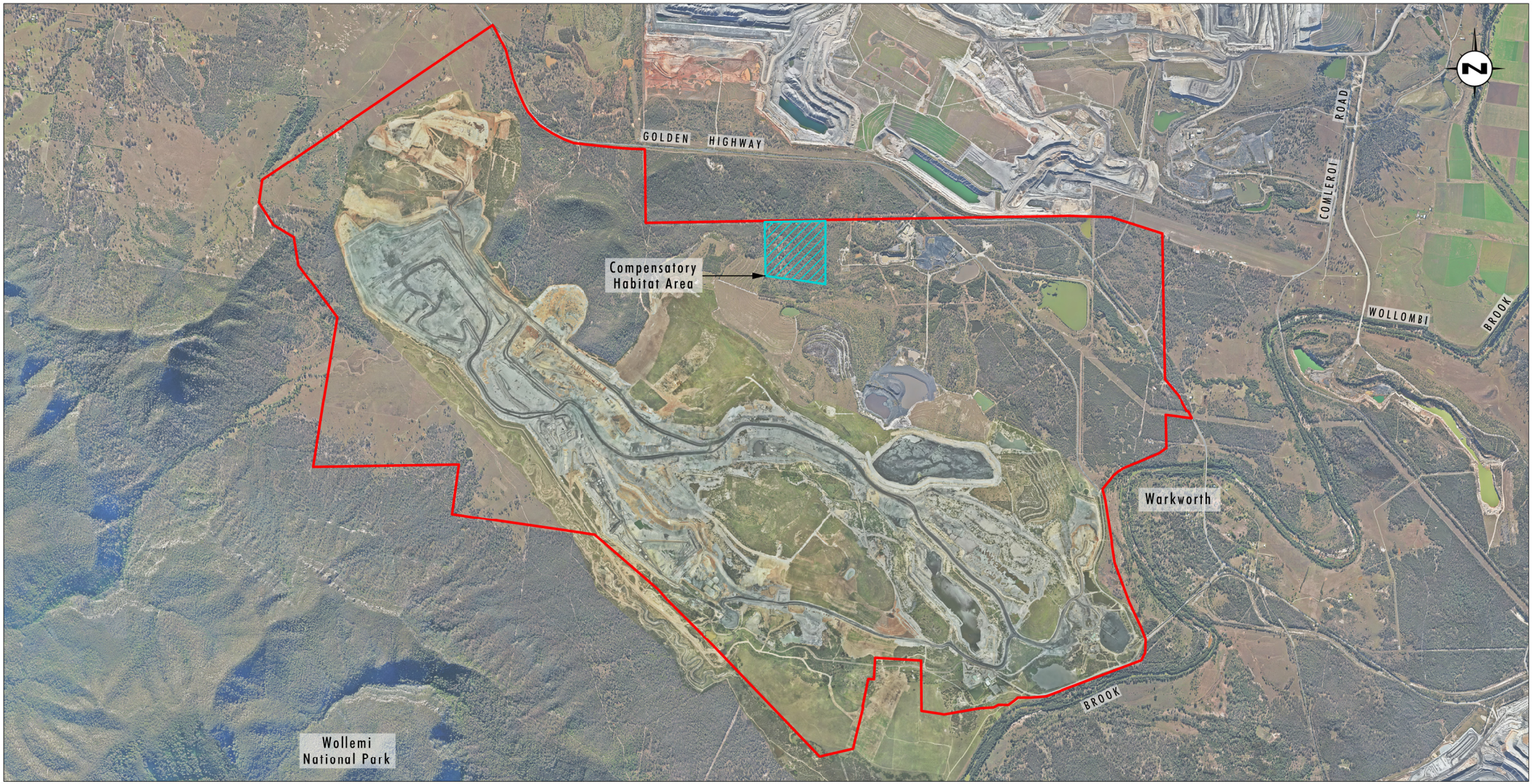


Image Source: AAM (2012), United (2016)

0 0.5 1.0 2.0km
1:50 000

Legend

- Project Area
- Compensatory Habitat Area

FIGURE 3.1

Compensatory Habitat Area

Section 6.13 of the Main EIS provides information to justify the feasibility and achievability of ecological rehabilitation. It is stated that an assessment of the United and Wambo mines rehabilitation areas identified that rehabilitation zones comply with EEC. Detail the assessment methodology used to determine compliance with EEC criteria.

Umwelt identified that isolated areas of rehabilitation on the lower slopes of the Project Area could potentially be consistent with the *Central Hunter Ironbark – Spotted Gum – Grey Box Forest in the NSW North Coast and Sydney Basin Bioregion EEC* listed under the TSC Act as per the final determination for the community (NSW Scientific Committee 2011). An assessment of Vegetation Zone 3 - HU816 Spotted Gum - Narrow-leaved Ironbark Shrub - Grass Open Forest of the Central and Lower Hunter – Moderate to Good Condition (Plantation) was undertaken to compare its floristic and specific attributes against those identified in the final determination following a similar approach undertaken for all vegetation surveyed as part of the Project (that is, the rehabilitation was treated no differently from other native vegetation areas). This assessment was done using detailed floristic plots completed within the Project Area. The results of this assessment identified that it did in fact conform with the EEC, totalling 29.42 hectares. A summary of the assessment is provided below:

- This EEC is characterised by a canopy dominated by four key eucalypt species, namely spotted gum (*Corymbia maculata*), broad-leaved ironbark (*Eucalyptus fibrosa*), grey gum (*Eucalyptus punctata*) and narrow-leaved ironbark (*Eucalyptus crebra*). The canopy layer of this community was dominated by spotted gum (*Corymbia maculata*) and hickory wattle (*Acacia implexa*), with some occurrences of sugar gum (*Eucalyptus cladocalyx*) totalling less than 5 per cent cover in places.

- This vegetation zone supports a reasonable proportion of species that are in the list of characteristic species for the EEC:

    - 15 out of 44 (34 per cent) native species recorded in this unit are characteristic species in the EEC listing, and

    - 15 out of 44 (34 per cent) species in the characteristic species list for the EEC were recorded in this unit. However of the 15 species recorded from the characteristic species list, only one species was a mid-storey or shrub species, the remaining species being either a canopy or ground layer species.

- Natural recruitment of spotted gum (*Corymbia maculata*) was recorded within the canopy, midstorey and ground cover layers. This was recorded as part of the biometric surveys of this vegetation zone. Therefore an overstorey regeneration score of 1 was allocated.

The Central Hunter Valley Eucalypt Forest and Woodland CEEC was listed under the EPBC Act during May 2015, and components of Vegetation Zone 3 were also identified as being consisted with this CEEC. The total area of Vegetation Zone 3 in the Project Area is 29.42 hectares. Of this, 1.17 hectares conforms with the CEEC. The remaining 28.25 hectares of this vegetation zone did not meet the condition thresholds for the community as it had a high proportion of exotic species (greater than 50 per cent perennial exotic understorey), in particular *Acacia saligna*, as well as areas where the introduced sugar gum (*Eucalyptus cladocalyx*) was present.

It is also noted that impacts on these areas of EEC and CEEC were included in the impacts of the Project and credits generated to require offsets for these impacts.

3.3 Office of Environment and Heritage

Compliance with the Biodiversity Certification Assessment Methodology (BCAM) requirements

Appendix A of the BCAM Manual (OEH 2015) provides a checklist of matters to be addressed and information to be provided for a report prepared by use of this methodology. After reviewing the Statement of Consistency (SoC) report against the BCAM requirements the following matters were identified as requiring further information or clarification:

The Statement of Consistency report was prepared to demonstrate how the assessment of impacts of the Project on biodiversity are consistent with the final United UHSA Biodiversity Certification Assessment Report (Umwelt 2015) submitted to OEH in September 2015, and to outline the proposed approach to offsetting the Project under the UHSA. Further to this, the assessment was completed in accordance with the Project specific assessment requirements provided by OEH and in line with the UHSA Interim Policy (DP&I 2012). The Statement of Consistency report was prepared referencing the assessments in the final United UHSA Biodiversity Certification Assessment Report (Umwelt 2015).

While the final United UHSA Biodiversity Certification Assessment Report (Umwelt 2015) presented all the information sought by OEH in its submission, it is acknowledged that this report is not currently available to be reviewed by the public as the NSW Government has not as yet finalised the draft UHSA Biodiversity Plan for public exhibition. It is further noted that the Statement of Consistency report was prepared in accordance with the guidance provided by OEH, however, as the draft UHSA material has not yet been publicly exhibited, further information has now been requested.

The following sections provide the information from the United UHSA Biodiversity Certification Assessment Report as per OEH's request in the submission.

a. A map showing the IBRA region and subregion of the project and its offset package

Figure 3.2 shows the IBRA regions, subregions and catchment management areas relevant to the Project and the offset sites.

b. A full description of the vegetation communities of the Project Area

Surveys of the Project Area identified six Plant Community Types (PCTs) across 10 condition classes being:

- HU812 Forest Red Gum grassy open forest on floodplains of the lower Hunter
  - *Moderate to Good Condition*
- HU816 Spotted Gum - Narrow-leaved Ironbark shrub - grass open forest of the central and lower Hunter
  - *Moderate to Good Condition – Plantation/Rehabilitation*

- HU869 Grey Box - Slaty Box shrub - grass woodland on sandstone slopes of the upper Hunter and Sydney Basin
    - *Moderate to Good Condition*
- HU905 Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter
    - *Moderate to Good Condition – Derived Native Grassland*
    - *Moderate to Good Condition*
    - *Moderate to Good Condition – Cooba Open Shrubland*
    - *Moderate to Good Condition – Thinned Canopy*
    - *Moderate to Good Condition – Regeneration*
- HU906 Bull Oak grassy woodland of the central Hunter Valley
    - *Moderate to Good Condition*
- HU945 Swamp Oak - Weeping Grass grassy riparian forest of the Hunter Valley
    - *Moderate to Good Condition.*

A full description of the vegetation communities present within the Project Area is included in Section 3.2.1 of the BAR (FBA) report (refer to **Appendix 4**).

c. Maps that show vegetation condition class or subclass, all state-listed EECs, and plot and transect locations relative to PCTs and their condition in the project area

Figure 3.3 shows the condition class of each of the 12 mapped vegetation zones and the location of all 49 plots/transects within these vegetation zones**. Figure 3.4** includes all threatened ecological communities (TECs) listed under the TSC Act.

d. A description of the drainage lines on the project area, with stream order and any riparian buffers identified and shown on a map

The majority of the Project Area is located within the catchment area of Wollombi Brook. Wollombi Brook is a major tributary of the Hunter River. One other minor tributary of the Hunter River, Waterfall Creek, is also located within the Project Area.

The Wollombi Brook catchment, in the vicinity of the Project Area, includes sub-catchments of Wambo Creek, North Wambo Creek and Redbank Creek (refer to **Figure 3.5**). Waterfall Creek, a sub-catchment of the Hunter River, is located in the north of the Project Area. The existing United and Wambo WMSs are also located within the Project Area.

Wambo Creek, including its tributary Stony Creek flows in a north-easterly direction and joins Wollombi Brook approximately 2 kilometres upstream of the Project Area.

North Wambo Creek is a tributary of Wollombi Brook flowing in a generally south-easterly direction through and along the southern flank of the Project Area and joining Wollombi Brook approximately one kilometre south of the Project Area. A section of North Wambo Creek has previously been diverted as part of the approved Wambo Open Cut mining operations. Redbank Creek's confluence with Wollombi Brook is located to the east of the Project Area, while Waterfall Creek is a minor drainage line that flows away from the Project Area in a north-easterly direction into the Hunter River. Redbank Creek flows through the centre of the United mine site and into a clean water catch dam.

The catchment boundaries for watercourses within and surrounding the Project Area are shown in **Figure 3.5**. Previous mining operations within the Project Area have modified local catchments through the capture of runoff from mining areas within the WMSs of both the existing United and Wambo Mines and diversion of upslope runoff around the mining operations.

The UHSA project area assessed those areas outside of existing and approved operations within the overall Project Area (refer to **Figure 3.5**). Within the UHSA project area there is one main drainage line being Redbank Creek which is a fourth order watercourse that flows in an easterly direction through the Project Area before joining Wollombi Brook approximately 4 kilometres upstream of the confluence with Hunter River (refer to **Figure 3.5**). Redbank Creek is an ephemeral watercourse with flows only occurring in the creek during storm events or after prolonged rainfall. Redbank Creek and its catchment are highly modified due to mining activities. The catchment consists of approximately 1080 hectares with approximately 885 hectares (82 per cent) located within existing mining areas. It is estimated that prior to mining Redbank Creek had a catchment of approximately 1290 hectares. Of this original catchment area, the majority is contained within the water management systems of United, Wambo and Hunter Valley Operations (South).

The Major Rivers Database (OEH 2011) indicates that Redbank Creek is a tributary to a major river (the Hunter River). Based on the definitions in Appendix 1 of the BCAM (DECCW 2011), Redbank Creek meets the definition of a Minor River. As a result, a riparian buffer of 30 metres either side of Redbank Creek has been identified as a regional biodiversity link (refer to **Figure 3.6**). In addition to this, Wollombi Brook and North Wambo Creek are identified as regional biodiversity links adjacent to the Project Area and a 30 metre buffer has been applied. Also located outside the Project Area is the Hunter River which is recognised as a state biodiversity link based on the definitions in Appendix 1 of the BCAM (DECCW 2011) and a 40 metre buffer has been applied.

Any of the drainage lines within the Project Area which have upstream tributaries as detailed on the Doyles Creek 1:25,000 topographic map, are considered to meet the definition of a minor creek and a riparian buffer 20 metres either side of these drainage lines was mapped as a local biodiversity link (refer to **Figure 3.6**).

There are also a number of minor watercourses in the Project Area. These include drainage lines which do not have upstream tributaries; however they are paths where water would flow intermittently or ephemerally. These are considered local biodiversity links and a buffer of 10 metres either side of the drainage line has been mapped (refer to **Figure 3.6**).

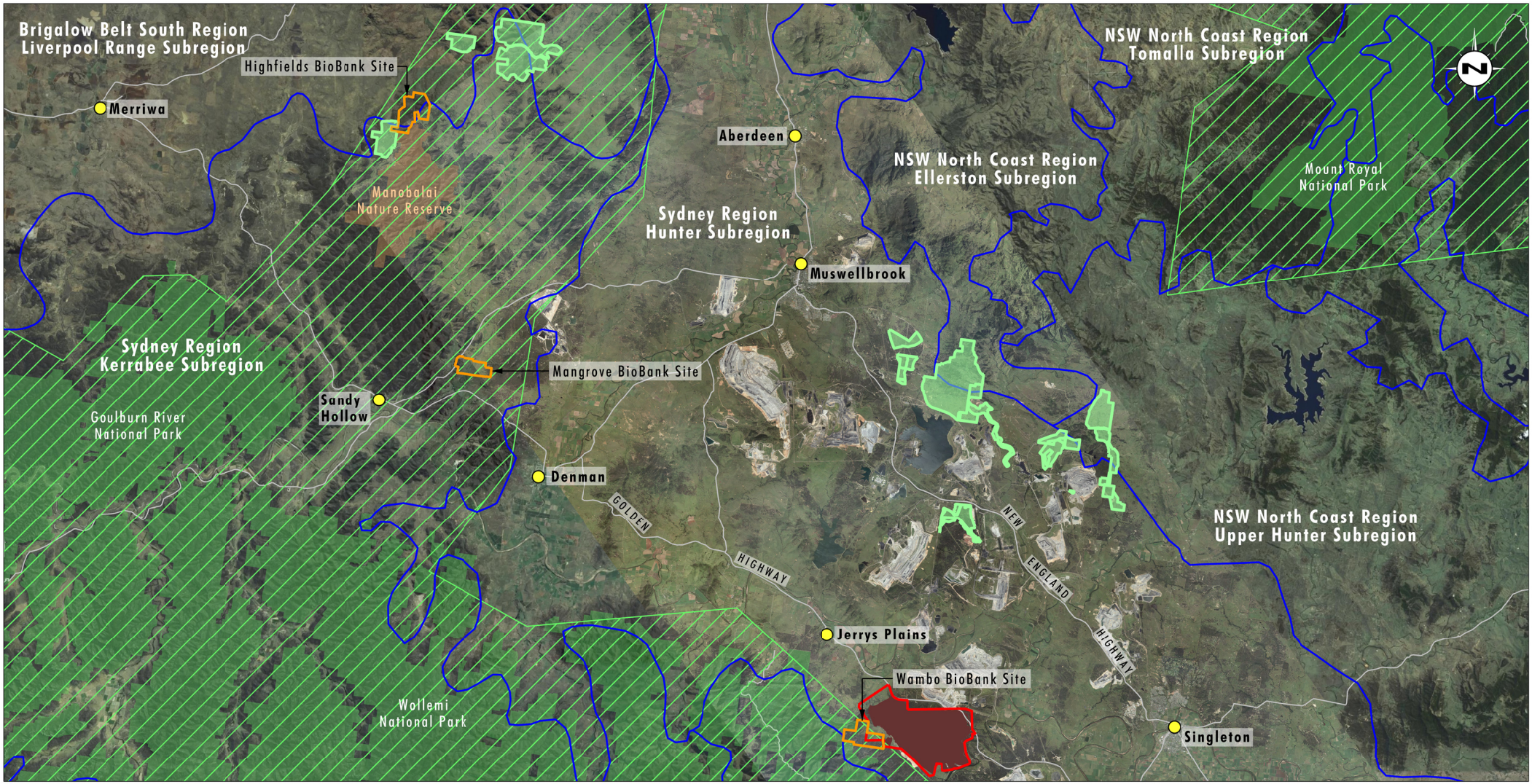


Image Source: Glencore (2008, 2013)
Data Source: Glencore (2016), Department of Lands (2013)

0 5 10 20km
1:400 000

Legend

- Development Site
- Biobank Sites
- Great Eastern Ranges Corridor Initiative
- Nature Reserve
- National Park
- IBRA V7 Region/Subregion
- Indicative Location of Mine Rehabilitation
- Other Glencore Offsets

FIGURE 3.2

IBRA Regions and Subregions

File Name (A4): R18/3509_592.dgn
20170530 10.30

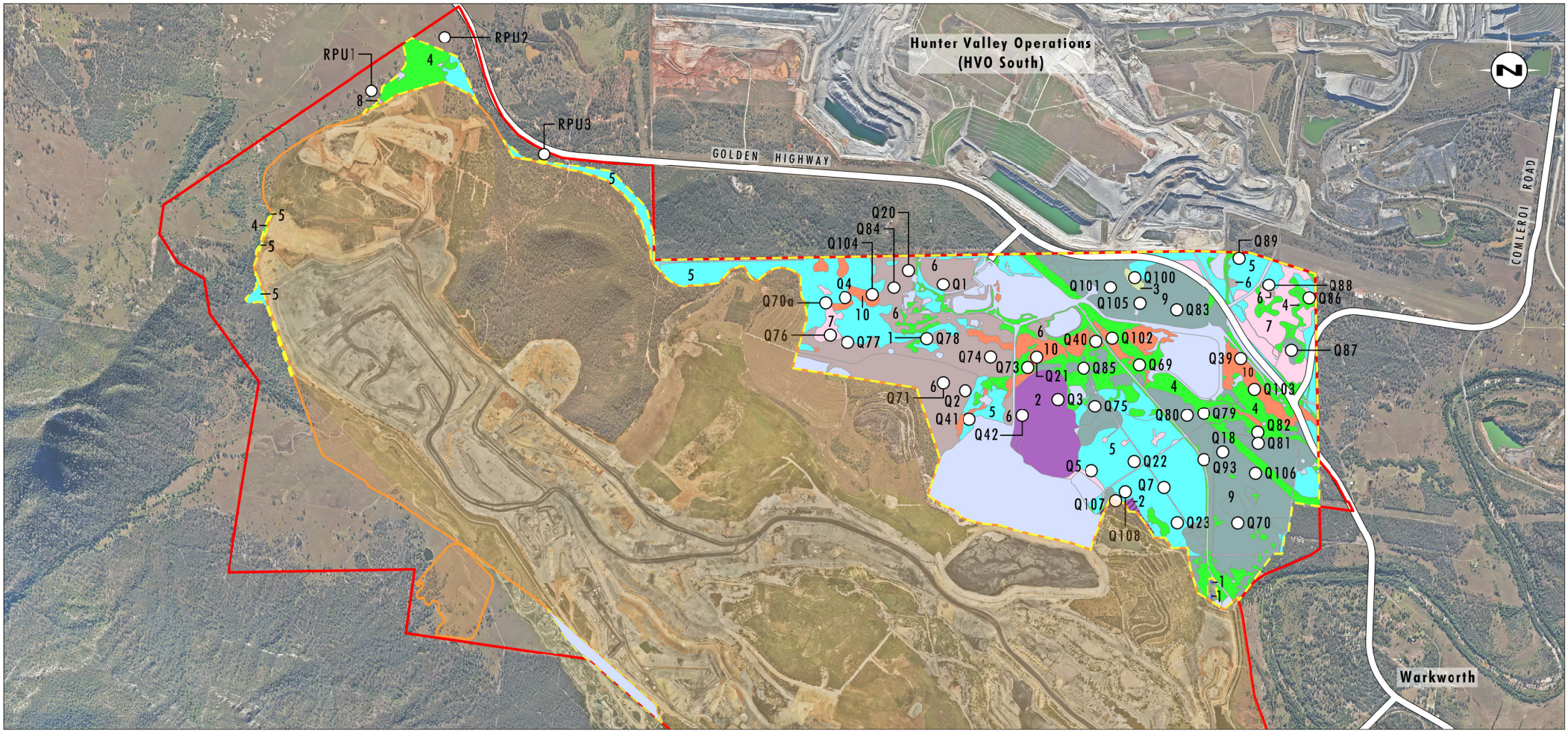


Image Source: AAM (2012), United (2016)
Data Source: Glencore (2014)

Legend

- Project Area
- Conceptual Additional Disturbance Area
- Approved Wambo Surface Development Area
- HU652 - Weeping Myall - Cooba - Scrub Wilga Shrubland of the Hunter Valley- Moderate to Good Condition
- 1 - HU812 - Forest Red Gum Grassy Open Forest on Floodplains of the Lower Hunter - Moderate to Good Condition
- 2 - HU816 - Spotted Gum - Narrow-leaved Ironbark Shrub - Grass Open Forest on Slopes of the Upper Hunter and Sydney Basin - Moderate to Good Condition - Plantation/Rehabilitation
- 3 - HU869 - Grey Box - Slaty Box Shrub - Grass Woodland on Sandstone Slopes of the Upper Hunter and Sydney Basin - Moderate to Good Condition
- 4 - HU905 - Low Condition - Derived Native Grassland
- 5 - HU905 - Narrow-leaved Ironbark - Grey Box grassy Woodland of the Central and Upper Hunter - Moderate to Good Condition
- 6 - HU905 - Moderate to Good Condition - Cooba Open Shrubland
- 7 - HU905 - Moderate to Good Condition - Regeneration
- 8 - HU905 - Moderate to Good Condition - Thinned Canopy
- 9 - HU906 - Bull Oak Grassy Woodland of the Central Hunter Valley - Moderate to Good Condition
- 10 - HU945 - Swamp Oak - Weeping Grass Grassy Riparian Forest of the Hunter Valley - Moderate to Good Condition
- Cleared Land
- Wambo Mine Rehabilitation
- Flora Survey Locations

FIGURE 3.3

Vegetation Zones and Plot/Transect Locations

File Name (A4): R18/3509/593.dgn
20170502 16.03

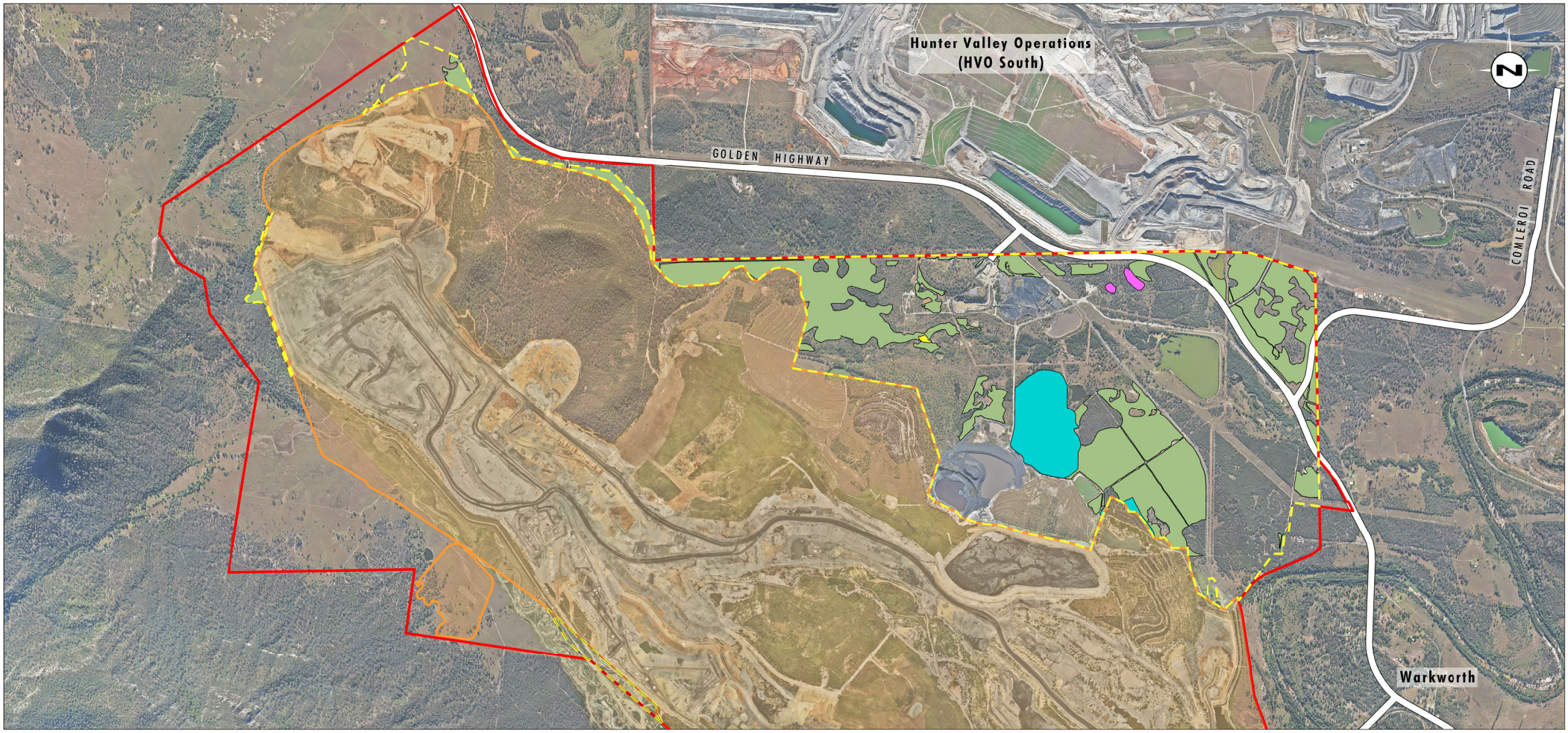


Image Source: AAM (2012), United (2016)
Data Source: Glencore (2014)

0 0.5 1.0 2.0km
1:40 000

Legend

- Project Area
- Conceptual Additional Disturbance Area
- Approved Wambo Surface Development Area
- Central Hunter Grey Box-Ironbark Woodland in the New South Wales North Coast and Sydney Basin Bioregions (EEC)
- Central Hunter Ironbark-Spotted Gum-Grey Box Forest in the New South Wales North Coast and Sydney Basin Bioregions (EEC)
- Hunter Lowland Redgum Forest in the Sydney Basin and New South Wales North Coast Bioregions (EEC)
- Hunter Valley Footslopes Slaty Gum Woodland in the Sydney Basin Bioregion (VEC)

FIGURE 3.4

TSC Act Listed Threatened Ecological Communities

File Name (A4): R18/3509_594.dgn
20170405 16.12

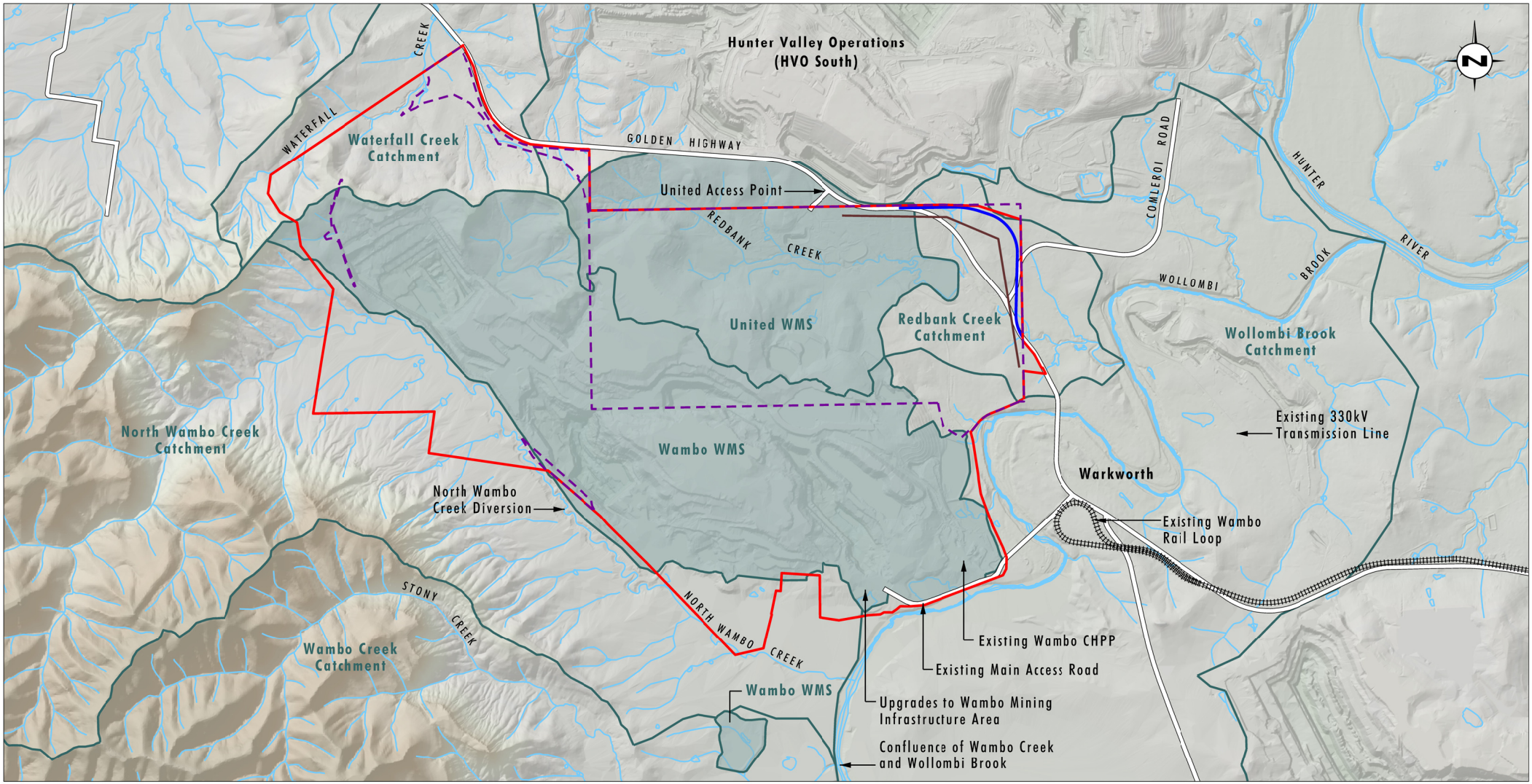


Image Source: AAM (2012), United (2015)
Data Source: Glencore (2014)

0 1.0 2.0 3.0km
1:60 000

Legend

- Project Area
- UHSA Project Area
- Existing 330kV Transmission Line
- Revised Proposed Relocated 330kV Transmission Line
- Proposed Golden Highway Realignment
- Catchment Area
- Water Management System Catchment

FIGURE 3.5

Surface Water Catchment Context

File Name (A4): R18/3509_599.dgn
20170328 16.12

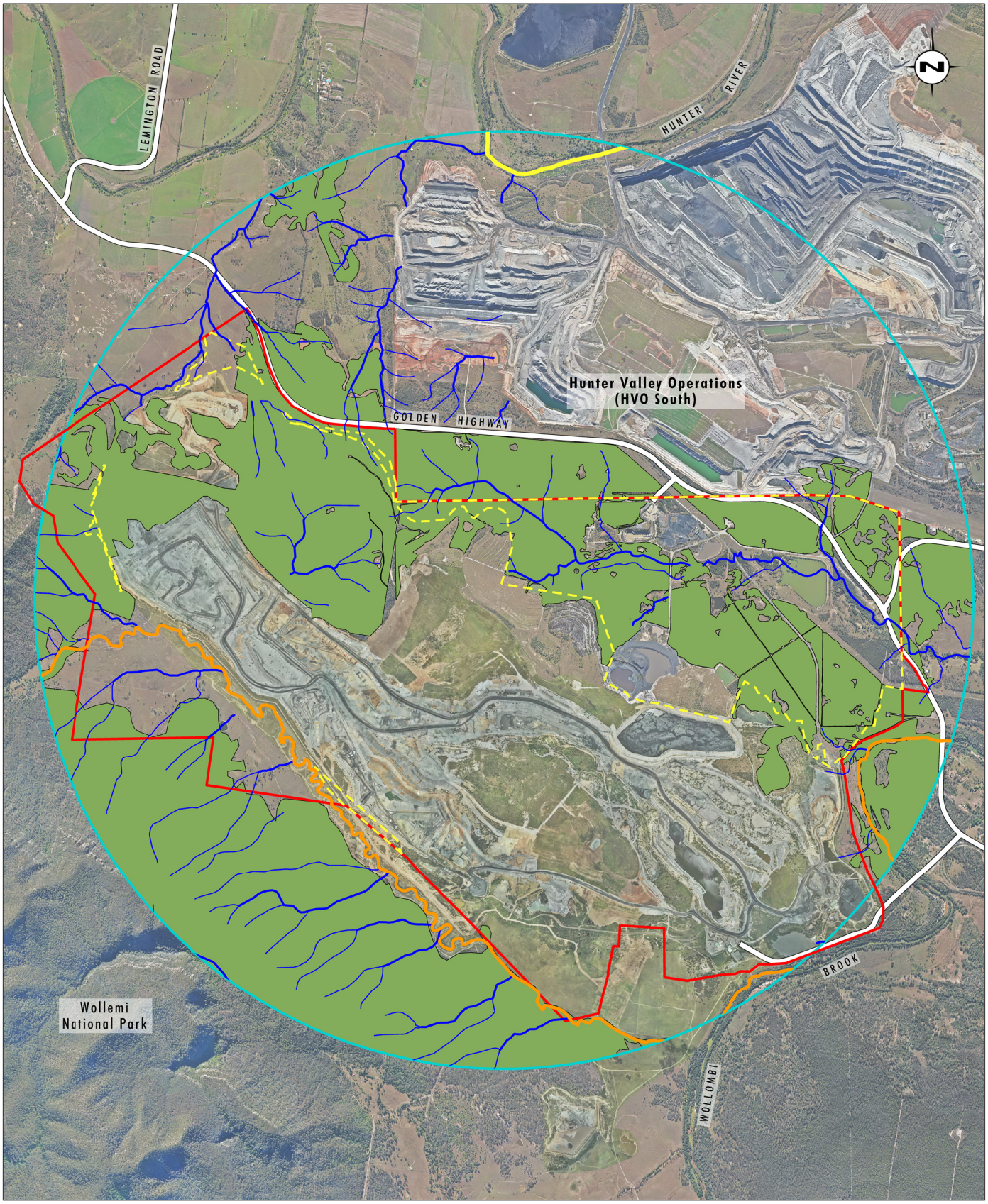


Image Source: United (2016)
Data Source: Glencore (2014)

0 1.0 2.0 2.5km
1:50 000

Legend

- Project Area
- Conceptual Additional Disturbance Area
- Local Biodiversity Link - Native Vegetation
- 6000 ha Assessment Circle
- State Biodiversity Link
- Regional Biodiversity Link
- Local Biodiversity Link

FIGURE 3.6

Biodiversity Links

e. A discussion of any wetlands in or adjacent to, or downstream of the project area

The Project Area does not contain and is not located close to any important wetlands, including SEPP 14 Coastal Wetlands or wetlands listed in the Directory of Important Wetlands of Australia (DIWA). In addition to this, Section 6.5 of the Statement of Consistency report provides an assessment of Wetlands of National Importance.

One listed wetland of national importance was identified, the Hunter Estuary Wetlands Ramsar site, as occurring within 50-100 kilometres of the boundary of the Project Area. An assessment under the EPBC Act Significant Impact Guidelines 1.1 found that the Project will not have a significant impact on the Hunter Estuary Ramsar site or any other Ramsar sites.

f. A discussion on local biodiversity corridors and map of those in and around the project area

Under BCAM biodiversity corridors are referred to as biodiversity links and the Director General of OEH can approve maps that show such links. No state or regional scale biodiversity link mapping products have been approved by the Director-General of OEH which cover the Hunter Region.

To show biodiversity links in and around the Project a figure has been prepared showing all biodiversity links within the assessment circle used in the BCAM assessment (**Figure 3.6**).

As outlined in the response to d. above, a riparian buffer of 30 metres either side of Redbank Creek has been identified as a regional biodiversity link based on the definitions in Appendix 1 of the BCAM (DECCW 2011). In addition to this, Wollombi Brook and North Wambo Creek are identified as regional biodiversity links adjacent to the Project Area and a 30 metre buffer has been applied. Also located outside the Project Area is the Hunter River which is recognised as a state biodiversity link based on the definitions in Appendix 1 of the BCAM (DECCW 2011) and a 40 metre buffer has been applied.

Any of the drainage lines within the assessment circle which have upstream tributaries as detailed on the Doyles Creek (9032-1N) 1:25,000 topographic map, are considered to meet the definition of a minor creek and a riparian buffer 20 metres either side of these drainage lines was mapped as a local biodiversity link (refer to **Figure 3.6**).

There are also a number of minor watercourses in the Project Area. These include drainage lines which do not have upstream tributaries; however they are paths where water would flow intermittently or ephemerally. These are considered local biodiversity links 10 metres either side of the drainage line (refer to **Figure 3.6**).

Any vegetation that is in moderate to good condition, greater than 30 hectares in size and greater than 30 metres wide have also been identified as a local biodiversity link.

The highest level of connectivity within the assessment circle is a state biodiversity link (the Hunter River), however the highest level of connectivity to be impacted by the Project is represented by a 30 metre buffer either side of Redbank Creek which is listed as a minor river on the Major Rivers Database (OEH 2011).

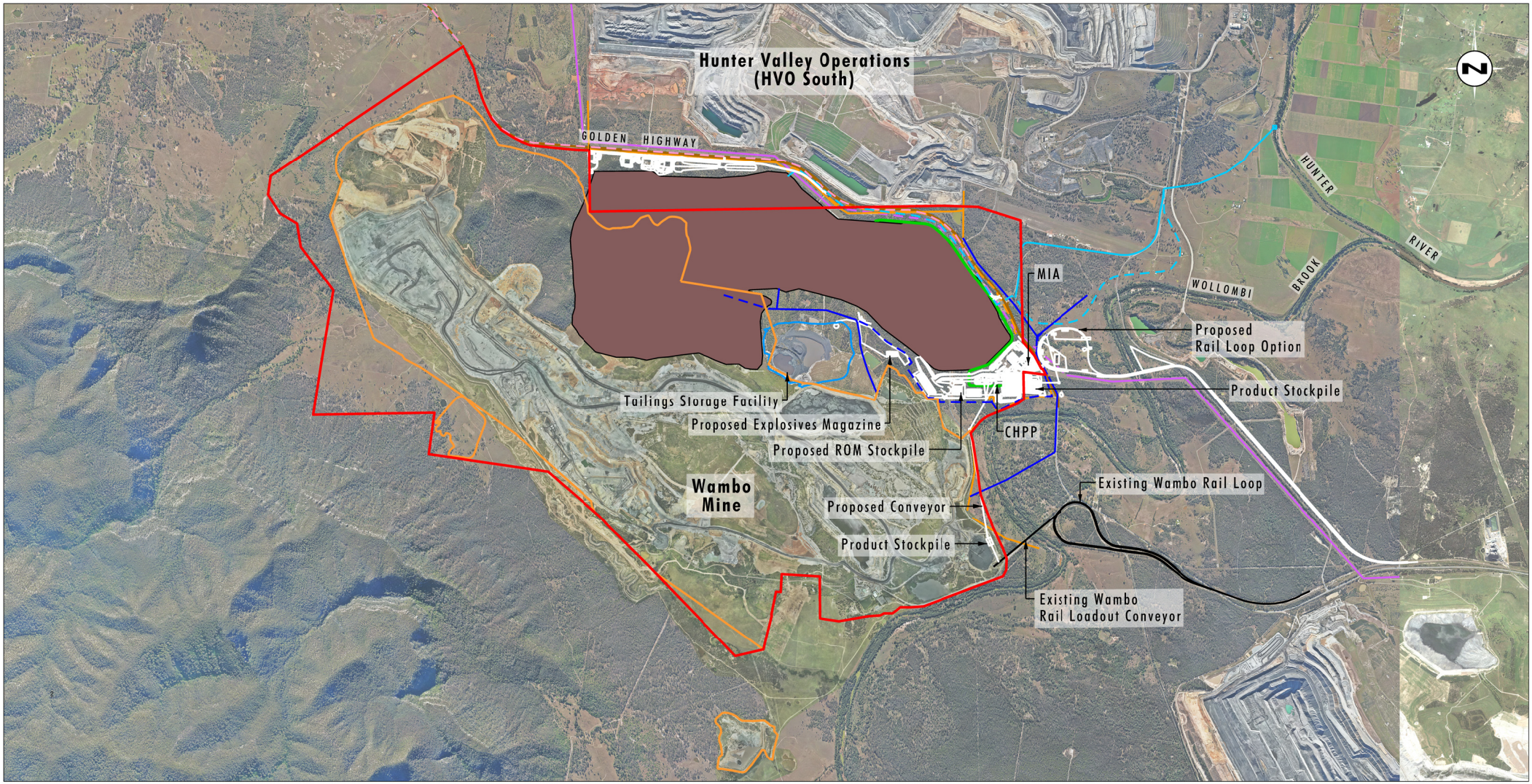


Image Source: AAM (2012), United (2016)
Data Source: United (2010)

Legend

- Project Area Boundary
- Approved Wambo Surface Development Area
- Existing Infrastructure
- Proposed Infrastructure
- Proposed Mining Extent
- Existing 330kV Transmission Line
- 330kV Transmission Line Relocation
- Existing 11kV Transmission Line
- 11kV Transmission Line Relocation
- Existing 66kV Transmission Line
- 66kV Transmission Line Relocation
- Existing Pipeline from River

FIGURE 3.7

Indicative Project Concept Design - Option 1

File Name (A4): R18/3509_596.dgn
20170405 16.14

g. Justification in the change in landscape value for the project area assessment

The landscape value score did not change for the additional disturbance area when compared to the United UHSA area. A reassessment undertaken due to the change in Project boundary found that all components of the landscape value score remained the same or within the same thresholds. The landscape value score has remained at 34.

h. A map of biodiversity corridors on and adjacent to the project area (more so than that presented in Figure 13.1)

Refer to the response to f. above.

i. A table that includes the landscape score components and the current score for the project area

Table 3.3 below includes the landscape score components and the current score for the Project Area.

Table 3.3 Landscape Value Assessment

% Native Vegetation Cover in Circle Before Certification	41-50%
% Native Vegetation Cover in Circle After Certification	31-40%
Connectivity Value	Regional Biodiversity Link
Adjacent Remnant Area	501 hectares
Landscape Value Score	34

j. A list of threatened species in the project area covered by both ecosystem credits and species credit species, and justification of why any of them have been excluded from further consideration during the assessment process

Appendix 4 includes the threatened species covered by both ecosystem and species credit species. Species credit species excluded from further assessment are detailed in **Appendix 4** and justification for these exclusions is provided. It is noted that OEH has previously reviewed and accepted this information as part of the United UHSA report submitted to OEH in 2015.

Under BCAM ecosystem species are predicted by OEH's Biodiversity Certification Credit Calculator and assumed to occur and therefore all relevant threatened ecosystem species were included in the assessment process. **Appendix 4** provides a list of the threatened ecosystem species recorded in the additional disturbance area and those which are predicted to occur by the Biodiversity Certification Credit Calculator.

k. Maps that show species credit species polygons and species polygons for threatened species that cannot withstand a loss

The southern myotis is identified in the Biodiversity Certification Credit Calculator as a red flag which is supposed to mean that it is unable to withstand further loss. It is noted, however, that in contrast, the Threatened Species Profile Database (TSPD) lists this species as able to withstand further loss. As identified in Figure 3.5 of the FBA (refer to **Appendix 4**) a total of 7.3 hectares of potential breeding habitat would be affected.

In addition, the endangered population of weeping myall (*Acacia pendula*) is identified as a red flag as it is unable to withstand further loss, however, this population has been entirely avoided by the Project and does not occur within the additional disturbance area for the Project.

l. A table of vegetation zones with Tg values, particularly indicating where the Tg values has changes due to species exclusion

Table 3.5 contains a table of vegetation zones with Tg values. The table lists the Tg scores for the predicted ecosystem credit fauna species associated with each of the vegetation types mapped in the Project Area as per the Biodiversity Certification Credit Calculator. No ecosystem species have been excluded resulting in no changes to the overall Tg values for vegetation zones.

Table 3.5 Predicted Ecosystem Credit Species

Common Name	Scientific Name	Tg
HU812 Forest Red Gum Grassy Open Forest on Floodplains of the Lower Hunter		
Barking Owl	*Ninox connivens*	0.33
Brown Treecreeper (eastern subspecies)	*Climacteris picumnus victoriae*	0.5
Hooded Robin (south-eastern form)	*Melanodryas cucullata cucullata*	0.6
Little Lorikeet	*Glossopsitta pusilla*	0.58
Scarlet Robin	*Petroica boodang*	0.75
Speckled Warbler	*Chthonicola sagittata*	0.38
Spotted-tailed Quoll	*Dasyurus maculatus*	0.38
Varied Sittella	*Daphoenositta chrysoptera*	0.75
HU816 Spotted Gum - Narrow-leaved Ironbark Shrub - Grass Open Forest of the Central and Lower Hunter		
Barking Owl	*Ninox connivens*	0.33

Common Name	Scientific Name	Tg
Brown Treecreeper (eastern subspecies)	*Climacteris picumnus victoriae*	0.5
Flame Robin	*Petroica phoenicea*	0.75
Hooded Robin (south-eastern form)	*Melanodryas cucullata cucullata*	0.6
Little Lorikeet	*Glossopsitta pusilla*	0.58
Regent Honeyeater	*Anthochaera phrygia*	0.38
Scarlet Robin	*Petroica boodang*	0.75
Speckled Warbler	*Chthonicola sagittata*	0.38
Spotted-tailed Quoll	*Dasyurus maculatus*	0.38
Square-tailed Kite	*Lophoictinia isura*	0.73
Turquoise Parrot	*Neophema pulchella*	0.55
Varied Sittella	*Daphoenositta chrysoptera*	0.75
HU869 Grey Box - Slaty Box Shrub – Grass Woodland on Sandstone Slopes of the Upper Hunter and Sydney Basin		
Barking Owl	*Ninox connivens*	0.33
Black-chinned Honeyeater (eastern subspecies)	*Melithreptus gularis gularis*	0.75
Brown Treecreeper (eastern subspecies)	*Climacteris picumnus victoriae*	0.5
Bush Stone-curlew	*Burhinus grallarius*	0.38
Corben's Long-eared Bat	*Nyctophilus corbeni*	0.48
Diamond Firetail	*Stagonopleura guttata*	0.75
Eastern Bentwing-bat	*Miniopterus schreibersii oceanensis*	0.75
Eastern Cave Bat	*Vespadelus troughtoni*	0.75
Eastern False Pipistrelle	*Falsistrellus tasmaniensis*	0.45
Flame Robin	*Petroica phoenicea*	0.75
Gang-gang Cockatoo	*Callocephalon fimbriatum*	0.5
Glossy Black-Cockatoo	*Calyptorhynchus lathami*	0.55
Greater Broad-nosed Bat	*Scoteanax rueppellii*	0.45
Grey-crowned Babbler (eastern subspecies)	*Pomatostomus temporalis temporalis*	0.75

Common Name	Scientific Name	Tg
Grey-headed Flying-fox	*Pteropus poliocephalus*	0.93
Hooded Robin (south-eastern form)	*Melanodryas cucullata cucullata*	0.6
Little Eagle	*Hieraaetus morphnoides*	0.73
Little Lorikeet	*Glossopsitta pusilla*	0.58
Masked Owl	*Tyto novaehollandiae*	0.33
Painted Honeyeater	*Grantiella picta*	0.75
Powerful Owl	*Ninox strenua*	0.33
Regent Honeyeater	*Anthochaera phrygia*	0.38
Scarlet Robin	*Petroica boodang*	0.75
Speckled Warbler	*Chthonicola sagittata*	0.38
Spotted-tailed Quoll	*Dasyurus maculatus*	0.38
Square-tailed Kite	*Lophoictinia isura*	0.73
Squirrel Glider	*Petaurus norfolcensis*	0.45
Swift Parrot	*Lathamus discolor*	0.75
Turquoise Parrot	*Neophema pulchella*	0.55
Varied Sittella	*Daphoenositta chrysoptera*	0.75
Yellow-bellied Sheathtail-bat	*Saccolaimus flaviventris*	0.45
HU905 Narrow-leaved Ironbark - Grey Box Grassy Woodland of the Central and Upper Hunter		
Barking Owl	*Ninox connivens*	0.33
Black-chinned Honeyeater (eastern subspecies)	*Melithreptus gularis gularis*	0.75
Brown Treecreeper (eastern subspecies)	*Climacteris picumnus victoriae*	0.5
Bush Stone-curlew	*Burhinus grallarius*	0.38
Eastern Bentwing-bat	*Miniopterus schreibersii oceanensis*	0.75
Eastern False Pipistrelle	*Falsistrellus tasmaniensis*	0.45
Eastern Freetail-bat	*Mormopterus norfolkensis*	0.45
Flame Robin	*Petroica phoenicea*	0.75

Common Name	Scientific Name	Tg
Gang-gang Cockatoo	*Callocephalon fimbriatum*	0.5
Glossy Black-Cockatoo	*Calyptorhynchus lathami*	0.55
Greater Broad-nosed Bat	*Scoteanax rueppellii*	0.45
Grey-crowned Babbler (eastern subspecies)	*Pomatostomus temporalis temporalis*	0.75
Grey-headed Flying-fox	*Pteropus poliocephalus*	0.93
Hooded Robin (south-eastern form)	*Melanodryas cucullata cucullata*	0.6
Little Eagle	*Hieraaetus morphnoides*	0.73
Little Lorikeet	*Glossopsitta pusilla*	0.58
Masked Owl	*Tyto novaehollandiae*	0.33
Painted Honeyeater	*Grantiella picta*	0.75
Powerful Owl	*Ninox strenua*	0.33
Regent Honeyeater	*Anthochaera phrygia*	0.38
Scarlet Robin	*Petroica boodang*	0.75
Southern Myotis	*Myotis macropus*	0.45
Speckled Warbler	*Chthonicola sagittata*	0.38
Spotted-tailed Quoll	*Dasyurus maculatus*	0.38
Square-tailed Kite	*Lophoictinia isura*	0.73
Swift Parrot	*Lathamus discolor*	0.75
Turquoise Parrot	*Neophema pulchella*	0.55
Varied Sittella	*Daphoenositta chrysoptera*	0.75
Yellow-bellied Sheathtail-bat	*Saccolaimus flaviventris*	0.45
HU906 Bull Oak Grassy Woodland of the Central Hunter Valley		
Barking Owl	*Ninox connivens*	0.33
Black-chinned Honeyeater (eastern subspecies)	*Melithreptus gularis gularis*	0.75
Bush Stone-curlew	*Burhinus grallarius*	0.38
Eastern Bentwing-bat	*Miniopterus schreibersii oceanensis*	0.75

Common Name	Scientific Name	Tg
Eastern False Pipistrelle	*Falsistrellus tasmaniensis*	0.45
Eastern Freetail-bat	*Mormopterus norfolkensis*	0.45
Flame Robin	*Petroica phoenicea*	0.75
Gang-gang Cockatoo	*Callocephalon fimbriatum*	0.5
Glossy Black-Cockatoo	*Calyptorhynchus lathami*	0.55
Greater Broad-nosed Bat	*Scoteanax rueppellii*	0.45
Grey-crowned Babbler (eastern subspecies)	*Pomatostomus temporalis temporalis*	0.75
Grey-headed Flying-fox	*Pteropus poliocephalus*	0.93
Hooded Robin (south-eastern form)	*Melanodryas cucullata cucullata*	0.6
Little Eagle	*Hieraaetus morphnoides*	0.73
Little Lorikeet	*Glossopsitta pusilla*	0.58
Masked Owl	*Tyto novaehollandiae*	0.33
Painted Honeyeater	*Grantiella picta*	0.75
Powerful Owl	*Ninox strenua*	0.33
Regent Honeyeater	*Anthochaera phrygia*	0.38
Scarlet Robin	*Petroica boodang*	0.75
Southern Myotis	*Myotis macropus*	0.45
Speckled Warbler	*Chthonicola sagittata*	0.38
Spotted-tailed Quoll	*Dasyurus maculatus*	0.38
Square-tailed Kite	*Lophoictinia isura*	0.73
Swift Parrot	*Lathamus discolor*	0.75
Turquoise Parrot	*Neophema pulchella*	0.55
Yellow-bellied Sheathtail-bat	*Saccolaimus flaviventris*	0.45
HU945 Swamp Oak - Weeping Grass Grassy Riparian Forest of the Hunter Valley		
Barking Owl	*Ninox connivens*	0.33
Gang-gang Cockatoo	*Callocephalon fimbriatum*	0.5
Little Eagle	*Hieraaetus morphnoides*	0.73

Common Name	Scientific Name	Tg
Spotted Harrier	*Circus assimilis*	0.73
Spotted-tailed Quoll	*Dasyurus maculatus*	0.38
Varied Sittella	*Daphoenositta chrysoptera*	0.75

m. Shape files of the three identified offset areas, including annotated vegetation shape files, survey effort and threatened species record shape files and copies of the BioBanking files on which their credit yield was calculated

Electronic shape files (.shp) of the offset areas, including vegetation mapping, survey effort, threatened species records and BioBanking Credit Reports have been provided to OEH as part of the response to submissions process.

Assessment of Overstorey Regeneration Values

OEH does not agree with the justification provided for the overstorey regeneration scores for the vegetation zones of HU905 – Low Condition – Derived Native Grassland and HU905 – Moderate to Good Condition – Cooba Open Shrubland. OEH identify that grey box (*Eucalyptus moluccana*) and narrow-leaved ironbark (*Eucalyptus crebra*) are the over-storey species that should be used to calculate the over-storey regeneration value for HU905 in any condition. The proponent needs to provide all supporting field data used to justify the proposed overstorey regeneration scores for these zones.

Umwelt has undertaken a thorough review of all recent vegetation surveys completed within the Project Area for the vegetation zones HU905 – Low Condition – Derived Native Grassland and HU905 – Moderate to Good Condition – Cooba Open Shrubland. This involved reviewing data sheets and photographs to determine whether any narrow-leaved ironbark (*Eucalyptus crebra*) or grey box (*Eucalyptus moluccana*) regeneration was recorded as present.

This review found no evidence of narrow-leaved ironbark (*Eucalyptus crebra*) or grey box (*Eucalyptus moluccana*) in the vegetation zone HU905 – Moderate to Good Condition – Cooba Open Shrubland. As a result the overstorey regeneration score remains at zero, which represents no change since the EIS and Statement of Consistency report. For vegetation zone HU905 – Low Condition – Derived Native Grassland it was found from two photographs that a single narrow-leaved ironbark (*Eucalyptus crebra*) and grey box (*Eucalyptus moluccana*) were regenerating in this zone. From this the overstorey regeneration score was determined to be 1, representing an increase from the 0.5 score determined as part of the UHSA.

The UHSA assessment was updated with these overstorey regeneration scores.

Assessment of Regent Honeyeater

The Assessment of the additional 4.27 ha of proposed disturbance requires the preparation of an expert report or assumed presence. If the proponent chooses to use an expert report, the expert must be approved by OEH prior to the preparation of the expert report.

As outlined in **Section 1.2** the Project has been revised to avoid impact on this area and therefore no further consideration of this issue is required.

Biodiversity Offset Package

The accredited assessor used in field work and credit calculations need to be clarified.

The Biodiversity Offset Package outlined in the Statement of Consistency Report was prepared by Kate Connolly (Senior Ecologist) and Ryan Parsons (Senior Ecologist), with review and technical direction from Travis Peake (Principal Ecologist). Field surveys of the offset sites were led by Ryan Parsons with assistance from Amy Nelson (Ecologist). The BioBanking assessments, including credit calculations, for the offset sites were prepared by Kate Connolly. Kate, Ryan, Amy and Travis are all accredited under the TSC Act as BioBanking and BioCertification Assessors.

Clarification is required in relation to Table 13.13 of the Statement of Consistency Report, which suggests that offsets for communities listed under the EPBC Act are not proposed to be offset using like-for-like rules.

Through the course of the UHSA program, OEH has released elements of the possible offsetting rules for consideration or discussion, however it was not until the provision of the draft UHSA offsetting rules to Glencore (United's parent company) on 22 March 2016 that a formal offsetting rule-based approach could be applied with any degree of certainty (noting that the rules provided were only draft). Notwithstanding the lack of defined UHSA offsetting rules during the course of the Project assessment, United sought to develop an offset strategy which addresses the key fundamentals of the anticipated UHSA Offsetting Rules, together with established practice in biodiversity offsetting where precedent on approach has already been made. Table 13.13 in the Statement of Consistency report outlines the key offsetting outcomes to be derived through the protection and management of the offset properties. Table 13.13 does not present the offsetting outcomes as per the draft offset rules under the UHSA as available at that time, rather presents the offsets by biodiversity type including critically endangered ecological communities under the EPBC Act, broad vegetation classes and species-credit species.

Following questions from Umwelt in relation to the Project, OEH provided a revised set of offset rules on 26 April 2016 (OEH 2016). The key changes related to the clarification of some ambiguous wording in the earlier draft version. Table 13.14 of the Statement of Consistency report shows the outcome of the application of the draft offset rules. These rules indicate how credits required for each PCT or species can be offset, initially following a "like-for-like" approach and then, in accordance with OEH requirements, following a set of "variation rules".

The location of post-mine rehabilitation planned to be used as an offset should be provided.

The approximate area of disturbance that will be rehabilitated to woodland / forest progressively over the life of the mine comprises approximately 2,450 hectares. This area is shown in the EIS. Of the approximately 2,450 hectares of woodland / forest rehabilitation, up to approximately 878 hectares is available for ecological rehabilitation to form part of the offset strategy. As discussed in **Section 3.1**, based on the current draft rules, only a total of 616.5 hectares of ecological rehabilitation is able to be used as part of the offset strategy.

The final make-up of the ecological rehabilitation as part of the Project will be based on the final offset rules that are applied. The location of the specific areas of ecological rehabilitation will be determined as part of the detailed rehabilitation planning process undertaken as part of the preparation of the Mining Operations Plan for the Project, once the final offsetting rules are determined.

Existing United Collieries Offset

Clarification is required for the relation between this project and the existing United Collieries Offset (DA-410-11-2002) which included a condition required an offset of at least 18.5 hectares.

This issue is addressed in **Section 3.2**.

Matters of National Environmental Significance

Additional information is required to satisfy the Matters of National Environmental Significance (MNES), required by the Supplementary SEARs.

OEH has reviewed the EIS in relation to the supplementary SEARs and has identified the following aspects of those SEARs that do not yet appear to have been addressed:

- **How the works are to be undertaken, and design parameters done that may have impacts on relevant MNES;**
- **An assessment of relevant impacts on threatened species and communities or water resources;**
- **The estimated effectiveness and costs of implementing mitigation measures to reduce or avoid impacts on MNES;**
- **The provision of an assessment with maps, descriptions of habit and habitats, survey effort in relation to DOEE survey requirements, and consideration of the impacts of the project on the full national range of the species and communities likely to be significantly affected by this proposal;**
- **A discussion on any significant residual impacts not addressed by the NSW assessment; and**
- **Details of the environmental record of the proponent.**

Discussions with OEH regarding the above comments indicated that OEH had inadvertently overlooked Section 7.0 of the EIS which specifically addressed the SEARs relating to MNES, including the above points. OEH subsequently undertook a review of Section 7.0 of the EIS and provided further correspondence dated 16 January 2017. This further correspondence OEH requested some further information be provided including information about how United proposes to manage significant impacts on MNES including avoidance, mitigation and offsets.

The requested information is provided in Section 8.0 of the BAR (FBA) report (refer to **Appendix 4**).

OEH does not agree with Umwelt's interpretation of the Conservation Advice for identifying Central Hunter Valley Eucalypt Forest and Woodland CEEC where *Allocasuarina luehmannii* (bulloak) dominates. The assessment needs to use the diagnostic characteristics provided in Sections 1.5.1 and 1.5.2 of the conservation advice to map the listed community.

Following further consultation with both DoEE and OEH the mapping of *Central Hunter Valley Eucalypt Forest and Woodland* CEEC has been revised in areas where *Allocasuarina luehmannii* (bulloak) dominates. Sections 1.5.1 Key Diagnostic Characteristics and 1.5.2 Other Diagnostic Considerations of the conservation advice were followed and clarification was sought from DoEE on how to interpret the conservation advice in relation to mapping areas dominated by *Allocasuarina luehmannii* (bulloak). A detailed description of how the mapping of the *Central Hunter Valley Eucalypt Forest and Woodland* CEEC was undertaken is provided in Section 3.2.3.1 of the United Wambo Coal Open Cut Coal Mine Project Biodiversity Assessment Report (Umwelt 2017).

The regent honeyeater, swift parrot and spotted-tailed quoll have been identified as likely to be significantly impacted in the Referral Decision. Accordingly, the proponent needs to demonstrate how they are managing the significant impacts, including avoidance, mitigations and offsets.

Section 8.0 of the BAR (FBA) report (refer to **Appendix 4**) includes a discussion on the management, including avoidance, mitigations and offsets, for the regent honeyeater, swift parrot and spotted-tailed quoll.

3.4 Community and NGO Submissions

A range of community and non-government organisations (NGOs) provided submissions responding to the public exhibition of the EIS for the Project. Forty-seven community and NGO submissions that were received included commentary on biodiversity impacts. The sections below outline the key comments and provide responses to the issues raised in the submissions.

3.4.1 Hunter Environment Lobby

The Hunter Environment Lobby (HEL) provided a detailed submission that indicated it objects to the Project due to impacts on threatened species and communities and the adequacy of the proposed offset strategy. HEL also engaged peer reviewers to undertake a technical review of the assessment of the biodiversity impacts related to the Project. The comments provided in these reviews are outlined in **Sections 3.4.1.1** and **3.4.1.2** below.

3.4.1.1 Review of Biodiversity Issues: United Wambo Open Cut Coal Mine Project by Dr Stephen Bell

Dr Stephen Bell provided a review of the biodiversity issues within the EIS documents relating to the Project. He stated that the EIS documents *"on the whole are comprehensive and well-constructed"*. Responses to his identified key issues are provided below.

Hunter Valley Weeping Myall Woodland

Tozer and Chalmers (2016, p32) argue that those parts of the Hunter Valley receiving the lowest rainfall and the highest temperatures potentially support HWMW, irrespective of the presence or absence of Acacia pendula. They claim that "all samples [of vegetation] located in the relatively restricted areas of the Hunter valley that experience the most extreme drought conditions (Figure 1c) are candidates for reassessment as a sample of Hunter Weeping Myall Woodland". Tozer and Chalmers (2016) further state that the presence or absence of Acacia pendula is irrelevant to recognition of the community, and that "dominant species are not a reliable basis for the classification and identification of community type under a continuum model". In their view, Acacia pendula individuals should not solely be used to indicate the presence of HWMW, but instead a detailed assessment of all floristic data should be made.

In their assessment of Hunter Weeping Myall Woodland within the Project area for the EIS, Umwelt have not specified how they demarcated the boundaries of this community, but there is strong evidence that they have simply encircled the relevant stands of Acacia pendula, perhaps with a small buffer. This procedure is counter to that implied by Tozer and Chalmers (2016), and it is therefore uncertain whether this critically endangered community, as defined by Tozer and Chalmers, has been fully delineated within the Project area. Consequently, any assessment of the potential impacts on Hunter Valley Weeping Myall Woodland contained within the EIS are incomplete.

While I disagree with the comments made by Tozer and Chalmers on this issue, their views are representative of the NSW Scientific Committee and I am obliged to apply their interpretation of HWMW to any project in which it occurs.

The *Hunter Valley Weeping Myall Woodland in the Sydney Basin Bioregion CEEC* listed under the TSC Act was mapped in the Project Area in accordance with the information outlined in the Final Determination for the community (NSW Scientific Committee 2016). Umwelt mapped the community through determining the composition of the vegetation, including all strata (trees, shrubs, groundcovers) and assessing this against the Final Determination. It is recognised that, as per Bell's submission, the identification of this community where it occurs without *Acacia pendula* as either a shrub or tree, or a sucker, is extremely difficult. Although the community could occur in the absence of this species in its various growth forms, the remaining assemblage of species is unlikely to occur in a repeating pattern, and at a scale, that would facilitate its identification and mapping and, importantly, its separation from other listed ecological communities, such as Central Hunter Grey Box – Ironbark Woodland EEC. Any other potential micro-occurrence of this community (devoid of *Acacia pendula*) would almost certainly be in an area that has been attributed to another NSW listed ecological community and/or the *Central Hunter Eucalypt Forest and Woodland CEEC*.

This community occurred as two small patches within the south-eastern corner of the Project Area and supported a very sparse (northern patch) to mid-dense (southern patch) canopy dominated by weeping myall (*Acacia pendula*). The mid-storey layer was very sparse and included young weeping myall 1 to 3 metres in height. The ground layer was sparse and less than 0.5 metres in height. Common native species included many-flowered mat-rush (*Lomandra multiflora* subsp. *multiflora*), ruby saltbush (*Enchylaena tomentosa*), climbing saltbush (*Einadia nutans*), creeping saltbush (*Atriplex semibaccata*), wallaby grass (*Rytidosperma* sp.), couch (*Cynodon dactylon*), barbed wire-grass (*Cymbopogon refractus*), shade plantain (*Plantago debilis*) and common everlasting (*Chrysocephalum apiculatum*).

This community corresponds with the Final Determination of Hunter Valley Weeping Myall Woodland of the Sydney Basin Bioregion CEEC (NSW Scientific Committee 2016) with regard to the following attributes:

- occurs within the NSW Sydney Basin Bioregion
- occurs in the Singleton Local Government Area (LGA) where it has previously been recorded
- supports a canopy dominated by weeping myall (*Acacia pendula*), which is listed as the most common and characteristic tree in this CEEC
- supports a reasonable proportion of species that are in the list of characteristic species for the CEEC.

According to the Final Determination (NSW Scientific Committee 2016) *"Characteristic species may be abundant or rare and comprise only a subset of the complete list of species recorded in known examples of the community"* and "*Species presence and relative abundance (dominance) will vary from site to site as a function of environmental factors such as soil properties (chemical composition, texture, depth, drainage), topography, climate, and through time as a function of disturbance (e.g. fire, logging, grazing) and weather (e.g. flooding, drought, extreme heat or cold)*".

Furthermore, the additional information on the community in the Final Determination states that *"Hunter Valley Weeping Myall Woodland is typically a mid-high (to 15 m) open forest or woodland with a dense to mid-dense canopy dominated by Weeping Myall (Acacia pendula) depending on disturbance and regrowth history; (Peake 2005; Umwelt 2006). Weeping Myall may be found to occur with Eucalyptus crebra (Narrow-leaved Ironbark), A. salicina (Cooba) and/or trees within the Acacia homalophylla–A. melvillei complex".*

While these statements do not exclude the possibility that the CEEC could occur without the presence of weeping myall, it is strongly suggested that this is required to identify the community. Recent literature by Tozer and Chalmers (2016) represent recent expert opinion and not the Final Determination which is the document required to be used in the identification of threatened communities under the TSC Act. While revised mapping requirements or community definitions may be incorporated into the Final Determination or guidelines published by OEH or the NSW Scientific Committee in the future, this is not currently relevant for this Project.

This community was not considered to conform to the Hunter Valley Weeping Myall (*Acacia pendula*) Woodland CEEC listed under the EPBC Act as the patches within the Project Area are less than the minimum condition threshold of 0.1 hectares as per the recently revised conservation advice for the community (TSSC 2014).

Mine Rehabilitation as Offset

I am particularly concerned about the ability of the mining industry to deliver appropriate offsets through mine rehabilitation. Indeed, there is growing evidence in the scientific literature that the expectations of what is attainable in the rehabilitation of mine sites differs markedly from what is actually achieved.

Section 13.4.4 of Appendix 13 in the Project documents describes how inspections of existing rehabilitation within the Project area showed these lands to be recognisable and consistent with Central Hunter Ironbark – Spotted Gum – Grey Box Forest in the NSW North Coast and Sydney Basin Bioregion EEC. Remarkably, this conclusion was based on the presence of only one (of four) target canopy species (Corymbia maculata, co-dominating with Acacia implexa and the South Australian Eucalyptus cladocalyx); the presence of fifteen (of 44; 34%) native species which characterise this EEC (or 13 of 33, 30%, excluding the endemic canopy species already noted); and the statement that natural recruitment of the canopy, mid storey and ground cover layers 'was occurring', but with no evidence in support.

Assuming Umwelt arrived at the decision that these existing rehabilitated areas comply with EEC criteria based on the OEH Guidelines (Guidelines for the Ecological Rehabilitation of Recognisable and Self-sustaining Plant Community Types for the UHSA, which I have been unable to source a copy of), I hold little confidence in the value of this document for policing the progress of mining rehabilitation. It follows, therefore, that any application of credits to mine rehabilitation is a poor substitute for the clearing of extant native vegetation.

Vegetation Zone 3 assigned to HU816 Spotted Gum - Narrow-leaved Ironbark Shrub - Grass Open Forest of the Central and Lower Hunter was confined to the lower slopes of the Project Area in isolated areas of rehabilitation. This vegetation zone supported a variable canopy that was very sparse to sparse in cover and between 5 to 11 metres in height. The canopy layer was dominated by spotted gum (*Corymbia maculata*) and hickory wattle (*Acacia implexa*), with some occurrences of introduced sugar gum (*Eucalyptus cladocalyx*) totalling less than 5 per cent cover in places. The mid-storey was mid-dense and dominated by native blackthorn (*Bursaria spinosa* subsp. *spinosa*), bulloak (*Allocasuarina luehmannii*), hopbush (*Dodonaea triangularis*), prickly Moses (*Acacia ulicifolia*), currawang (*Acacia doratoxylon*), kurrajong (*Brachychiton populneus* subsp. *populneus*) and black wattle (*Acacia decurrens*). An overstorey regeneration score of 1 was allocated to this vegetation zone as the sole typical canopy species spotted gum was recorded as regenerating.

Common forbs and sub-shrubs included kidney weed (*Dichondra repens*), ruby saltbush (*Enchylaena tomentosa*), shade plantain (*Plantago debilis*), many-flowered mat-rush (*Lomandra multiflora* subsp. *multiflora*), berry saltbush (*Einadia hastata*), variable glycine (*Glycine tabacina*), blue trumpet (*Brunoniella australis*), purple burr-daisy (*Calotis cuneifolia*), twining glycine (*Glycine clandestina*), native sarsaparilla (*Hardenbergia violacea*), common everlasting (*Chrysocephalum apiculatum*), rock fern (*Cheilanthes sieberi* subsp. *sieberi*), *Phyllanthus virgatus,* amulla (*Eremophila debilis*), small St Johns wort (*Hypericum gramineum*) and pale mat-rush (*Lomandra glauca*). Native grasses included barbed-wire grass (*Cymbopogon refractus*), purple wiregrass (*Aristida ramosa*), *Paspalidium distans*, hairy panic (*Panicum effusum*), windmill grass (*Chloris truncata*), weeping grass (*Microlaena stipoides* var. *stipoides*), Queensland bluegrass (*Dichelachne sericeum*), *Bothriochloa* sp., *Aristida* sp. and *Austrostipa* sp.

This vegetation zone was deemed to be consistent with *Central Hunter Ironbark – Spotted Gum – Grey Box Forest in the NSW North Coast and Sydney Basin Bioregion EEC* listed under the TSC Act as per the final determination for the community (NSW Scientific Committee 2011) with regard to the following attributes:

- this EEC is characterised by a canopy dominated by four key eucalypt species, namely spotted gum (*Corymbia maculata*), broad-leaved ironbark (*Eucalyptus fibrosa*), grey gum (*Eucalyptus punctata*) and narrow-leaved ironbark (*Eucalyptus crebra*). The canopy layer of this community was dominated by spotted gum (*Corymbia maculata*) and hickory wattle (*Acacia implexa*), with some occurrences of sugar gum (*Eucalyptus cladocalyx*) totalling less than 5 per cent cover in places

- this vegetation zone supports a reasonable proportion of species that are in the list of characteristic species for the EEC

    - 15 out of 44 (34 per cent) native species recorded in this unit are characteristic species in the EEC listing, and

    - 15 out of 44 (34 per cent) species in the characteristic species list for the EEC were recorded in this unit. However of the 15 species recorded from the characteristic species list, only one species was a mid-storey or shrub species, the remaining species being either a canopy or ground layer species.

- Natural recruitment of spotted gum (*Corymbia maculata*) was recorded within the canopy, midstorey and ground cover layers. This was recorded as part of the biometric surveys of this vegetation zone. Therefore an overstorey regeneration score of 1 was allocated.

While this rehabilitation is unlikely to represent a higher quality example of the *Central Hunter Ironbark – Spotted Gum – Grey Box Forest EEC* , in assessing the communities to be impacted by the Project, the precautionary principle was applied to ensure the full extent of potential impacts were considered. This area of rehabilitation is associated with older works at the United mine and was not subject to the same level of rigour in relation to rehabilitation standards as what is expected to be required under the UHSA and the *Guidelines for the Ecological Rehabilitation of Recognisable and Self-sustaining Plant Community Types for the UHSA* (OEH 2015). The OEH 2015 guideline was not considered in any way in regard to whether or not this community formed part of the EEC.

It is acknowledged that ecological mine rehabilitation in the Hunter Valley is subject to ongoing research and improvements. While there is limited published research on rehabilitation of mine sites to woodland communities in the Hunter Valley, there is an extensive body of unpublished work; much of which has focused on rehabilitation undertaken at Mount Owen and other Glencore sites. Additionally, rehabilitation objectives should be understood in the context of the nature of vegetation communities in the Hunter Valley and the long history of vegetation disturbance associated with various land uses in the Hunter Valley which has contributed to the current composition and structure of these vegetation communities.

The ecological rehabilitation proposed under this Project will consider the requirements of the *Guidelines for the Ecological Rehabilitation of Recognisable and Self-sustaining Plant Community Types for the UHSA* (OEH 2015), which is a very significant advance on any previous (largely non-ecological) prescriptions. The Guidelines provide objectives and preliminary completion criteria against which ecological rehabilitation can be measured to determine whether it comprises a *recognisable and self-sustaining* PCT. The final completion criteria for the rehabilitation will be incorporated into a Mining Operations Plan (MOP) for the Project. The MOP needs to be approved by the Department of Industry, Division of Resources and Energy (DRE) and is a statutory plan that is enforceable providing statutory rigor to the rehabilitation requirements.

Central Hunter Swamp Oak Forest

Central Hunter Swamp Oak Forest is discussed as a Groundwater Dependent Ecosystem (Section 8.2.1, Appendix 13), however Swamp Oak (Casuarina glauca) is a highly invasive wood [sic] weed in the central and upper Hunter, which grows both along riparian corridors but also on adjacent slopes of Permian geology. I do not consider this species nor the community that it dominates to be of any conservation value (from a flora perspective), and I would not agree that it is groundwater dependent.

Section 8.2.1 of the Statement of Consistency report states that the Central Hunter Swamp Oak Forest was likely to be dependent on groundwater reserves in certain circumstances, for example: in times of drought. It is recognised that the characteristic species of this community (swamp oak, *Casuarina glauca*) can be a coloniser of disturbed areas; this typically occurs where there is still some presence of surface water supply, such as road edges and the upper margins of flood terraces and river banks, although it can occur naturally outside of such areas. Nonetheless, the natural community itself typically occurs in riparian and floodplain areas, or lake margins, in areas of an at least semi-dependence on groundwater. The vegetation is not consistent with any community listed under the TSC Act or EPBC Act.

Hunter Valley River Oak Forest

Hunter Valley River Oak Forest is described for lands adjacent to the Project area (a potential GDE), and for the Mangrove offset area. Section 8.2.3 of Appendix 13 states that it "comprises a dense canopy layer of river oak (Casuarina cunninghamiana) and occasional emergents of river red gum (Eucalyptus camaldulensis) and rough-barked apple (Angophora floribunda)". Umwelt claim (p. 283 of the EIS) that this community does not form part of any TSC Act or EPBC Act listed community, but I disagree with their view.

Paragraph 8 of the Final Determination for River-Flat Eucalypt Forest on Coastal Floodplains EEC (NSW Scientific Committee 2005) states that "in the lower Hunter valley, 'Central Hunter Riparian Forest' (map unit 13), 'Wollombi Redgum-River Oak Woodland' (map unit 14) and 'Redgum Rough-barked Apple Swamp Forest' (map unit 38) of NPWS (2000) fall within this community". The Wollombi Redgum-River Oak Woodland is described by NPWS (2000) as occurring "on alluvium associated with the Wollombi Brook and its major tributaries…". In relation to the River-Flat eucalypt forest EEC, it is stated that "Both the River Flat Forest [on coastal floodplains] and the Wollombi Redgum River Oak Forest share similar habitats and species composition.

I understand this text to mean that riparian forests along the Wollombi River and major tributaries are in fact included in the River-Flat Eucalyptus Forest on Coastal Floodplains EEC, and should be assessed as such.

It is possible that the Hunter Valley River Oak Forest could correspond with the Final Determination to list River-flat Eucalypt Forest EEC. The EIS predicts no impact of any consequence on this community, therefore whether or not it precisely meets the Final Determination is not a matter of concern.

3.4.1.2 Review of Ecological Assessment for the United Wambo Open Cut Coal Mine Project (Glencore/Peabody) by David C. Paull

The following section provides a response to issues raised in the biodiversity review by David Paull on behalf of HEL.

Planning Framework

The planning pathway undertaken by the proponent (with collaboration by the NSW Government) has hindered a transparent and publicly accountable environmental assessment process for this project. The public are expected to believe in a strategic assessment process for mining in the Hunter. But accountability has not been achieved as key UHSA documents have not been finalised.

It was understood by United that the UHSA process was planned to be completed by the date of the exhibition of the EIS for the Project, and was expected to be available for public review and comment prior to the release of a Project to be assessed under the UHSA. United were advised by OEH undertake the assessment under the UHSA Interim Policy. However, the draft UHSA Biodiversity Plan has not as yet been finalised by the relevant government departments or publicly exhibited and is not in place.

As the environmental approvals process for the Project occurred prior to the completion of the Upper Hunter Strategic Assessment Biodiversity Plan, the OEH and Department of Planning and Environment (DPE) were consulted early in the assessment phase to consider the most appropriate reporting pathway for the Project. As the Project occurred within the UHSA Project Area, Glencore was directed by OEH to undertake the assessment under the UHSA Interim Policy as outlined in OEH's letter to DPE dated 24 July 2015 and included as Attachment 2 to the SEARs. This included the preparation of a 'Statement of Consistency' Report to identify how the Project fitted within the UHSA process under the UHSA Interim Policy (DP&I 2012). This work was completed and provided as part of the EIS, satisfying the SEARs.

As discussed at the beginning of **Section 3.0**, it is noted that as at the time of preparation of this report the UHSA has not been finalised with the draft UHSA Biodiversity Plan yet to be subject to public exhibition. In the absence of a final UHSA Biodiversity Plan and to provide certainty for the progression of the approval process for the Project, in addition to the UHSA assessment provided as part of the EIS an assessment has been completed for the Project under the FBA which is current NSW Government policy.

While the biodiversity impacts of the Project were referred under the EPBC Act . . . the key issue here is that approval of the UHSA under Part 10 of the EPBC Act has not occurred and the preparation of a Biodiversity Plan has not been completed . . . Without the details of biodiversity impacts provided in the EIS and the lack of a Biodiversity Plan for the public to view, means that there is no public accountability for biodiversity impacts of this Project.

The EIS and Statement of Consistency Report were prepared as directed by OEH and DPE with the intent that the UHSA Biodiversity Plan would be available to be assessed against the Project. As also discussed above to provide certainty for the assessment of the Project an assessment has been completed for the Project under the FBA which is current NSW Government policy.

No adherence to the NSW Biodiversity Offset Policy is demonstrated in the EIS, no assessment of the biodiversity impacts is provided, merely the results of a credit assessment using the BioCertification Assessment Methodology (BCAM). Details of the offsets are not provided.

The SEARs submission from OEH clearly states that the Project is *"covered by the UHSA and therefore biodiversity impacts related to the proposed development are to be assessed and documented in accordance with the Biodiversity Certification Assessment Methodology" . . . "unless the proponent wishes the project to be assessed under the NSW Biodiversity Offsets Policy for Major Projects and the Framework for Biodiversity Assessment".* As Glencore, in consultation and agreement with OEH and DPE, chose to assess the project under the UHSA, the *NSW Biodiversity Offsets Policy for Major Projects* was not applicable. The Statement of Consistency report was therefore prepared to facilitate the assessment of the Project in line with the UHSA Interim Policy (DP&I 2012).

Regardless, as discussed above to provide certainty for the assessment of the Project an assessment has been completed for the Project under the FBA which is current NSW Government policy.

Use of the BCAM rather than the Biobanking Assessment Methodology (BBAM) is allowed due to the UHSA process, OEH contends that as the UHSA covers impacts on threatened species, this turns off the requirements of the Threatened Species Conservation Act 1995 (TSC Act) and the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act). But while the UHSA allows the use of BCAM which is a methodology, consent under the TSC Act has not been turned off (except by an interim policy) as the Part 10 requirements of the EPBC Act have not been met. Use of a methodology cannot be considered as a substitute for the application of an impact assessment as required under the EP&A Act, and the use of the Framework for Biodiversity Assessment (FBA) should still apply in this case.

The biodiversity assessment for the Project was completed in accordance with the SEARs and in close consultation with DPE and OEH. The Statement of Consistency report was prepared in line with the UHSA Interim Policy (DP&I 2012).

Regardless, as discussed above to provide certainty for the assessment of the Project an assessment has been completed for the Project under the FBA which is current NSW Government policy.

Essentially, OEH are saying in Appendix 2 of the SEARs is that there are no 'high risk' (whatever that means, as this has no policy meaning) matters except the Commonwealth listed Central Hunter Valley Eucalypt Forest and Woodland CEEC. They state there are no matters for 'further consideration' which is an assessment consideration contained within the FBA and new Offset Policy for Major Projects. This ignores the state listed TECs present on the site, as well as a number of threatened species.

It is my contention that the equivalent state listed TEC Central Hunter Grey Box – Ironbark Woodland, the Regent Honeyeater, the Swift Parrot are matters for 'further consideration' due to an impact on critically endangered species or ecological communities. Though listed as only 'endangered' in NSW, the Box Ironbark Woodland and the Swift Parrot are listed as 'critically endangered' by the Commonwealth and so should be considered as such by the NSW consent authorities.

As outlined above, OEH's submission to the SEARs did not specify any matters for further consideration for NSW-listed threatened species. It should be noted that OEH further states that as the UHSA is yet to be endorsed, that Matters of National Environmental Significance (MNES) will need to be assessed under a separate approval pathway through the submission of an EPBC Act Referral. An EPBC Act Referral was submitted in October 2015 that included detailed assessments of relevant MNES, including the regent honeyeater (*Anthochaera phrygia*) and swift parrot (*Lathamus discolor*). The Project was deemed to be a 'Controlled Action' on 7 December 2015, due to the potential for significant impacts on the following matters protected under the EPBC Act:

- *Central Hunter Valley Eucalypt Forest and Woodland CEEC*
- regent honeyeater (*Anthochaera phrygia*)
- swift parrot (*Lathamus discolor*)
- spotted-tailed quoll (*Dasyurus maculatus maculatus*)
- a water resource.

Section 6.1 of the Statement of Consistency Report, in accordance with the SEARs, addresses all relevant or potentially-relevant MNES. Furthermore, Section 7.0 of the EIS outlines the required information in relation to MNES as required by the SEARs.

In relation to the regent honeyeater and swift parrot, these species have been recorded in the region and wider locality but they have not been recorded within the proposed disturbance area despite six years of recent and targeted winter bird surveys. A further detailed assessment of the potential impacts of the Project on these species is included in the BAR (FBA) report for the Project (refer to **Appendix 4**).

Missing Data

Another key issue that has detracted from the reliability of this assessment is the fact that only information from one of the proponents, Glencore, has been used in the EIS, the BioCertification Report for the Wambo site, prepared by Niche consultants for Peabody, has not been utilised. While none of the development footprint lies within the Wambo UHSA strategic assessment area, Wambo lies adjacent to the western perimeter of the proposed open cut pit and therefore within the assessment circle for the current Project.

It is acknowledged that the disturbance area for the Project is near the study area for the Wambo BCAM assessments undertaken for the UHSA by Niche (2014). The results in the Statement of Consistency report are broadly consistent with the information in the Wambo UHSA report (Niche 2014). The Wambo UHSA generated credits for the following entities:

- HU905 Narrow-leaved Ironbark, Grey Box grassy woodland of the central and upper Hunter
- HU712 River Oak riparian grassy tall woodland of the western Hunter Valley (Brigalow Belt South Bioregion and Sydney Basin Bioregion)
- HU869 Grey Box, Slaty Box Shrub grass woodland on sandstone slopes of the upper Hunter and Sydney Basin
- Scant Pomaderris (*Pomaderris queenslandica*)

- Southern myotis (*Myotis macropus*)
- River red gum (*Eucalyptus camaldulensis*) endangered population.

Of the above biodiversity features, the United UHSA report (Umwelt 2015) and, subsequently, the Statement of Consistency report, also generates credits for HU905 and HU869 and southern myotis as these features are consistent across the United and Wambo mine sites. HU712, the river red gum endangered population and scant pomaderris do not occur within the disturbance area for the Project and therefore credits have not been calculated for these features.

Proposed Extent of Impact

The UHSA methodology categorises species as either ecosystem-credit species or species-credit species… Using this approach rather than the use of the assessment of significance process according to s. 5A of the EP&A Act, all non-threatened species and some threatened species which are ecosystem species do not require further detailed assessment under the methodology. Species credit species do require further assessment and a calculation of impact species-credits under the UHSA methodology. However, this has been done poorly in the EIS as significant information gained during the UHSA field survey process is missing from the EIS.

The Statement of Consistency Report was prepared to demonstrate how the assessment of impacts on biodiversity and the proposed offsetting framework for the Project was in line with the UHSA Interim Policy (DP&I 2012). The Statement of Consistency Report was prepared referencing the methods and assessments in the final United UHSA Biodiversity Certification Assessment Report (Umwelt 2015) submitted to OEH in September 2015 as agreed with DPE and OEH.

Appendix A of the Statement of Consistency Report provides the methods undertaken as part of the United UHSA (Umwelt 2015) and the United Wambo Open Cut Coal Mine Project. This appendix was modified from the United UHSA report to be relevant for the additional survey and assessment requirements for the Project as outlined in Section 5.0 of the Statement of Consistency Report. Appendix A includes descriptions of the vegetation zone assessment, landscape value, targeted threatened species surveys and assessments and figures showing survey effort across the site.

A detailed discussion of the biodiversity survey undertaken as part of the Project is also provided in the BAR (FBA) report (refer to **Appendix 4**).

The EIS identifies only six ecosystem credit species which were recorded during field surveys in the Project Area . . . . For the eastern bentwing-bat and eastern cave bat, only foraging habitat is covered by ecosystem credits whilst their breeding habitat is covered by species credits. The EIS contends that no breeding habitat exists in the Project Area for these species. However, the EIS does not consider potential breeding habitat which may exist in the Wambo assessment area.

Breeding habitat for the eastern bentwing-bat includes karst (limestone) caves and for the eastern cave bat, caves, tunnels, mines or buildings, as outlined in the Threatened Species Profile Database (TSPD). None of these features occur within the disturbance area for the Project and none are known to occur in the immediate adjoining areas, however the north-eastern edge of Wollemi National Park supports a substantial area of escarpments and potentially a large number of caves, although not limestone caves. The

Wambo UHSA report (Niche 2014) states that this habitat is not present in the Wambo UHSA study area. The TSPD further notes that no maternity colonies for the eastern bentwing-bat are known in the Hunter-Central Rivers Catchment Management Area (CMA).

Roost sites for cave-roosting micro-bat species are known to occur in Wollemi National Park particularly along the northern escarpment areas of the Park and near Reubens Creek, up to 40 km from the Project Area (DEC 2005). These areas will not be impacted by the Project.

However, the EIS does not consider all the ecosystem credit threatened species found adjacent to the development footprint as detailed in the draft UHSA Biocertification Report completed by Umwelt for the United mine in 2014 (overleaf). This details 34 fauna species within the United UHSA assessment circle but no consideration is given to the majority of these in the EIS or impacts on habitat or connectivity for these species. These include Regent Honeyeater, Koala, Swift Parrot and number of woodland birds such as the Hooded Robin. Indeed, if the 16 threatened species recorded in the Wambo UHSA assessment area were taken into account, this also raises the number of species which should have been considered in the EIS.

The Statement of Consistency Report was prepared referencing the methods and assessments in the final United UHSA Biodiversity Certification Assessment Report (Umwelt 2015) submitted to OEH in September 2015. The assessment considered all relevant species using the assessment process specified by the OEH BCAM methodology. Ecosystem-credit species such as the hooded robin and swift parrot are predicted by the landscape assessment and are captured in the generation of ecosystem credits for the Plant Community Types (PCTs) impacted by the development. Furthermore, the importance of corridors and connectivity are captured through the identification of local and/or regional biodiversity links as part of the connectivity value of the site.

The EIS states that four species credit species were recorded during field surveys of the Project Area . . . The issue of the endangered population of weeping myall has not been addressed in the EIS. With respect to microbats, Umwelt state that due to the absence of potential breeding habitat (sandstone caves) within the additional disturbance area, no credits are required for the large-eared pied bat, eastern bentwing-bat or eastern cave bat. This does not take into account the potential breeding habitat in the adjacent Wambo Mine assessment area. However, credits are required for the Southern Myotis though this has not been directly addressed in the EIS.

The Weeping Myall (*Acacia pendula*) population in the Hunter catchment is highlighted as a Red Flag in Section 9.0 of the Statement of Consistency report and identified as a high risk entity in Table 11.1 of the Statement of Consistency report as per the *Attachment 1: Cumulative impact and risk assessment methods and results, including detailed instructions for the Central Hunter Valley eucalypt forest and woodland CEEC* (OEH 2015). The endangered population of weeping myall has been entirely avoided by the Project and does not occur within the additional disturbance area boundary. This is clearly addressed in Section 4.0 of the Statement of Consistency report where avoidance measures for high risk entities are outlined.

As outlined above, potential breeding habitat features for the large-eared pied bat, eastern bentwing-bat or eastern cave bat do not exist within the disturbance area for the Project and none are known to occur in the immediate locality. The Wambo UHSA report (Niche 2014) states that this habitat is not present in the Wambo UHSA study area. The Project will not affect breeding habitat for these species.

Furthermore, the methods for calculating the species credits generated for the southern myotis (*Myotis macropus*) are specifically outlined in Section 5.3.3 of the Statement of Consistency report. This included revising the approach to determining southern myotis breeding habitat, from what was undertaken as part of the UHSA, to be in line with guidelines provided by OEH in March 2016. A total of 7.3 hectares of potential breeding habitat was identified in the additional disturbance area using the revised assessment method. This area was revised from the 13.4 hectares of habitat identified in the UHSA report (Umwelt 2015) as a result of the more detailed site-based surveys that were undertaken for the Project, which found that the eastern portion of Redbank Creek does not contain large pooling water bodies or perpetual flow in accordance with the guidelines. The species credits required for the southern myotis (562 credits) as a result of the Project are outlined in Table 3.2 and Table 12.1 of the Statement of Consistency Report.

Species credits have also been generated for the southern myotis as part of the FBA assessment.

Umwelt have ignored the species credit species found by Niche on the adjacent Wambo site, Pomaderris queenslandica where a small colony was found less than 2 kilometres from the current pit boundary. It is unknown if this species was surveyed by Umwelt for their United assessment, though possible habitat exists along the southern boundary of the Project Area and may be impacted, indirect impacts such as dust and should be considered in the EIS.

Scant pomaderris (*Pomaderris queenslandica*) was identified as a species requiring targeted survey as part of the UHSA for the United Project Area (Umwelt 2015) and is specifically outlined in Table A.4 in Appendix A of the Statement of Consistency report. According to the TSPD, the species is detectable during all months of the year. Threatened flora species surveys were undertaken during several separate field trips in order to adequately survey during the required seasonal survey periods of all species credit flora species with potential to occur in the Project Area. Field surveys including targeted floristic searches were undertaken during:

- 11 to 12 February, 24 April and 5 May 2009
- 26 to 28 February, 18 to 20 March, 11, 12, 23 and 24 September and 9 to 10 October 2013
- 5 to 7 March 2014
- 27 May and 9 and 10 July 2015 and
- 14 April 2016 (non-UHSA disturbance area).

Scant pomaderris was not recorded during these extensive surveys and therefore species credits have not been generated for the species. As per the final UHSA report for the United Project Area, this has been accepted as adequate by OEH.

The same approach applies in the FBA assessment for the Project.

It is further noted that indirect effects on biodiversity, including dust, have been assessed in both the Statement of Consistency report and the BAR (FBA) report. An extensive range of dust management measures have been incorporated into the design of the Project as outlined in the EIS.

The grassy woodland vegetation in the valley forms a corridor for wildlife linking areas to the west with Wollemi Creek and the lowland vegetation to the south east. This is a well-used corridor judging by the number of threatened species records known from here (Figure 2). In terms of effective corridor width, as defined under the BioBanking Assessment Methodology and BCAM, the proposal constitutes an effective 100% removal of the corridor width in this location. Though recognised for its importance in all methodologies, connectivity has not been addressed in the EIS and as the Biodiversity Plan is not available, it remains to be seen how the state and commonwealth governments are able to accommodate this consideration of landscape impact.

In Biodiversity Certification assessments, fragmentation of habitat is addressed as part of the Landscape Value score including consideration of features before and after the development including percentage of native vegetation cover, connectivity value and vegetation condition. The change in connectivity has therefore been an integral part of the assessment of the Project using BCAM.

The Project Area is connected to a large area of remnant vegetation to the west where there are extensive areas of moderate to good condition native vegetation associated with Wollemi National Park. There is more than 501 hectares of moderate to good condition native vegetation which meets the very large category for an adjacent remnant area under BCAM.

The issue of biodiversity corridors and how they were considered in the BCAM assessment is discussed further in **Section 3.3**.

Assessment of Survey Effort

The effort undertaken to detect and describe the key threatened species is unknown. This information is contained within the final UHSA Biocertification report for United (Umwelt 2015) which is not publicly available.

Appendix A of the Statement of Consistency report contains information on the field survey methodology undertaken as part of the United Collieries UHSA (Umwelt 2015) and the United Wambo Open Cut Coal Mine Project. Broadly, this section was modified from the United Collieries UHSA report (Umwelt 2015) (currently not publicly available) so that it could be relevant for the additional survey and assessment requirements for the Project as outlined in Section 5.0 of the Statement of Consistency report. The United UHSA was submitted to OEH in September 2015 and the methods accepted as adequate by OEH on 25 September 2015.

A detailed discussion of the biodiversity survey undertaken as part of the Project is also provided in the BAR (FBA) report (refer to **Appendix 4**).

Assessment of Significance Impact

While Umwelt did not consider there to be any significant impact upon any threatened species, it is expected that profound impacts will result on the survival of a number of threatened species as the proposed coal mine will remove the majority of native vegetation, particularly grassy woodland within the Project Area. This is particularly true for the resident species and also true for the rare 'nomadic' species such as Regent Honeyeater and Swift Parrot where significant loss of habitat and breaks in habitat continuity are serious cumulative impacts.

Assessments of significance of impact on threatened species has not been dealt with adequately as the proponent was guided by OEH into disregarding the TSC Act. However, use of the 7 Part test criteria demonstrates that 19 the TSC Act-listed threatened species recorded in the wider study area will experience significant impacts, including the Regent Honeyeater, Swift Parrot, Spotted-tailed Quoll, Koala, Squirrel Glider, Brush-tailed Phascogale, woodland birds and threatened micro- bats.

The biodiversity assessment for the Project was completed in accordance with the SEARs and in accordance with NSW Government policy. The consideration of impacts on threatened species was undertaken in an appropriate manner consistent with that policy.

Specifically in regard to the UHSA assessment, the preparation of the UHSA addresses many of the components of the Seven Part Tests by using the Biodiversity Certification Credit Calculator, a formal tool developed by OEH for such assessments. Although it is understood that the preparation of a BioCertification Assessment under the UHSA is intended to supersede the requirement to prepare Seven Part Tests, this is not currently clearly defined in the legislation and therefore the Seven Part Test of Significance in accordance with s. 5A of the EP&A Act was provided in Table 5.2 of the Statement of Consistency report.

Impacts on threatened species (ecosystem-credit and species-credit species) are predicted in the Biodiversity Certification Credit Calculator by the landscape features of the disturbance area (native vegetation cover, IBRA regions, patch sizes, condition and plant community types) and assessed by the impact on these features and credits generated as appropriate. Furthermore, Red Flags identify impacts on areas of high conservation value including threatened species that are very rare, critically endangered, have few populations, have a restricted distribution or poorly known habitat requirements. Habitat loss is assessed in the Biodiversity Certification Credit Calculator through the existing and future Site Value scores entered for each vegetation zone. The extent of habitat loss is ultimately determined by the measure of ecosystem credits and species credits calculated in the Biodiversity Certification Credit Calculator.

The BCAM process does not categorise whether species are 'significantly impacted' by a Project in the same way as s. 5A of the EP&A Act. As noted above, the assessments for the Project were completed in accordance with the SEARs and relevant government policy (UHSA Interim Policy and FBA) and an alternative assessment of impacts on threatened species is not required for the Project.

In summary, the assessment was undertaken following relevant guidelines and methods and a further assessment of the significance of impact is not required. Regardless, we disagree with the contention in the submission that 19 TSC Act listed threatened species would be significantly impacted by the Project.

Adequacy of Offset Package

The details of the offset strategy are vague in the EIS with very little detail about the offsets other than some maps and the biodiversity credit values. There is no information presented on the survey effort used to inform these assessments.

The offset package for the Project was presented in the Statement of Consistency report. Section 13.0 of the Statement of Consistency report outlined the key survey methods, landscape features, threatened species and vegetation zones delineated at each proposed offset sites. Furthermore, Appendix D of the Statement of Consistency report included detailed descriptions of the Plant Community Types (PCTs) delineated for the proposed offset sites.

Further detail of each of the proposed offset sites in accordance with the requirements of BBAM (OEH 2014) is provided in the BAR (FBA) report (refer to **Appendix 4**).

In relation to the mine rehabilitation offset, on page 287 of the EIS, Umwelt has claimed that:

"…mine site ecological rehabilitation contributing 25 per cent of the overall biodiversity offset requirement. Currently estimated at approximately 878 hectares of ecological rehabilitation …"

But according to their own figures, this is not the case as they have claimed that the 878 ha will generate an incredible 4,755 credits which is in fact over half of the total credit requirement for the CEEC.

As discussed in **Section 3.1**, subsequent to the public exhibition of the EIS OEH has provided revised draft offset rules relating to the use of rehabilitation. Based on these revised draft rules, the area of rehabilitation able to be used as an offset has changed. The revised rehabilitation areas and the credits generated are provided in **Section 3.1**.

The offset package has not demonstrated a level of credit retirement sufficient in order to alleviate significant residual impacts upon a suite of threatened matters and it appears that this may be an impossible task given the critical level of loss of central hunter woodlands.

As discussed in the EIS and Statement of Consistency report, it was acknowledged that all of the biodiversity offsets required for the Project had not been secured at the time of public exhibition of the EIS. Since that time further offsets have been secured with an expansion of the Wambo offset site and the area of impact of the Project has also been reduced, reducing the credit requirement for the Project.

As outlined in the BAR (FBA) report there remains a credit deficit with the currently secured offsets and United is undertaking ongoing work on the offset strategy to secure the additional offsets required. As permitted by the FBA the additional offsets required may be sourced from a range of options including:

- land-based offset sites

- securing required credits through the open credit market
- contributing money to supplementary measures in accordance with relevant conservation or recovery actions and/or
- payments to an offset fund.

Consultation is ongoing with OEH and DPE regarding the offset strategy for the Project.

The Wambo Offset property contains the last patch of the critically endangered Hunter Valley Eucalypt CEEC in the locality, though the condition of this would be further degraded due to its proximity to the proposed pit.

The Wambo Offset site does not contain the last patch of *Central Hunter Valley Eucalypt Forest and Woodland CEEC* in the locality. The *Central Hunter Valley Eucalypt Forest and Woodland CEEC* within the Project Area is made up of a range of vegetation types that are known to occur in the locality including:

- HU816 Spotted Gum - Narrow-leaved Ironbark Shrub - Grass Open Forest of the Central and Lower Hunter
- HU869 Grey Box - Slaty Box Shrub - Grass Woodland on Sandstone Slopes of the Upper Hunter and Sydney Basin
- HU905 Narrow-leaved Ironbark – Grey Box Grassy Woodland of the Central and Upper Hunter
- HU906 Bull Oak Grassy Woodland of the Central Hunter Valley.

These vegetation communities that contain species characteristic to the CEEC overlap with Permian soil landscapes extensively in areas surrounding the Project Area. For example, the Flora Assessment for the South Wambo Underground Mine Modification (FloraSearch 2016) identified extensive areas of the community within the study area for the Project. It is acknowledged that these landscapes are currently fragmented and disturbed in the locality by agriculture and industry, including coal mining, however other areas outside the Wambo Offset Site are likely to contain the CEEC.

The Wambo Offset Site is not predicted to be adversely impacted by indirect impacts associated with the Project.

The proponent claims that suitable offsets are just not available. However, if this is the case, it would suggest that the regional persistence and condition of state and commonwealth-listed TECs are at critical levels in the locality.

As outlined above, offset investigations are ongoing to secure suitable land-based offsets for the Project. Particular focus of these investigations is on providing appropriate offsets for the *Central Hunter Valley Eucalypt Forest and Woodland CEEC* in the Hunter Valley.

Matters of National Environmental Significance

The assessments provided in the EIS concluded that the Project is likely to have a significant impact on the Central Hunter Valley Eucalypt Forest and Woodland CEEC due to the loss of 223.5 hectares of the community, but the assessments for the three threatened species identified above concluded that the Project is unlikely to result in a significant impact on these species. As a result, the assessment concluded that there are no significant residual impacts not addressed by the UHSA that need to be addressed in accordance with the Environmental Protection and Biodiversity Conservation Act 1999 (EPBC Act) Environmental Offset Policy.

The fact the proponent saw no significant impact for any threatened species, suggests that no additional offset measures would be required. However, given the extent of the impact and the inadequacy of the offset arrangements for the Project, significant impacts upon the Spotted-tailed Quoll, Regent Honeyeater and Swift Parrot are likely . . . and additional measures should be required for these species and ecosystems.

As outlined above, the UHSA / BCAM and FBA processes do not categorise whether species are 'significantly impacted' by a Project in the same way as previous approaches. The offsetting drivers for Projects for some threatened species are not the significance of the impact, but the vegetation communities and threatened species predicted to be affected and credits generated that require offsetting.

As discussed in the EIS, Statement of Consistency report and BAR (FBA) report, United has sought to avoid and minimise potential impacts on the ecological values of the Project Area throughout the project planning process. This has included avoidance and minimisation of disturbance of key vegetation communities through designing the Project to maximise use of existing mining and transport facilities, and the avoidance of all areas of weeping myall.

Measures for mitigating impacts on MNES highlighted by the DoEE, being the spotted-tailed quoll, regent honeyeater and swift parrot, are outlined in Section 7.2.2 of the EIS and more specifically in Section 10 of the Statement of Consistency report and Section 8.0 of the BAR (FBA) report. These measures include:

- implementation of clearing procedures to minimise the impacts of the clearing process and maximise the recovery of any valuable biodiversity resources (e.g. seed collection, re-use of hollow logs and hollows where appropriate)
- feral animal and noxious weed control
- fencing and access control
- management of domestic stock
- bushfire management

The BAR (FBA) report provides a further detailed assessment of the impacts of the Project on the species discussed in the submission and of the offsetting outcomes for these species.

In addition, there are several records of the New Holland Mouse Pseudomys novaehollandiae to the west of the current pit, including one within the current Project Area. This species is vulnerable under the EPBC Act. These, records while not in the BioNet Atlas, were recorded by Niche consultants while undertaking surveys for Peabody during the BioCertification surveys in 2013-14. The habitat requirements of Hunter Valley New Holland Mouse are not well documented, though studies at Ravensworth show they inhabit ironbark- box-spotted gum forest and adjacent areas of regeneration (Glencore Mt Owen monitoring reports). Judging by the distribution of records of this species in the locality, it shows they utilise lower slope woodlands and forest. Given this, it seems likely that this species also will suffer a significant impact given the extensive removal of valley vegetation in the locality.

The EPBC Act Referral for the Project, submitted in October 2015, provided an assessment for the New Holland mouse (*Pseudomys novaehollandiae*) which is listed as vulnerable under the EPBC Act. The disturbance area provides potentially suitable habitat for this species, however it has not been recorded in this area. This species has been recorded once, in 1981, within a 10 kilometre radius of the disturbance area on the NSW Atlas of Wildlife. While potential habitat is present for this species it would be unlikely to comprise part of an important population as defined under the *Significant Impact Guidelines 1.1* (DoE 2013) as they would not be at the known limits of their ranges and consequently would be unlikely to be important for maintaining genetic diversity or be key populations for breeding or dispersal. The Assessment of Significance under the EPBC Act concluded that the species was unlikely to be significantly impacted by the Project. Furthermore, DoEE also did not consider this species would be subject to a significant impact in its determination of the Project being a controlled action.

For the purposes of the BCAM assessment, the New Holland mouse is an ecosystem credit species and therefore does not require specific survey or assessment. The same applies for FBA.

Adequacy of Offset According to the Commonwealth Offset Policy

The Policy states that direct offsets must constitute 90% of the offset outcomes, with the other 10% being provided in 'in-kind' measures which will benefit the conservation of any particular species through research or other recovery actions. With respect to the critically endangered ecological community CHVEFW, it is not acceptable to use another vegetation community as an offset, even though it is another CEEC, to offset the loss of the impacted CHVEFW ecological community. The offset proposal in the EIS offsets Box Gum CEEC for the impacted community at a level of about 40% of the total offset requirement; this is not consistent with the Commonwealth offset policy.

An assessment of the proposed offset package in relation to the *EPBC Act Environmental Offsets Policy* (DSEWPC 2012) was not undertaken as the Project was assessed under the UHSA Interim Policy and therefore the Commonwealth Offset Policy was not relevant.

With the completion of the BAR (FBA) report, an assessment of the proposed offset package also does not require assessment against the Commonwealth Environmental Offsets Calculator as a bilateral agreement is in place for use of the FBA. However, regardless of this, further information of how the offsets meet the intent of the Commonwealth Offsets Policy is provided in the BAR (FBA) report (refer to **Appendix 4**).

Looking at the objectives of the Policy, it is hard to see how the offset package proposed in its current form could meet more than one of these objectives. As well, given the poor quality of the offset package, it is also hard to see how it could gain sufficient points on the Offset Calculator. But without more detail on the offset package it is not possible to run this analysis.

The requirements for the offset strategy for the Project have been quantified in accordance with government policy, clearly indicating the quantum of offsets required for the Project. As outlined above, offset investigations are ongoing to secure the remaining offsets required for the Project and under the relevant government policy there is a range of options available to provide the required offsets.

3.4.2 Lock the Gate Alliance

Overall, Lock the Gate outlines that it objects to the Project due to the impact on threatened species and communities and the adequacy of the proposed offset strategy. Responses to key issues are provided below.

The clearing of 464ha of vegetation, close to half of which is Central Hunter Valley Eucalypt Forest, a critically endangered ecological community under the Environment Protection Biodiversity Conservation Act is an unacceptable impact.

A total of approximately 223.5 hectares of *Central Hunter Valley Eucalypt Forest and Woodland CEEC* was identified within the additional disturbance area for the Project. Following mapping revisions in response to further information received from DoEE, and revisions to the additional disturbance boundary the area of *Central Hunter Valley Eucalypt Forest and Woodland CEEC* in the disturbance area for the Project is now 189.5 hectares.

An Assessment of Significance prepared for the EPBC Act Referral was undertaken to determine the significance of the potential impact on the CEEC. The assessment of significance identified that the loss (prior to revisions stated above) of 223.5 hectares of the community is likely to have a significant impact on the *Central Hunter Valley Eucalypt Forest and Woodland CEEC* as it will reduce the extent of the community, adversely impact some areas of critical habitat of the ecological community and interfere with the recovery of the ecological community. This assessment will remain the same despite the reduction in CEEC disturbance from 223.5 to 189.5 hectares.

A risk assessment by OEH of the potential impacts to the *Central Hunter Valley Eucalypt Forest and Woodland CEEC* (OEH 2015) identified that the maximum potential removal of the CEEC from all UHSA project areas would result in a 12 per cent reduction in the current extent or 5 per cent of the pre-European extent of the vegetation community. OEH's risk assessment also indicated that the removal of all potential areas of the CEEC from the United UHSA Project Area would break connectivity and isolate patches located to the east of the United UHSA Project Area around the Pokolbin district.

OEH concluded that, with the predicted regional impacts for UHSA projects (including the United UHSA Project Area), the community will persist across its range, but that there will be a substantial decrease in its extent across the Central Hunter Valley portion of its distribution. The worst case scenario comprising the removal of all habitat areas from within all the UHSA project areas was estimated by OEH to have a potentially major consequence on the regional population, and the likelihood of this consequence eventuating was estimated to be "likely" (OEH 2015).

The assessment above did not, to Umwelt's knowledge; factor in the likely regeneration of this community across its range in areas where land use is amenable to its recovery. The vast majority of the present form of the CEEC in the Hunter Valley is from regeneration since previous clearing.

As discussed in **Section 3.1**, the impacts on the CEEC are proposed to be offset and while a significant offset for this community has currently been secured; further work is ongoing to secure an additional offset area.

A 25% limit on the contribution that future mine rehabilitation can make towards fulfilling offset requirements applies for both the FBA assessment and the UHSA. Contrary to this policy, the proponent proposes to meet 56% of the required offset credits for Central Hunter Valley Eucalypt forest CEEC through mine rehabilitation and to provide only 7.7% of its offset requirements in direct offsets for this community. The EIS should not have been released for public comment with a proposal that clearly violates Government policy.

As discussed in **Section 3.1**, subsequent to the public exhibition of the EIS OEH has provided revised draft offset rules relating to the use of rehabilitation. Based on these revised draft rules, the area of rehabilitation able to be used as an offset has changed. The revised rehabilitation areas and the credits generated are provided in **Section 3.1**.

As also discussed in **Section 3.1**, the area of CEEC offset secured as a direct land based offset has also been increased since the public exhibition of the EIS.

Failure to assess the biodiversity impact of this project in accordance with the SEARs, including the attachment specifying the Commonwealth's requirements.

The EIS and Statement of Consistency report were prepared in accordance with the SEARs and fully addressed all requirements. For biodiversity matters, the revised SEARs, issued on 5 December 2015 (replacing an earlier issue of the SEARs issued in July 2015), required the following:

- *an assessment of the likely biodiversity impacts of the development, having regard to the NSW Biodiversity Offsets Policy for Major Projects, OEH's requirements (see Attachment 2) and Department of Environment's requirements (see Attachment 3); and*

- *a description of the measures that would be implemented to avoid, minimise, manage and/or mitigate impacts on biodiversity;*

An assessment of likely biodiversity impacts of the Project was provided in the Statement of Consistency report in Appendix 13 of the EIS. Although the SEARs required this to be undertaken having regard to the *NSW Biodiversity Offsets Policy for Major Projects* (OEH 2014), it was agreed with DPE and OEH that the assessment was to be done in accordance with the BCAM in accordance with the UHSA Interim Policy (DP&I 2012). Furthermore, OEH's requirements as outlined in Attachment 2 of the SEARs address this as a suitable pathway and note the Project's use of the UHSA Interim Policy (DP&I 2012).

Regarding the MNES, outlined in Attachment 3 of the SEARs, the requirements of the SEARs are specifically addressed by Section 7.0 of the EIS as well as assessment in the Statement of Consistency report and

further assessment provided in the BAR (FBA) report. This includes detailed assessments of the MNES considered by the DoEE to be significantly impacted by the Project being *Central Hunter Valley Eucalypt Forest and Woodland CEEC*, regent honeyeater (*Anthochaera phrygia*), swift parrot (*Lathamus discolor*) and spotted-tailed quoll (*Dasyurus maculatus maculatus*).

Avoidance and minimisation measures for the Project are specifically outlined in both the Statement of Consistency report and the BAR (FBA) report including the relocation of the disturbance, alternate designs of the Project and specific construction techniques tailored to avoid impacts. Measures for mitigating impacts on biodiversity were guided by the *UHSA Guidelines for the Mitigation of Coal Mining Impacts on Biodiversity* (OEH 2015). These measures include:

- landform establishment
- implementation of clearing procedures to minimise the impacts of the clearing process and maximise the recovery of any valuable biodiversity resources (e.g. seed collection, re-use of hollow logs and hollows where appropriate)
- feral animal and noxious weed control
- fencing and access control
- management of domestic stock
- bushfire management
- ensuring appropriate environmental management measures are in place as part of the mining operations to minimise the potential for indirect impacts including:
    - water management systems that seek to minimise the potential for damage to flora and fauna and their habitats from erosion and unnatural flooding events
    - noise control systems to minimise noise impacts
    - dust control measures to minimise dust impacts
    - lighting controls to minimise night light impacts
    - blasting controls to minimise blast overpressure and vibration impacts.
- employee education and training.

The environmental assessment requirements for this project have not been met for biodiversity and we are profoundly concerned about the quality, thoroughness and honesty of the information provided.

As outlined in the sections above, the Statement of Consistency report was prepared in accordance with the UHSA Interim Policy (DP&I 2012) which specifies the assessment requirements for approval of a Project in the event that this occurs prior to the finalisation of the UHSA process. The assessment provided in the EIS was undertaken in accordance with this policy and in accordance with the requirements of DPE and OEH

and was a thorough assessment of the biodiversity impacts of the Project. The report was prepared by suitably qualified and highly experienced professional ecologists and any assertion that the material provided is not prepared honestly is strongly rejected.

As discussed at the beginning of **Section 3.0**, the UHSA process was planned to be completed by the date of the exhibition of the EIS for the Project, and was expected to be available for public review and comment prior to the EIS being publicly exhibited. Unfortunately, this has not been the case, and the UHSA is currently being finalised by relevant government departments for public exhibition. This situation was outside of United's control and is unfortunate.

As also discussed above, it is noted that as at the time of preparation of this report the UHSA has not been finalised with the draft UHSA Biodiversity Plan yet to be subject to public exhibition. In the absence of a final UHSA Biodiversity Plan and to provide certainty for the progression of the approval process for the Project, in addition to the UHSA assessment provided as part of the EIS an assessment has been completed for the Project under the FBA which is current NSW Government policy.

Failure to mention species that will be impacted by this projects, such as the New Holland Mouse (EPBC Vulnerable) and failure to provide assessment for others, like the Koala, Regent honeyeater and Spotted-tail quoll.

The Statement of Consistency report was prepared to provide the required assessment of the Project in accordance with the UHSA Interim Policy (DP&I 2012) and the requirements of OEH and DPE. The assessment requirements of this policy were met. As discussed above, a further assessment for the Project has been completed under the FBA policy. These assessment approaches represent current NSW Government policy and the requirements of these policies have been met. All relevant species were considered and assessed, as relevant. The assessment requirements under these policies are somewhat different to previous types of biodiversity assessment that Lock the Gate would have seen in older EIS's, however, this reflects a change in government policy and the Project assessment has complied with relevant guidelines and is appropriate.

Especially in regard to the New Holland mouse (*Pseudomys novaehollandiae*), the EPBC Act Referral for the Project provided an assessment for the species which is listed as vulnerable under the EPBC Act. It was noted that the disturbance area provides potentially suitable habitat for this species, however it has not been recorded in this area. This species has been recorded once, in 1981, within a 10 kilometre radius of the disturbance area on the NSW Atlas of Wildlife. While potential habitat is present for this species it would be unlikely to comprise part of an important population as defined under the *Significant Impact Guidelines 1.1* (DoE 2013) as they would not be at the known limits of their ranges and consequently would be unlikely to be important for maintaining genetic diversity or be key populations for breeding or dispersal. The Assessment of Significance under the EPBC Act concluded that the species was unlikely to be significantly impacted by the Project. Furthermore, the DoEE also did not consider this species would be subject to a significant impact in its determination of the Project being a controlled action.

Threatened species including the New Holland mouse, koala, regent honeyeater and spotted-tailed quoll were assessed as per the BCAM in the United UHSA report. Furthermore, koala, regent honeyeater and spotted-tailed quoll were specifically assessed and discussed in Section 6.0 of the Statement of Consistency report.

These species were also all considered and assessed in the BAR (FBA) report following the FBA methodology.

Failure to provide access to policies and documents upon which the assessment relies.

The provision of public access to NSW Government policy and documents is the responsibility of the NSW Government and is outside of United's control.

As discussed above, United understood that the UHSA process was planned to be completed by the date of the exhibition of the EIS for the Project, and was expected to be available for public review and comment. However, this has not occurred. The EIS and Statement of Consistency Report were prepared as directed by OEH and DPE with the intent that the UHSA Biodiversity Plan would be available to be assessed against the Project. Glencore do not have any control over the timeframes that the Biodiversity Plan will be delivered by government departments.

As also discussed above, as the UHSA has not been finalised to provide certainty for the progression of the approval process for the Project, in addition to the UHSA assessment provided as part of the EIS an assessment has been completed for the Project under the FBA which is current NSW Government policy.

Failure to identify and map offsets already committed to by each proponent relative to the areas proposed now for clearing, and failure to address how the new proponent of the Wambo open cut will take on offset commitments for that project.

The existing offsets owned and managed by Wambo will be unaffected by the Project and Wambo will remain responsible for these existing offsets.

In regard to United's existing compensatory habitat area, under the development consent for United's former underground mining operations (DA-410-11-2003-i granted in November 2003), Schedule 4, condition 45, required United to establish "at least 18.5 hectares of compensatory habitat on the surface colliery holding to the satisfaction of the Director-General, to replace the woodland vegetation removed by the development". The approach to satisfying this requirement is discussed in **Section 3.2**.

Nowhere in the Environmental Assessment is the threshold of "impacts for further consideration" mentioned. The Office of Environment and Heritage has seriously erred in telling the proponent no such matters are present, when such a conclusion is properly supposed to be made in the assessment itself.

As discussed in **Section 3.4.1**, OEH specifically outlined in the SEARs that *"no matters for further consideration have been identified of NSW listed threatened biodiversity, however, the proponent is reminded that because the UHSA has yet to be endorsed that matters of national environmental significance will need to be considered by a separate assessment pathway".* As stated above, MNES were specifically assessed in the EPBC Act Referral submitted to the DoE (now DoEE) in October 2015, in Section 7.0 of the EIS and in Section 6.0 of the Statement of Consistency report.

It should also be noted that '*impacts requiring further consideration*' is a term used to describe impacts on biodiversity values which will require further consideration by the consent authority under the FBA. Under BCAM, these are broadly equivalent to 'Red Flags' which is an area regarded as having high biodiversity conservation values. Land containing a red flag area can only be biodiversity certified if the Secretary is satisfied that the criteria in Section 2.4 of the BCAM have been met. Red flags in relation to the United Project are outlined in Section 9.0 of the Statement of Contingency report. These include:

- *Central Hunter Valley Eucalypt Forest and Woodland CEEC* listed under the EPBC Act
- *Hunter Floodplain Red Gum Woodland in the NSW North Coast and Sydney Basin Bioregions EEC* listed under the TSC Act
- *Central Hunter Ironbark – Spotted Gum – Grey Box Forest in the NSW North Coast and Sydney Basin Bioregion EEC* listed under the TSC Act
- *Central Hunter Grey Box – Ironbark Woodland in the NSW North Coast and Sydney Basin Bioregions EEC* listed under the TSC Act.
- Southern myotis (*Myotis macropus*) listed as vulnerable under the TSC Act
- Redbank Creek, considered a regional biodiversity link and
- Other unnamed drainage lines, considered to be local biodiversity links.

We note that this issue is specifically addressed in the BAR (FBA) report (refer to **Appendix 4**).

The condition class of the forest to be cleared for this mine is crucial to understanding its impact on this critically endangered community and has not been assessed. The proponent has not provided any substantial information about the condition of the forest to be cleared, beyond admitting that some areas of moderate quality condition will be cleared for this project. Without ground-truthed mapping of the condition of the remaining extent of this forest it is impossible to know the extent of the impact of this project. This mapping and assessment across the extent of this critically endangered community must be undertaken for this project and the UHSA.

The *Central Hunter Valley Eucalypt Forest and Woodland CEEC* was listed under the EPBC Act during May 2015, and it was therefore not captured in the initial United UHSA report. How the CEEC is considered in the UHSA Biodiversity Plan (when finalised) is the responsibility of government and it outside the control of United.

Specifically for the Project, following the listing of this community, United undertook a range of targeted surveys and vegetation mapping to determine the extent and condition of the CEEC within the Project Area. Umwelt has consulted extensively with OEH and DoEE regarding the mapping methods required to appropriately capture the community across the Project Area in accordance with the listing advice for the CEEC (DoE 2015). All of the remnant (that is, woody) vegetation communities considered to conform to the CEEC within the disturbance area were categorised as being in 'Moderate to Good' vegetation condition, as per the BCAM Manual (OEH 2015), which is the highest condition category and generates that largest quantities of credits (as opposed to low condition).

Additionally, a small proportion of grassland that was derived from the remnant woodland form was also identified as conforming to the CEEC within the disturbance area. The derived grassland forms of the CEEC were categorised as being in 'Low' vegetation condition, as per the BCAM Manual (OEH 2015).

The majority of the CEEC in the disturbance area was represented by the Narrow-leaved Ironbark – Grey Box Grassy Woodland of the Central and Upper Hunter. In addition, a regenerating form of this community was identified in the north-eastern portion of the additional disturbance area which was dominated by young grey box, narrow-leaved ironbark and bulloak. A small amount of Grey Box - Slaty Box Shrub - Grass Woodland on Sandstone Slopes of the Upper Hunter and Sydney Basin was included in the CEEC as well as a small patch of the Planted/Rehabilitated Spotted Gum - Narrow-leaved Ironbark Shrub - Grass Open Forest of the Central and Lower Hunter.

Umwelt has undertaken an intensive program of review of the CEEC based on a series of communications, via teleconference and email, with DoEE staff from the assessment team and the Ecological Communities section. CEEC mapping revisions have followed the advice provided by the Department. The final mapping of the CEEC was undertaken considering the detailed technical advice from DoEE regarding the identification of the CEEC.

The assessment undertaken for the impact on Spotted-tailed quoll, Large-eared pied bat, New Holland mouse, and Eastern cave bat are not of a standard that should have been accepted and released for public comment. There is insufficient information provided about the impact of this project on these species. It is possible that there are other species, communities and populations for which this is the case, but the assessment material is too poor to tell.

The assessment of the impacts of the Project on these species has been completed in accordance with relevant NSW government policy and is complete and appropriate to provide for the assessment of the Project. As discussed above, the assessment processes for biodiversity in NSW have evolved due to changes in NSW government policy and the assessment approach used for this Project differs from that in older EIS's in how it assess impacts on threatened species. The Project assessment has been completed using the required assessment approaches and is appropriate.

Under the assessment approach used, impacts on threatened species (ecosystem-credit and species-credit) are predicted in the Biodiversity Certification Credit Calculator by the landscape features of the disturbance area (native vegetation cover, IBRA regions, patch sizes, condition and plant community types) and assessed by the impact on these features and credits generated as appropriate. Furthermore, Red Flags identify impacts on areas of high conservation value including threatened species that are very rare, critically endangered, have few populations, have a restricted distribution or poorly known habitat requirements. Habitat loss is assessed in the Biodiversity Certification Credit Calculator through the existing and future Site Value scores entered for each vegetation zone. The extent of habitat loss is ultimately determined by the measure of ecosystem credits and species credits calculated in the Biodiversity Certification Credit Calculator.

The BCAM and FBA processes do not categorise whether species are 'significantly impacted' by a Project in the same way as s. 5A of the EP&A Act and instead focus on the generation of credits to account for any impacts using NSW government developed calculators that must be used for the assessment. The level of credits required to be retired in order to offset a project is determined by a range of factors which, at a high level, considers the extent of impact and the importance of that species or community. The assessment for the Project has been undertaken using the relevant government supplied calculators and following the required assessment process.

The placement of the project in limbo between the current Framework for Biodiversity Assessment and the stalled Upper Hunter Strategic Assessment has resulted in serious deficiencies in the assessment making it unfit for exhibition. These must be rectified and a supplementary environmental assessment put on public exhibition before any further assessment is undertaken by the Department of Planning.

It is noted that the assessment for the Project was completed in accordance with the UHSA Interim Policy (DP&I 2012) and in accordance with the SEARs and further requirements provided by DPE and OEH.

As discussed above, it is noted that as at the time of preparation of this report the UHSA has not been finalised with the draft UHSA Biodiversity Plan yet to be subject to public exhibition. In the absence of a final UHSA Biodiversity Plan and to provide certainty for the progression of the approval process for the Project, in addition to the UHSA assessment provided as part of the EIS an assessment has been completed for the Project under the FBA which is current NSW Government policy and which is publicly available.

3.4.3 Nature Conservation Council of NSW

The Nature Conservation of NSW submission raised issues in relation to:

- the significance of impacts on threatened species and ecologically endangered communities (including the *Central Hunter Eucalypt Forest and Woodland CEEC*)
- the lack of publicly available documentation in relation to the UHSA
- the loss of habitat for threatened fauna species, and
- the inadequacy of the proposed offset strategy particularly in relation to the use of mine rehabilitation for the *Central Hunter Eucalypt Forest and Woodland CEEC*.

Responses to these issues are captured in **Sections 3.4.1** and **3.4.2** above.

Other specific issues raised in the submission that have not been responded to above are addressed below.

While the proposed Project claims to avoid, minimise and offset impacts on threatened species and their habitats, it is our view that the proposed measures are inadequate and will not compensate for the significant impacts of the project on biodiversity. We have seen no evidence in reviewing various coal mine proposals in the Hunter Valley region over recent years that proponents of coal mines ever give genuine consideration to the question of avoiding the inevitable environmental damage associated with coal mining (whether underground or open cut) by actually not proceeding with the proposal.

A detailed discussion of the measures put in place to avoid, minimise and offset impacts including the alternative mine plans considered and avoidance measures implemented was provided in the EIS.

As outlined in the EIS, a number of design changes were implemented during the early stages of designing the Project that ameliorated likely impacts of the Project on biodiversity, including threatened species, endangered ecological communities, and/or their habitats. A key alternative considered was to develop the United

Open Cut as a standalone mining operation which would have resulted in approximately 148 hectares of further disturbance to biodiversity than the proposed Project due to the need to develop stand-alone coal processing facilities, mine infrastructure and transportation infrastructure (rail line, rail loop and train loading facility). This Option 1 Project (refer to **Figure 3.7**) represented the largest disturbance footprint alternative. This included impacts to the north of the Project Area in areas containing *Central Hunter Valley Eucalypt Forest and Woodland CEEC* and infrastructure associated with a proposed rail loop option would have impacted areas of potential *Warkworth Sands Woodland in the Sydney Basin Bioregion EEC*, and *Hunter Floodplain Red Gum Woodland in the NSW North Coast and Sydney Basin Bioregions EEC* occurring to the southeast of the Project Area.

The revision of these designs substantially reduced the likely overall impact of the Project on biodiversity.

The option of not proceeding with the Project was considered in the EIS. This option would mean the closure of the Wambo Open Cut in 2020 as well as no further operations at United. Whilst rehabilitation and closure works would continue for some years following the cessation of mining, such operations would be at a much lower intensity than the current mining operations within the Wambo Open Cut and there would be a significant reduction in employee numbers. The employment opportunities for up to approximately 250 Wambo Open Cut employees would be lost as would the significant flow on effect to the local, regional and state economy. Not proceeding with the Project would also not result in the biodiversity impacts that result from the Project.

Proceeding with the Project will provide a range of economic and social benefits at local, regional and State levels. The Project would inject approximately $2.1 billion into the Hunter Valley regional economy and approximately $3.0 billion into the State economy. These benefits would not be realised should the Project not proceed. It is acknowledged that not progressing with the Project would have potential benefits to the local community and environment in terms of avoiding some of the impacts from mining. As outlined in Section 9.3 of the EIS, the Project has been assessed against the principles of ecologically sustainable development as required by the EP&A Act. This assessment has indicated that the Project is consistent with the principles of ecologically sustainable development. With the implementation of appropriate management, mitigation and offset measures and with consideration of the outcomes of the detailed economic assessment of the Project the assessment found that the Project would result in a net benefit to the NSW community.

We are also concerned that it is unclear what offsetting rules apply to the Project.

As outlined in the sections above, it is acknowledged that the UHSA Biodiversity Plan has not been released for public comment or approved by the relevant government authorities and this has resulted in a lack of context and information available for reviewing this Project. The UHSA assessment was undertaken in accordance with the UHSA Interim Policy (DP&I 2012) and following offsetting rules provided by OEH for use in the assessment.

As also discussed above, to provide certainty for the assessment of the Project (as the UHSA Biodiversity Plan has not been finalised), an assessment has been undertaken in accordance with the FBA. This assessment is provided in **Appendix 4**. The FBA policy, including the offsetting rules that apply, are publicly available.

Payments will be made into the Upper Hunter Biodiversity Offsets scheme. We have significant concerns with the use of upfront monetary payments in lieu of genuine offsets. Upfront payments for biodiversity offsetting must only be permitted where it can be demonstrated that the payment will result in the identification and protection of appropriate offset sites before development commences.

United is committed to delivering a biodiversity offset strategy that meets government guidelines and appropriately compensates for the unavoidable loss of ecological values as a result of the Project. First and foremost, United is committed to providing up front land-based offsets to meet a substantial proportion of the credit requirement of the Project. It is currently proposed that the biodiversity offset strategy will consist of the Highfields, Mangrove and Wambo offset sites as well as mine rehabilitation as outlined in the EIS. Further land-based offsets are currently being sought to address the residual credit requirements for Project.

NSW Government policy provides a range of mechanisms for retiring biodiversity credits for a Project. Payments made to a biodiversity offset fund are one of the mechanisms available and could be an option used to meet part of the offset requirements for the Project. The operation of the fund is the responsibility of the NSW Government who would be responsible for use of the fund to provide biodiversity offset outcomes.

It is unclear whether these proposed offsets meet Federal offsetting requirements for species listed under the EPBC Act.

The assessment of the Project under the EPBC Act will be undertaken via the bilateral agreement between the Commonwealth and NSW Governments. Under this process the NSW assessment processes are used to provide the necessary assessments and then the final decision whether or not to approve the Project under the EPBC Act remains a Commonwealth responsibility. The suitability of the offsetting approach for the Project is therefore assessed under NSW policy and the SEARs. This assessment has been completed as part of the EIS and further information regarding the proposed offsets is provided in this RTS (Part B) report.

The EIS identifies nine vegetation zones across the UHSA region as having red flag status. These are areas regarded as having high biodiversity conservation values as defined in Section 2.3 of the Biodiversity Certification Assessment Methodology (BCAM). Under the BCAM red flag areas should be protected unless it is decided that the impacts on the red flag area can be offset in accordance with the rules and requirements in section 10 of the BCAM. Although the EIS identifies red flags for the purpose of the BCAM, there is no clear explanation of what the impacts on these areas will be, or whether those impacts can be appropriately offset. Further information and assessment is needed on this particular aspect of the proposal.

A red flag is an area regarded as having high biodiversity conservation values as defined in Section 2.3 of the BioCertification methodology (DECCW 2011). The revised offsetting outcomes under the UHSA process, including for those entities that have red flag status is provided in **Section 3.1**.

We are also concerned that the EIS concludes that the Proposal will not have a significant impact on the swift parrot. The swift parrot has been recorded within 3kms of the United Wambo Project disturbance area. There is also a seasonal population of swift parrots in the remnant of the Ravensworth State Forest, part of another proposed coal mine project (Mount Owen Continued Coal mining Operations) by Glencore and only 20 kms from the United Wambo Project disturbance area – just next door for a prolific flier like the swift parrot. Any potentially suitable foraging habitat for swift parrots in the Hunter Valley is precious and should not be cut down. We do not necessarily agree that the proposal will have no significant impact on the swift parrot.

It is acknowledged that the swift parrot was recorded 14 years ago in the locality along Wallaby Scrub Road approximately 3 km to the southeast of the Project Area in 2002. These birds were observed foraging in Blakelys red gum (*Eucalyptus blakleyi*) during surveys undertaken for the Warkworth Coal Mine Extension Project. In recent years, the species has targeted the habitats within the Singleton Military Area, being recorded in high numbers (50+) foraging in box-gum woodland habitats in 2015 and 2016 (Birdline 2016).

Targeted winter bird surveys were undertaken across the United Project Area during 2010, 2011, 2012, 2013, 2014 and 2016. Winter bird surveys targeting the swift parrot and the regent honeyeater were undertaken by two ecologists during June, July or August each year, and comprised a total of 106.6 person hours of survey, as outlined in Appendix A of the Statement of Consistency report. Surveys comprised a combination of predetermined sites and sites positioned during the surveys to target areas of eucalypt flowering. Surveys included both visual searches (using binoculars) and call play back surveys (using a loud hailer). The swift parrot was not recorded during the six years of targeted survey within the Project Area.

Of the key tree species listed for the swift parrot as important foraging habitat in NSW during autumn and winter by the National Recovery Plan for the species (Saunders and Tzaros 2011) two, (spotted gum (*Corymbia maculata*) and forest red gum (*Eucalyptus tereticornis*)), have been recorded in the additional disturbance area. Approximately 29 hectares of HU816 Spotted Gum - Narrow-leaved Ironbark shrub - grass open forest occurs in the additional disturbance area in plantation/rehabilitation form. A total of only 0.29 hectares of HU812 Forest Red Gum grassy open forest on floodplains of the lower Hunter occurs in the additional disturbance area. While the occasional, infrequent presence of the swift parrot cannot be categorically ruled out, it is very likely that any occurrence in the disturbance area would be rare and of very limited duration, and of no significance to the species as a whole.

The National Recovery Plan for the swift parrot (Saunders and Tzaros 2011) identifies that during foraging on the mainland swift parrots have been found to preferentially forage in large, mature trees that provide more reliable foraging resources than younger trees. The approximate 29 hectares of Spotted Gum - Narrow-leaved Ironbark shrub - grass open forest that occurs in the additional disturbance area in plantation/rehabilitation form contains a young canopy with trees between 5 and 11 metres in height. No mature spotted gum trees occur in the vegetation zone.

A comparison of the priority habitat areas identified for the swift parrot by Saunders and Tzaros (2011) against the known occurrence of the species in the additional disturbance area is detailed below:

- Habitat used for nesting. Nesting does not occur on the Australian mainland and does not occur in the Project Area.

- Habitat used by large proportions of the swift parrot population. The swift parrot has not been recorded in the additional disturbance area despite six years of targeted monitoring in relation to regent honeyeater and swift parrot surveys). No proportion of the swift parrot population is known to forage in the additional disturbance area.

- Habitat used repeatedly between seasons (site fidelity). The swift parrot has not been recorded in the additional disturbance area despite six years of targeted monitoring. The swift parrot has not repeatedly used any parts of the additional disturbance area.

- Habitats used for prolonged periods of time (site persistence). The swift parrot has not been recorded in the additional disturbance area despite six years of targeted monitoring. The swift parrot has not been recorded in the additional disturbance area on a single occasion.

It was concluded that the swift parrot is unlikely to be significantly impacted in accordance with the *Significant Impact Guidelines 1.1* (DoE 2013) as:

- the swift parrot has not been recorded in the disturbance area despite six years of recent targeted monitoring

- there is less than 30 hectares of vegetation zones within the disturbance area that contain key foraging tree species (Saunders and Tzaros 2011) for the swift parrot in NSW

- there are no mature trees (favoured for foraging) in the approximate HU816 29 hectares of Spotted Gum - Narrow-leaved Ironbark shrub - grass open forest in the disturbance area

- none of the potential habitat areas in the disturbance area are consistent with the characteristics of habitat critical to the survival for the swift parrot as per the National Recovery Plan for the species (Saunders and Tzaros 2011).

It should be noted that under BCAM for the UHSA and under the FBA, the swift parrot is an ecosystem-credit species and does not generate credits specifically for the species. However its habitat is modelled to co-occur with certain plant community types (PCTs) and for those its presence contributes towards the generation of credit requirements.

The BAR (FBA) report also includes a further discussion on the swift parrot including outlining the offsetting outcomes for the species, indicating that a substantial offset is provided that is numerous times larger than the area impacted by the Project.

3.4.4 Hunter Communities Network

The Hunter Communities Network submission made comments in relation to a number of issues that have been addressed in detail earlier in this response to submissions report. This included comments relating to:

- the impacts on native vegetation and habitats for threatened species on the Hunter Valley floor

- specific impacts on the *Central Hunter Eucalypt Forest and Woodland CEEC*

- lack of information on proposed biodiversity offsets

- the biodiversity assessment in relation to the SEARs and requirements from the Commonwealth DoEE

- the lack of assessments of significance for threatened species and communities

- the lack of information on survey and assessment methodology

- the lack of identification of existing offsets for the Wambo and United mine.

Responses to these issues are captured in **Sections 3.4.1** to **3.4.3** above.

Other specific issues raised in the submission that have not been responded to above are addressed below.

The proposed biodiversity offsets are not consistent with the NSW Biodiversity Offsets Policy for Major Development (Offsets Policy). Under this policy federally listed CEECs must be offset by 'like-for-like' areas of vegetation. The proposal offsets only 56 ha of 'like-for-like' CEEC. The remainder of the offset is proposed through 312.9 ha of Grassy Box Gum Woodland CEEC which is not 'like-for-like' and 878 ha of rehabilitation.

The entire offset proposal for the impacted CEEC fails to meet the NSW Offsets Policy. The offset proposal also fails to meet the EPBC Act requirement for 'like-for-like' offsets.

As outlined in the EIS, as the Project was assessed under the UHSA, it was therefore not required to be consistent with the *NSW Biodiversity Offsets Policy for Major Projects* (OEH 2014) or the EPBC Act Environmental Offsets Policy (DSEWPC 2012) as the Project is assessed using the Biodiversity Certification Assessment Methodology (BCAM) under Part 10 of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). This is a different assessment and approval path to that outlined in the *NSW Biodiversity Offsets Policy for Major Projects*. However, as also discussed above, as the UHSA process has not yet been finalised by the NSW Government, an assessment under the *NSW Biodiversity Offsets Policy for Major Projects* (the FBA) has also been completed for the Project addressing the concern raised in the submission.

3.4.5 Ryde Hunters Hill Flora and Fauna Preservation Society

The Ryde Hunters Hill Flora and Fauna Preservation Society submission made comments in relation to a number of issues that have been addressed in detail earlier in this response to submissions report. This included comments relating to:

- the clearance of native vegetation and threatened species habitat, including the *Central Hunter Eucalypt Forest and Woodland CEEC*, and
- the use of mine rehabilitation as offsets.

Responses to these issues are captured in **Sections 3.4.1** and **3.4.2** above.

Other specific issues are addressed below.

This [impact] represents major destruction of the State's biodiversity and will destroy the habitat of a range of species including some which are literally "on their last legs" such as the Spotted tailed Quoll. (This species is difficult to breed in captivity and especially reliant on natural habitat areas.)

The spotted-tailed quoll is listed as vulnerable under the NSW *Threatened Species Conservation Act 1995* (TSC Act) and endangered under the Commonwealth EPBC Act. Under the Threatened Species Conservation Regulation 2010, a vulnerable species is facing a high risk of extinction in NSW in the medium-term future. Under the EPBC Act, an endangered species is a species facing a very high risk of extinction in the wild in the near future.

Regarding the habitats of the spotted-tailed quoll, as outlined in the recently published recovery plan for the species (DELWP 2016), the spotted-tailed quoll, while a primarily forest-dependent species, occupies a wide range of habitat types including rainforest, wet and dry sclerophyll forest, coastal heathland, scrub and dunes, woodland, heathy woodland, swamp forest, mangroves, on beaches and sometimes in grasslands or pastoral areas adjacent to forested areas. The species can occupy home ranges of several hundred to several thousand hectares in size (DELWP 2016).

A single spotted-tailed quoll (*Dasyurus maculatus maculatus*) was recorded by a remote camera in 2013 during pest management surveys by United environmental staff. Despite targeted surveys undertaken in February and March 2013 and March 2014 the species was not re-recorded on the site. It is likely that the additional disturbance area forms part of a large home range area for one or a small number of spotted-tailed quolls that forage within in the additional disturbance area on an occasional basis as part of a local population occurring in the Wollemi National Park.

Habitat that is critical to the survival of the species includes large patches of forest with adequate denning resources and relatively high densities of medium-sized mammalian prey (DELWP 2016). No denning resources (such as rock crevices, large hollow logs, caves, boulder tumbles and underground burrows) are known to occur in the disturbance area.

Section 13.0 of the Statement of Consistency report outlines the proposed offset strategy for the Project which includes substantial areas of woodland and forested habitats suitable for the spotted-tailed quoll.

It should be noted that under both the UHSA and the FBA, the spotted-tailed quoll is an ecosystem-credit species and does not generate credits specifically for the species. However its habitat is modelled to co-occur with certain plant community types (PCTs) and for those its presence contributes towards the generation of credit requirements.

The BAR (FBA) report also includes a further discussion on the quoll including outlining the offsetting outcomes for the species, indicating that a substantial offset is provided that is several times larger than the area impacted by the Project.

3.4.6 National Parks Association of NSW

The National Parks Association of NSW submission raised issues in relation to:

- the clearance of native vegetation, including the *Central Hunter Eucalypt Forest and Woodland CEEC*
- the loss of habitat for threatened fauna species, and
- the adequacy of the proposed offset strategy particularly in relation to the use of mine rehabilitation.

Responses to these issues are captured in **Sections 3.4.1** and **3.4.2** above.

3.4.7 Community Submissions

Forty-one community submissions included commentary on the impacts of the Project in relation to biodiversity. The majority of these submissions were opposed to the Project based on the potential ecological impacts. A number of the community submissions raised issues that were the same as the issues raised in the NGO submissions relating to biodiversity. The issues raised in the community submissions are outlined below with some example quotes provided:

- the clearance of native vegetation, including the *Central Hunter Eucalypt Forest and Woodland CEEC*

  'It is outrageous that an irreplaceable Critically Endangered Ecological Community (CEEC) is to be cleared for coal extraction for private gain. This is so clearly not in the public interest. Development consent most properly must be refused. The impact of the proposal on EPBC Act listed CEEC Central Hunter Valley Eucalypt Forest cannot be offset'.

- the loss of habitat for threatened fauna species, including the spotted-tailed quoll

  'Threatened Species such as the Spotted-tailed Quoll, Regent Honeyeater and Swift Parrot will lose important habitat if this project proceeds. These species are already in severe trouble and any further loss of habitat will drive them towards extinction'.

- inadequacy of the offset package

  'The proponent is offering a 'biodiversity offset' package that will protect the equivalent of just 7% of the bulldozed area of this community protection in existing woodland. In contrast 56% of the offset requirement is proposed to be met through future mine rehabilitation. This is a clear violation of the 25% limit on meeting offset obligations through mine rehab promises, and is a clear indication that impacts on this community cannot be offset and the mine should be refused consent'.

  'In addition the whole concept of 'biodiversity offsets' is ridiculous and should be scrapped as a condition - if biodiversity is harmed we need to recognise we may have to wear that harm forever. The decision should be made acknowledging that rather than pretending it's not the case'.

- the inappropriate use of mine rehabilitation as offsets

  'This project will clear 464ha of vegetation, with 56% of the offset requirement met through future mine rehabilitation'.

- supposed inconsistency with the NSW biodiversity policy, and

  'Biodiversity offsets are inconsistent with the NSW biodiversity policy'.

- the lack of transparency in the assessment process (i.e. Upper Hunter Strategic Assessment)

  'The thing that I am most outraged by is the proponent's reliance in part on the Upper Hunter Assessment Strategy, which has not yet been released'.

Each of the above issues has been addressed in detail above as these issues were all raised in the NGO submissions. Responses to these issues are therefore provided in **Sections 3.3** to **3.4.5** above.

4.0 Additional Environmental Management and Mitigation Measures

Section 8.0 of the EIS included a summary of all the proposed environmental management and monitoring measures for the Project. As a result of submissions received on the EIS, United has committed to additional environmental management and monitoring measures and refined some of the measures outlined in the EIS in this response to submissions (Part B). These additional or refined measures are outlined below.

Water Resources

- Additional monitoring of metals/metalloids within both the WMS and the downstream receiving environment, as well as setting triggers for pH will be undertaken on an ongoing basis. This includes water quality monitoring for EC, pH and key AMD indicators. These include sulphate and key metals (Al, As, Co, Cu, Fe, Mn, Ni, Se and Zn), which are already captured within the proposed monitoring program for the Project.

- Ongoing monitoring of the leachate generated from the waste emplacements will be undertaken and will include:

  - pH
  - salinity (EC)
  - TSS
  - Sulphate
  - acidity/alkalinity.

  Follow up elemental testing will be undertaken if any low pH conditions are detected to ensure that key water quality parameters remain within appropriate criteria.

Tailings Management Plan

- To mitigate potential impacts due to PAF and PAF-UC results for certain coal seams, a tailings management plan will be developed for the Project. The plan will include monitoring and management of tailings slurry to help maintain NAF conditions. The plan will draw on findings by GeoTerra (2017) and be prepared in consultation with relevant regulators.

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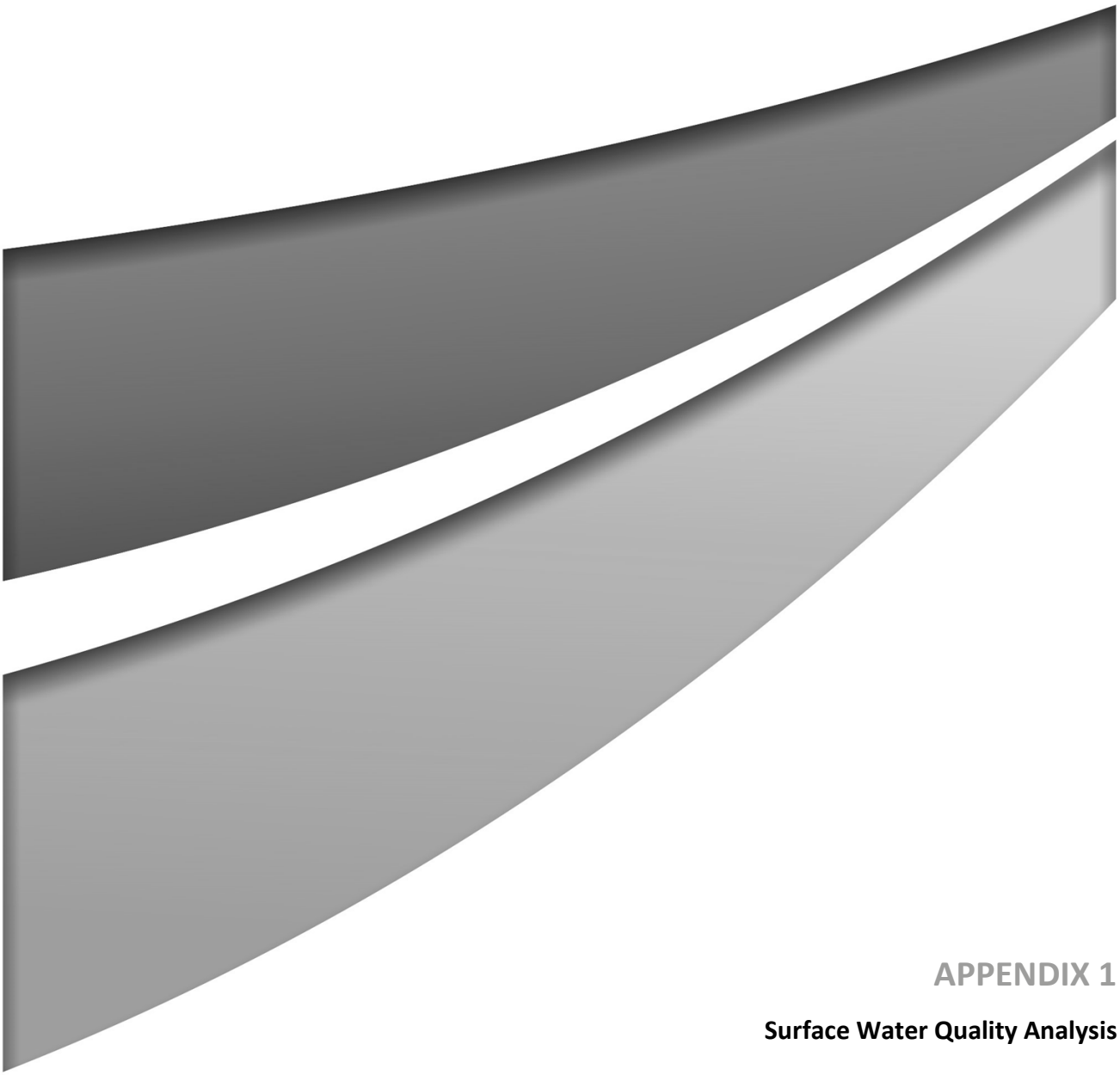
Water Research Laboratory 1996, *Flooding in Wollombi Brook,* prepared for SKM



APPENDIX 1

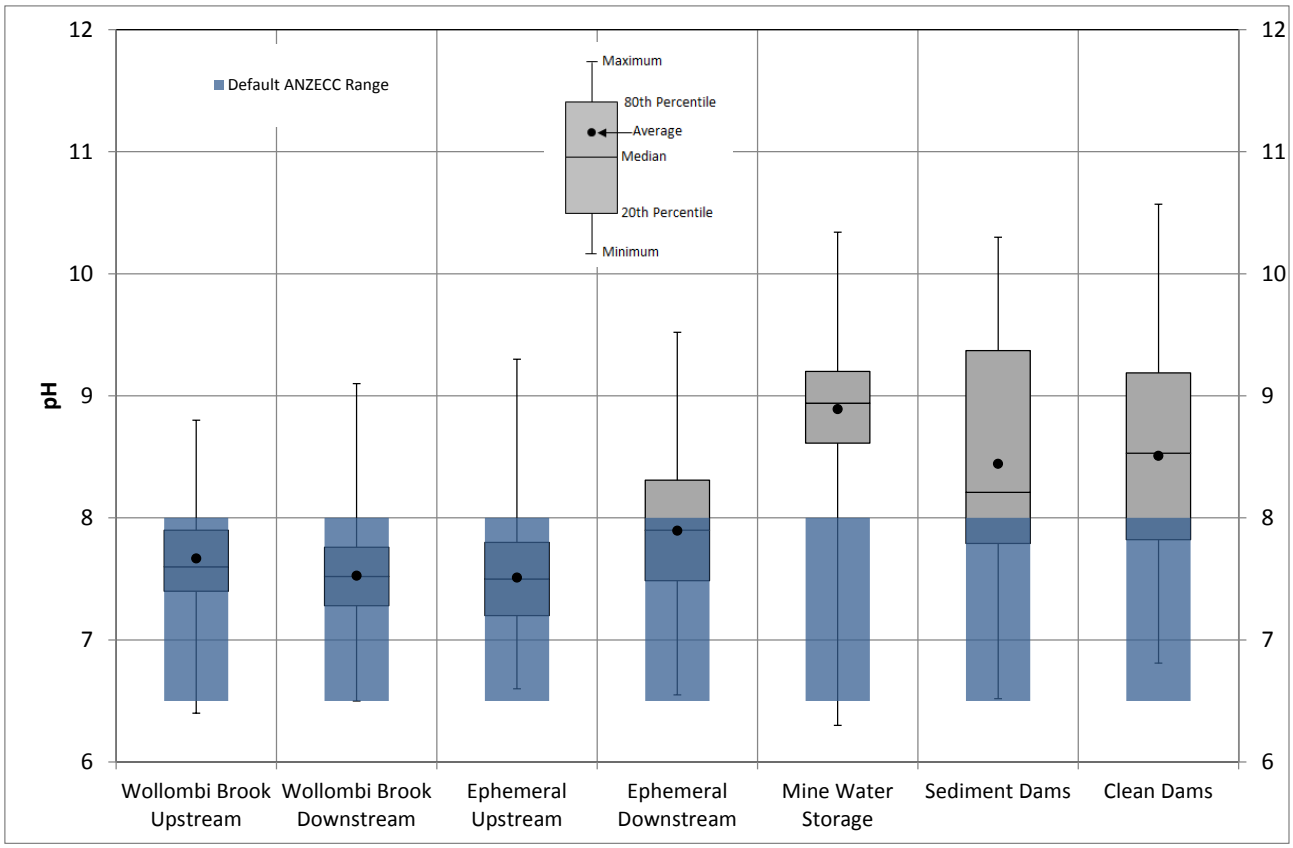
Surface Water Quality Analysis

1.0 Surface Water Quality

1.1 Water Quality Analysis

1.1.1 pH

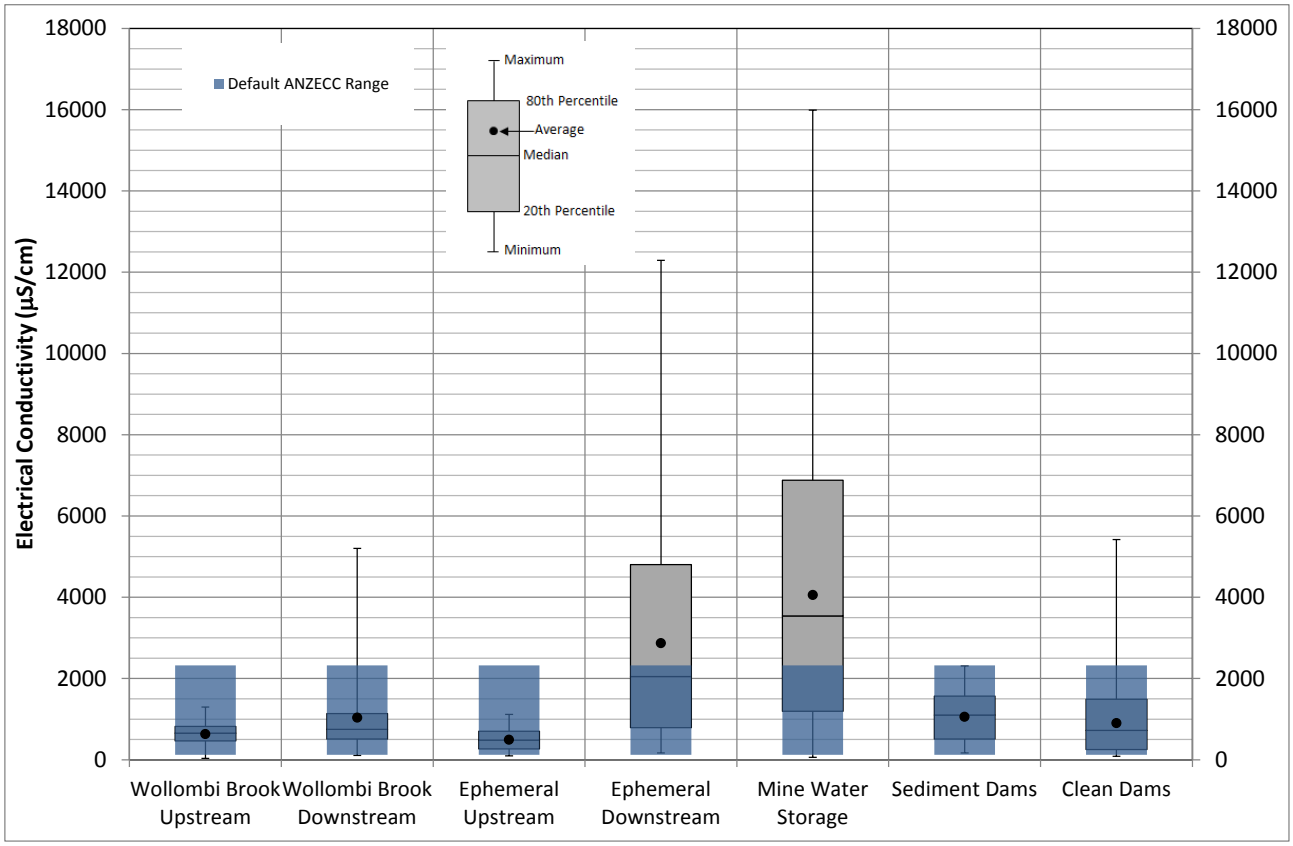
A statistical analysis of the pH of receiving waters (Wollombi Brook and Ephemeral Creeks), mine water storages, sediment dams and clean dams is presented in **Graph 1.1**. The analysis was undertaken using recent and historical water quality monitoring data for 19 receiving water monitoring locations, 21 mine water storages, three sediment dams (dirty water) and four clean water dams.



Graph 1.1 Statistical Water quality analysis - pH

1.1.2 EC

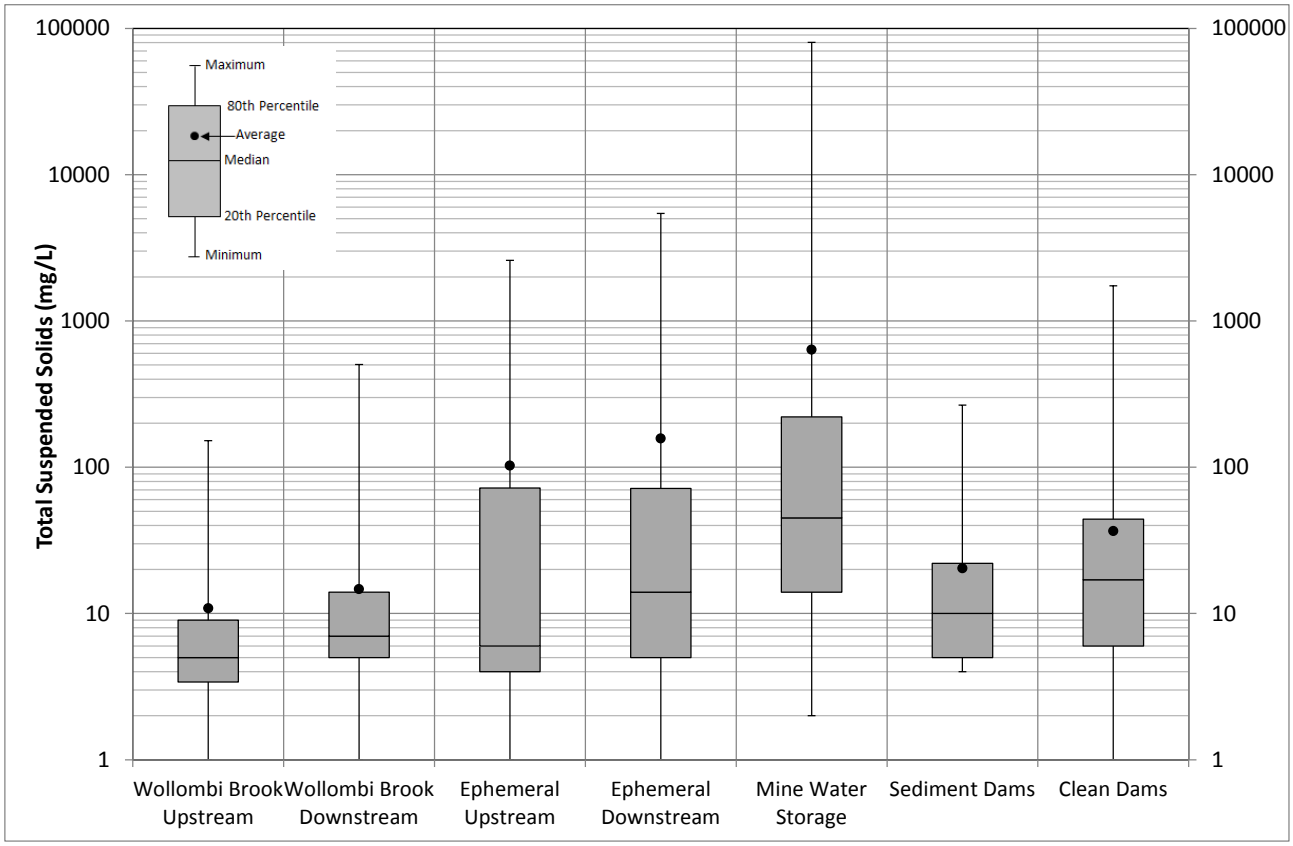
A statistical analysis of the electrical conductivity (EC) of receiving waters (Wollombi Brook and Ephemeral Creeks), mine water storages, sediment dams and clean dams is presented in **Graph 1.2**. The analysis was undertaken using recent and historical water quality monitoring data for 19 receiving water monitoring locations, 21 mine water storages, three sediment dams (dirty water) and four clean water dams.



Graph 1.2 Statistical Water quality analysis - EC

1.1.3 TSS

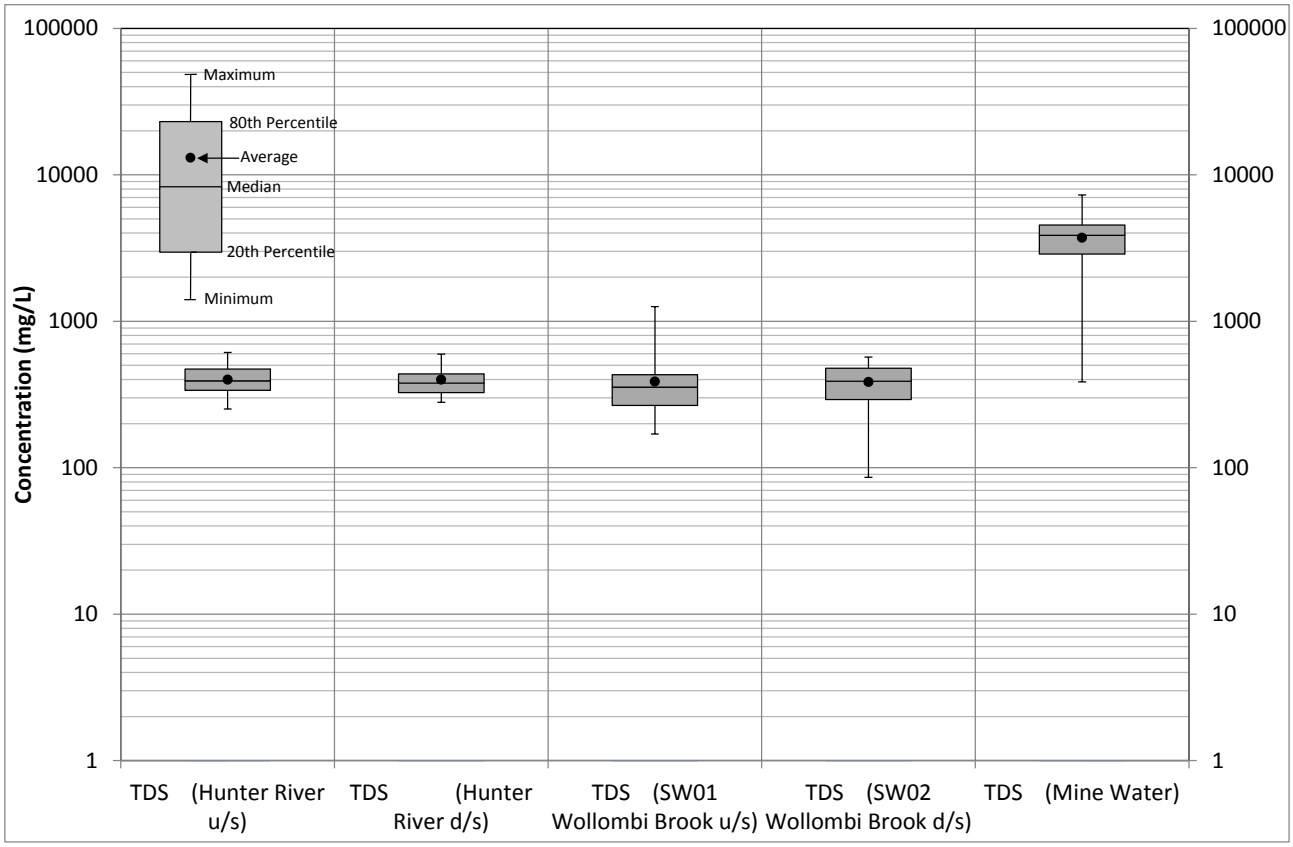
A statistical analysis of the total suspended solids (TSS) of receiving waters (Wollombi Brook and Ephemeral Creeks), mine water storages, sediment dams and clean dams is presented in **Graph 1.3**. The analysis was undertaken using recent and historical water quality monitoring data for 19 receiving water monitoring locations, 21 mine water storages, three sediment dams (dirty water) and four clean water dams. There is no ANZECC default trigger value for TSS.



Graph 1.3 Statistical Water quality analysis – TSS

1.1.4 TDS

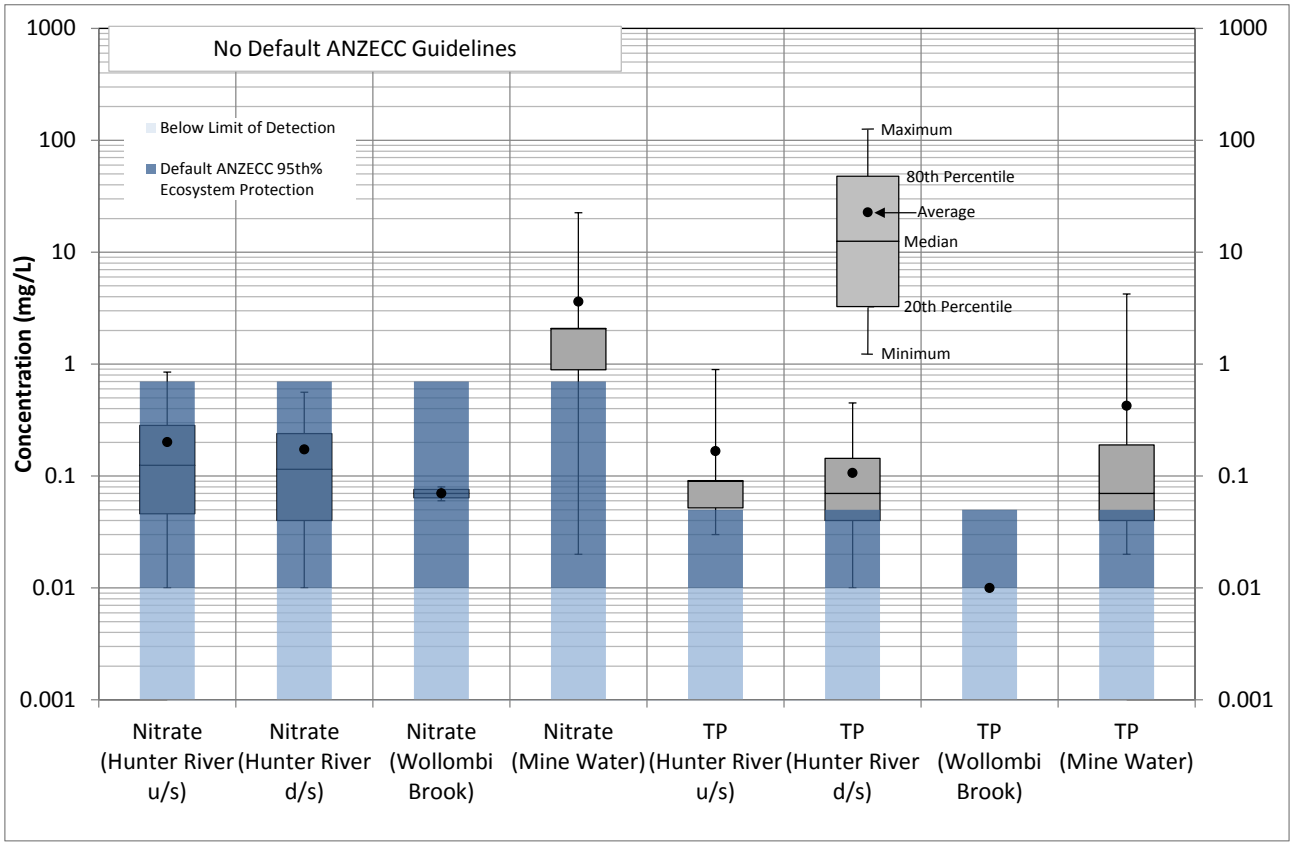
A statistical analysis of the total dissolved solids of receiving waters (Wollombi Brook and Ephemeral Creeks), mine water storages, sediment dams and clean dams is presented in **Graph 1.4**. The analysis was undertaken using recent and historical water quality monitoring data for four receiving water monitoring locations and six mine water storages. There is no ANZECC default trigger value for TDS.



Graph 1.4 Statistical Water quality analysis - TDS

1.1.5 Nutrients

A statistical analysis of the nutrient concentrations (nitrate and total phosphorus) of receiving waters (Wollombi Brook and Ephemeral Creeks), mine water storages, sediment dams and clean dams is presented in **Graph 1.5**. The analysis was undertaken using recent and historical water quality monitoring data for 19 receiving water monitoring locations, 21 mine water storages, three sediment dams (dirty water) and four clean water dams.



Graph 1.5 Statistical Water quality analysis – Nitrate and Total Phosphorus

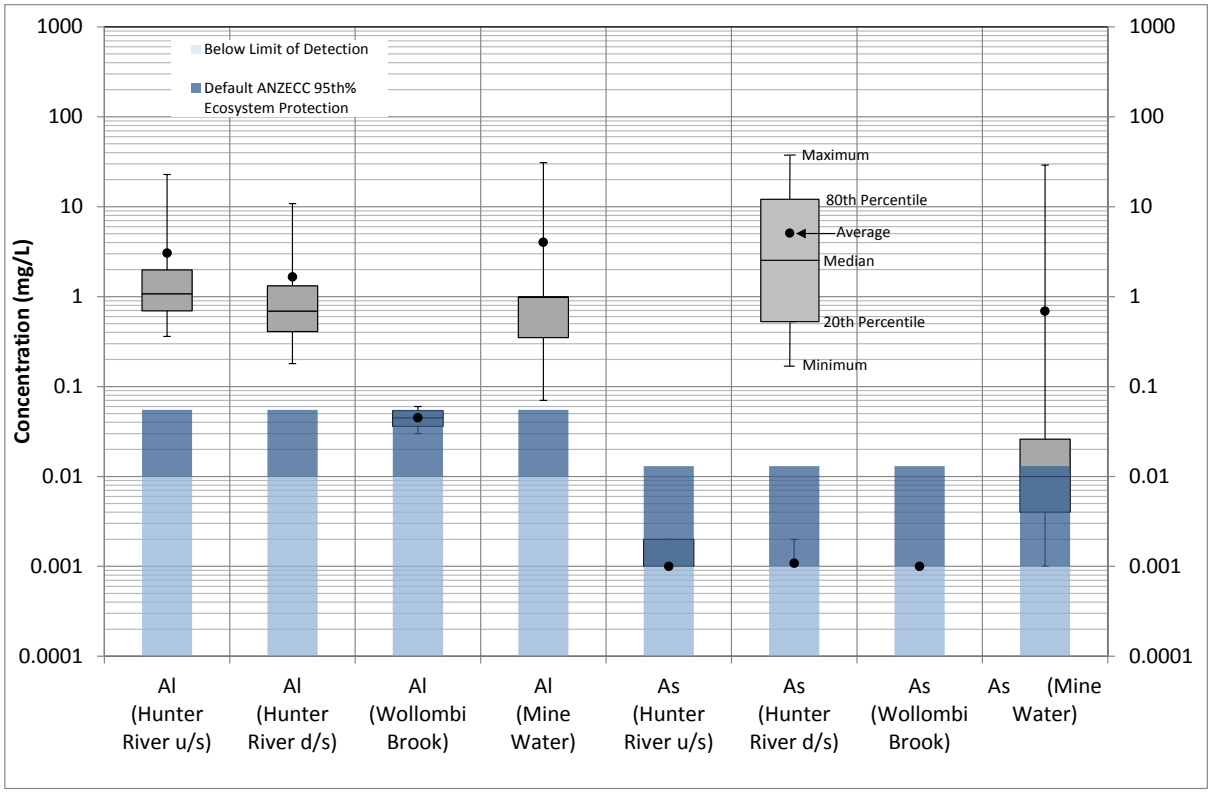
1.1.6 Metals

A statistical analysis of the total concentrations of metals within receiving waters (the Hunter River, Wollombi Brook and Ephemeral Creeks) and mine water storages is presented in **Graphs 1.6** to **1.12**. The analysis was undertaken using recent and historical water quality monitoring data for 6 receiving water monitoring locations and 6 mine water storages.

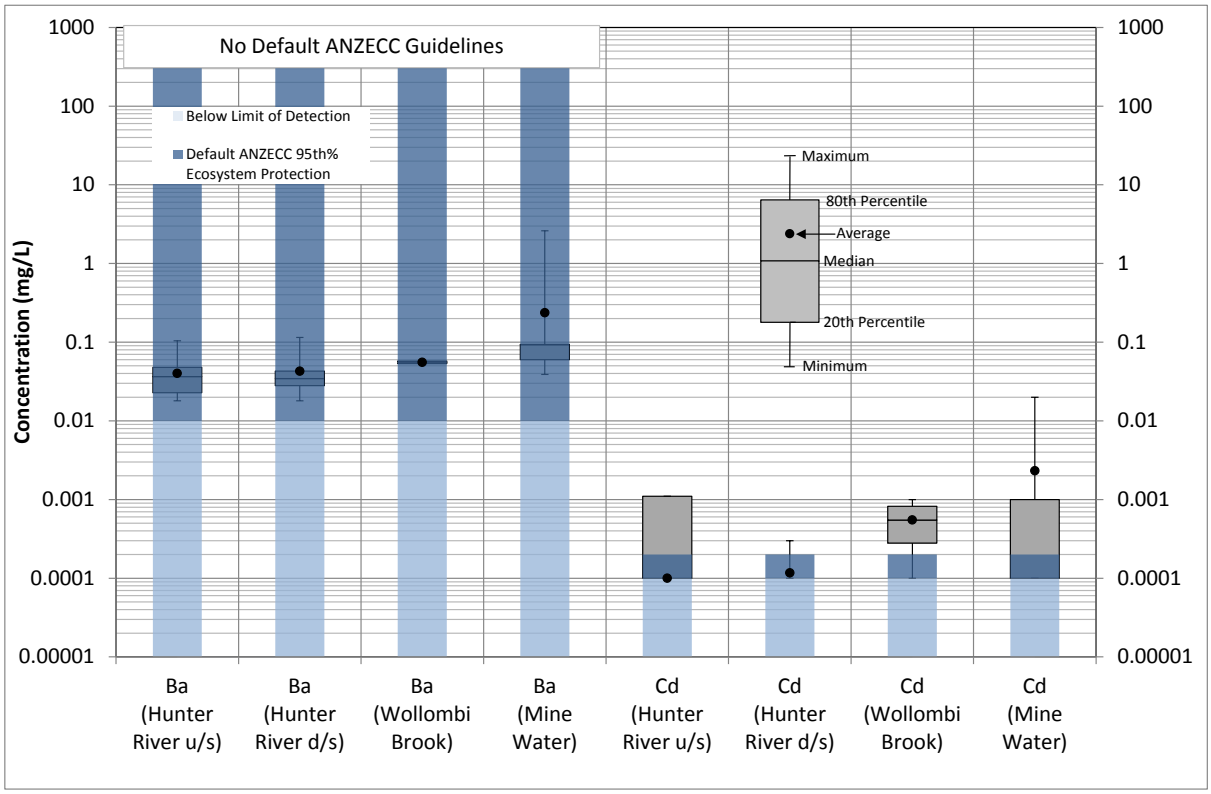
Table 1.1 presents the number of water quality results for each analyte that were available to include in the box and whisker plot analysis.

Table 1.1 Summary of data counts

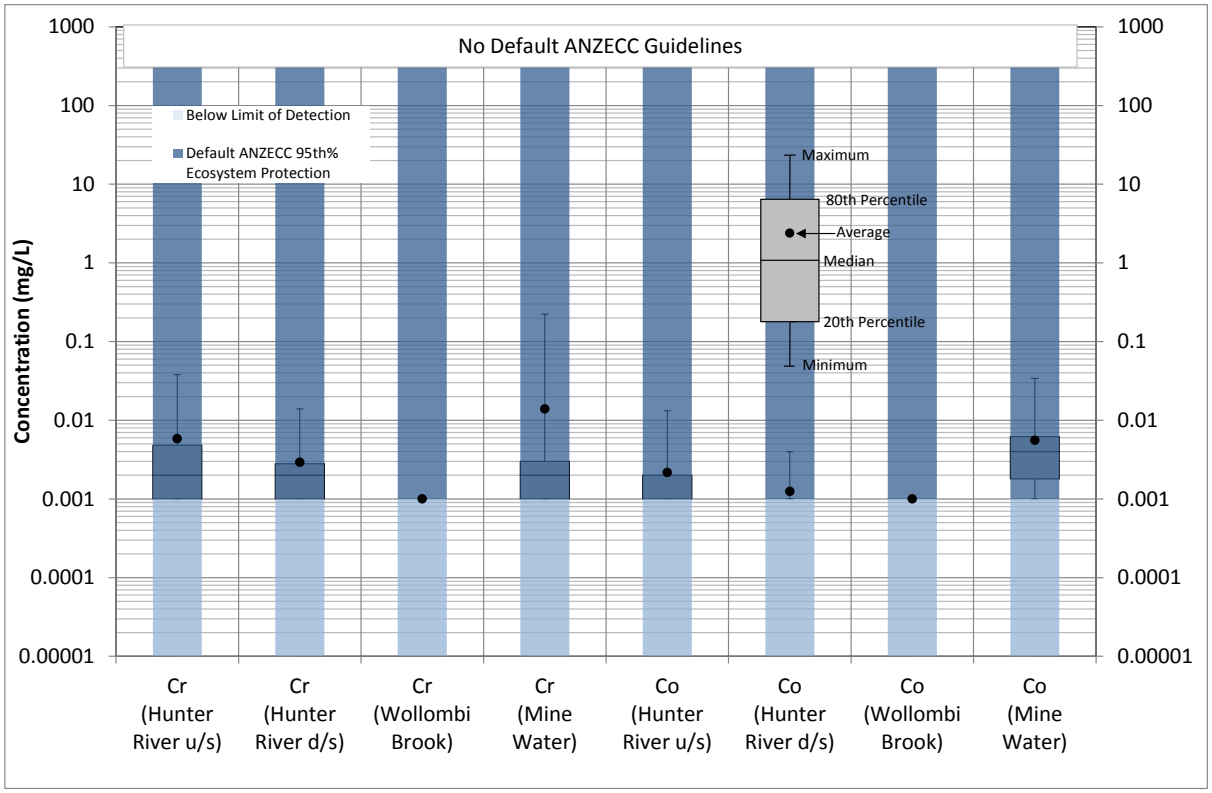
Analyte	Hunter River u/s	Hunter River d/s	Wollombi Brook	Mine Water
Al	12	12	2	26
As	12	12	2	79
Ba	12	12	2	26
Cd	12	12	2	79
Cr	12	12	2	76
Co	12	12	2	25
Cu	12	12	2	76
Fe	12	12	2	25
Hg	12	12	2	12
Se	12	12	2	26
Pb	12	12	2	79
Mn	12	12	2	26
Zn	12	12	2	75
Nitrate	12	12	2	26
TP	12	12	2	26
TDS	12	12	69	20



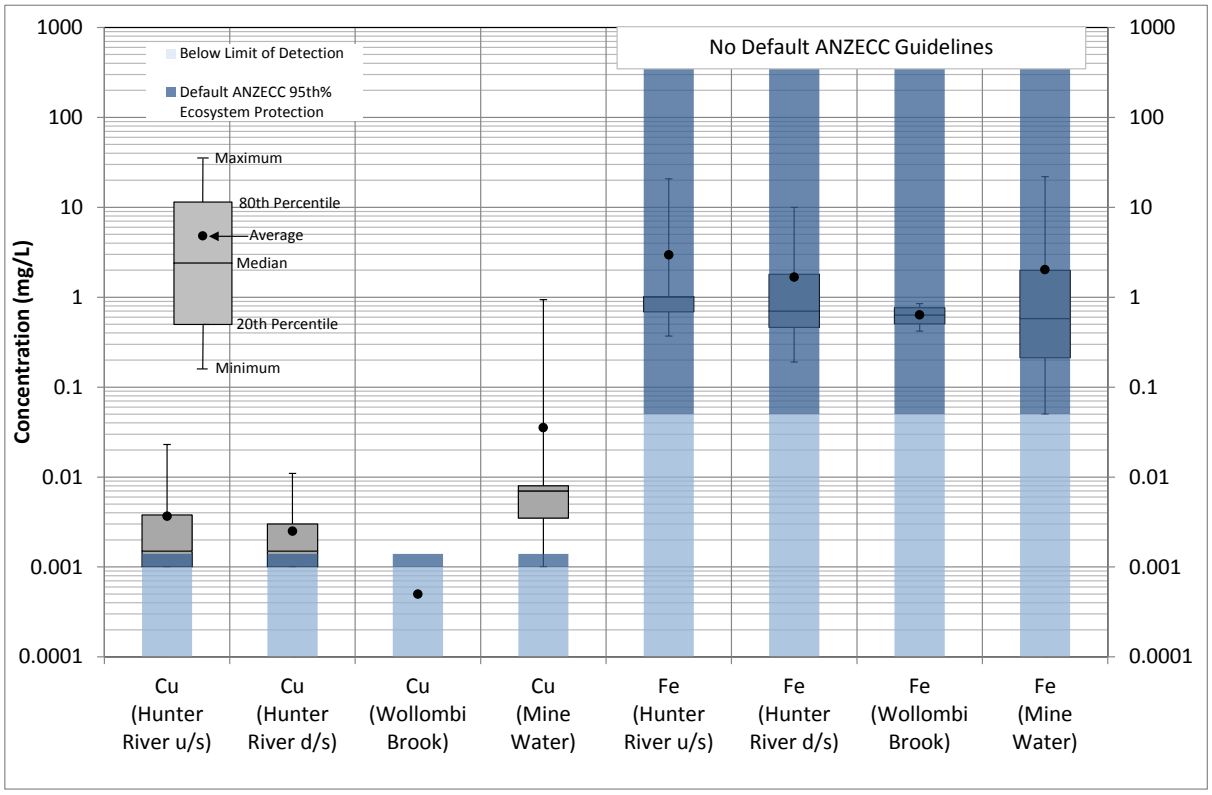
Graph 1.6 Statistical Water quality analysis – Aluminium and Arsenic



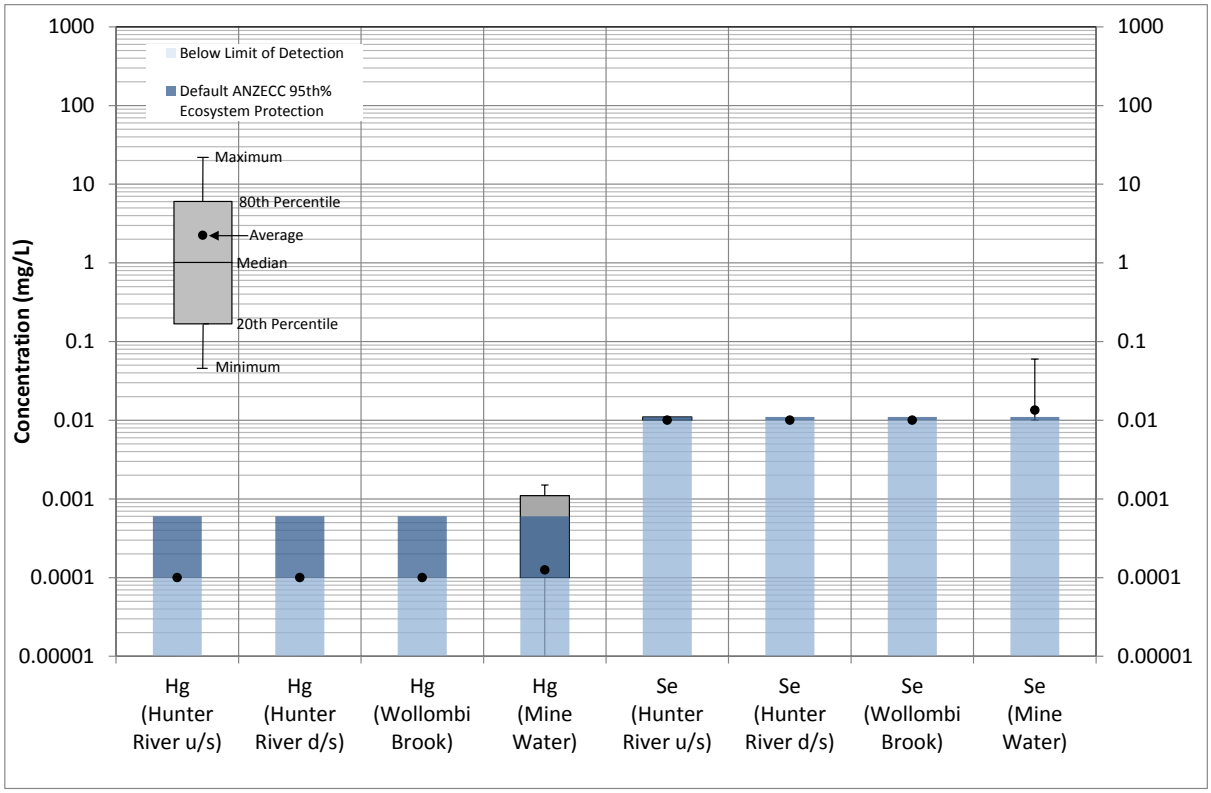
Graph 1.7 Statistical Water quality analysis – Barium and Cadmium



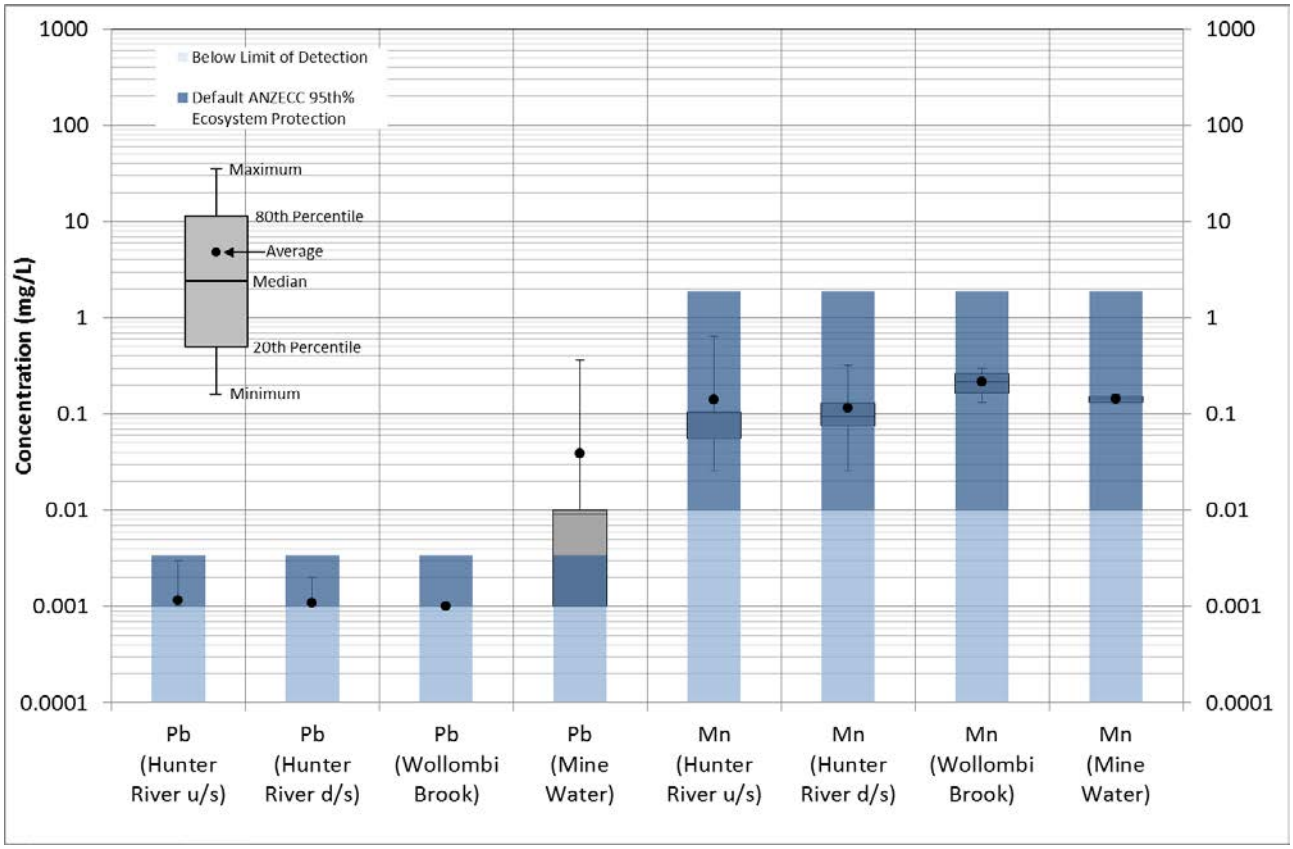
Graph 1.8 Statistical Water quality analysis – Chromium and Cobalt



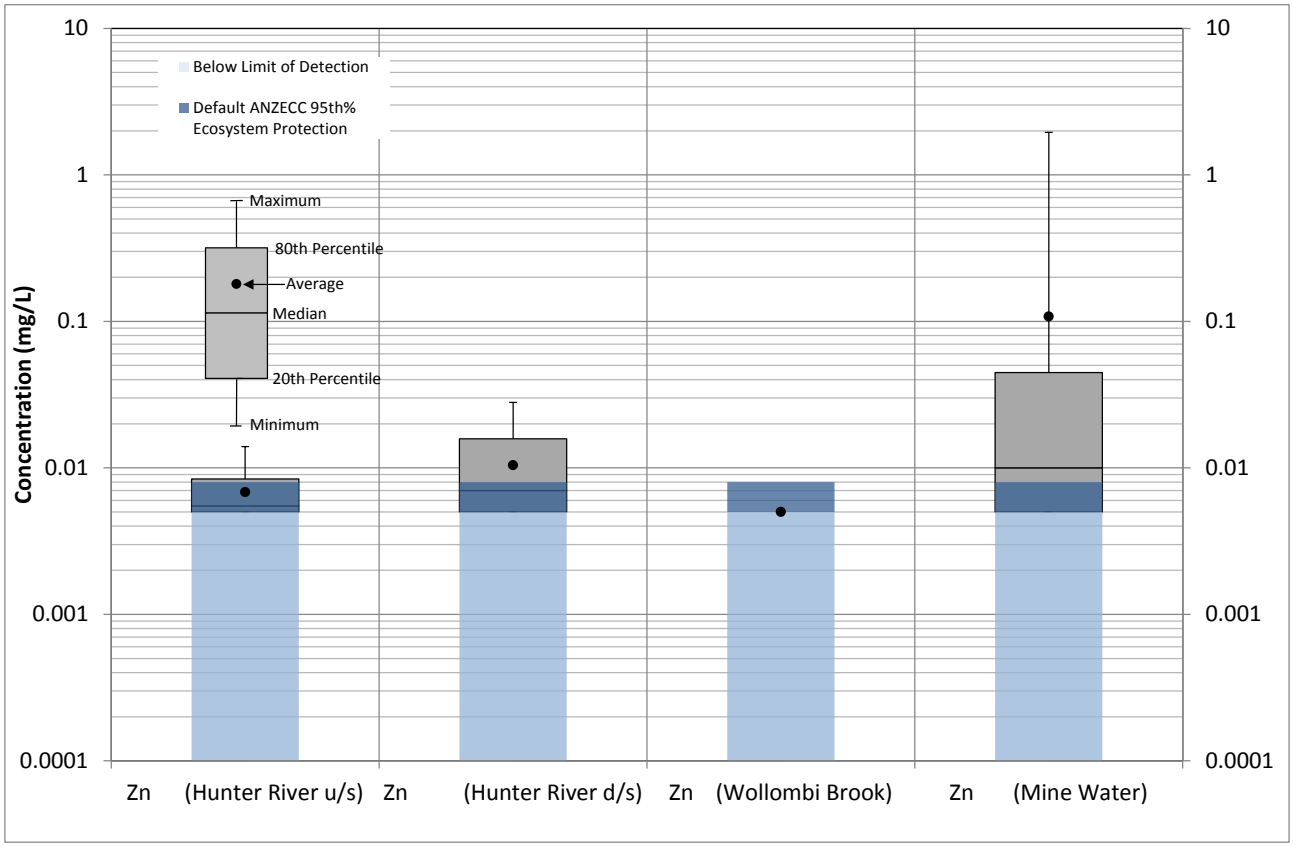
Graph 1.9 Statistical Water quality analysis – Copper and Iron



Graph 1.10 Statistical Water quality analysis – Mercury and Selenium



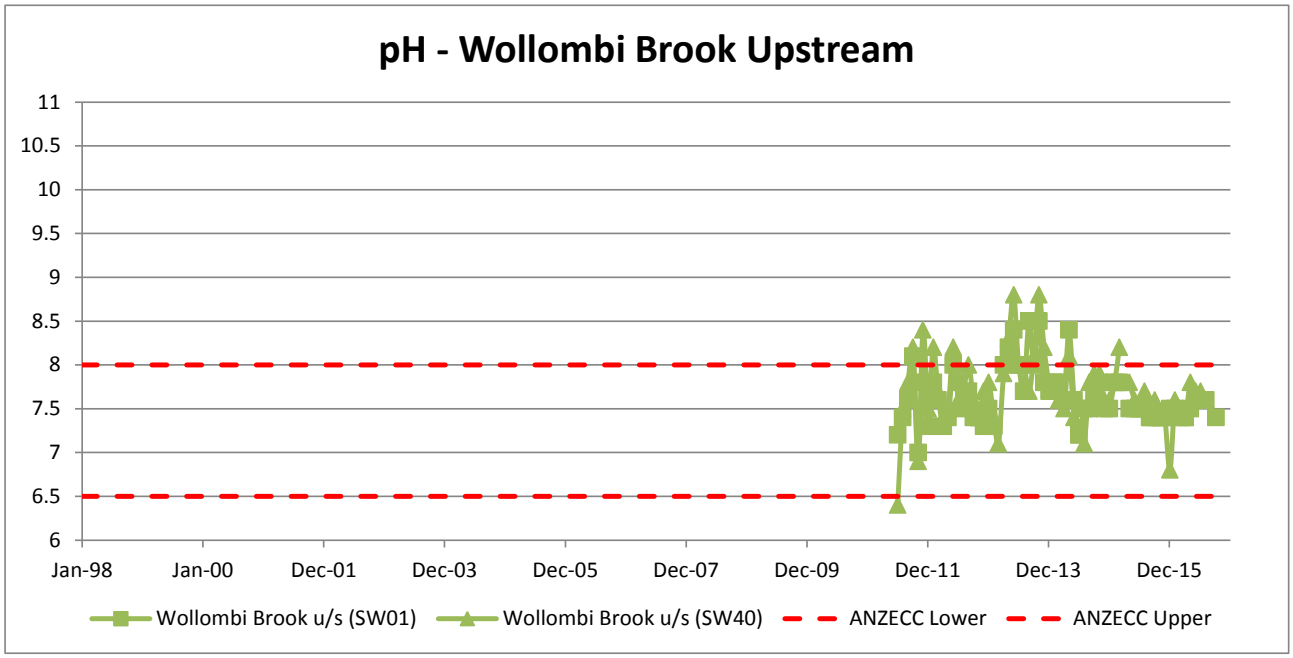
Graph 1.11 Statistical Water quality analysis – Lead and Manganese



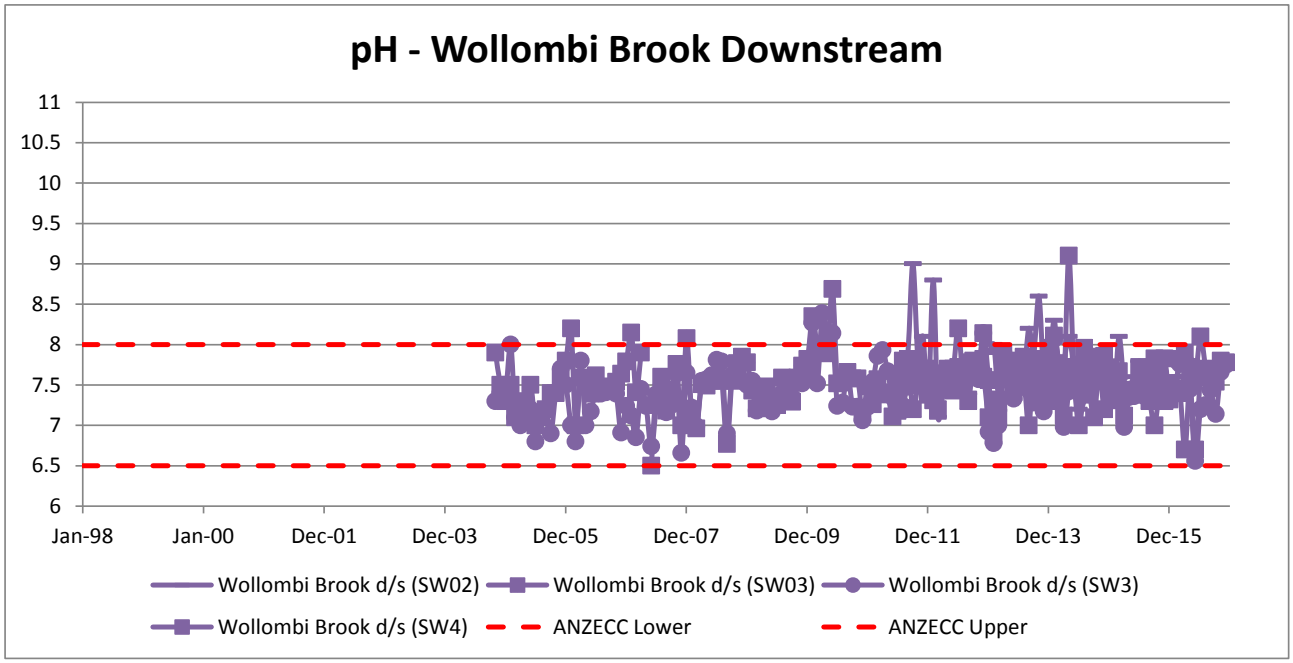
Graph 1.12 Statistical Water quality analysis – Zinc

1.2 Wollombi Brook

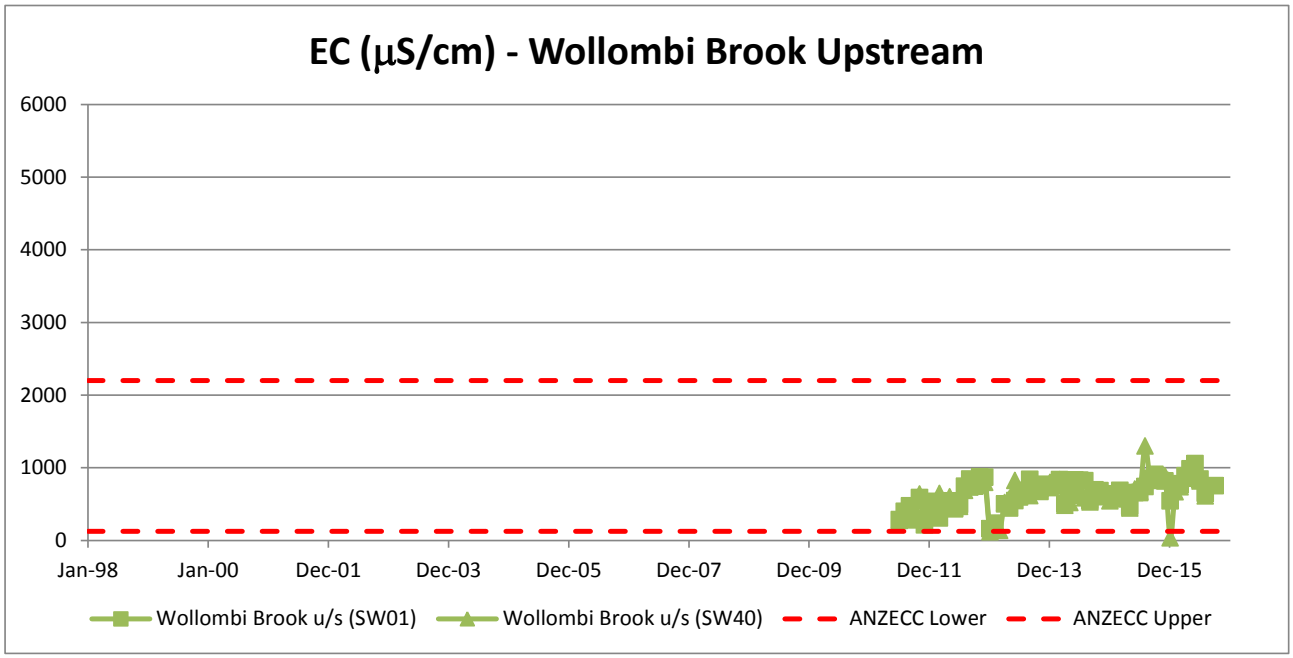
1.2.1 pH



Graph 1.13 Temporal distribution of pH data for Wollombi Brook Upstream of the Project

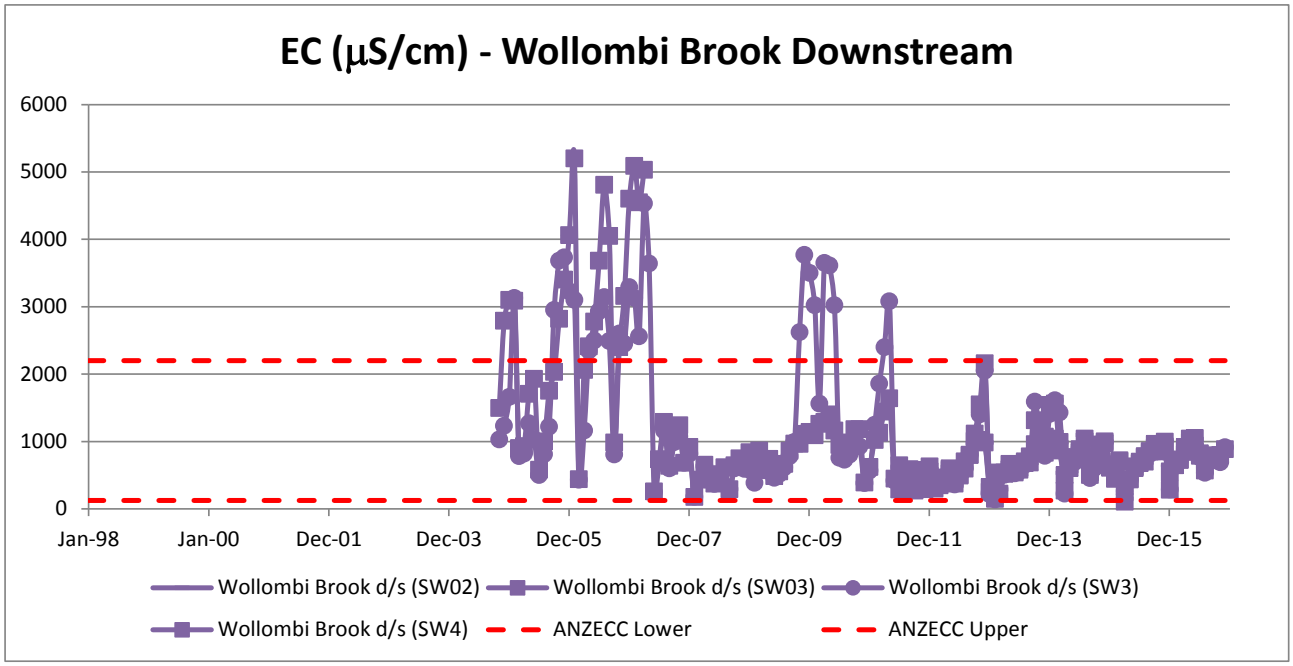


Graph 1.14 Temporal distribution of pH data for Wollombi Brook Downstream of the Project



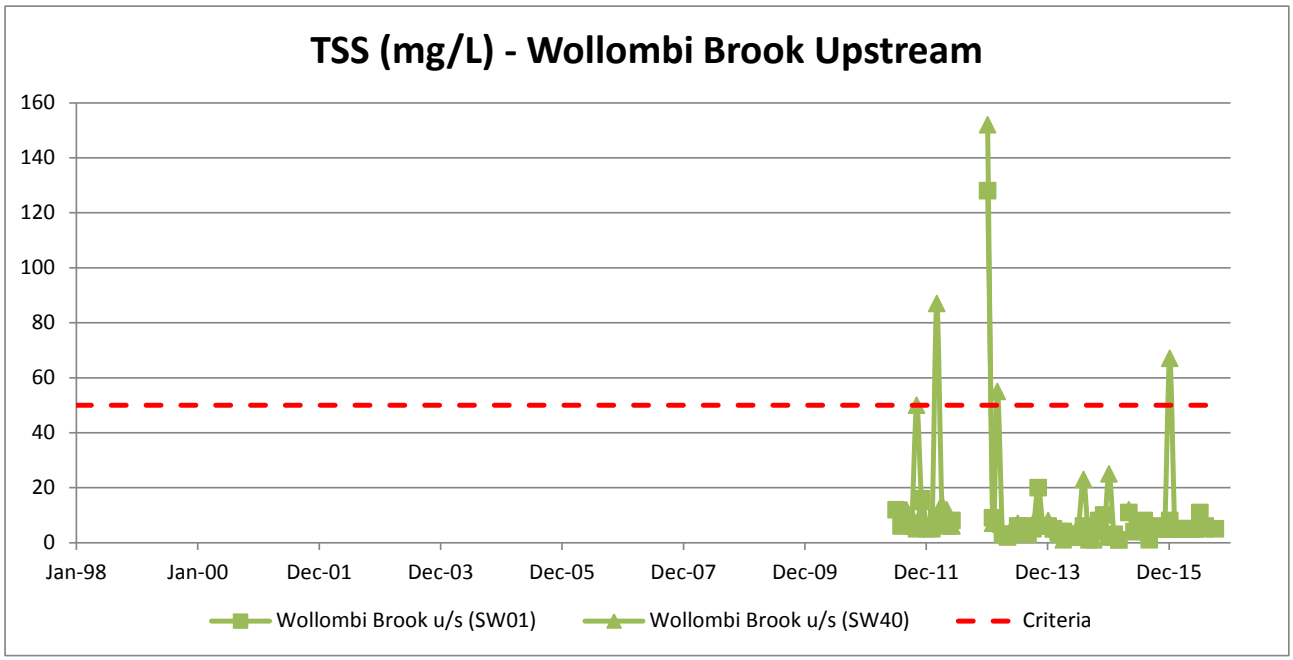
1.2.2 EC

Graph 1.15 Temporal distribution of EC data for Wollombi Brook Upstream of the Project

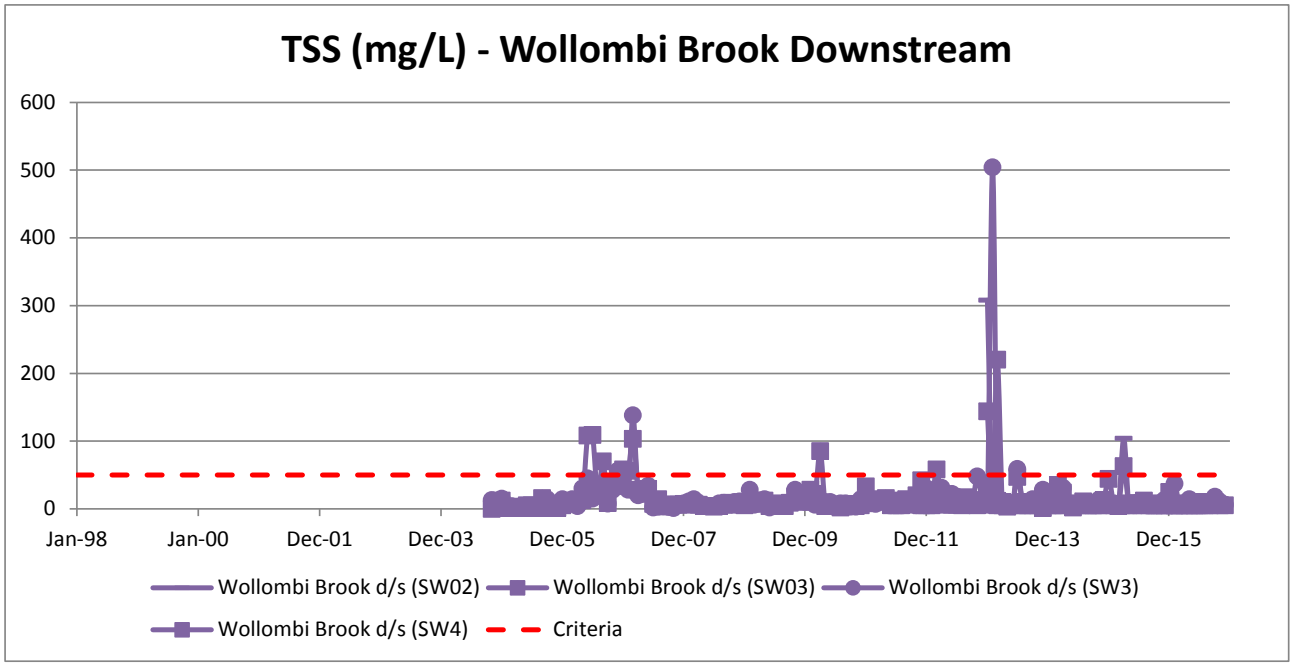


Graph 1.16 Temporal distribution of EC data for Wollombi Brook Downstream of the Project

1.2.3 TSS



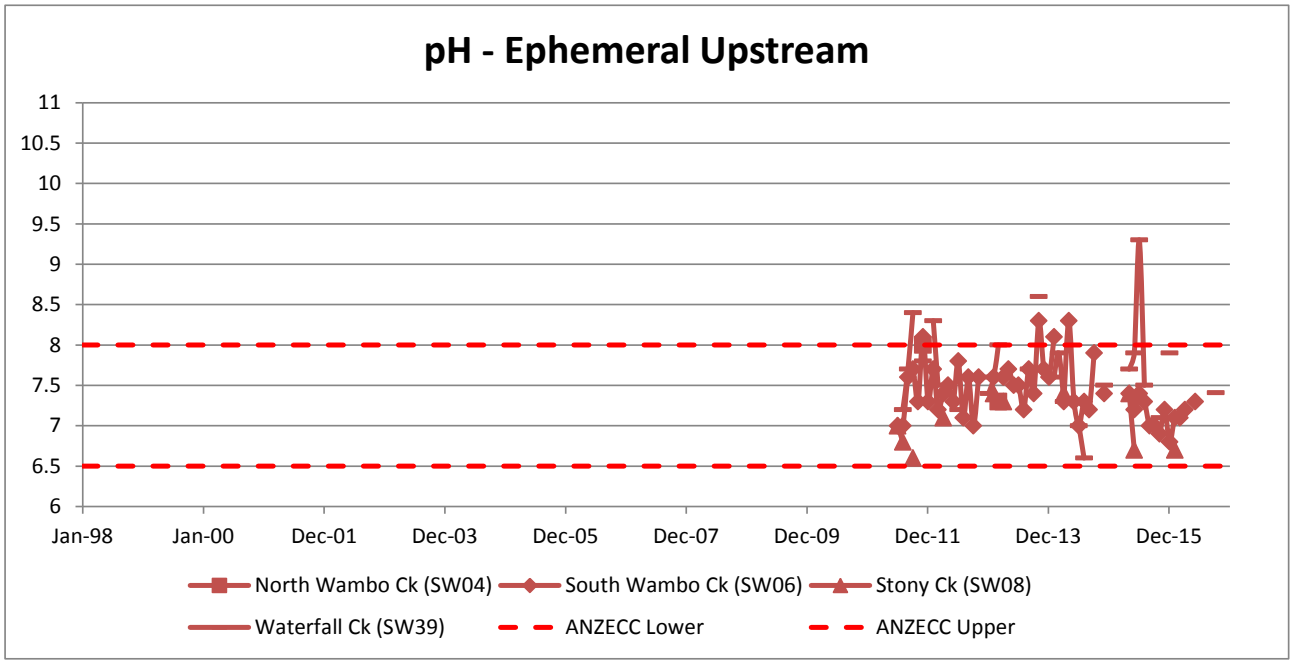
Graph 1.17 Temporal distribution of TSS data for Wollombi Brook Upstream of the Project



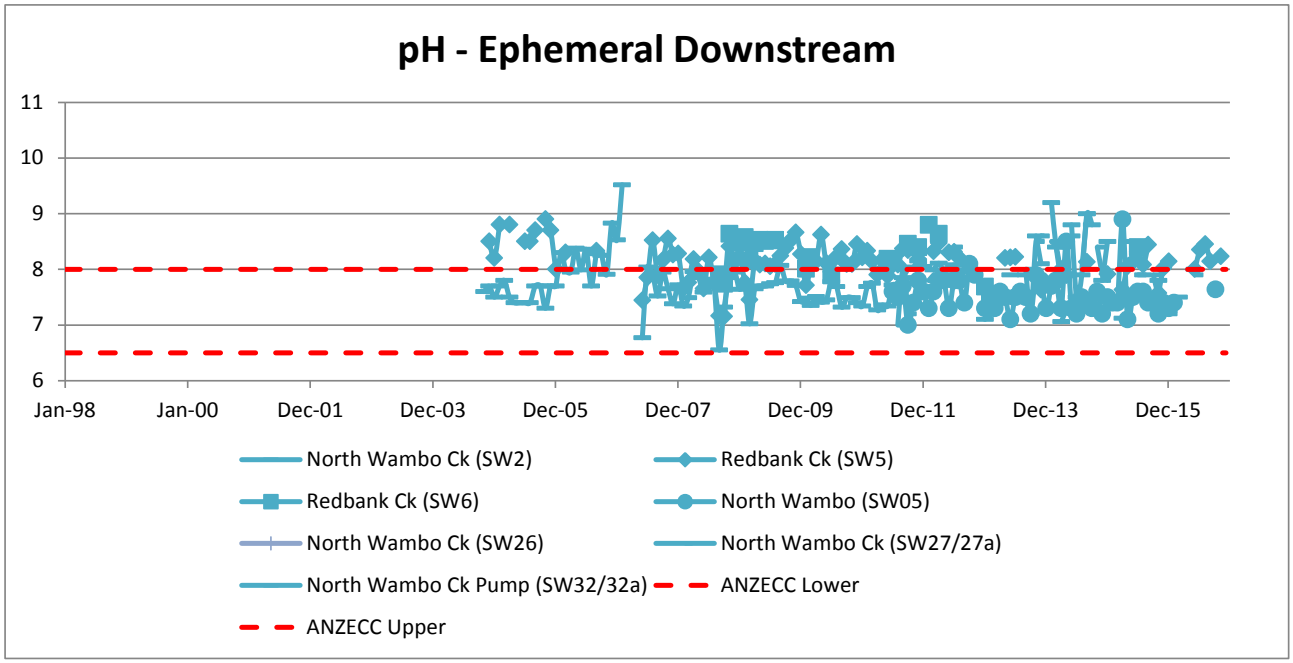
Graph 1.18 Temporal distribution of TSS data for Wollombi Brook Downstream of the Project

1.3 Ephemeral

1.3.1 pH

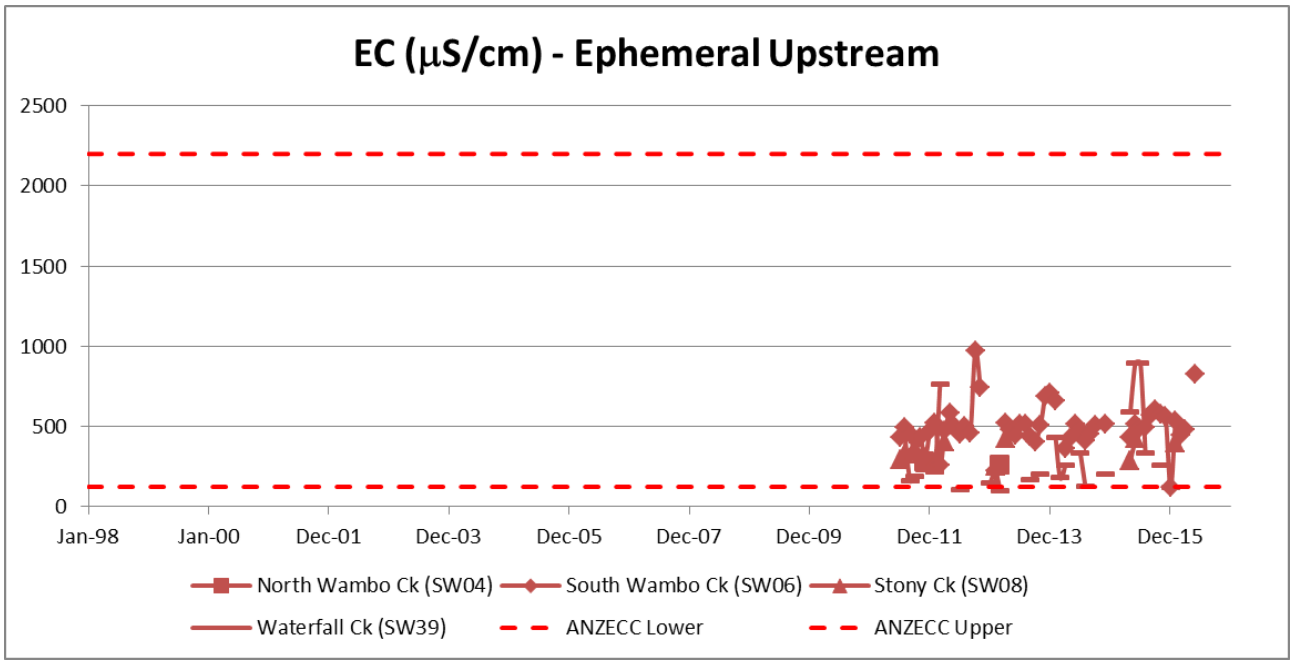


Graph 1.19 Temporal distribution of pH data for Ephemeral Streams Upstream of the Project

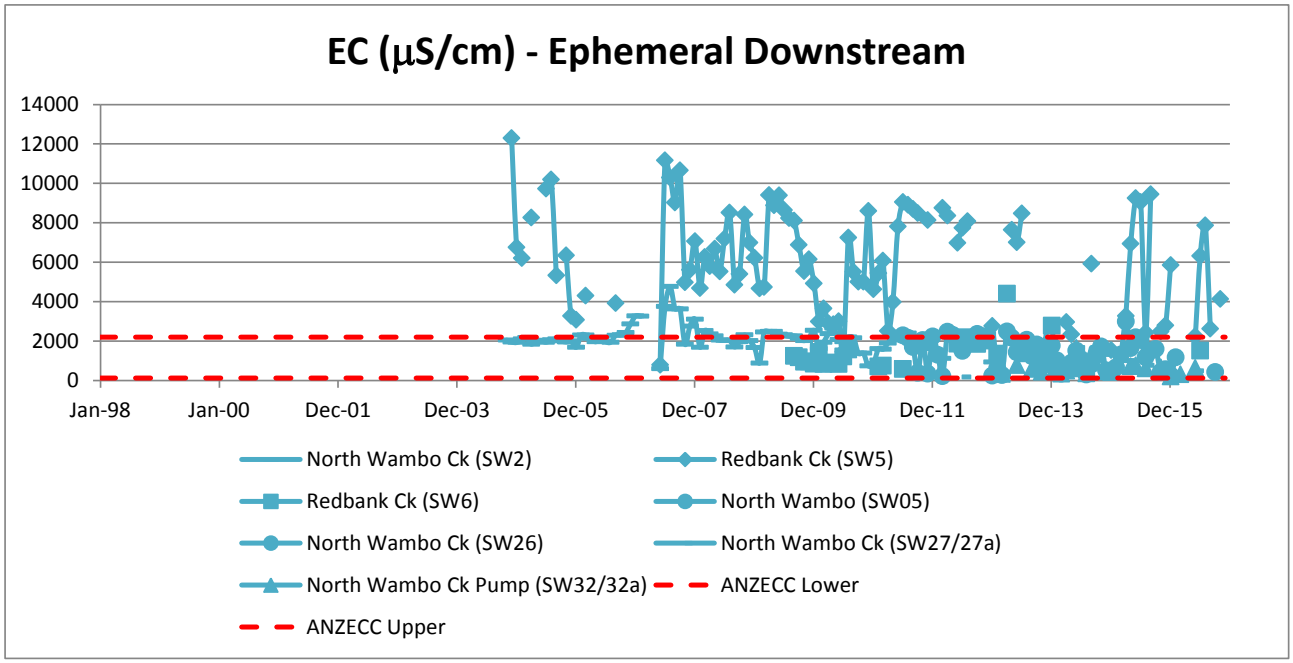


Graph 1.20 Temporal distribution of pH data for Ephemeral Streams downstream of the Project

1.3.2 EC

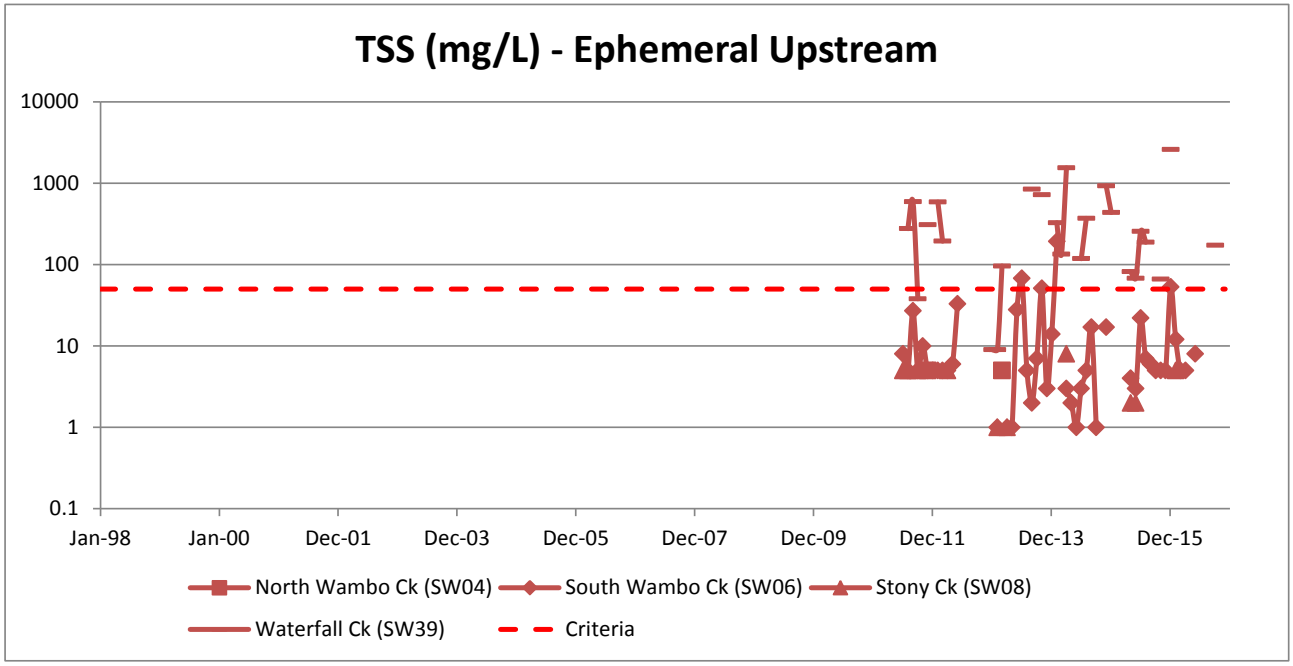


Graph 1.21 Temporal distribution of EC data for Ephemeral Streams Upstream of the Project

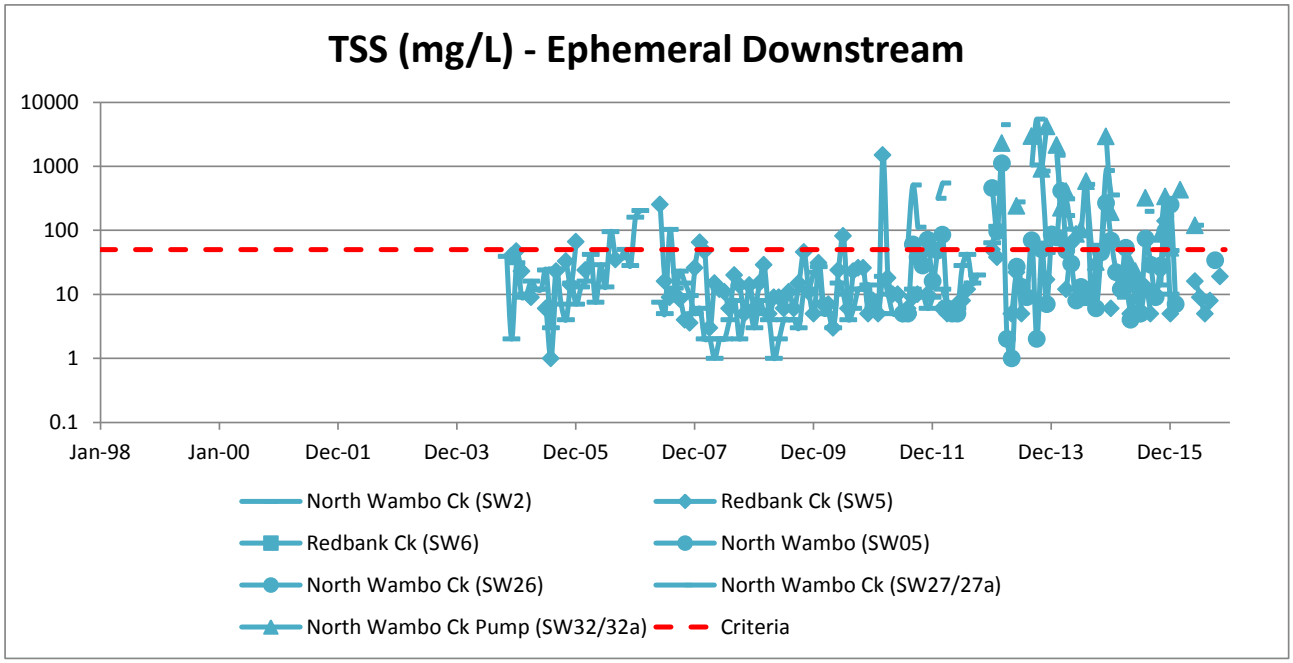


Graph 1.22 Temporal distribution of EC data for Ephemeral Streams Downstream of the Project

1.3.3 TSS



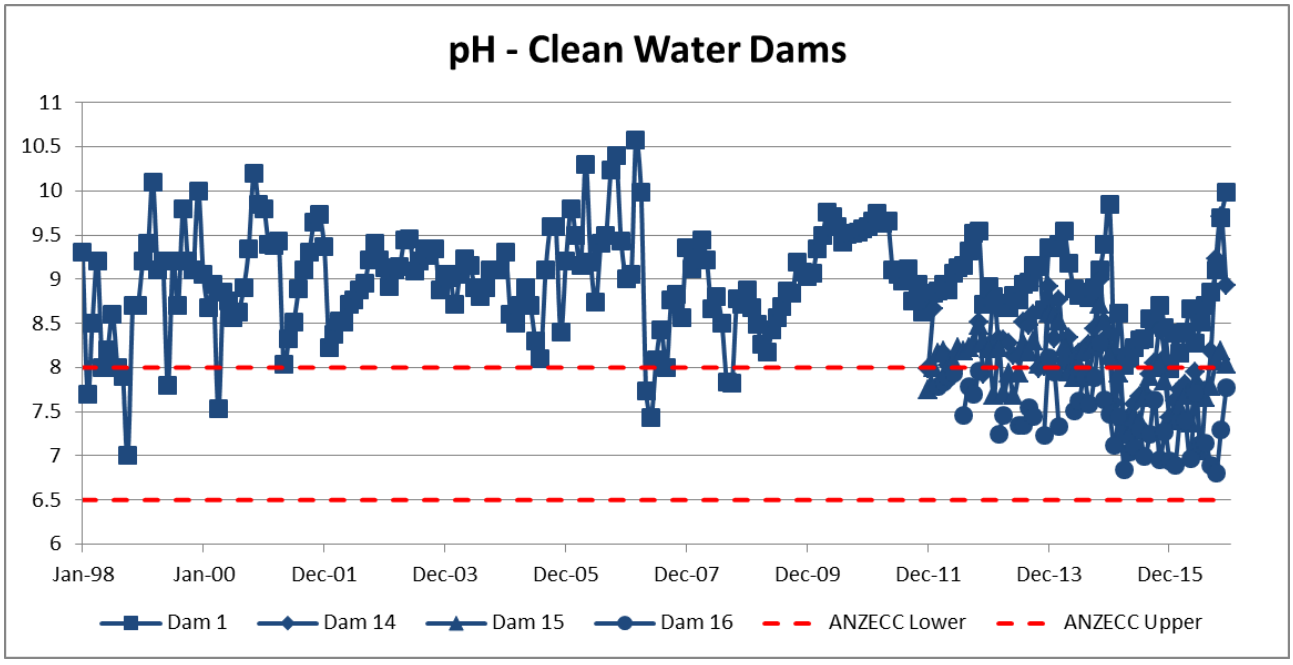
Graph 1.23 Temporal distribution of TSS data for Ephemeral streams Upstream of the Project



Graph 1.24 Temporal distribution of TSS data for Ephemeral streams Downstream of the Project

1.4 Clean Water

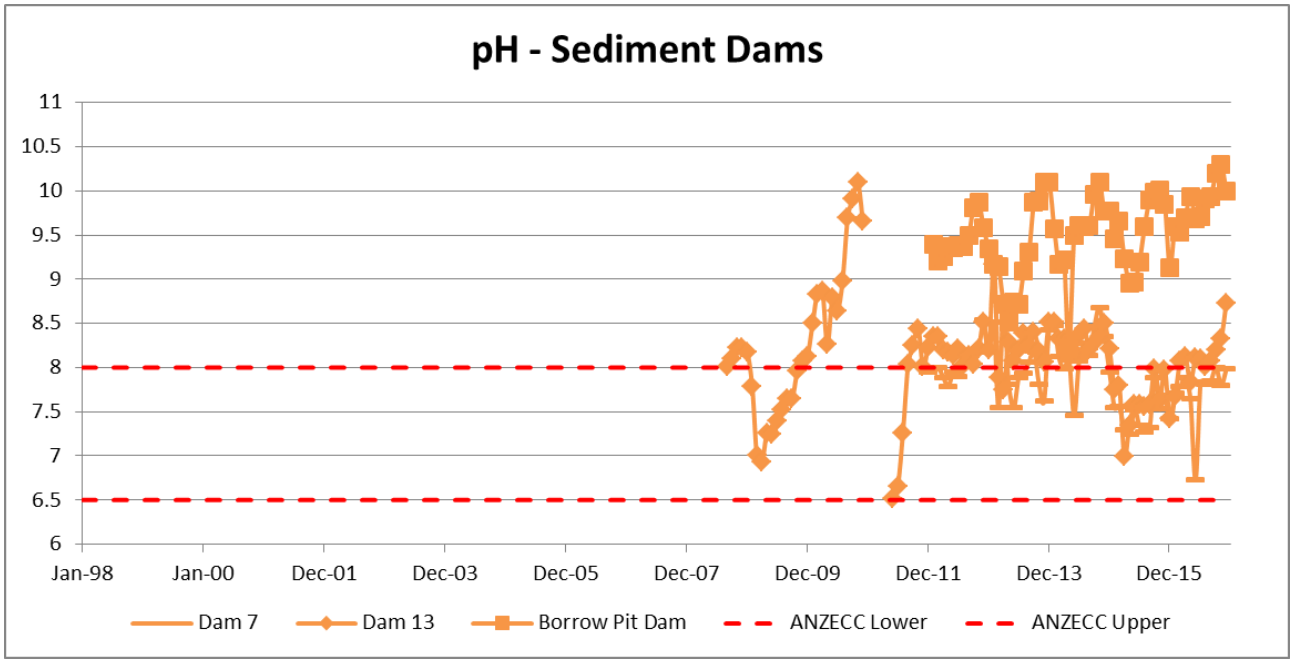
1.4.1 pH



Graph 1.25 Temporal distribution of pH data for Clean Water Dams

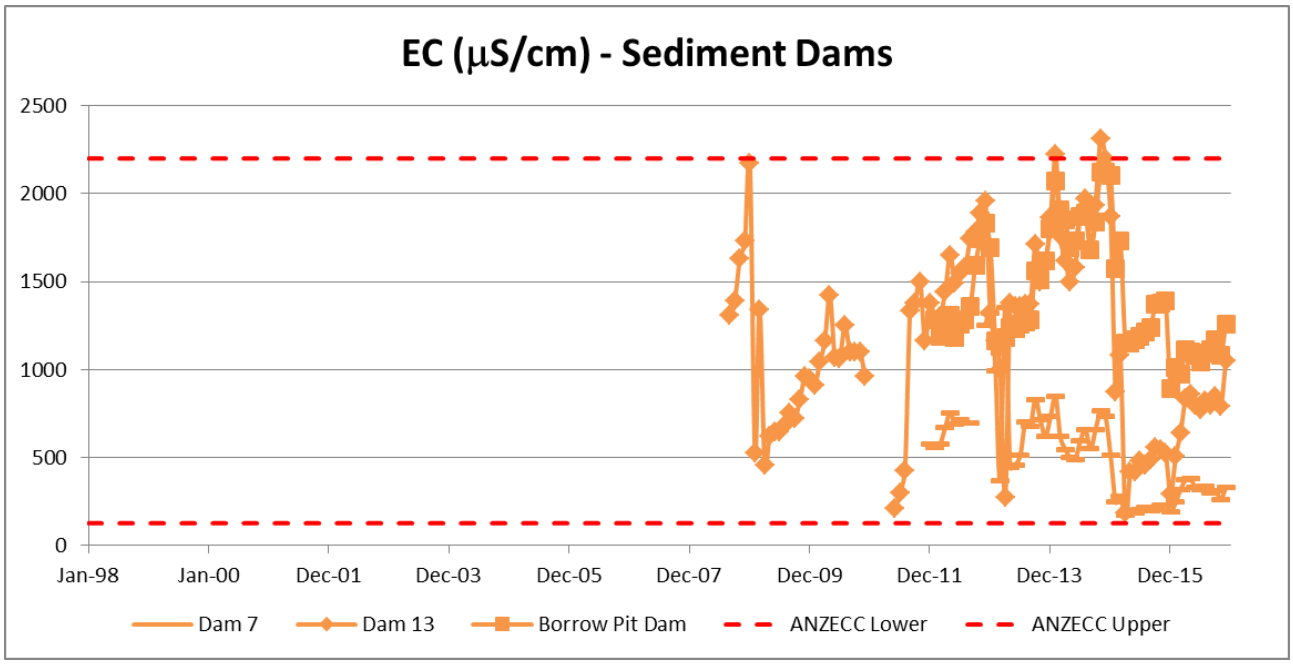
1.5 Sediment Dams

1.5.1 pH



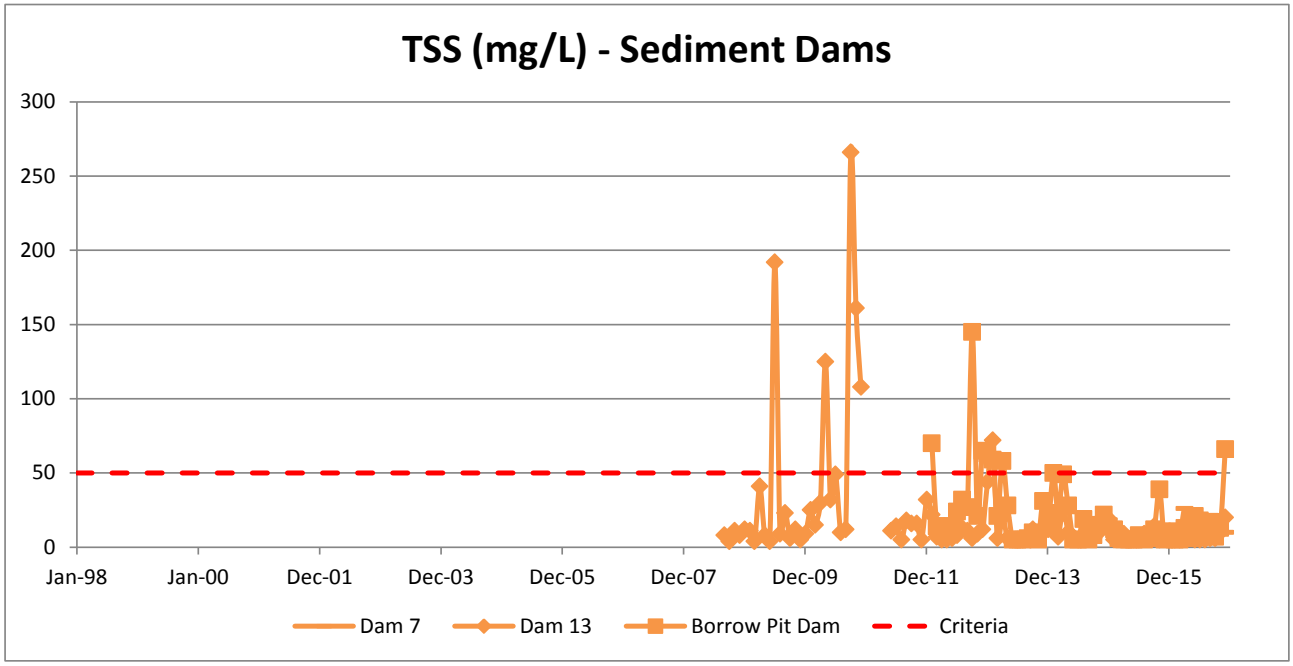
Graph 1.28 Temporal distribution of pH data for Sediment Dams

1.5.2 EC



Graph 1.29 Temporal distribution of EC data for Sediment Dams

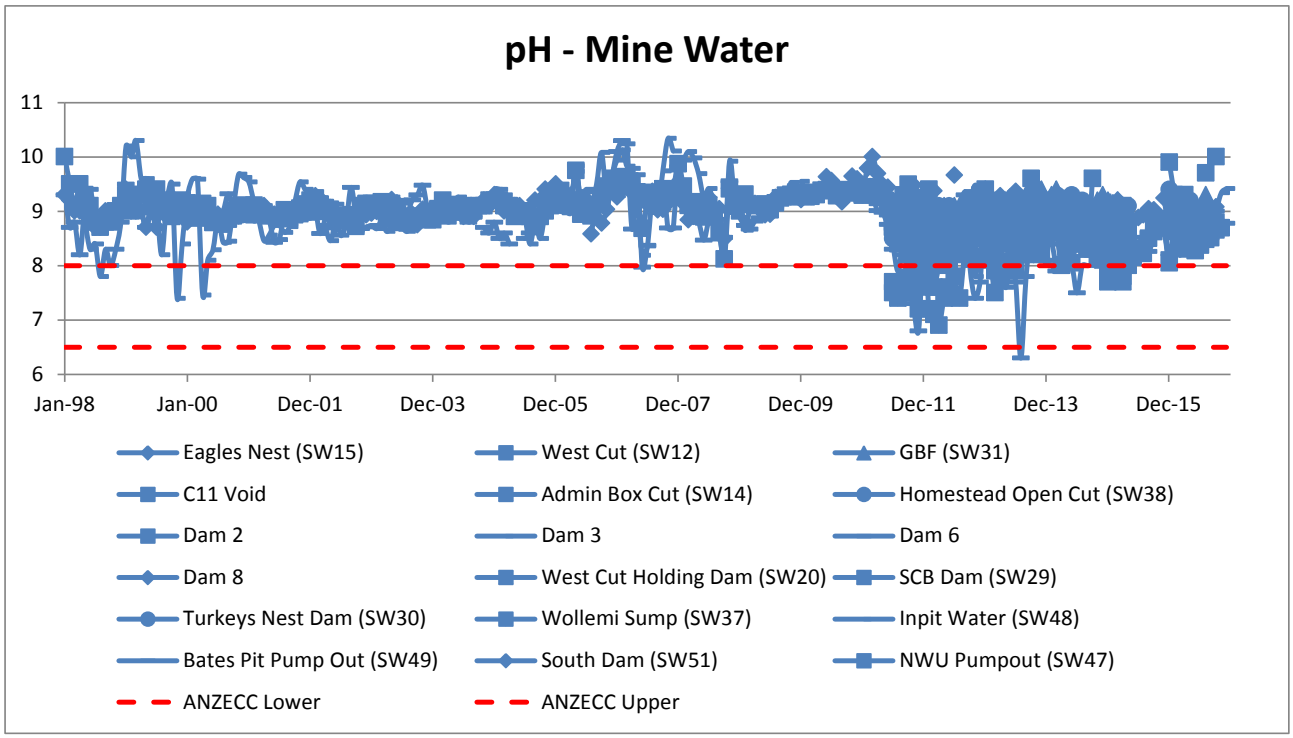
1.5.3 TSS



Graph 1.30 Temporal distribution of TSS data for Sediment Dams

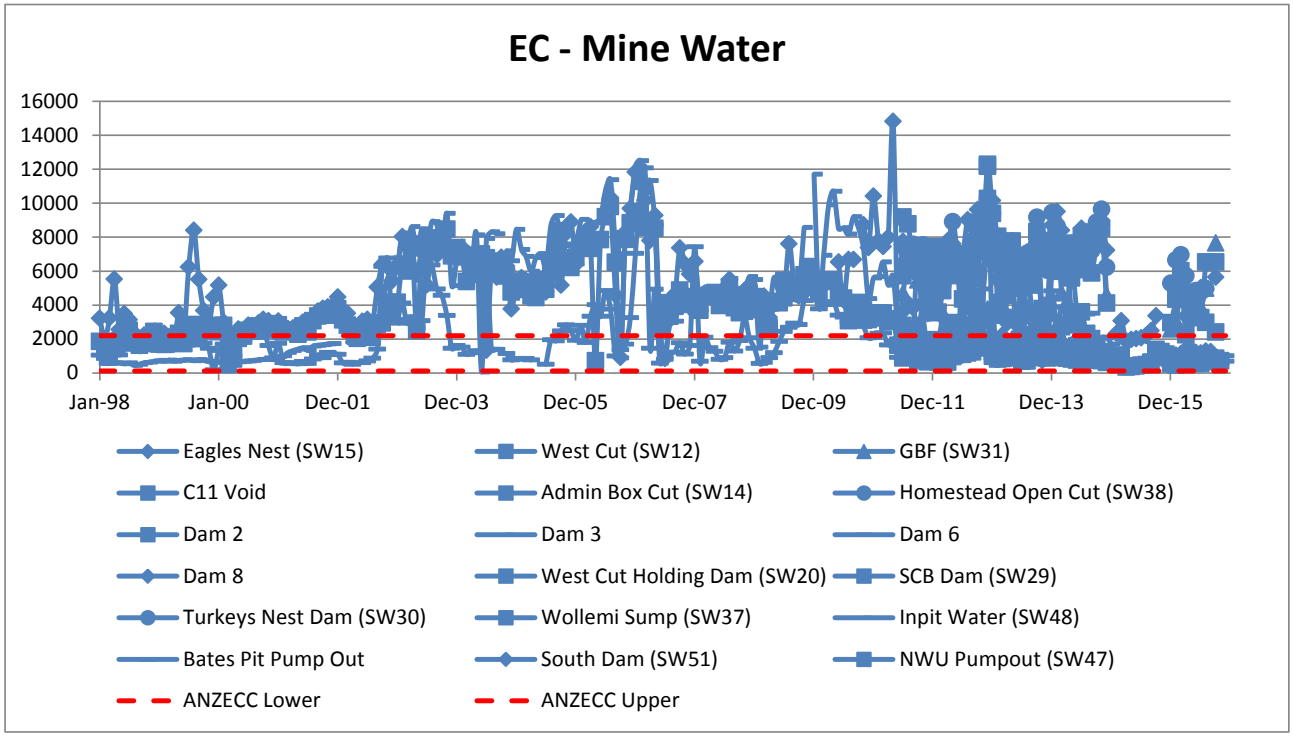
1.6 Mine Water Dams

1.6.1 pH



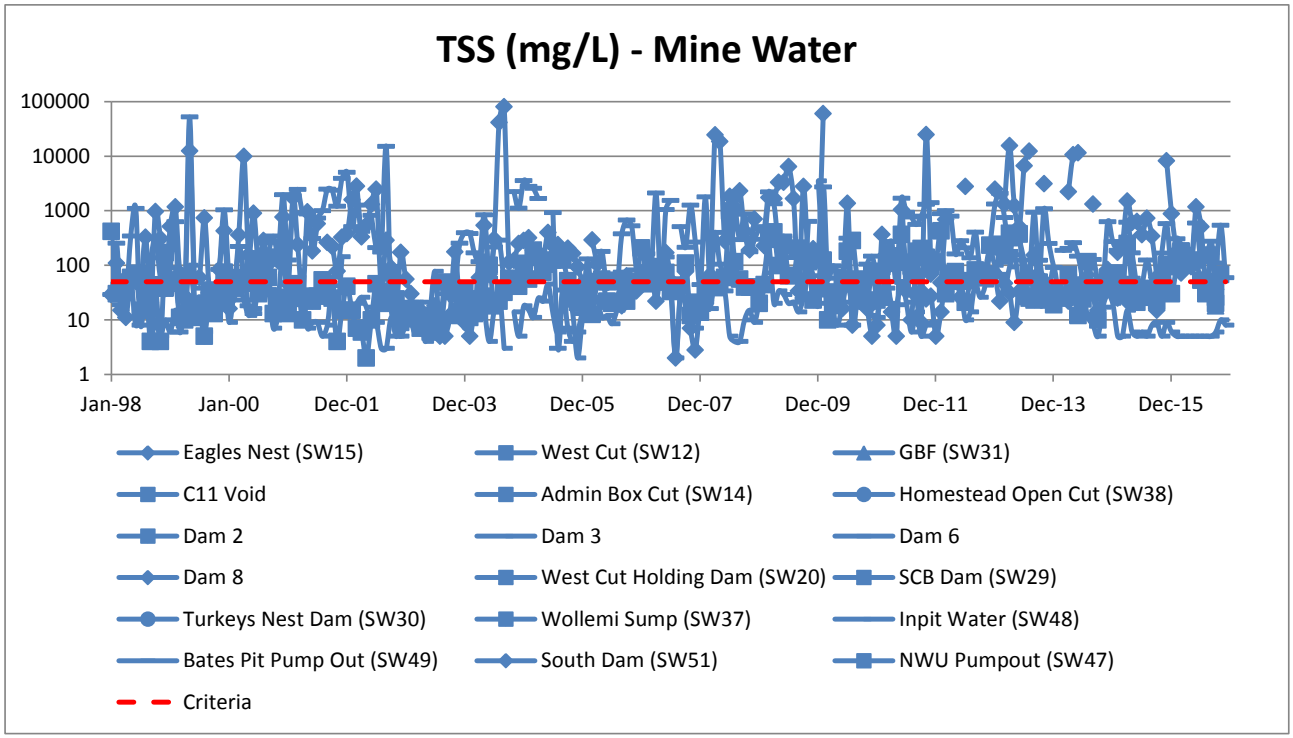
Graph 1.31 Temporal distribution of pH data for Mine Water storages

1.6.2 EC



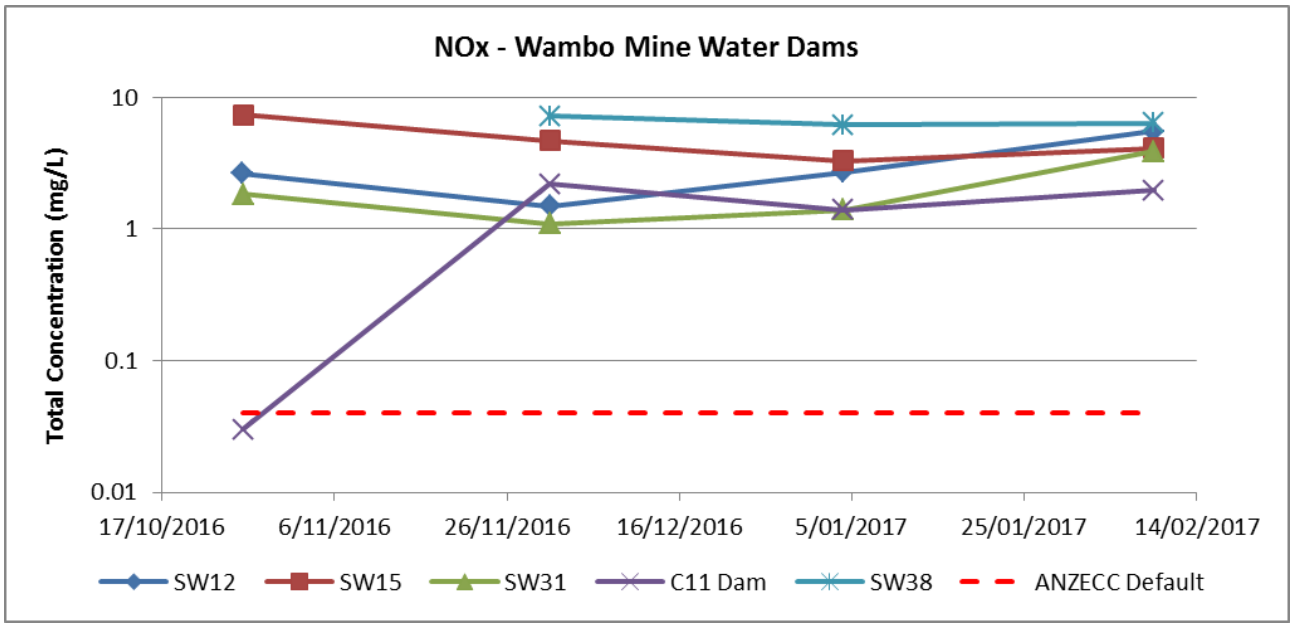
Graph 1.32 Temporal distribution of EC data for Mine Water storages

1.6.3 TSS

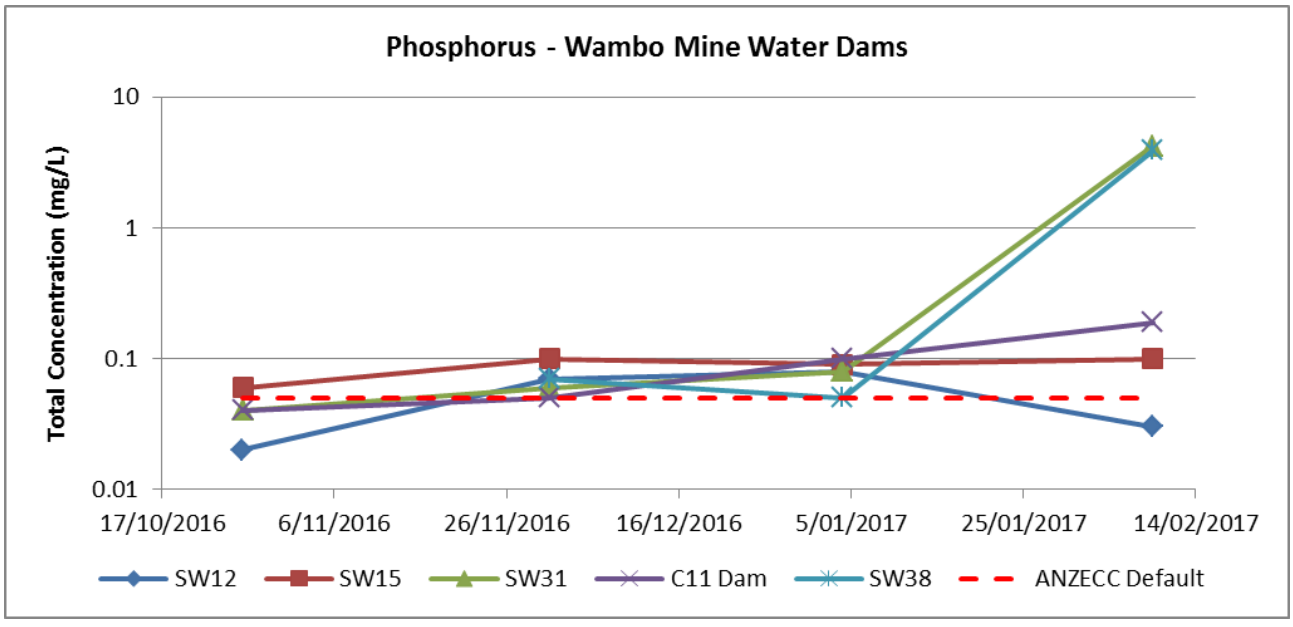


Graph 1.33 Temporal distribution of TSS data for Mine Water storages

1.6.4 Nutrients

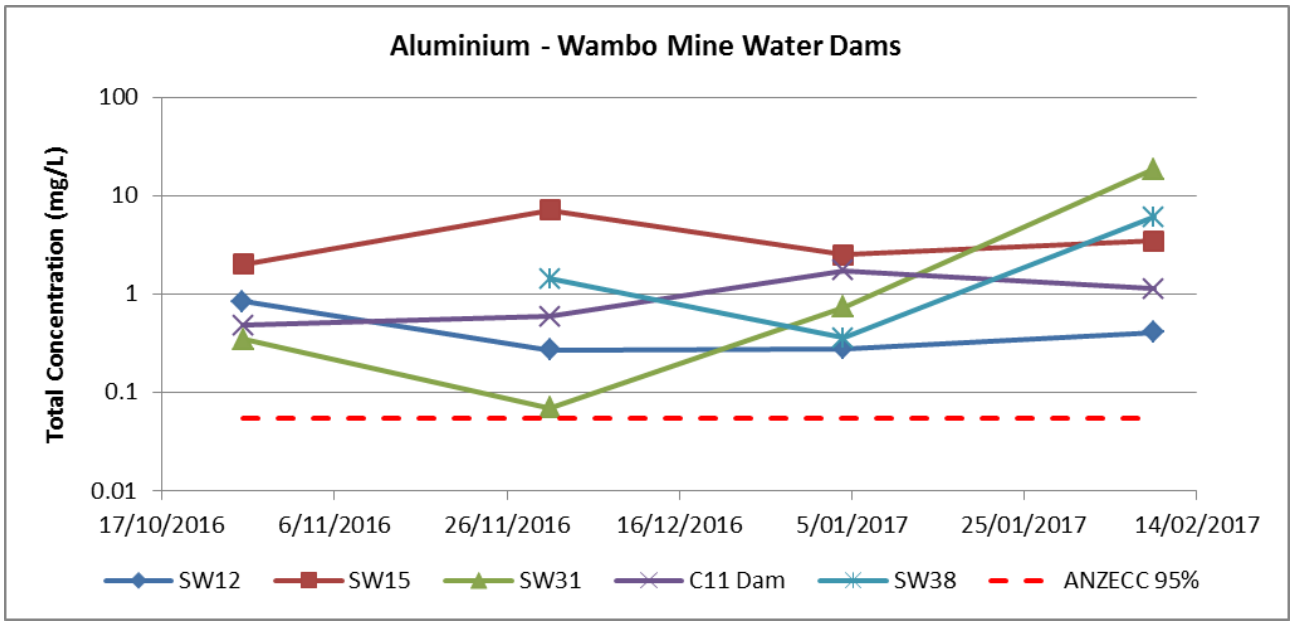


Graph 1.34 Temporal distribution of NOx data for Wambo Mine Water Dams

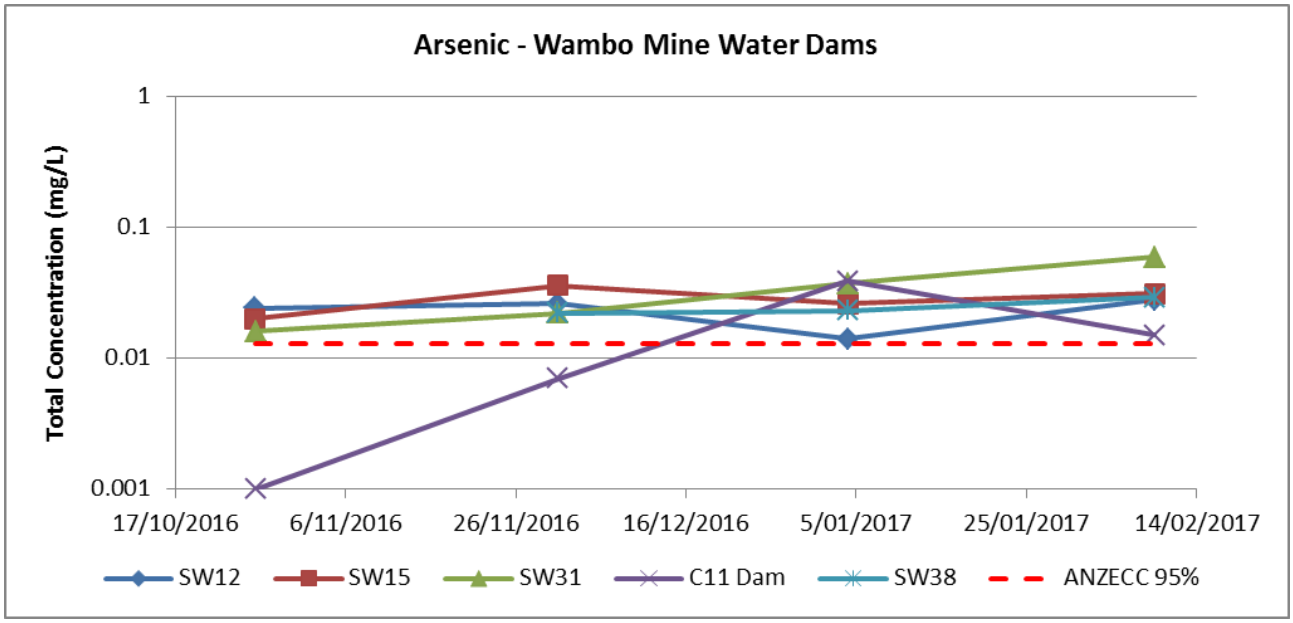


Graph 1.35 Temporal distribution of Phosphorus data for Wambo Mine Water Dams

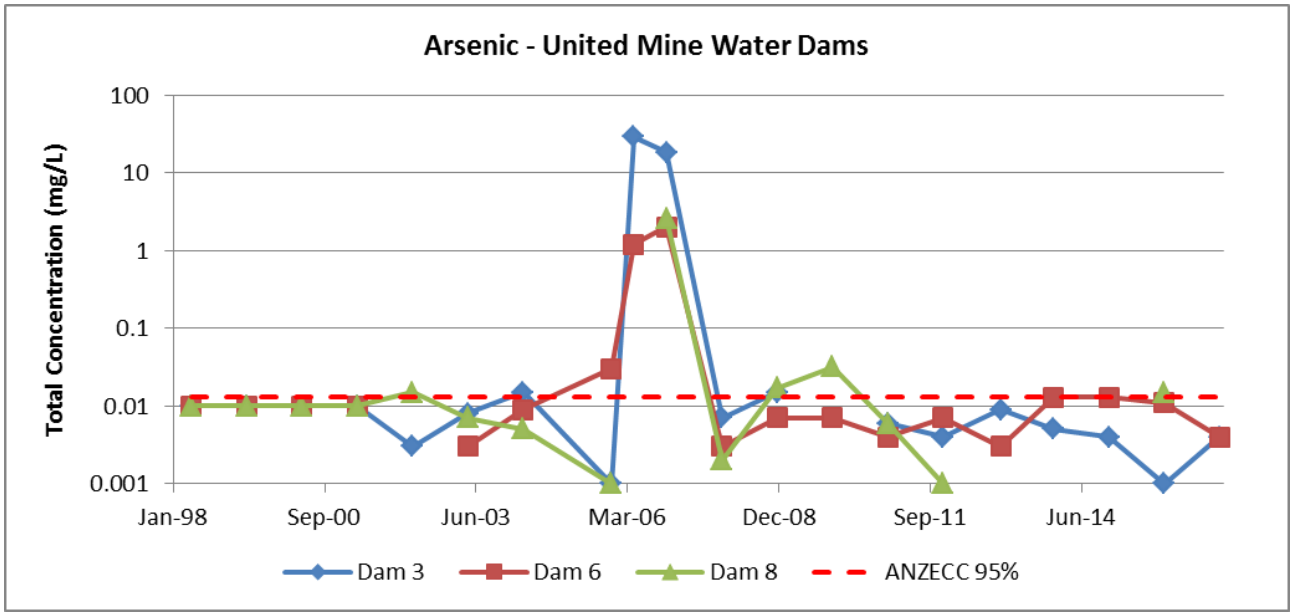
1.6.5 Metals



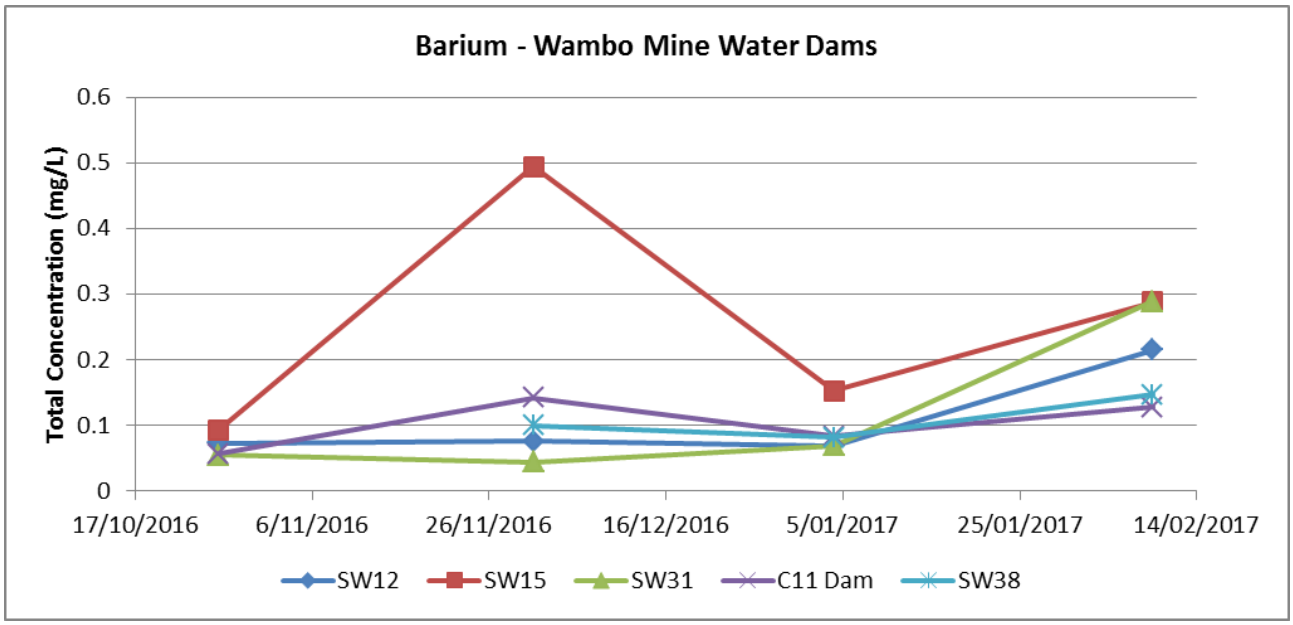
Graph 1.36 Temporal distribution of Aluminium data for Wambo Mine Water Dams



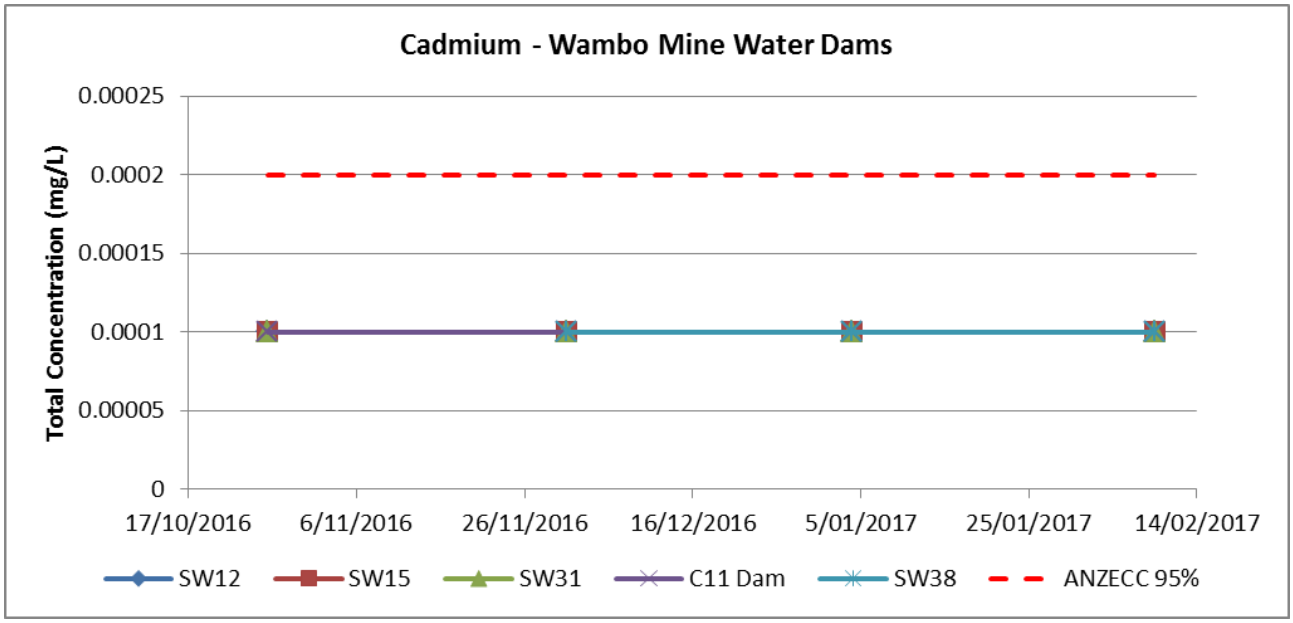
Graph 1.37 Temporal distribution of Arsenic data for Wambo Mine Water Dams



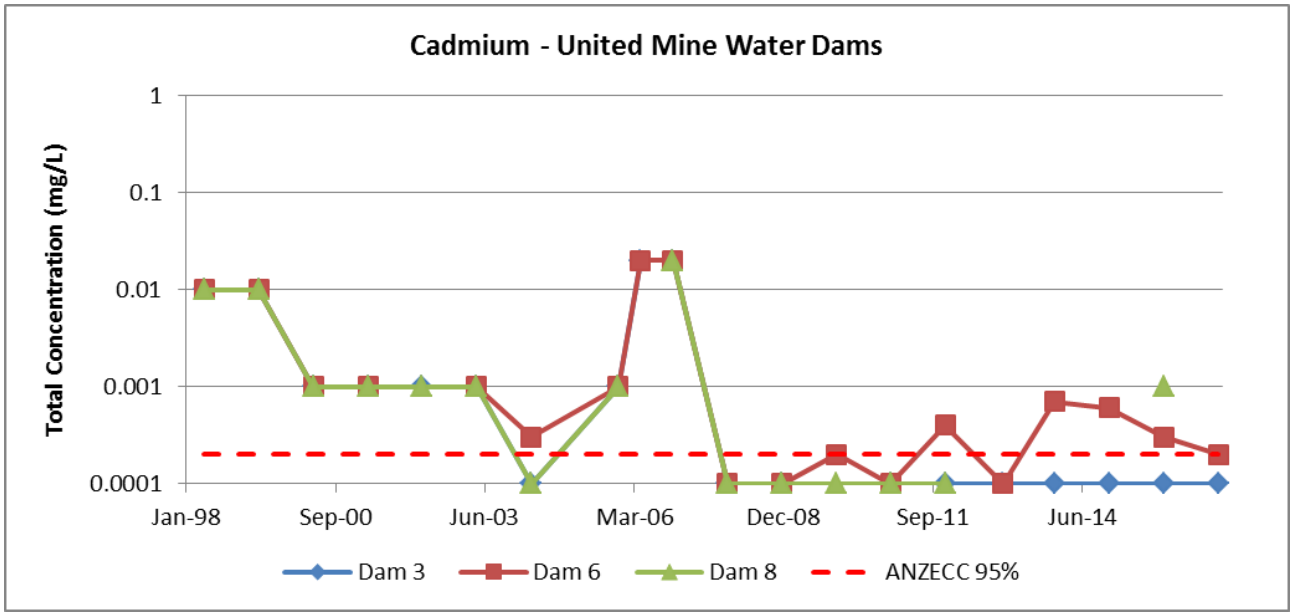
Graph 1.38 Temporal distribution of Arsenic data for United Mine Water Dams



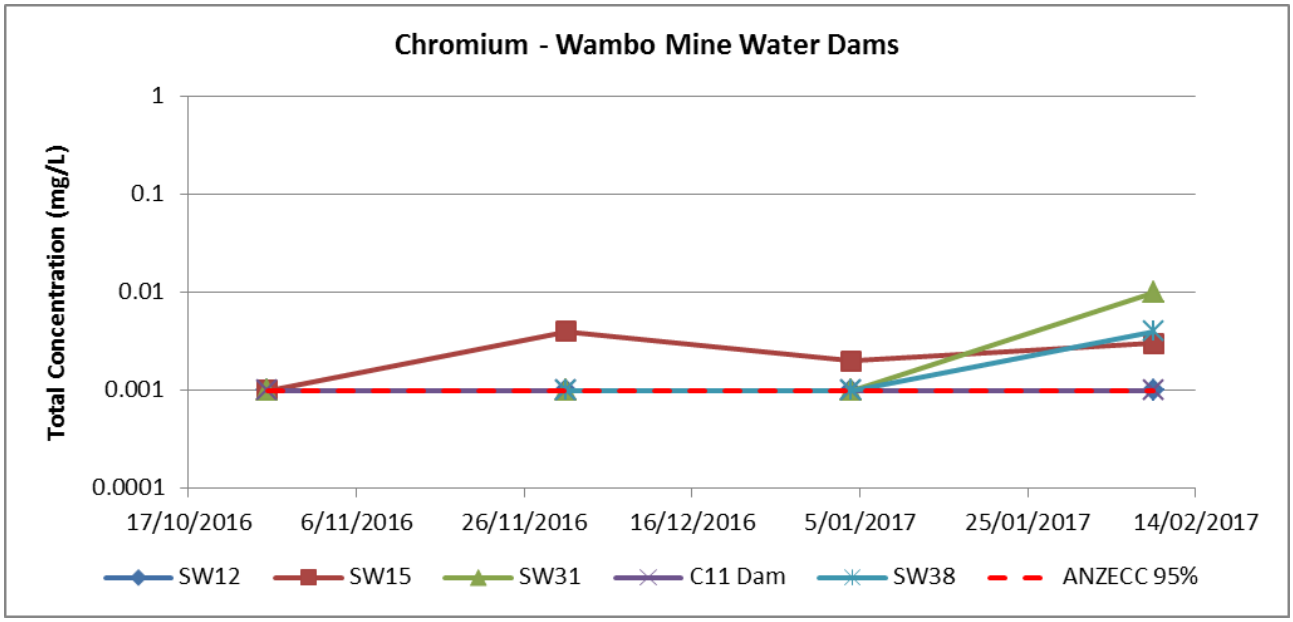
Graph 1.39 Temporal distribution of Barium data for Wambo Mine Water Dams



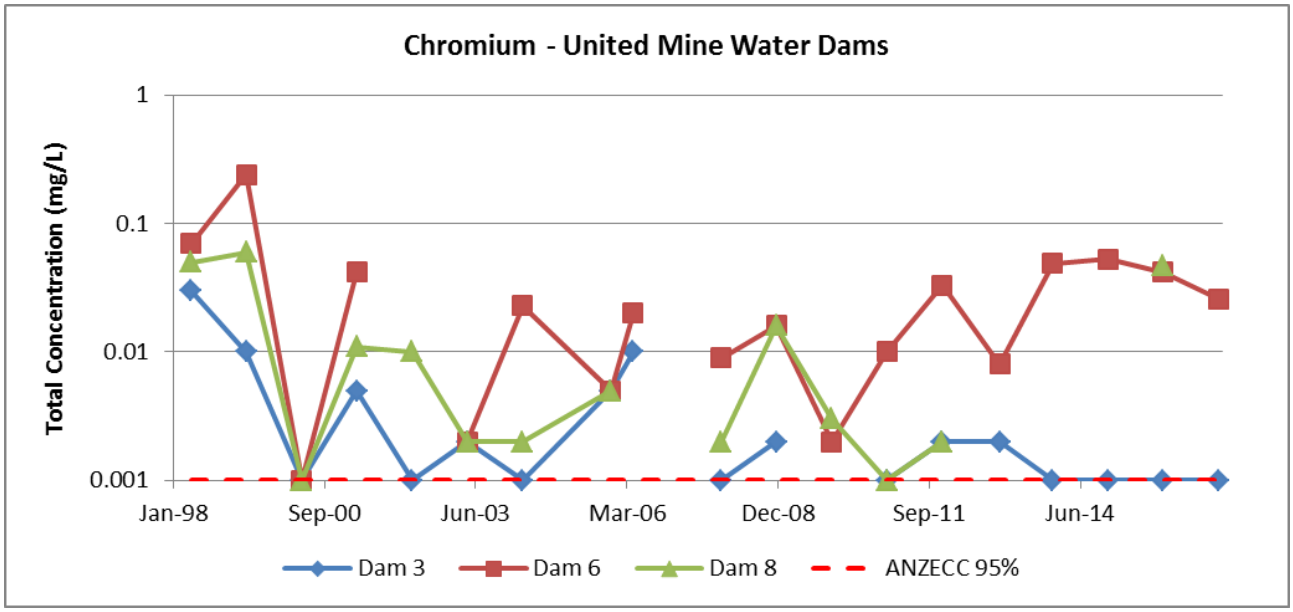
Graph 1.40 Temporal distribution of Cadmium data for Wambo Mine Water Dams



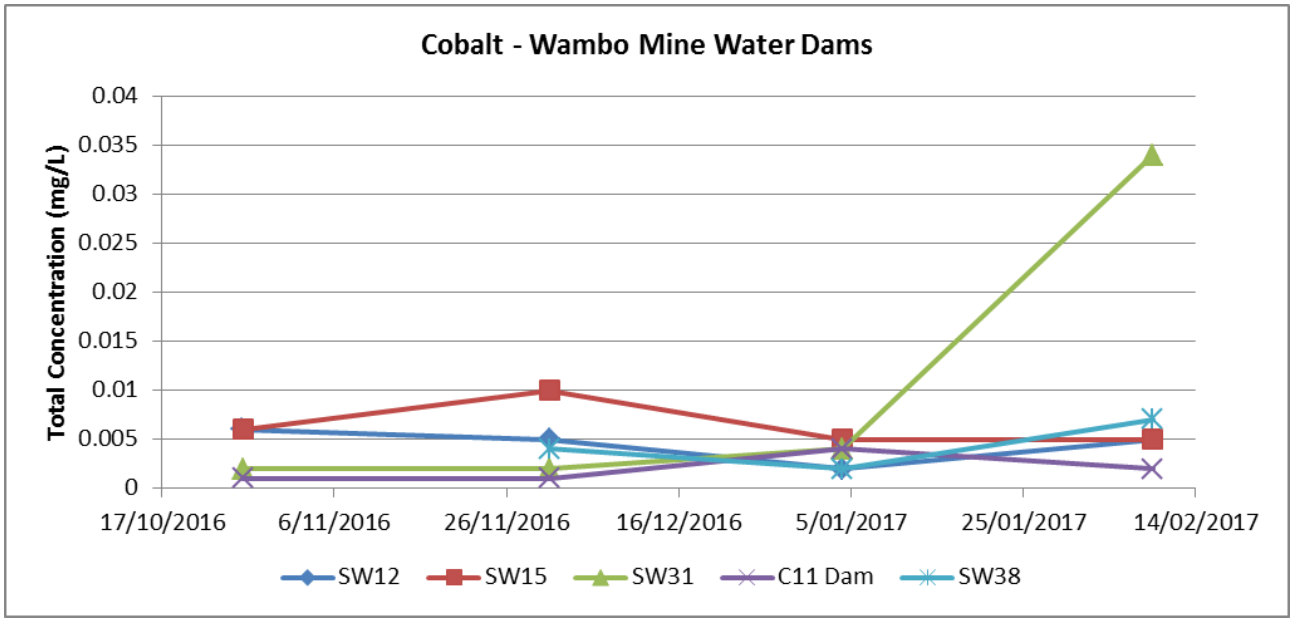
Graph 1.41 Temporal distribution of Cadmium data for United Mine Water Dams



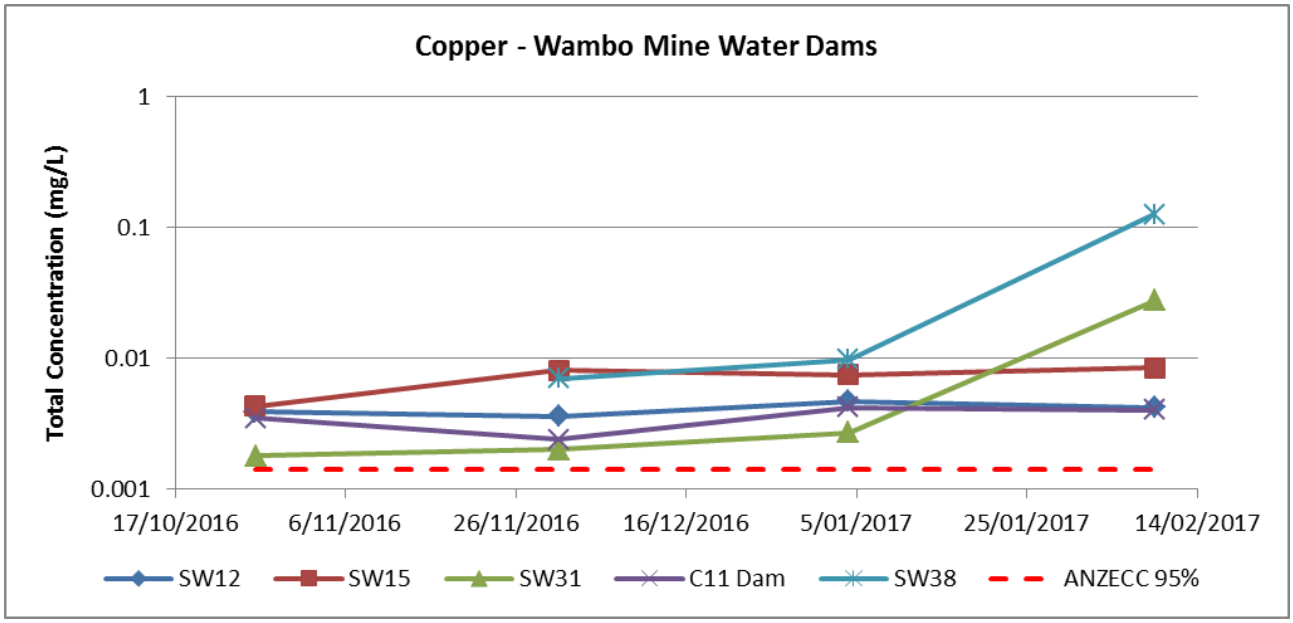
Graph 1.42 Temporal distribution of Chromium data for Wambo Mine Water Dams



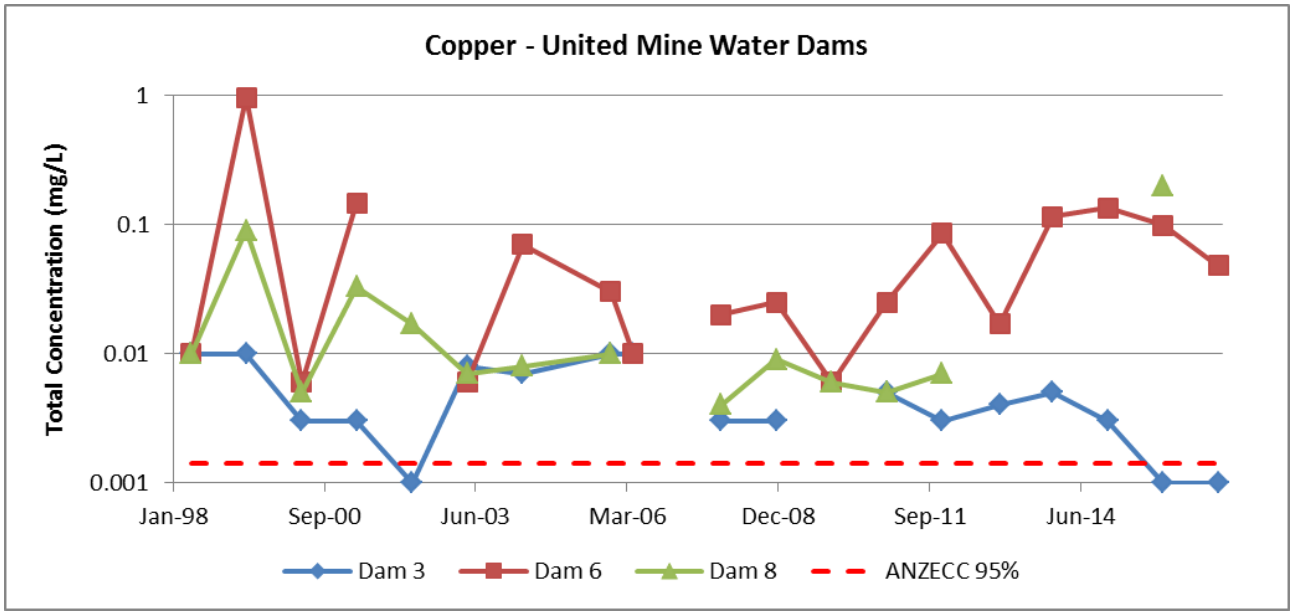
Graph 1.43 Temporal distribution of Chromium data for United Mine Water Dams



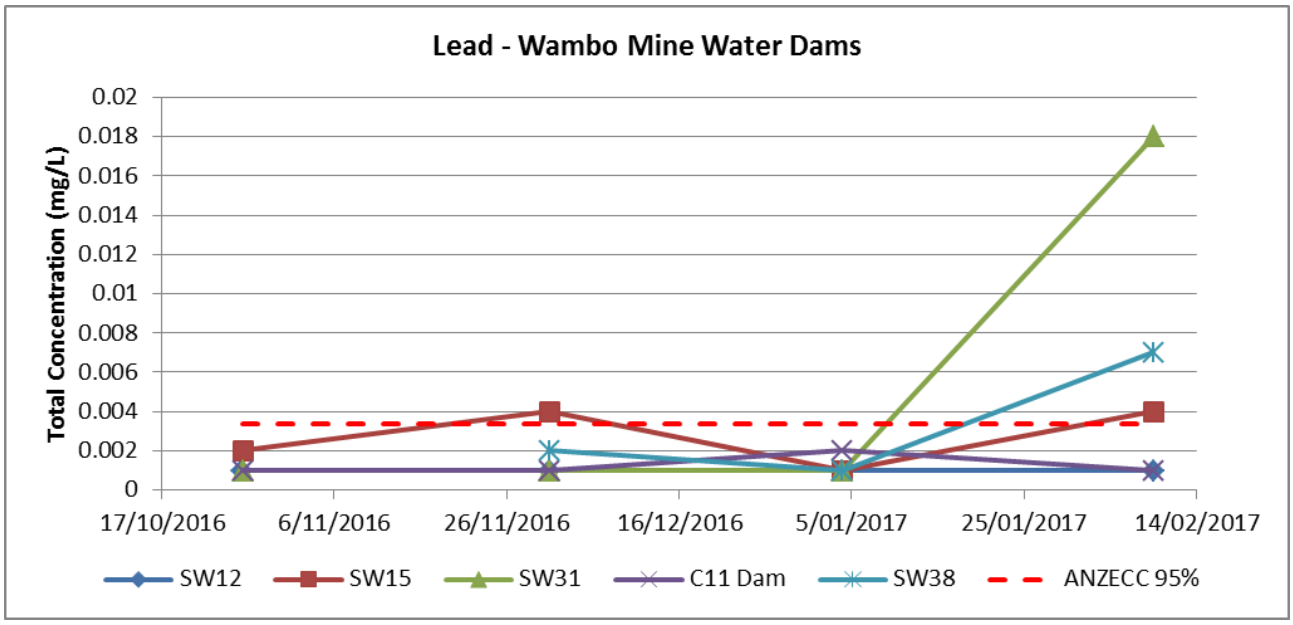
Graph 1.44 Temporal distribution of Cobalt data for Wambo Mine Water Dams



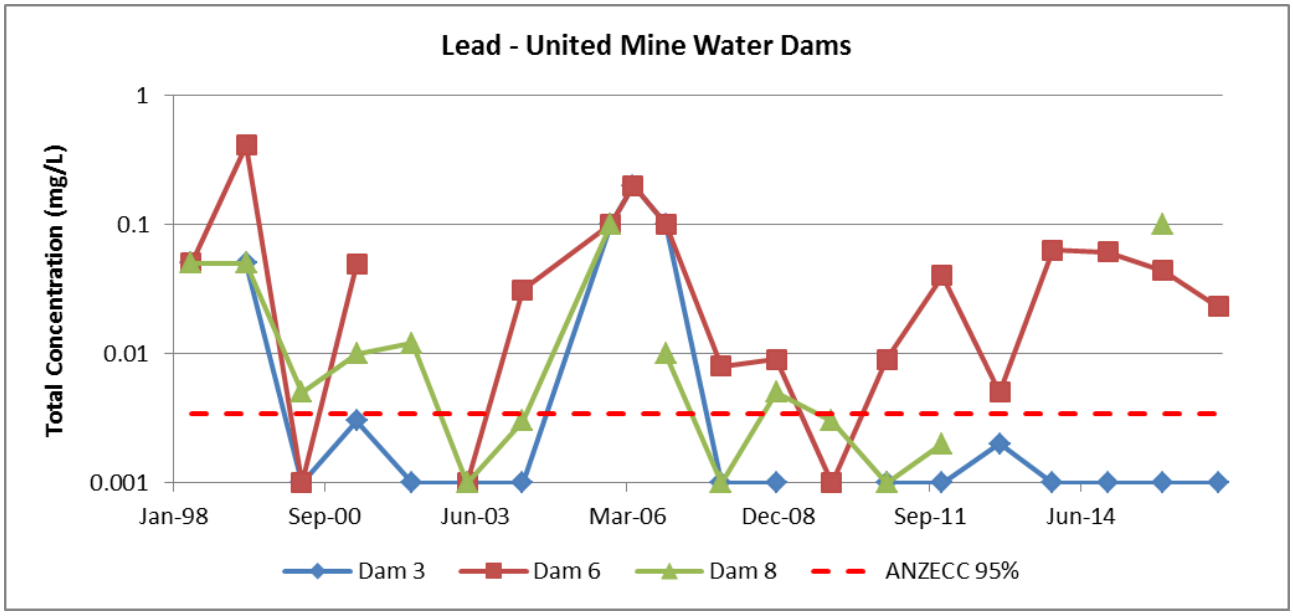
Graph 1.45 Temporal distribution of Copper data for Wambo Mine Water Dams



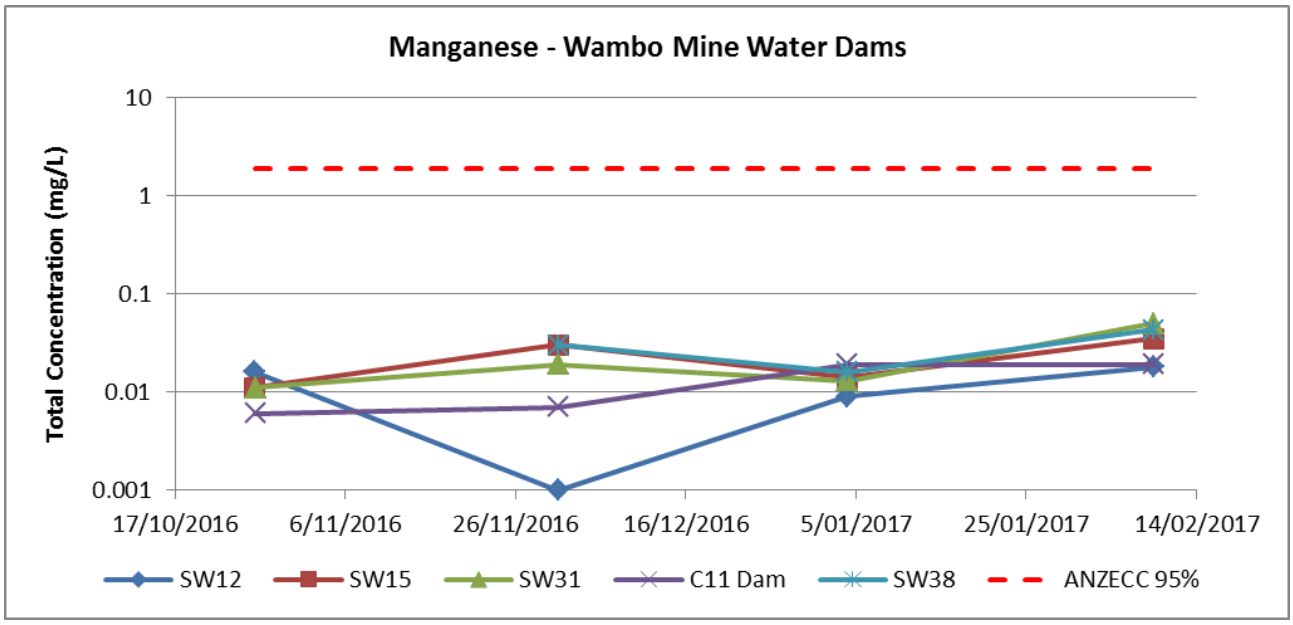
Graph 1.46 Temporal distribution of Copper data for United Mine Water Dams



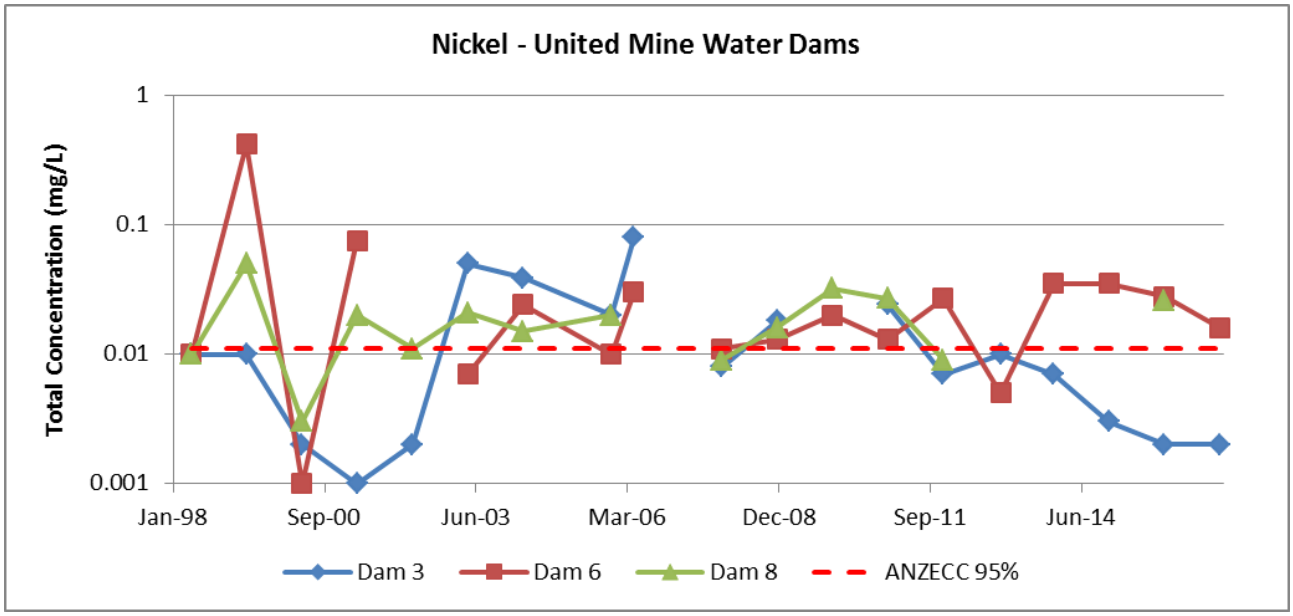
Graph 1.47 Temporal distribution of Lead data for Wambo Mine Water Dams



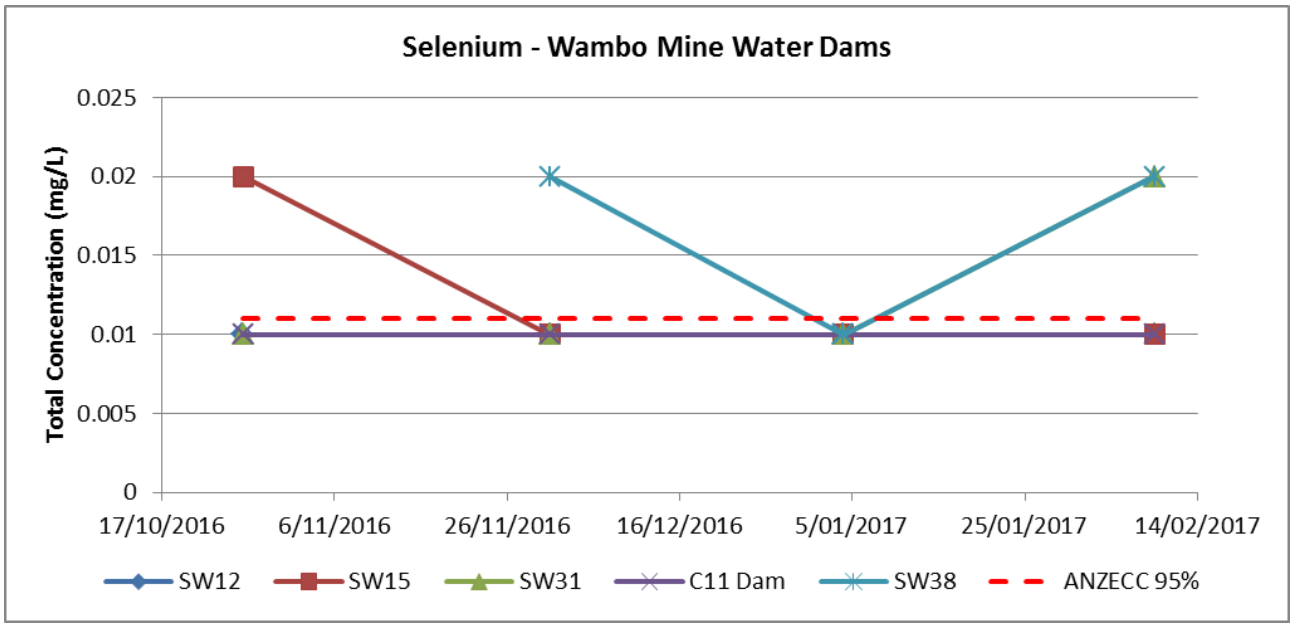
Graph 1.48 Temporal distribution of Lead data for United Mine Water Dams



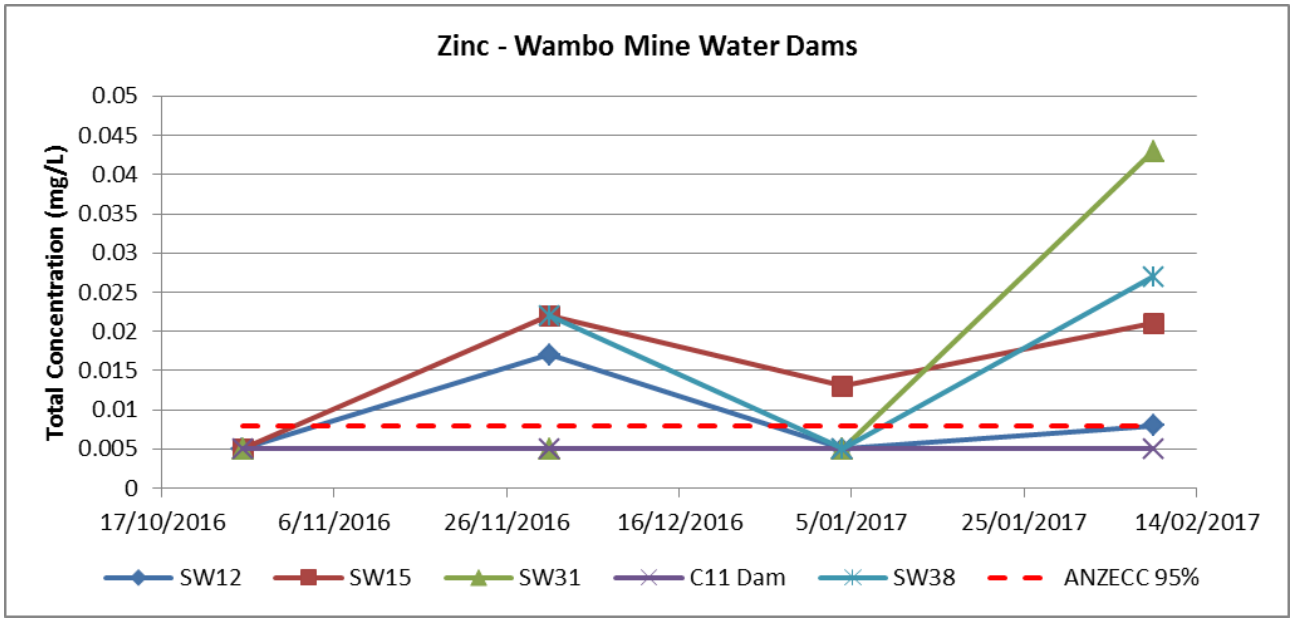
Graph 1.49 Temporal distribution of Manganese data for Wambo Mine Water Dams



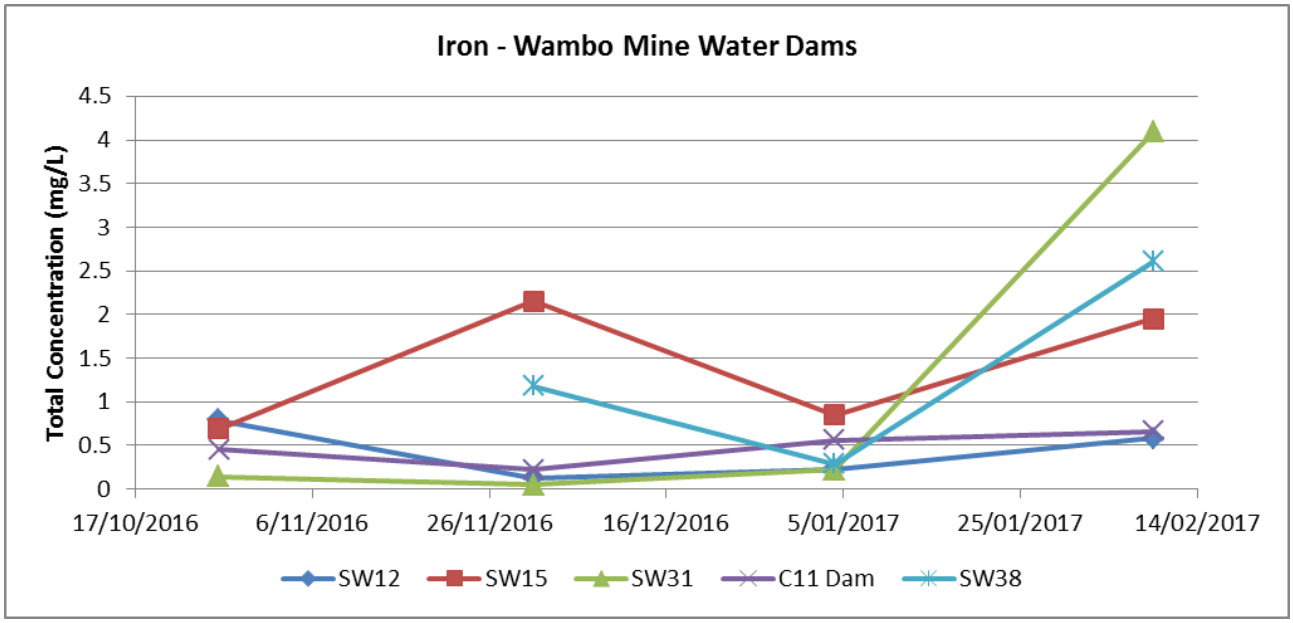
Graph 1.50 Temporal distribution of Nickel data for United Mine Water Dams



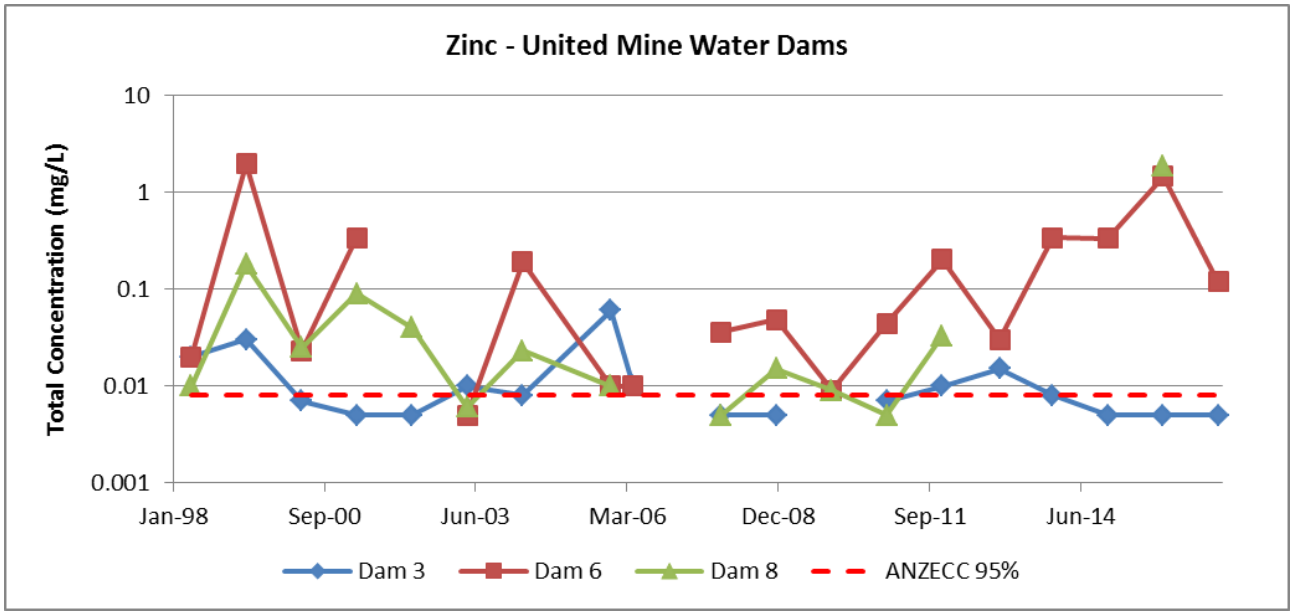
Graph 1.51 Temporal distribution of Selenium data for Wambo Mine Water Dams



Graph 1.52 Temporal distribution of Zinc data for Wambo Mine Water Dams



Graph 1.53 Temporal distribution of Iron data for Wambo Mine Water Dams



Graph 1.54 Temporal distribution of Zinc data for United Mine Water Dams

Flooding Figures

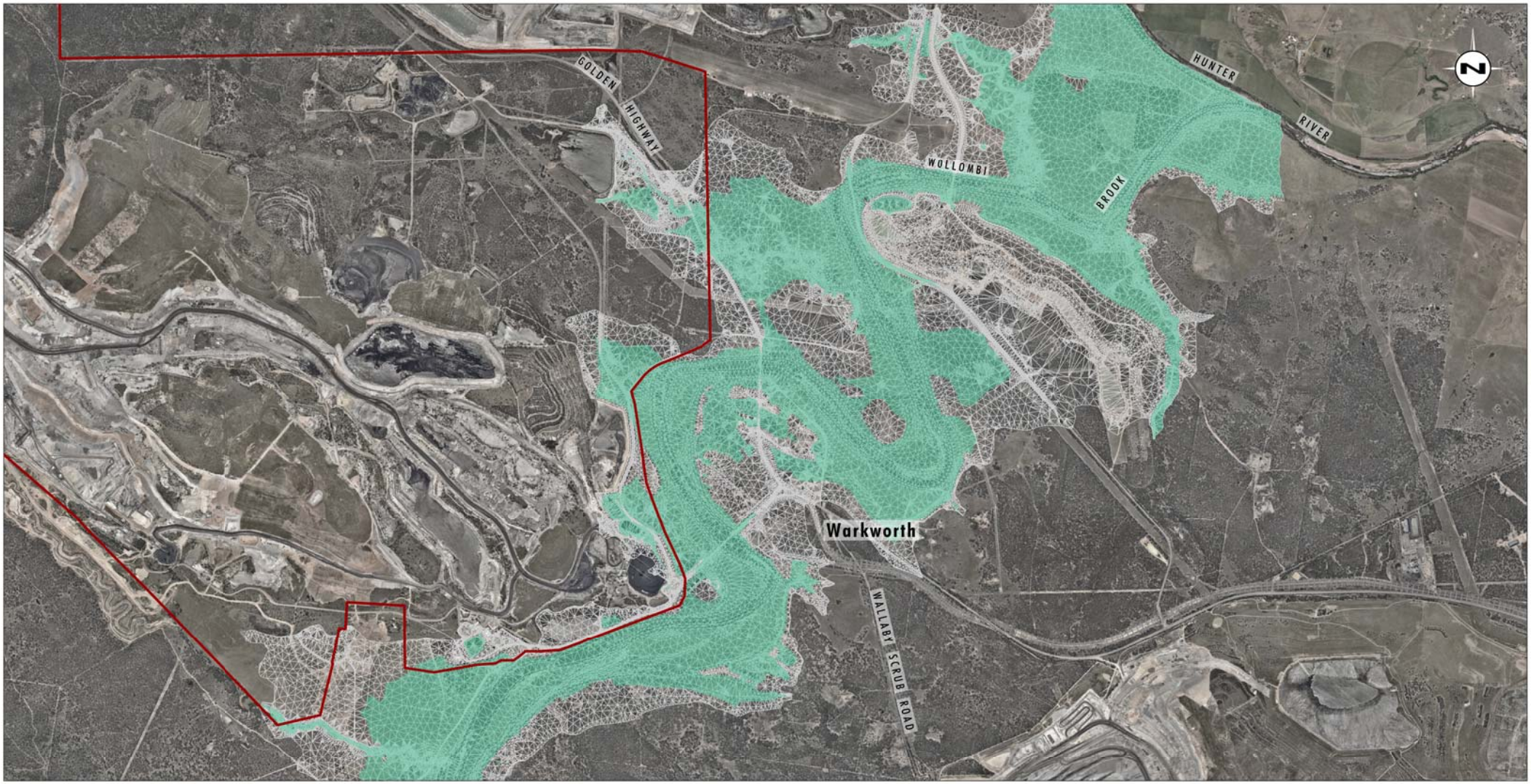


Image Source: Nearmap (Nov 2016)

0 0.5 1.0 2.0km
1:40 000

Legend

- Project Area
- Flood Planning Area

FIGURE 1

Flood Planning Area

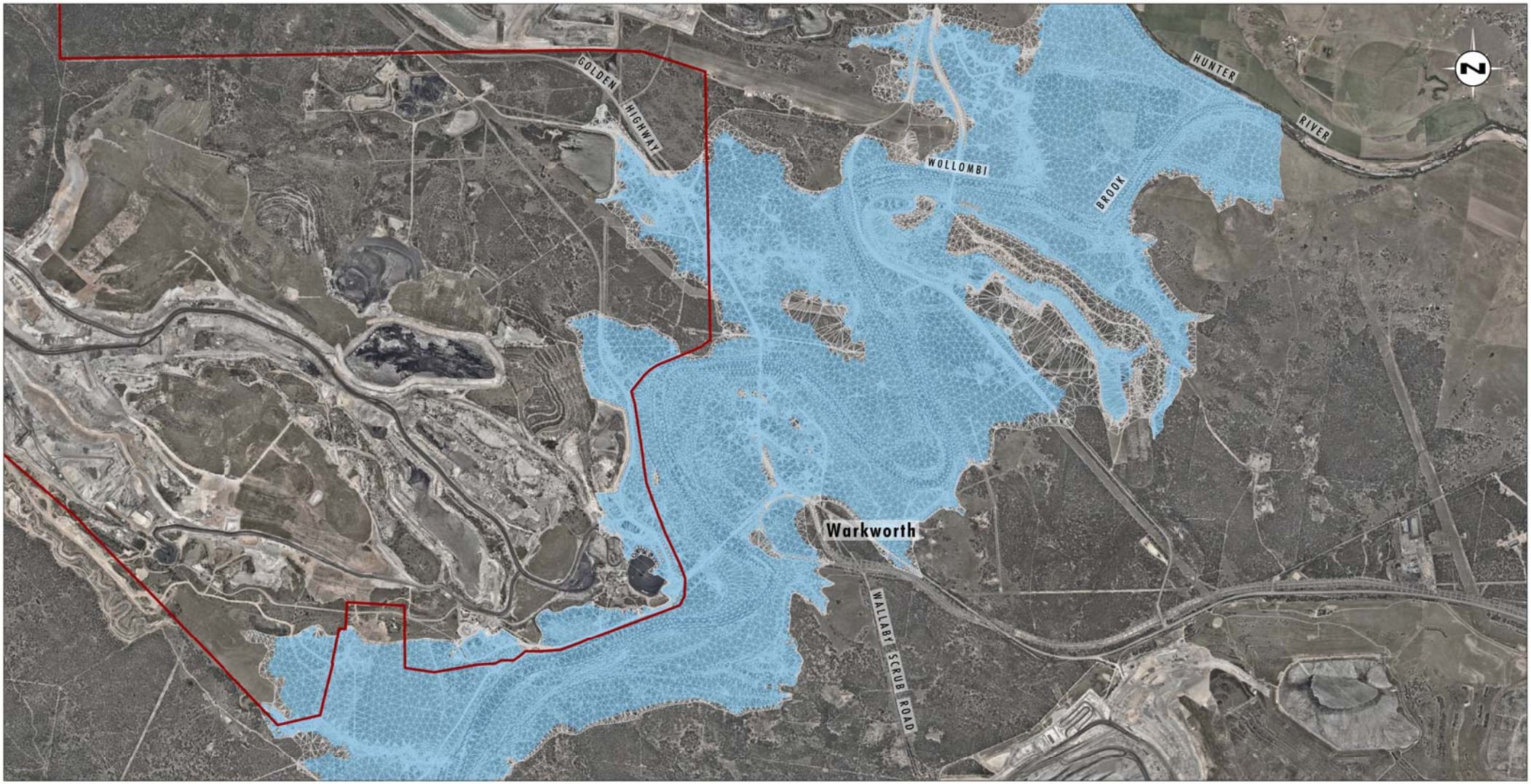


Image Source: Nearmap (Nov 2016)

0 0.5 1.0 2.0km
1:40 000

Legend

- Project Area
- Flood Prone Land

FIGURE 2

Flood Prone Land

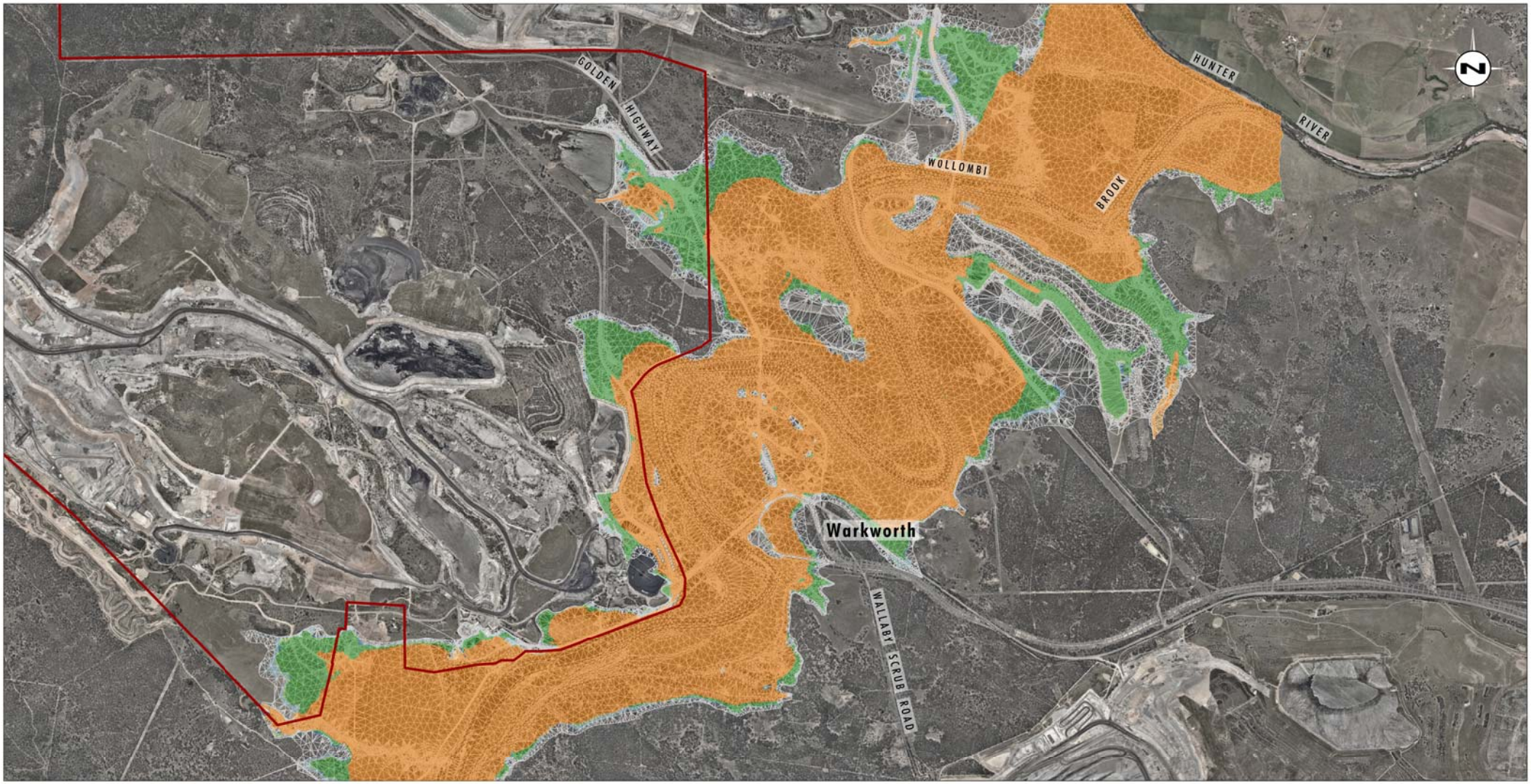


Image Source: Nearmap (Nov 2016)

0 0.5 1.0 2.0km
1:40 000

Legend

- Project Area

Categories

- High Hazard - Floodway
- Low Hazard - Floodway
- High Hazard - Storage
- Low Hazard - Storage
- High Hazard - Fringe
- Low Hazard - Fringe

FIGURE 3

Flood Prone Land - Hydraulic Categorisation

File Name (A4): R18/3509_504.dgn
20170224 10.11

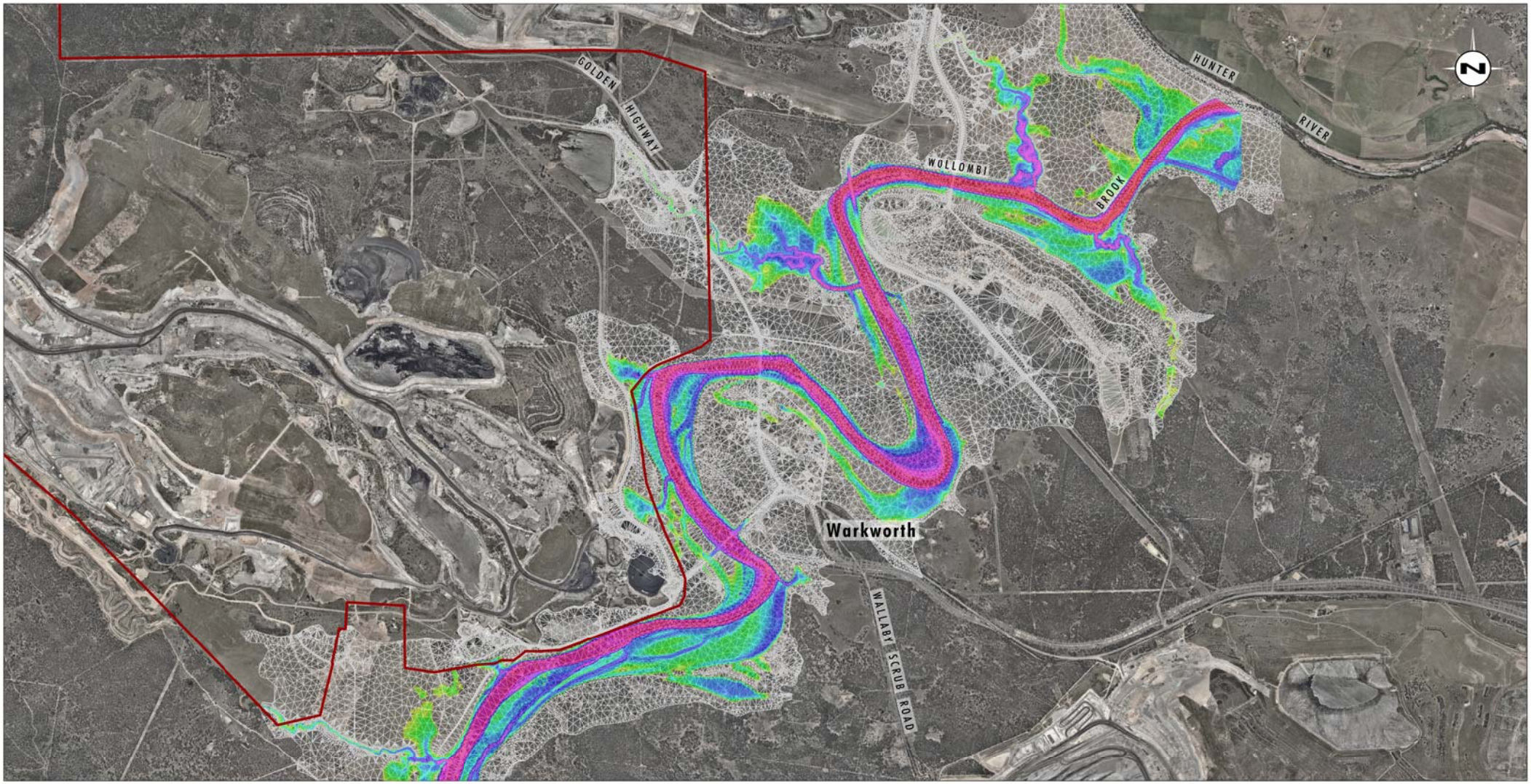


Image Source: Nearmap (Nov 2016)

0 0.5 1.0 2.0km
1:40 000

Legend

Project Area

Water Depth (metres)

12	2	0.001
8	1.5	
6	1	
4	0.5	
3	0.2	

FIGURE 4

10% AEP Flood Event -
Maximum Modelled Flood Depths -
Existing Scenario

File Name (A4): R18/3509_500.dgn
20170224 14.52

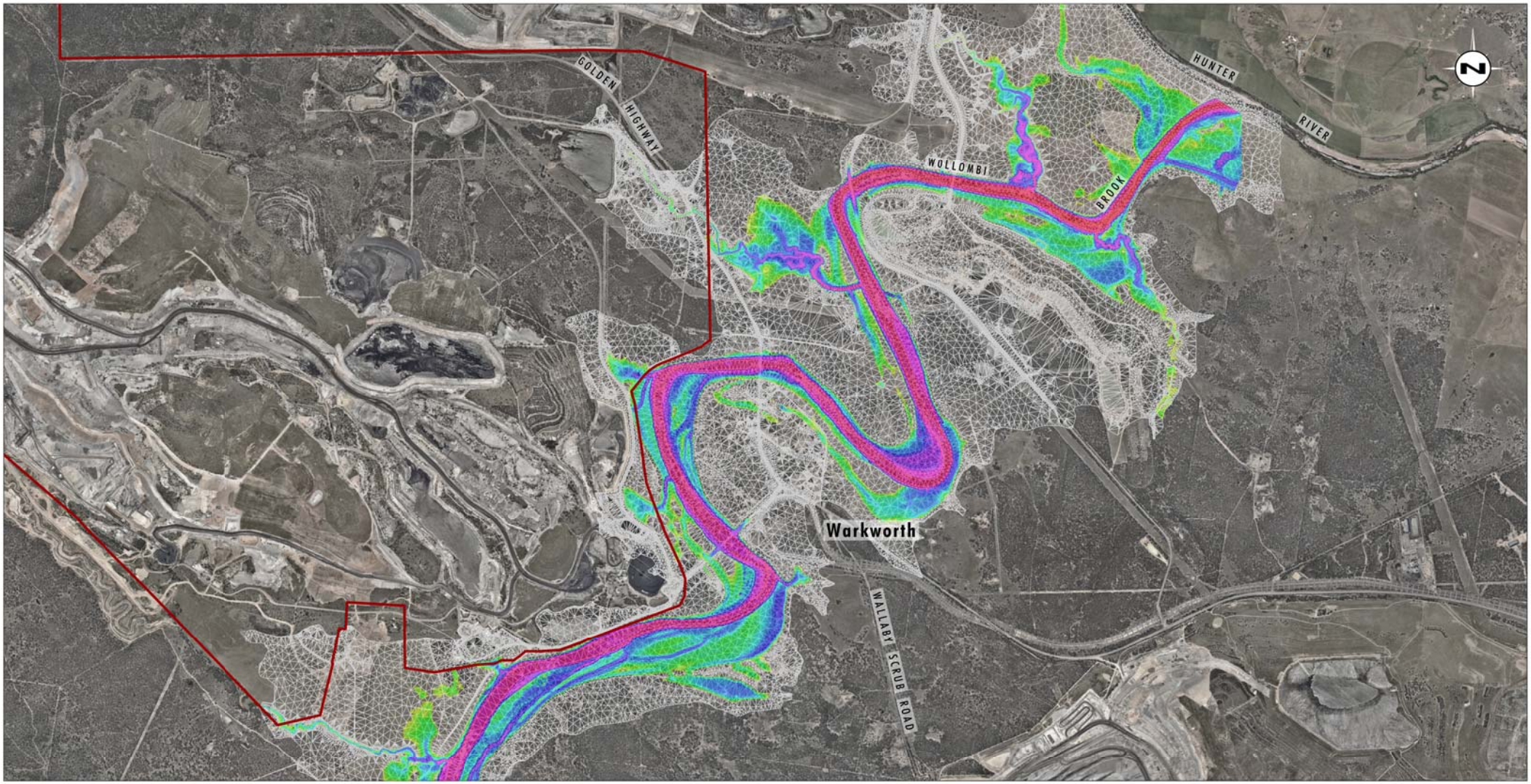


Image Source: Nearmap (Nov 2016)

0 0.5 1.0 2.0km
1:40 000

Legend

Project Area

Water Depth (metres)

12	2	0.001
8	1.5	
6	1	
4	0.5	
3	0.2	

FIGURE 5

10% AEP Flood Event -
Maximum Modelled Flood Depths -
Developed Scenario

File Name (A4): R18/3509_501.dgn
20170224 9.59

Image Source: Nearmap (Nov 2016)

0 0.5 1.0 2.0km
1:40 000

Legend

Project Area

Change in Depth (metres)

0.5	0	-0.5
0.2	-0.01	
0.1	-0.05	
0.05	-0.1	
0.01	-0.2	

FIGURE 6

10% AEP Flood Event -
Maximum Modelled Flood Depth -
Changes with Project

File Name (A4): R18/3509_505.dgn
20170224 10.19

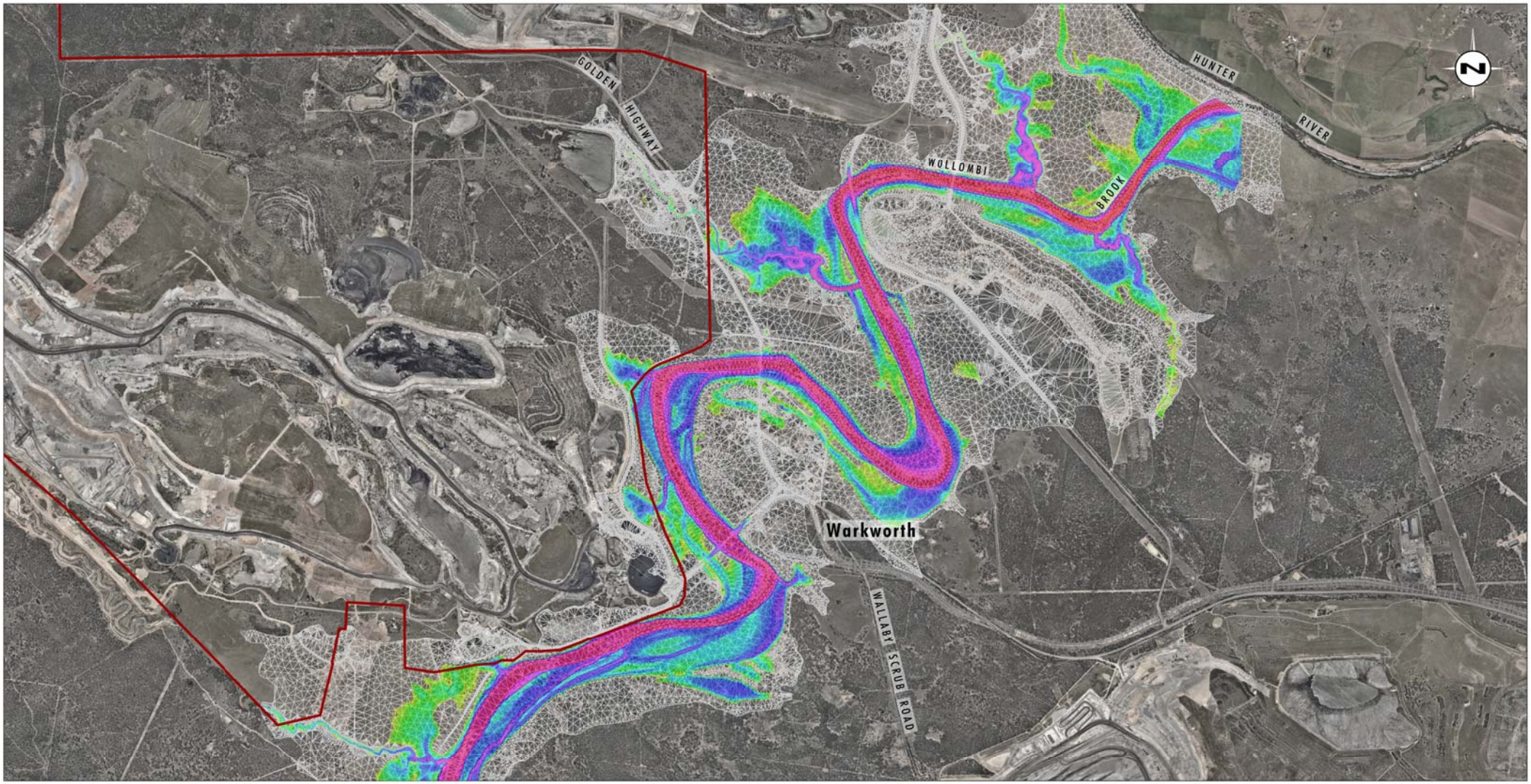


Image Source: Nearmap (Nov 2016)

0 0.5 1.0 2.0km
1:40 000

Legend

Project Area

Water Depth (metres)

12	2	0.001
8	1.5	
6	1	
4	0.5	
3	0.2	

FIGURE 7

5% AEP Flood Event -
Maximum Modelled Flood Depths -
Existing Scenario

File Name (A4): R18/3509_506.dgn
20170224 9.57

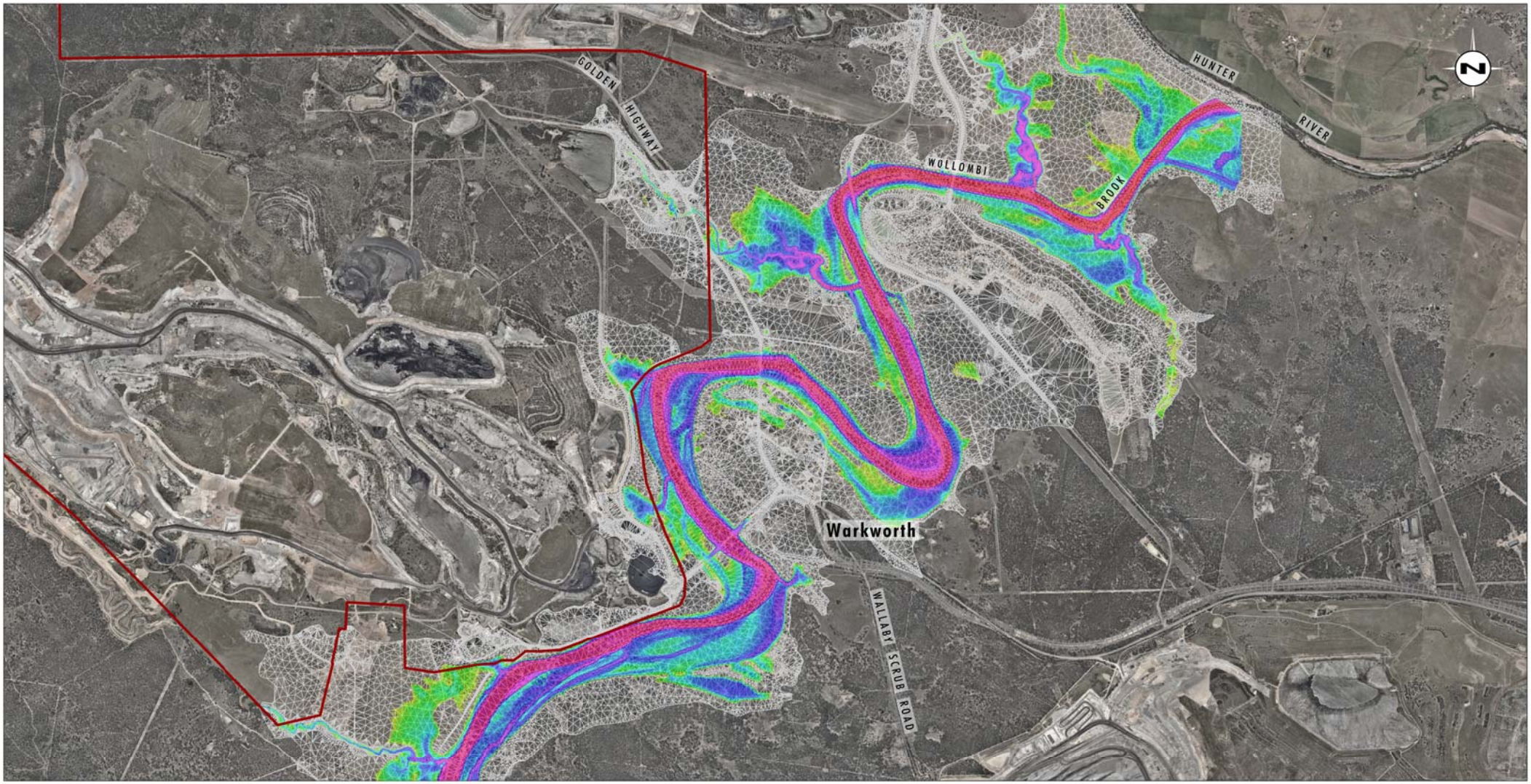


Image Source: Nearmap (Jan2016)

0 0.5 1.0 2.0km
1:40 000

Legend

Project Area

Water Depth (metres)

12	2	0.001
8	1.5	
6	1	
4	0.5	
3	0.2	

FIGURE 8

5% AEP Flood Event -
Maximum Modelled Flood Depths -
Developed Scenario

File Name (A4): R18/3509_507.dgn
20170224 9.57

Image Source: Nearmap (Nov 2016)

0 0.5 1.0 2.0km
1:40 000

Legend

Project Area

Change in Depth (metres)

0.5	0	-0.5
0.2	-0.01	
0.1	-0.05	
0.05	-0.1	
0.01	-0.2	

FIGURE 9

5% AEP Flood Event -
Maximum Modelled Flood Depth -
Changes with Project

File Name (A4): R18/3509_508.dgn
20170224 10.19

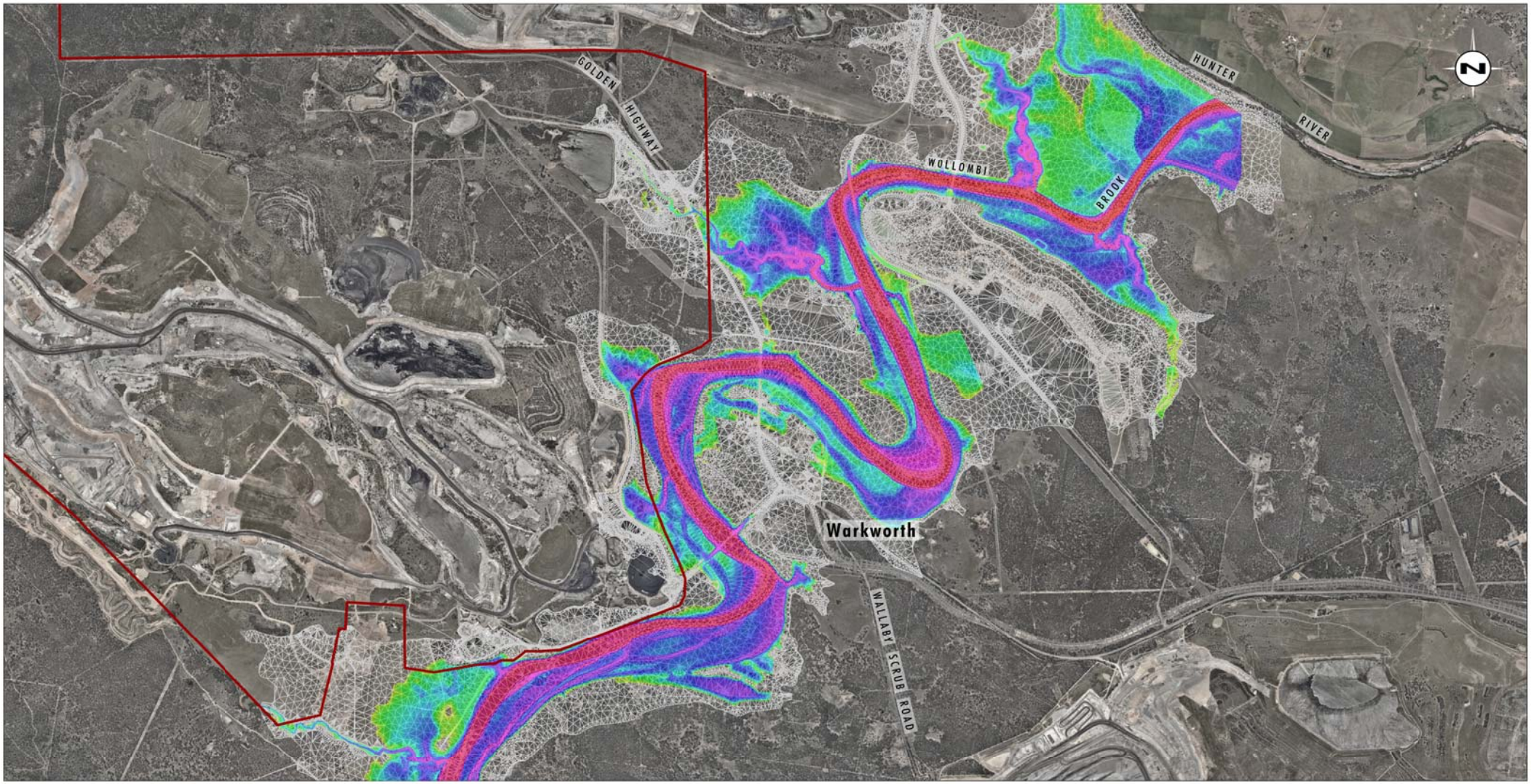


Image Source: Nearmap (Nov 2016)

0 0.5 1.0 2.0km
1:40 000

Legend

Project Area

Water Depth (metres)

12	2	0.001
8	1.5	
6	1	
4	0.5	
3	0.2	

FIGURE 10

1% AEP Flood Event -
Maximum Modelled Flood Depths -
Existing Scenario

File Name (A4): R18/3509_509.dgn
20170224 14.54

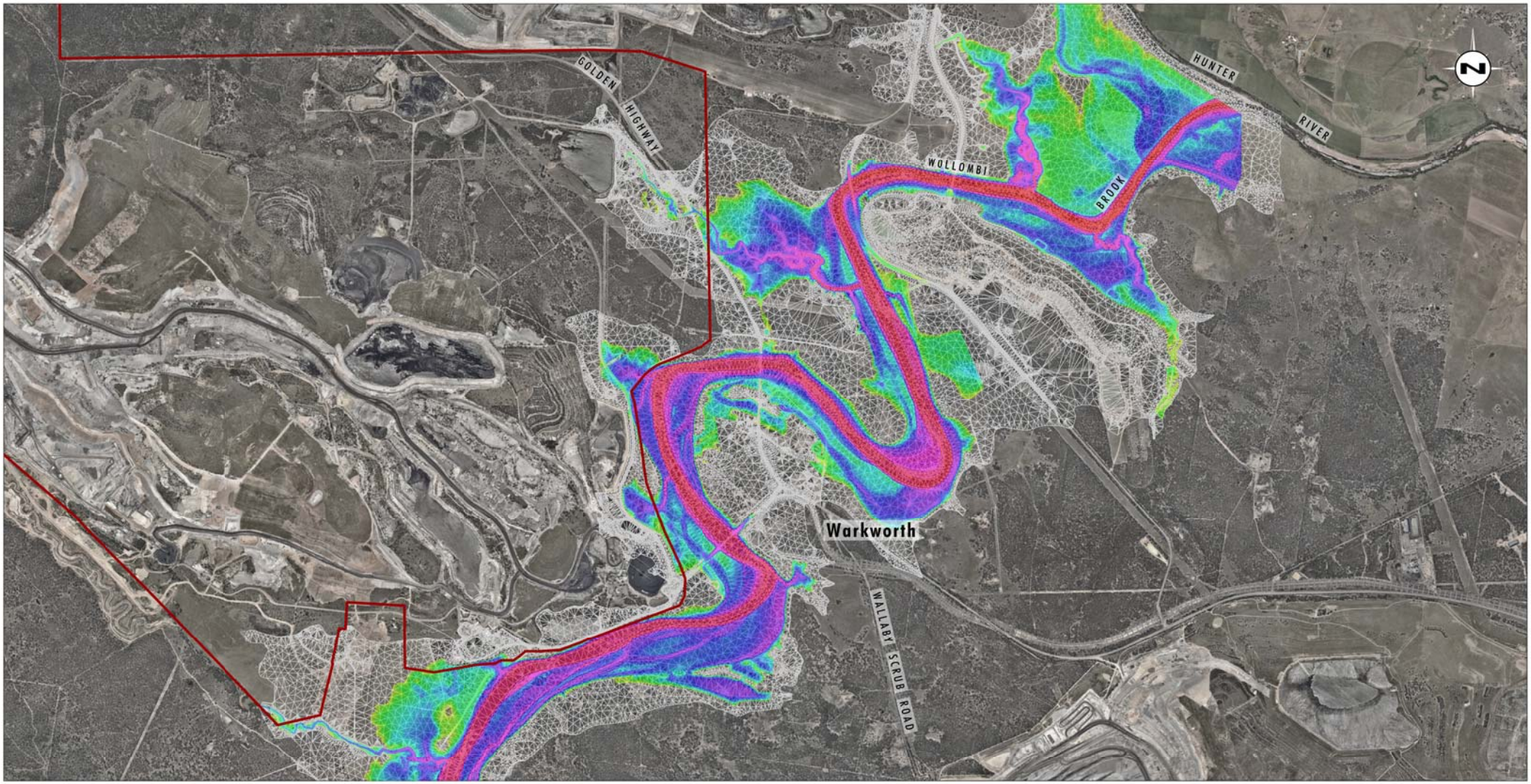


Image Source: Nearmap (Jan2016)

0 0.5 1.0 2.0km
1:40 000

Legend

Project Area

Water Depth (metres)

12	2	0.001
8	1.5	
6	1	
4	0.5	
3	0.2	

FIGURE 11

1% AEP Flood Event -
Maximum Modelled Flood Depths -
Developed Scenario

File Name (A4): R18/3509_510.dgn
20170224 9.57

Image Source: Nearmap (Nov 2016)

0 0.5 1.0 2.0km
1:40 000

Legend

Project Area

Change in Depth (metres)

0.5	0	-0.5
0.2	-0.01	
0.1	-0.05	
0.05	-0.1	
0.01	-0.2	

FIGURE 12

1% AEP Flood Event -
Maximum Modelled Flood Depth -
Changes with Project

File Name (A4): R18/3509_511.dgn
20170224 10.19

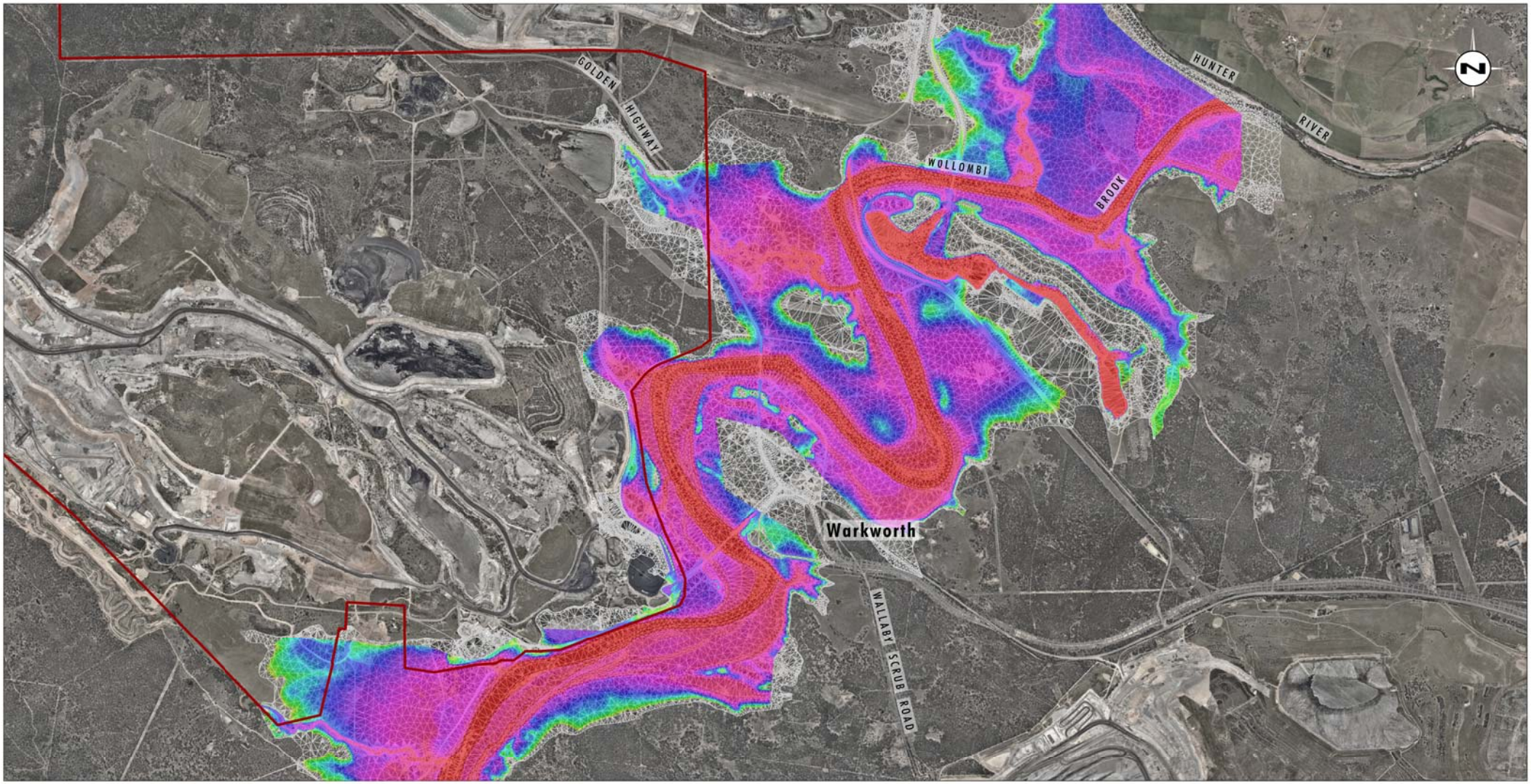


Image Source: Nearmap (Nov 2016)

0 0.5 1.0 2.0km
1:40 000

Legend

Project Area

Water Depth (metres)

12	2	0.001
8	1.5	
6	1	
4	0.5	
3	0.2	

FIGURE 13

PMF Event -
Maximum Modelled Flood Depths -
Existing Scenario

File Name (A4): R18/3509_512.dgn
20170224 12.57

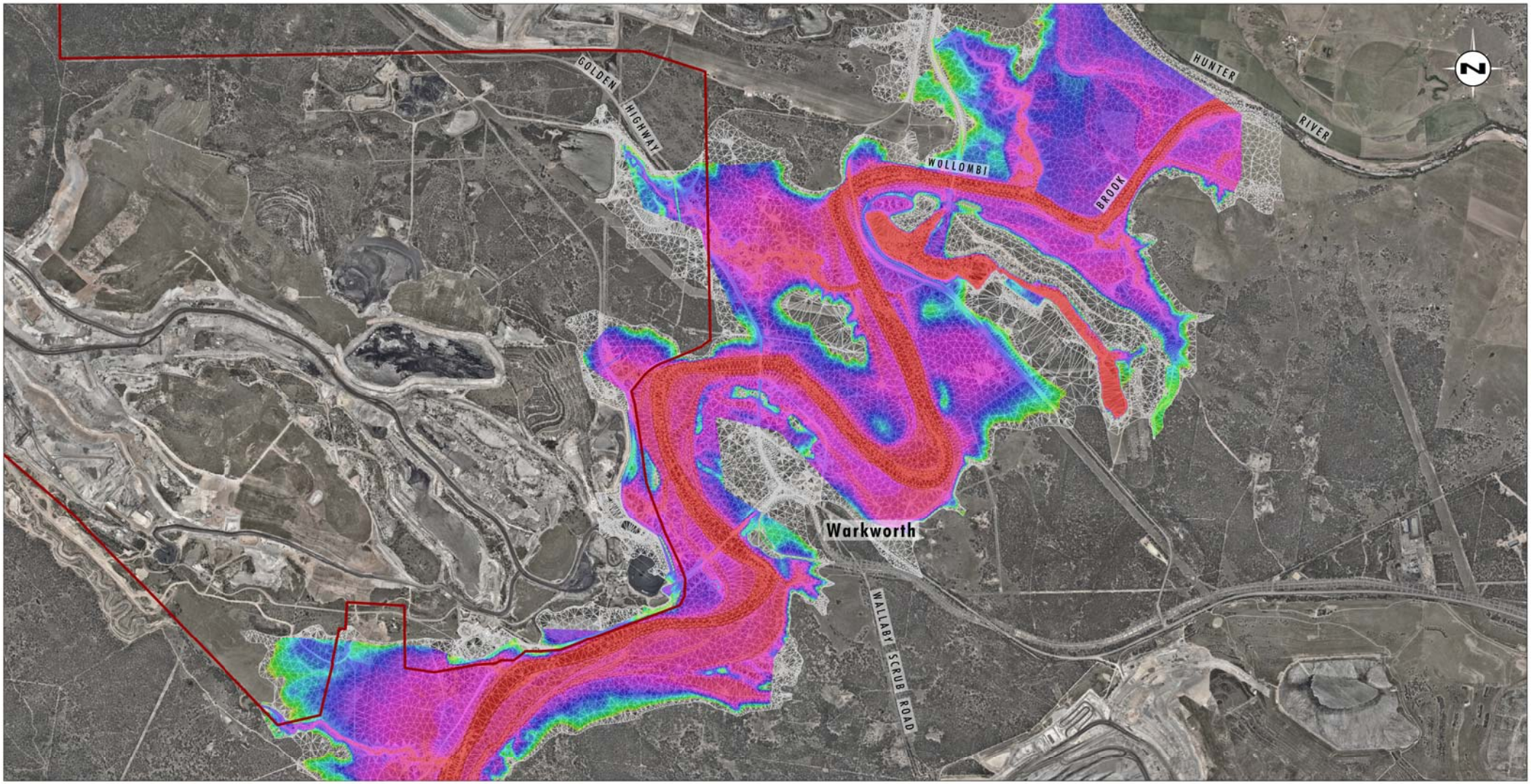


Image Source: Nearmap (Jan2016)

0 0.5 1.0 2.0km
1:40 000

Legend

Project Area

Water Depth (metres)

12	2	0.001
8	1.5	
6	1	
4	0.5	
3	0.2	

FIGURE 14

PMF Event -
Maximum Modelled Flood Depths -
Developed Scenario

File Name (A4): R18/3509_513.dgn
20170224 12.57

Image Source: Nearmap (Nov 2016)

0 0.5 1.0 2.0km
1:40 000

Legend

Project Area

Change in Depth (metres)

0.5	0	-0.5
0.2	-0.01	
0.1	-0.05	
0.05	-0.1	
0.01	-0.2	

FIGURE 15

PMF Event -
Maximum Modelled Flood Depth -
Changes with Project

File Name (A4): R18/3509_559.dgn
20170224 10.19

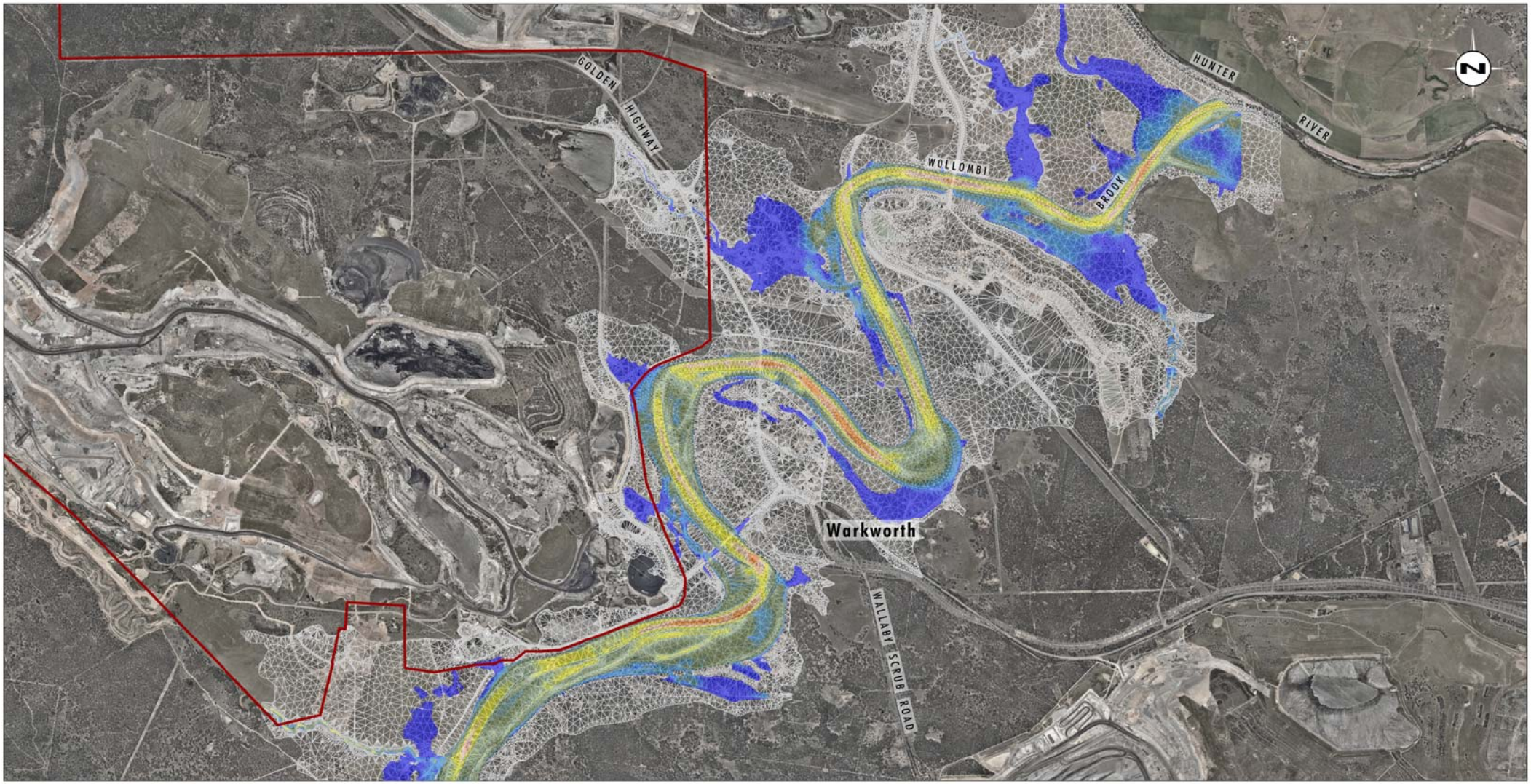


Image Source: Nearmap (Nov 2016)

0 0.5 1.0 2.0km
1:40 000

Legend

Project Area

Flow Velocity (m/s)

5	1.25
2.25	1
2	0.75
1.75	0.5
1.5	0.25

FIGURE 16

10% AEP Flood Event -
Maximum Modelled Flow Velocities -
Existing Scenario

File Name (A4): R18/3509_560.dgn
20170224 13.09

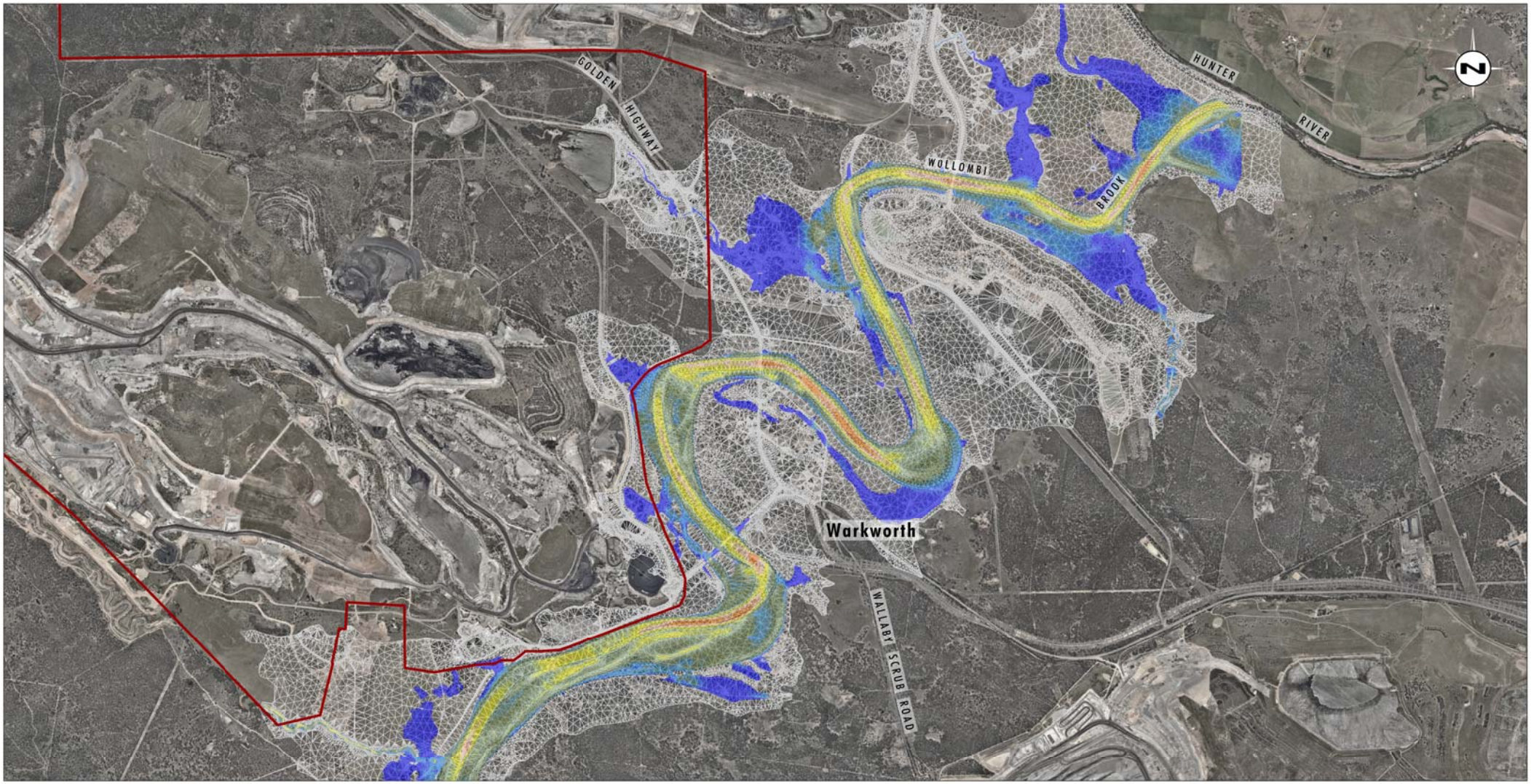


Image Source: Nearmap (Jan2016)

0 0.5 1.0 2.0km
1:40 000

Legend

Project Area

Flow Velocity (m/s)

5	1.25
2.25	1
2	0.75
1.75	0.5
1.5	0.25

FIGURE 17

10% AEP Flood Event -
Maximum Modelled Flow Velocities -
Developed Scenario

File Name (A4): R18/3509_561.dgn
20170224 13.09

Image Source: Nearmap (Nov 2016)

0 0.5 1.0 2.0km
1:40 000

Legend

Project Area

Change in Depth (metres)

0.5	0	-0.5
0.2	-0.01	
0.1	-0.05	
0.05	-0.1	
0.01	-0.2	

FIGURE 18

10% AEP Flood Event -
Maximum Modelled Flow Velocities -
Changes with Project

File Name (A4): R18/3509_562.dgn
20170224 10.19

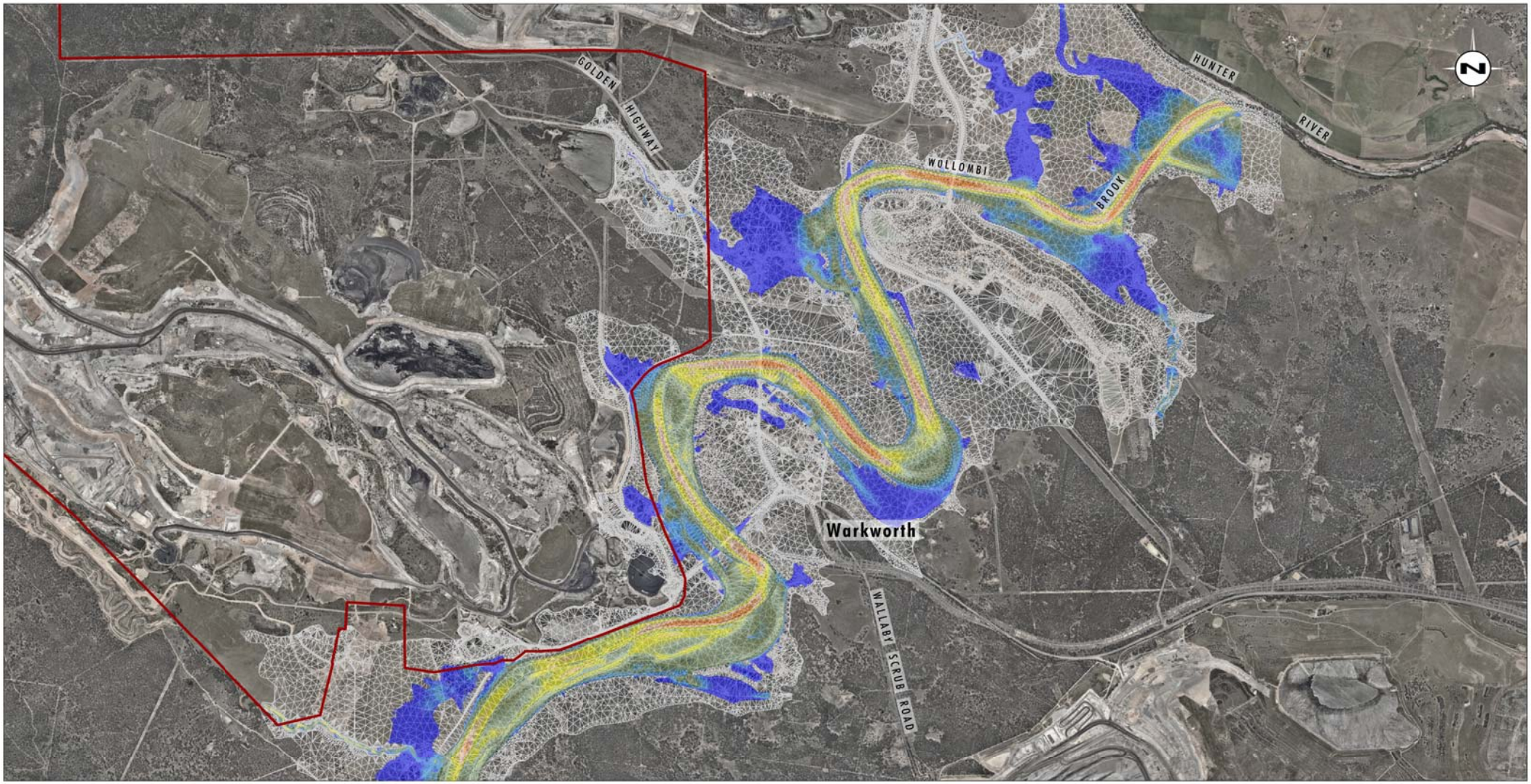


Image Source: Nearmap (Nov 2016)

0 0.5 1.0 2.0km
1:40 000

Legend

Project Area

Flow Velocity (m/s)

5	1.25
2.25	1
2	0.75
1.75	0.5
1.5	0.25

FIGURE 19

5% AEP Flood Event -
Maximum Modelled Flow Velocities -
Existing Scenario

File Name (A4): R18/3509_563.dgn
20170224 13.09

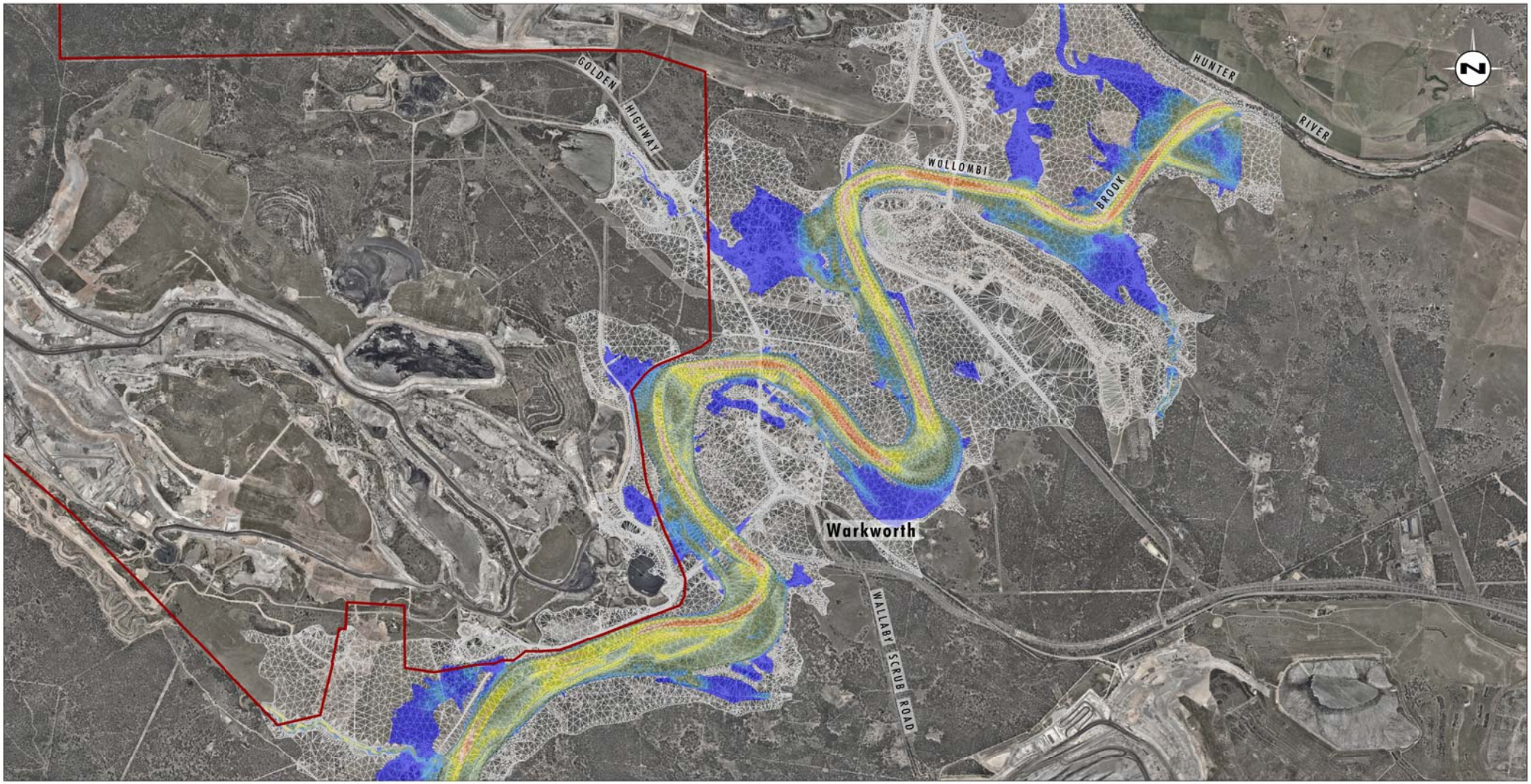


Image Source: Nearmap (Jan2016)

0 0.5 1.0 2.0km
1:40 000

Legend

Project Area

Flow Velocity (m/s)

5	1.25
2.25	1
2	0.75
1.75	0.5
1.5	0.25

FIGURE 20

5% AEP Flood Event -
Maximum Modelled Flow Velocities -
Developed Scenario

File Name (A4): R18/3509_564.dgn
20170224 13.09

Image Source: Nearmap (Nov 2016)

0 0.5 1.0 2.0km
1:40 000

Legend

Project Area

Change in Depth (metres)

0.5	0	-0.5
0.2	-0.01	
0.1	-0.05	
0.05	-0.1	
0.01	-0.2	

FIGURE 21

5% AEP Flood Event -
Maximum Modelled Flow Velocities-
Changes with Project

File Name (A4): R18/3509_565.dgn
20170329 8.18

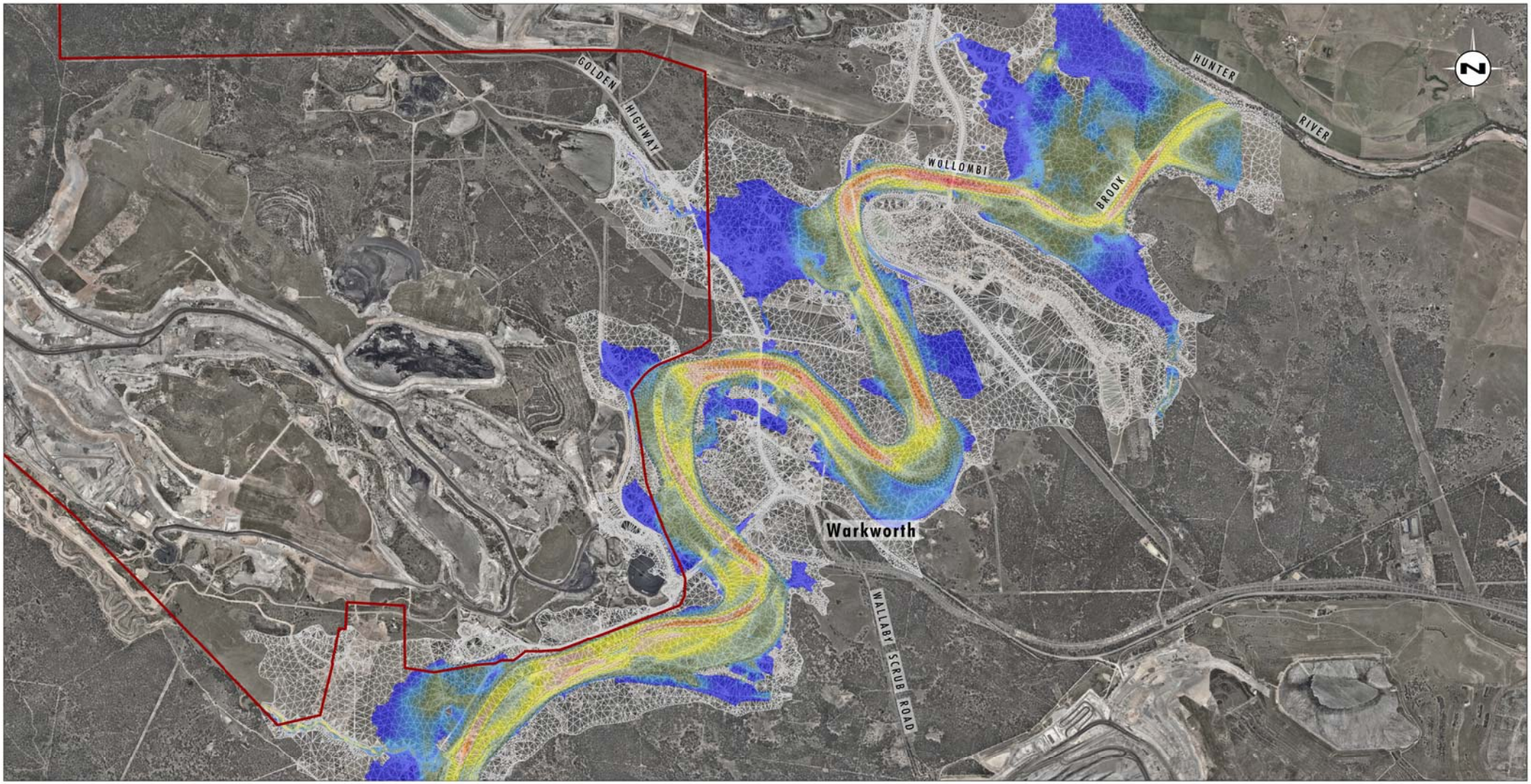


Image Source: Nearmap (Nov 2016)

0 0.5 1.0 2.0km
1:40 000

Legend

Project Area

Flow Velocity (m/s)

5	1.25
2.25	1
2	0.75
1.75	0.5
1.5	0.25

FIGURE 22

1% AEP Flood Event -
Maximum Modelled Flow Velocities -
Existing Scenario

File Name (A4): R18/3509_566.dgn
20170329 8.15

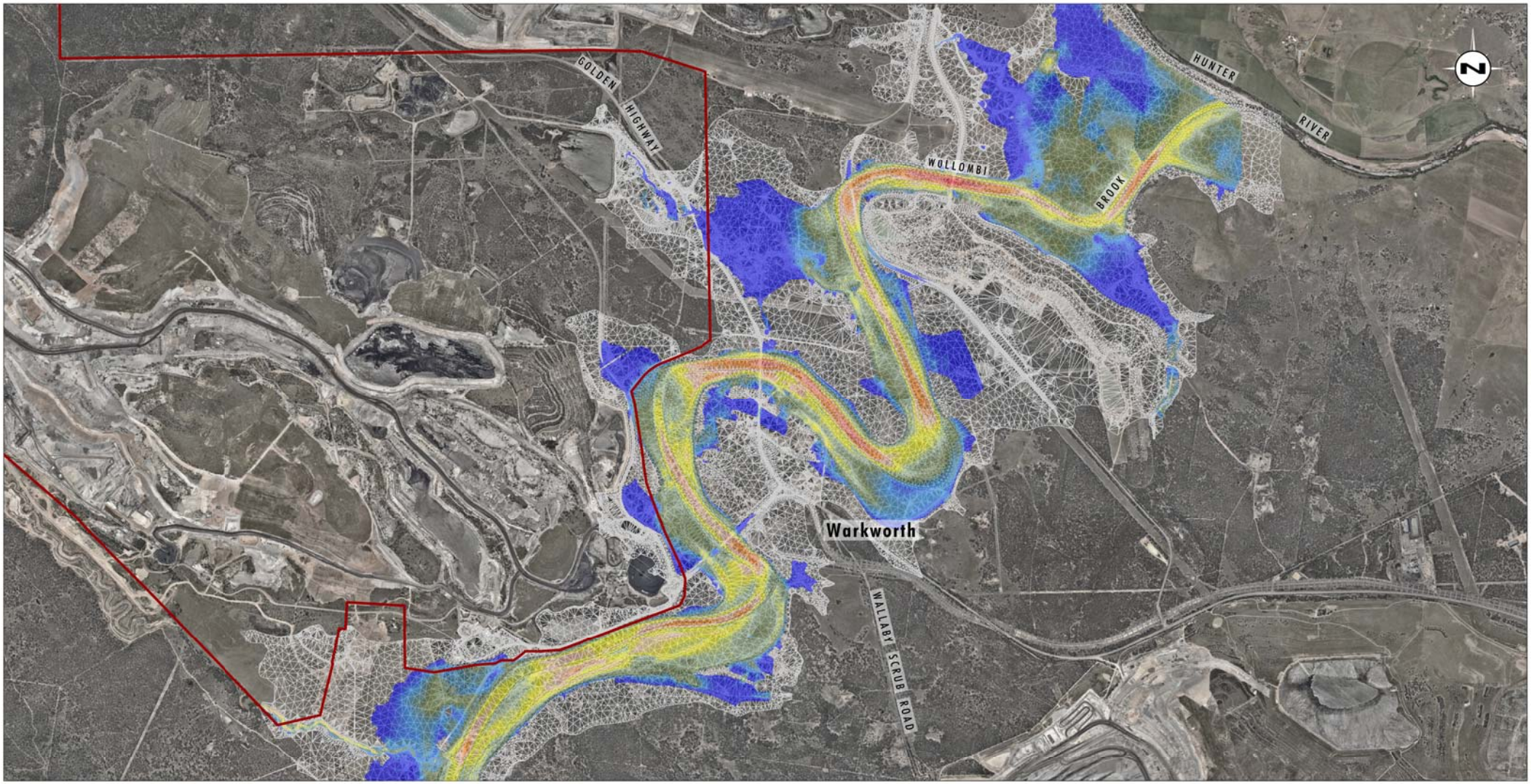


Image Source: Nearmap (Jan2016)

0 0.5 1.0 2.0km
1:40 000

Legend

Project Area

Flow Velocity (m/s)

5	1.25
2.25	1
2	0.75
1.75	0.5
1.5	0.25

FIGURE 23

1% AEP Flood Event -
Maximum Modelled Flow Velocities -
Developed Scenario

File Name (A4): R18/3509_567.dgn
20170329 8.20

Image Source: Nearmap (Nov 2016)

0 0.5 1.0 2.0km
1:40 000

Legend

Project Area

Change in Depth (metres)

0.5	0	-0.5
0.2	-0.01	
0.1	-0.05	
0.05	-0.1	
0.01	-0.2	

FIGURE 24

1% AEP Flood Event -
Maximum Modelled Flow Velocities-
Changes with Project

File Name (A4): R18/3509_568.dgn
20170329 8.22

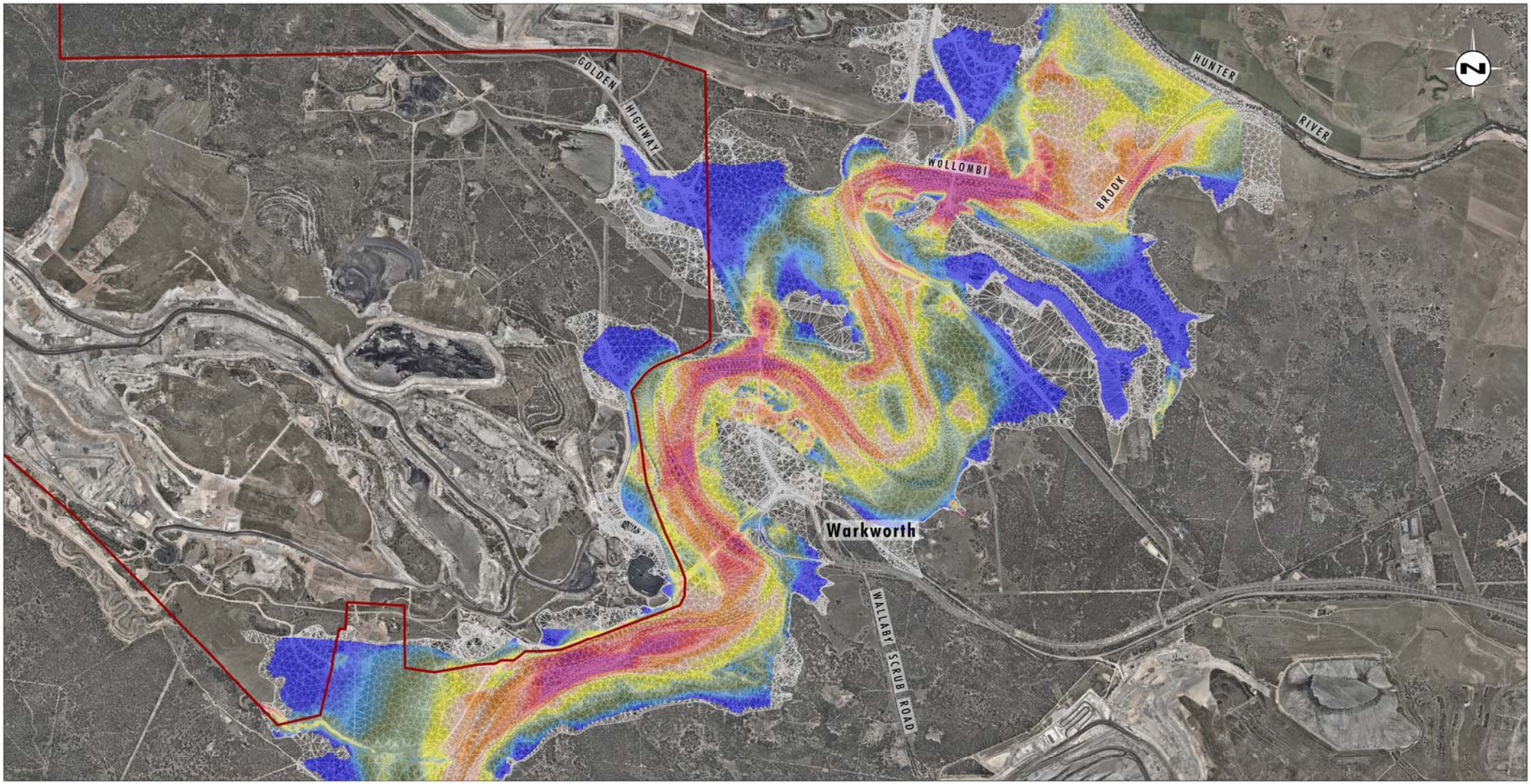


Image Source: Nearmap (Nov 2016)

0 0.5 1.0 2.0km
1:40 000

Legend

Project Area

Flow Velocity (m/s)

5	1.25
2.25	1
2	0.75
1.75	0.5
1.5	0.25

FIGURE 25

PMF Event -
Maximum Modelled Flow Velocities -
Existing Scenario

File Name (A4): R18/3509_569.dgn
20170329 8.25

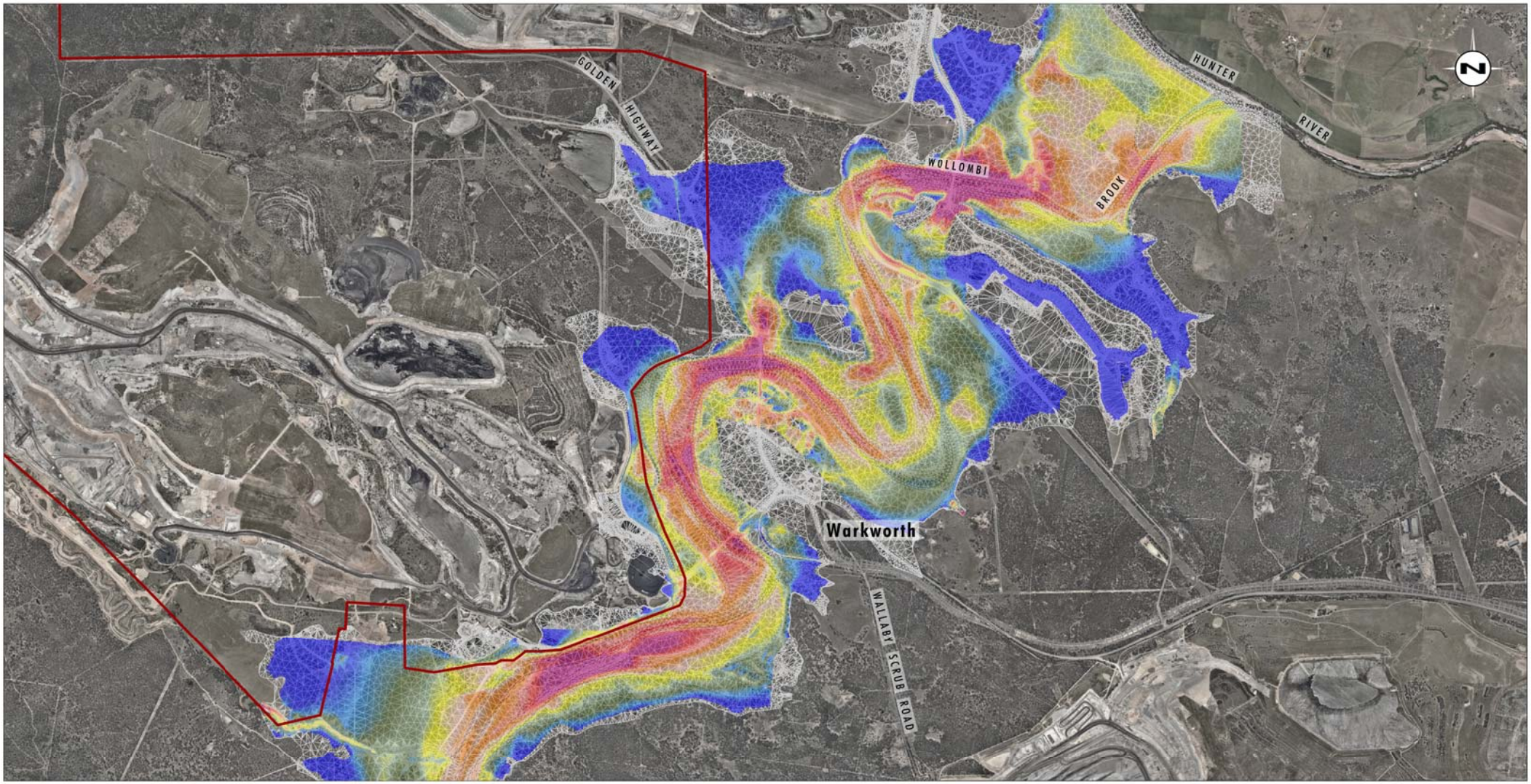


Image Source: Nearmap (Jan2016)

0 0.5 1.0 2.0km
1:40 000

Legend

Project Area

Flow Velocity (m/s)

5	1.25
2.25	1
2	0.75
1.75	0.5
1.5	0.25

FIGURE 26

PMF Event -
Maximum Modelled Flow Velocities -
Developed Scenario

File Name (A4): R18/3509_570.dgn
20170329 8.33

Image Source: Nearmap (Nov 2016)

0 0.5 1.0 2.0km
1:40 000

Legend

Project Area

Change in Depth (metres)

0.5	0	-0.5
0.2	-0.01	
0.1	-0.05	
0.05	-0.1	
0.01	-0.2	

FIGURE 27

PMF Event -
Maximum Modelled Flow Velocities-
Changes with Project

File Name (A4): R18/3509_571.dgn
20170329 8.35

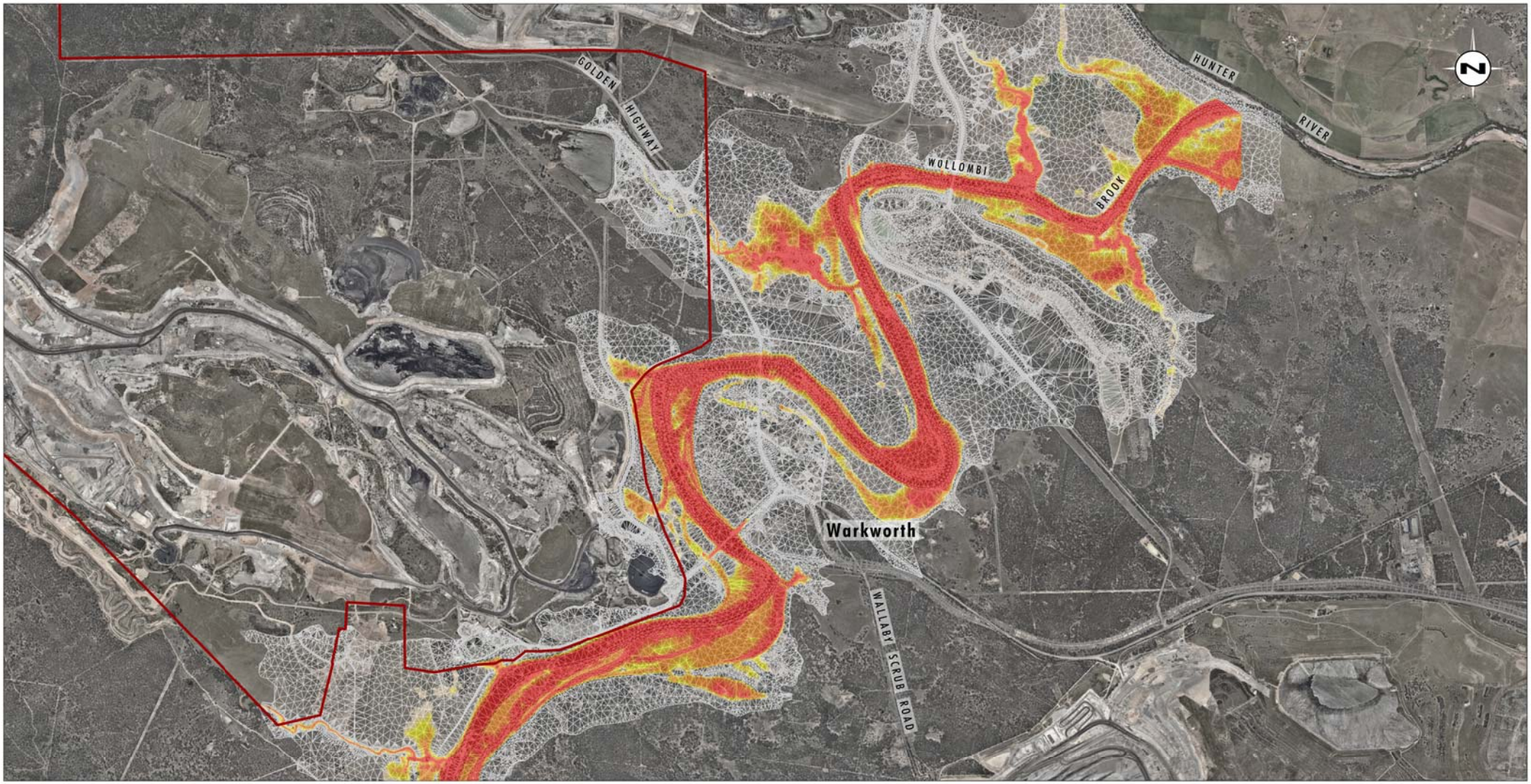


Image Source: Nearmap (Nov 2016)

0 0.5 1.0 2.0km
1:40 000

Legend

Project Area

Hazard Category

- Low Hazard - Walking and Vehicle Access
- Low Hazard - Vehicles unstable
- High Hazard - Wading unsafe
- High Hazard - Damage to light structures

FIGURE 28

10% AEP Flood Event -
Maximum Modelled Flood Hazard Categories -
Existing Scenario

File Name (A4): R18/3509_572.dgn
20170329 8.38

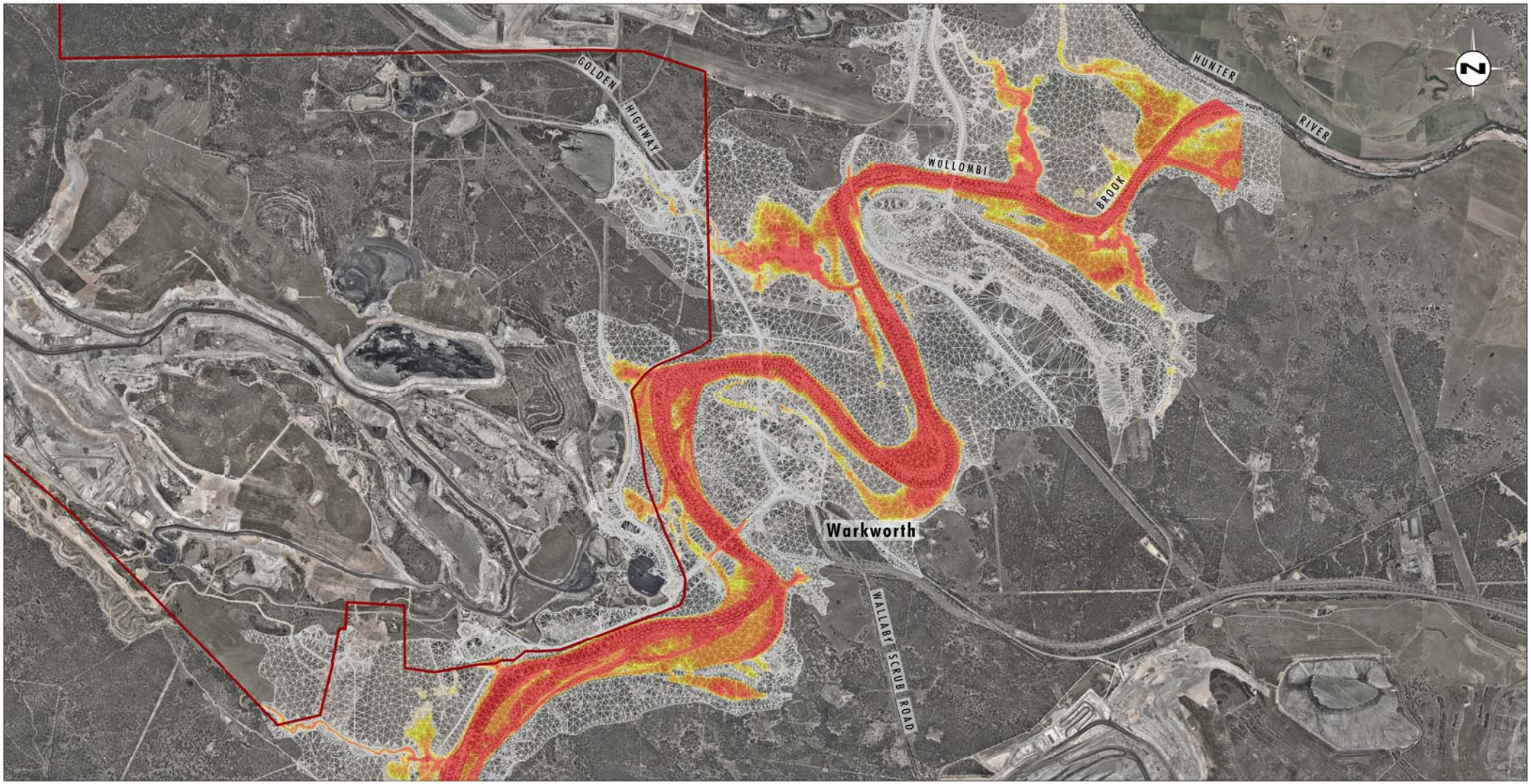


Image Source: Nearmap (Nov 2016)

0 0.5 1.0 2.0km
1:40 000

Legend

Project Area

Hazard Category

- Low Hazard - Walking and Vehicle Access
- Low Hazard - Vehicles unstable
- High Hazard - Wading unsafe
- High Hazard - Damage to light structures

FIGURE 29

10% AEP Flood Event -
Maximum Modelled Flood Hazard Categories -
Developed Scenario

File Name (A4): R18/3509_573.dgn
20170329 8.41

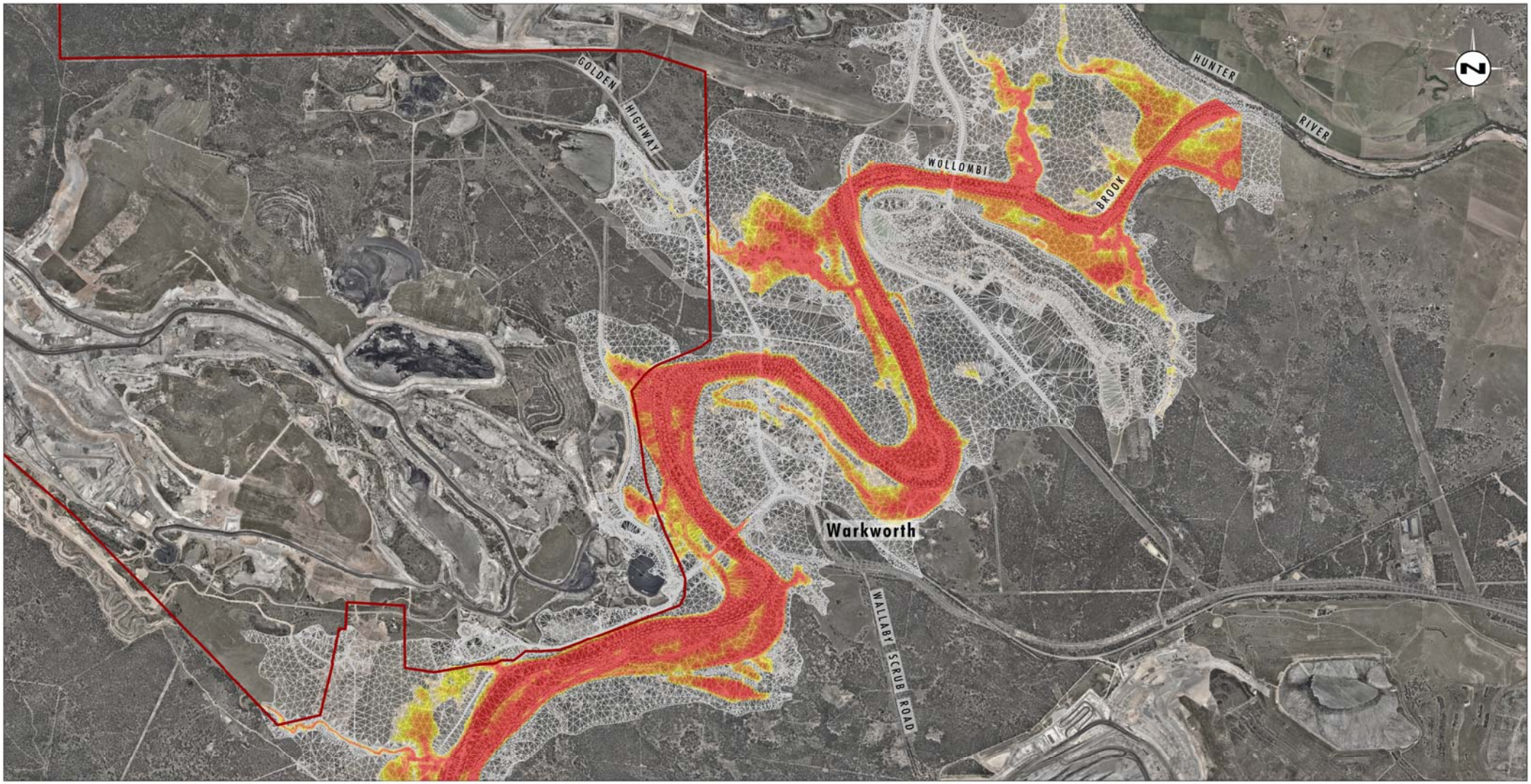


Image Source: Nearmap (Nov 2016)

0 0.5 1.0 2.0km
1:40 000

Legend

Project Area

Hazard Category

- Low Hazard - Walking and Vehicle Access
- Low Hazard - Vehicles unstable
- High Hazard - Wading unsafe
- High Hazard - Damage to light structures

FIGURE 30

5% AEP Flood Event -
Maximum Modelled Flood Hazard Categories -
Existing Scenario

File Name (A4): R18/3509_574.dgn
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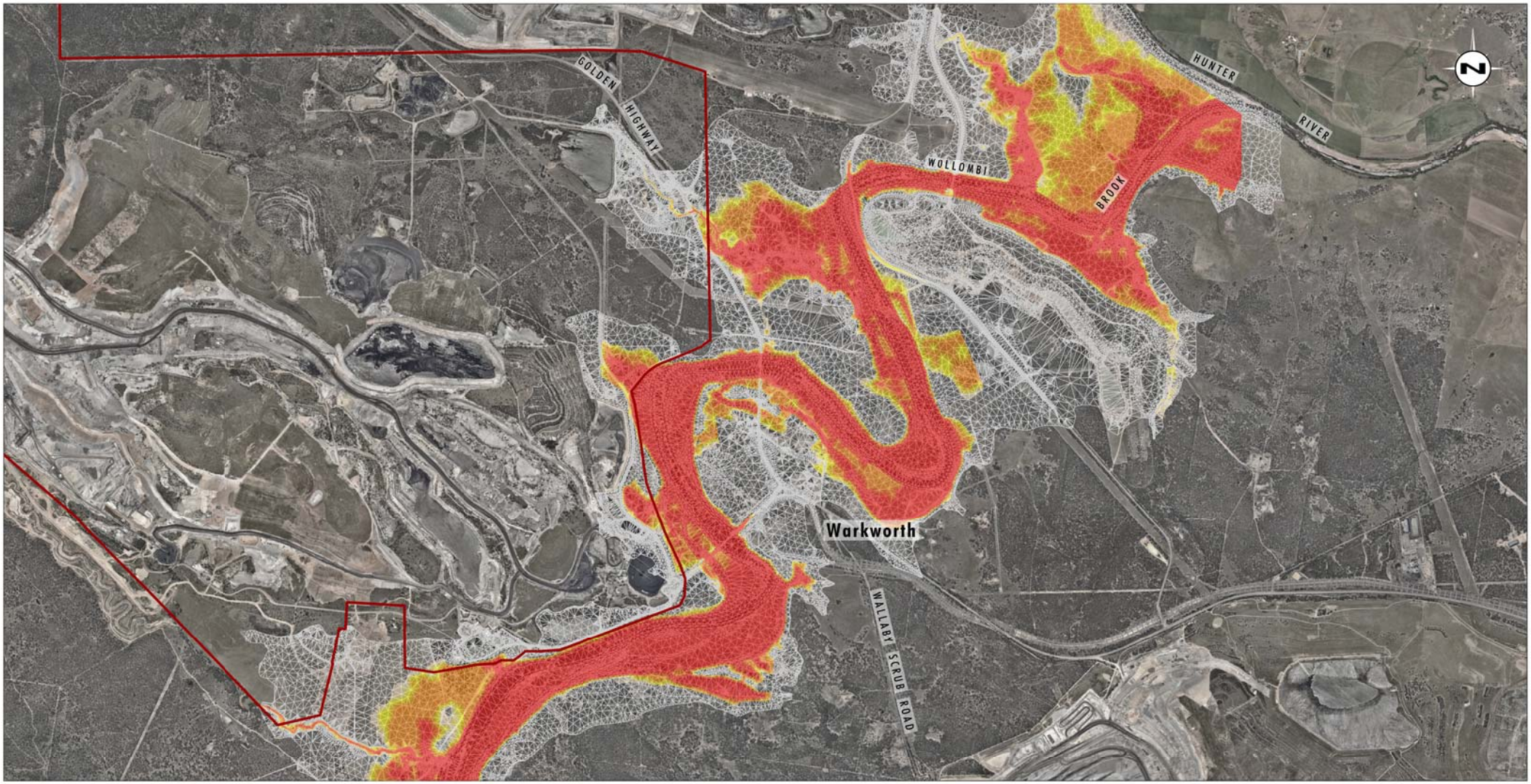

Image Source: Nearmap (Nov 2016)

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1:40 000

Legend

Project Area

Hazard Category

- Low Hazard - Walking and Vehicle Access
- Low Hazard - Vehicles unstable
- High Hazard - Wading unsafe
- High Hazard - Damage to light structures

FIGURE 31

1% AEP Flood Event -
Maximum Modelled Flood Hazard Categories -
Existing Scenario

File Name (A4): R18/3509_576.dgn
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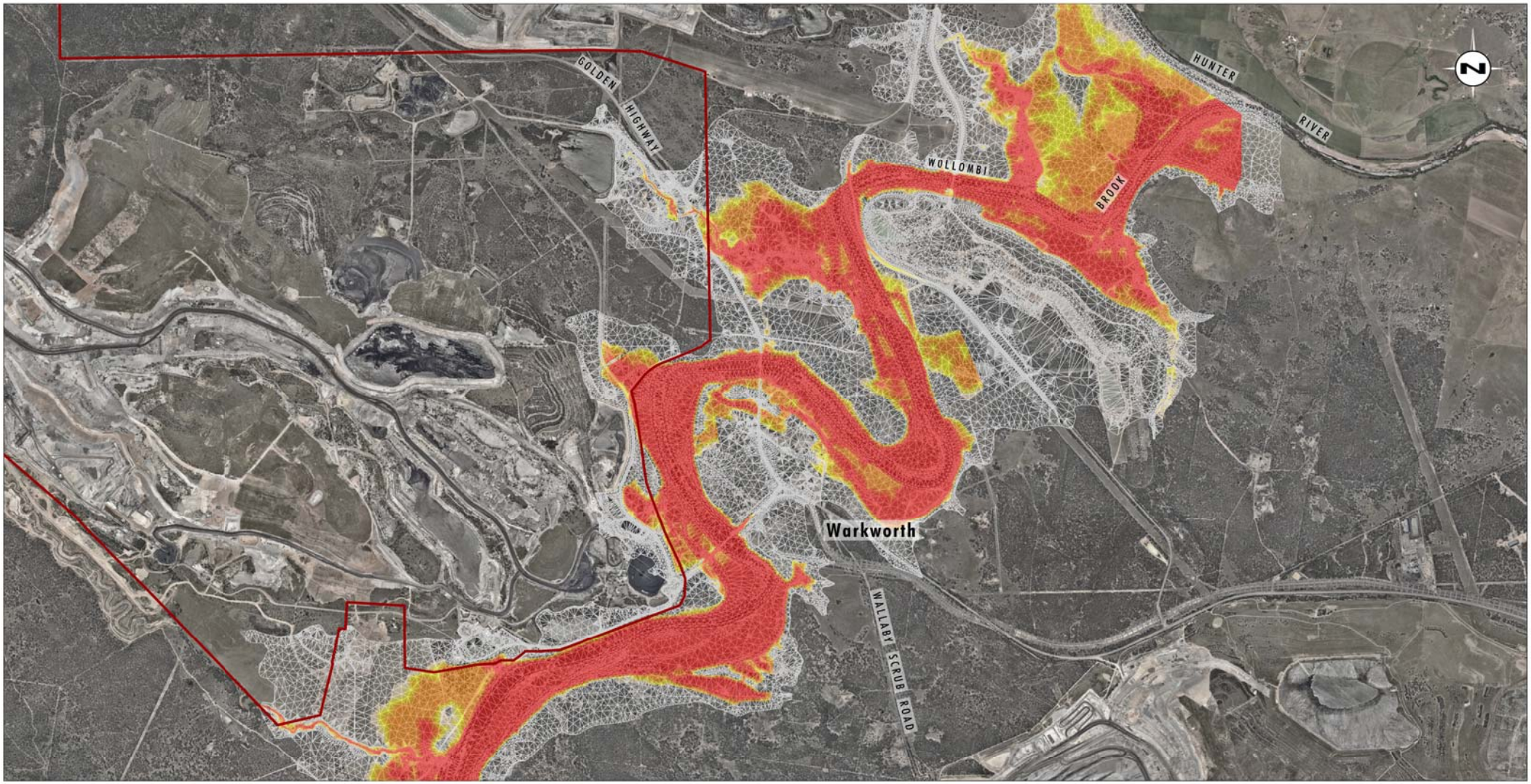

Image Source: Nearmap (Nov 2016)

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1:40 000

Legend

Project Area

Hazard Category

- Low Hazard - Walking and Vehicle Access
- Low Hazard - Vehicles unstable
- High Hazard - Wading unsafe
- High Hazard - Damage to light structures

FIGURE 32

1% AEP Flood Event -
Maximum Modelled Flood Hazard Categories -
Developed Scenario

File Name (A4): R18/3509_577.dgn
20170329 8.48

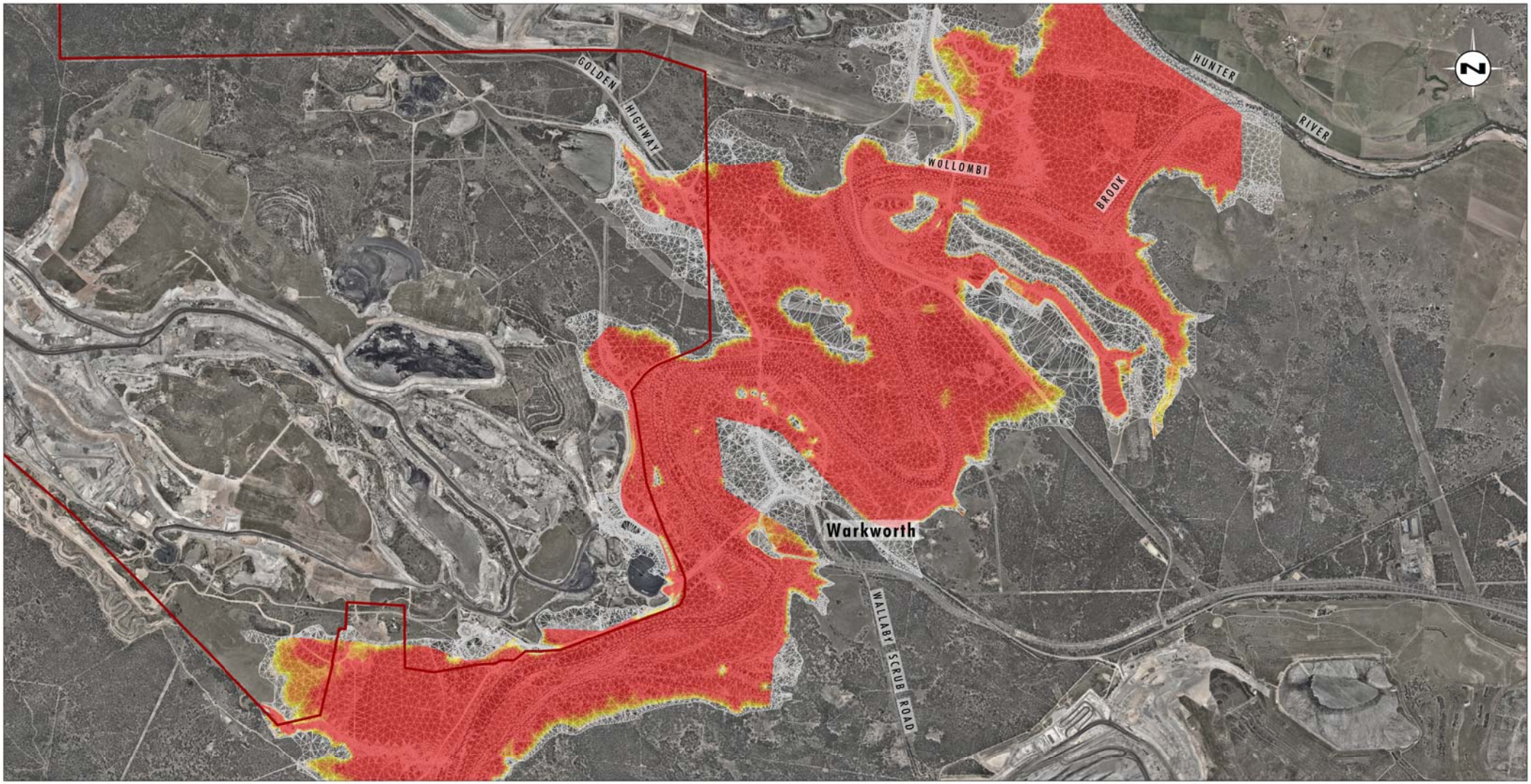

Image Source: Nearmap (Nov 2016)

0 0.5 1.0 2.0km
1:40 000

Legend

Project Area

Hazard Category

- Low Hazard - Walking and Vehicle Access
- Low Hazard - Vehicles unstable
- High Hazard - Wading unsafe
- High Hazard - Damage to light structures

FIGURE 33

PMF Event - Maximum Modelled Flood Hazard Categories - Existing Scenario

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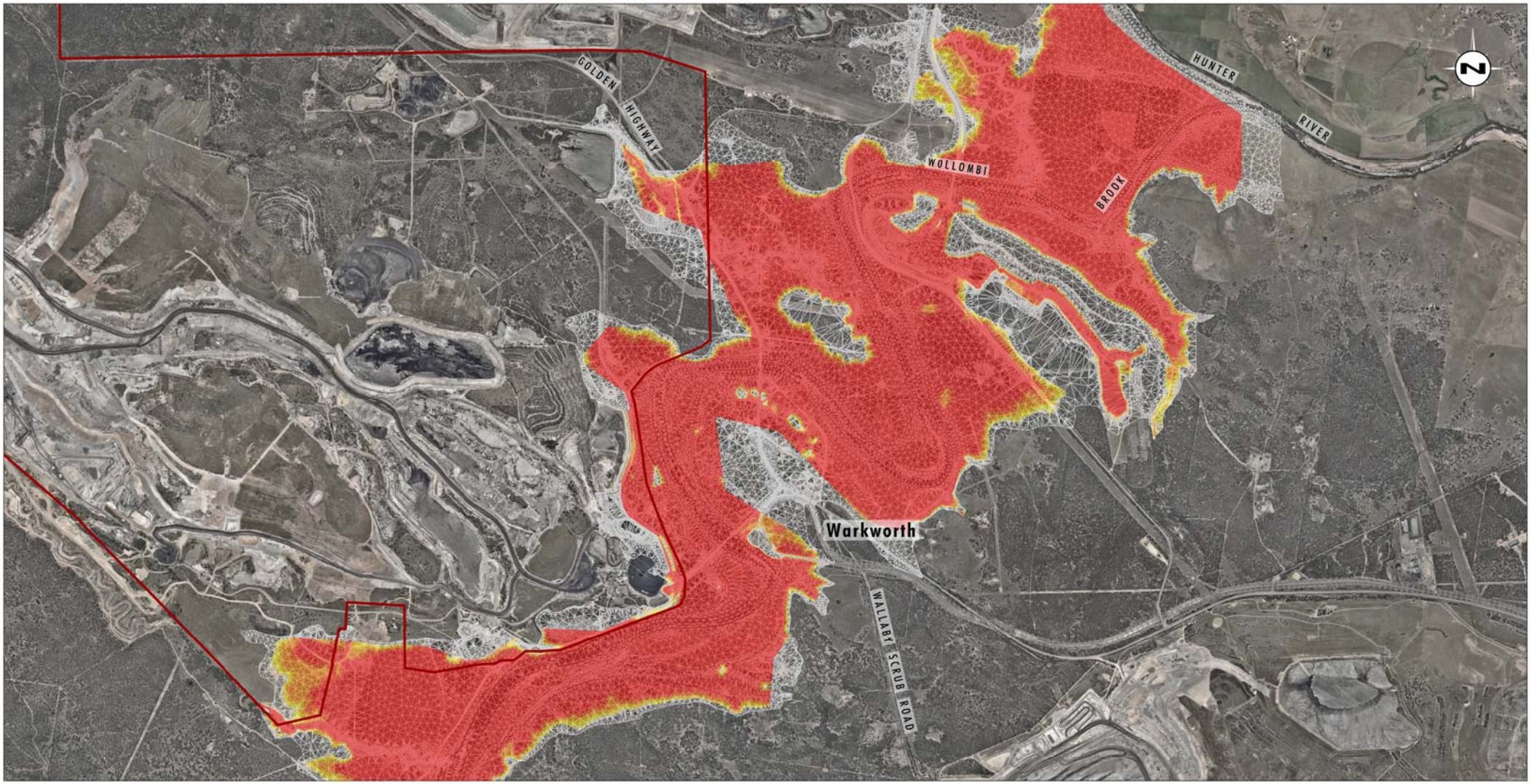

Image Source: Nearmap (Nov 2016)

0 0.5 1.0 2.0km
1:40 000

Legend

Project Area

Hazard Category

- Low Hazard - Walking and Vehicle Access
- Low Hazard - Vehicles unstable
- High Hazard - Wading unsafe
- High Hazard - Damage to light structures

FIGURE 34

PMF Event - Maximum Modelled Flood Hazard Categories - Developed Scenario

File Name (A4): R18/3509_579.dgn
20170329 8.53

APPENDIX 2

Groundwater Figures

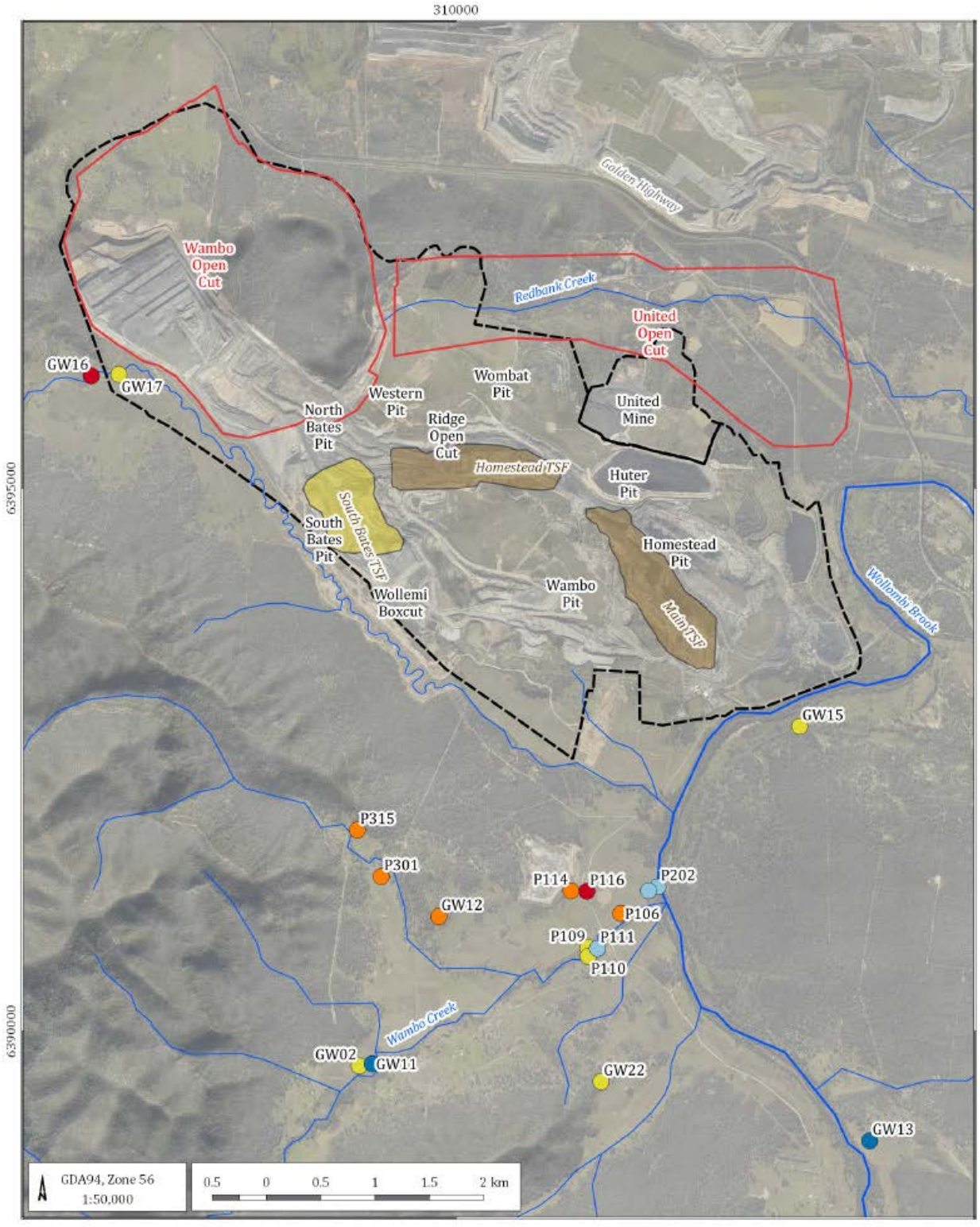

Figure 1 2015 water quality distribution map – Electrical conductivity

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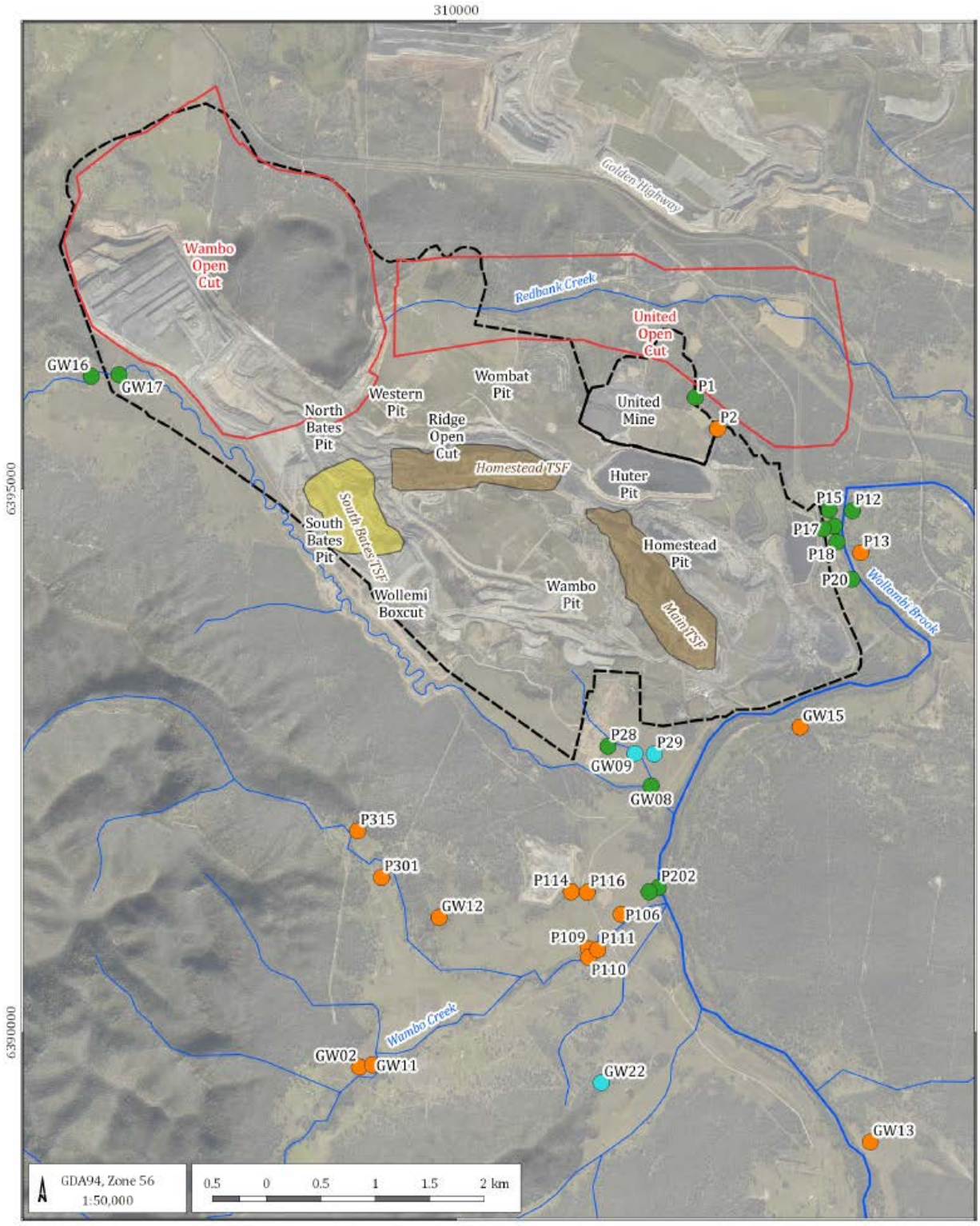

Figure 2 2015 water quality distribution map – pH

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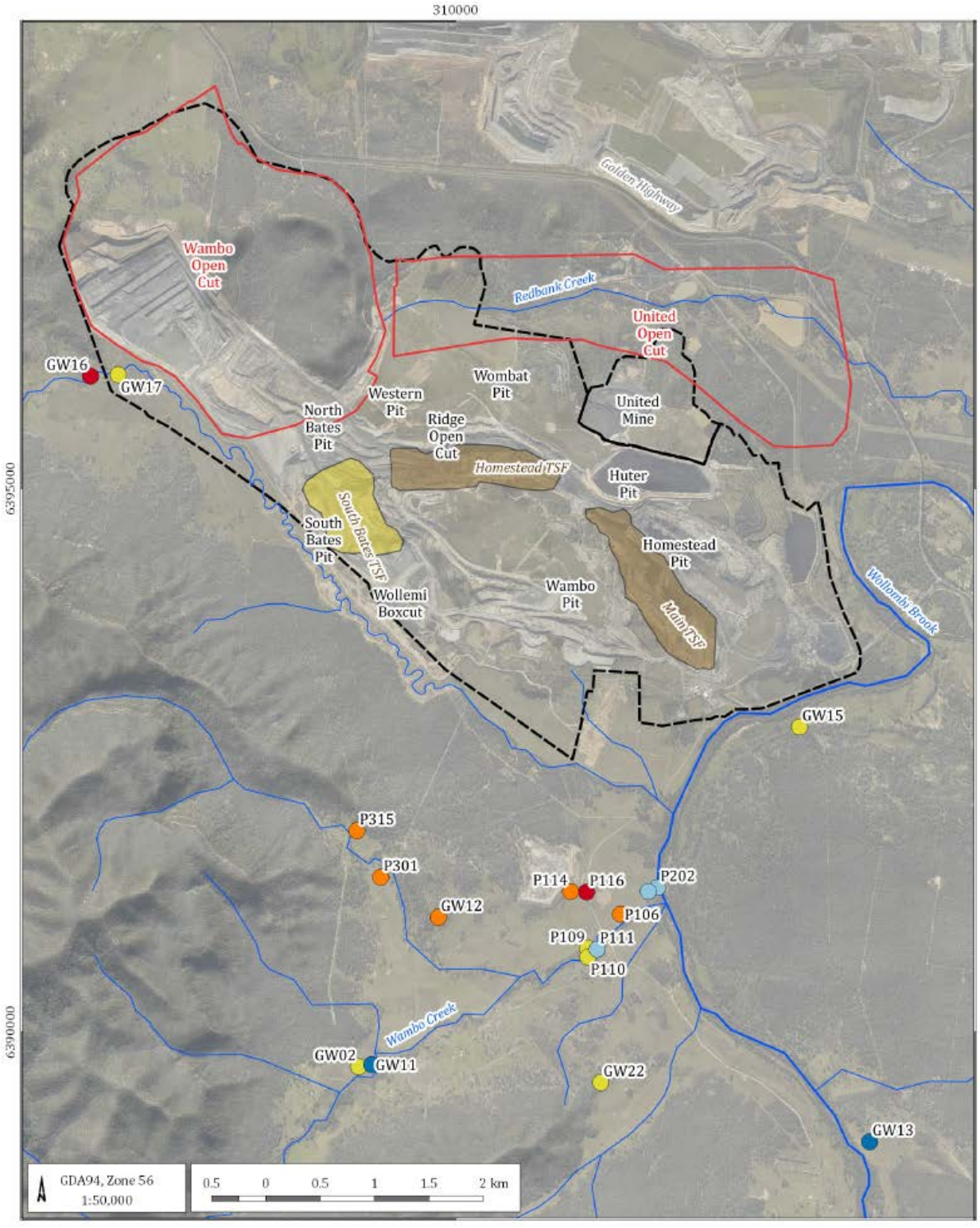

Figure 3 2015 water quality distribution map – Total aluminium

© AGE, 2017

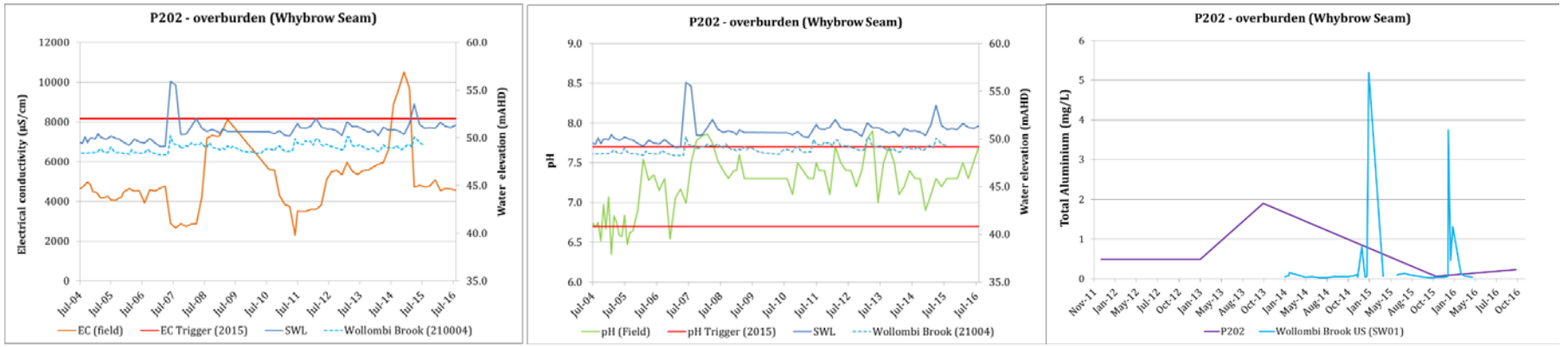

Figure 4 Permian coal measures bore P202: EC (left), pH (middle) and water level trends versus 2015 trigger levels and total aluminium trends (right)

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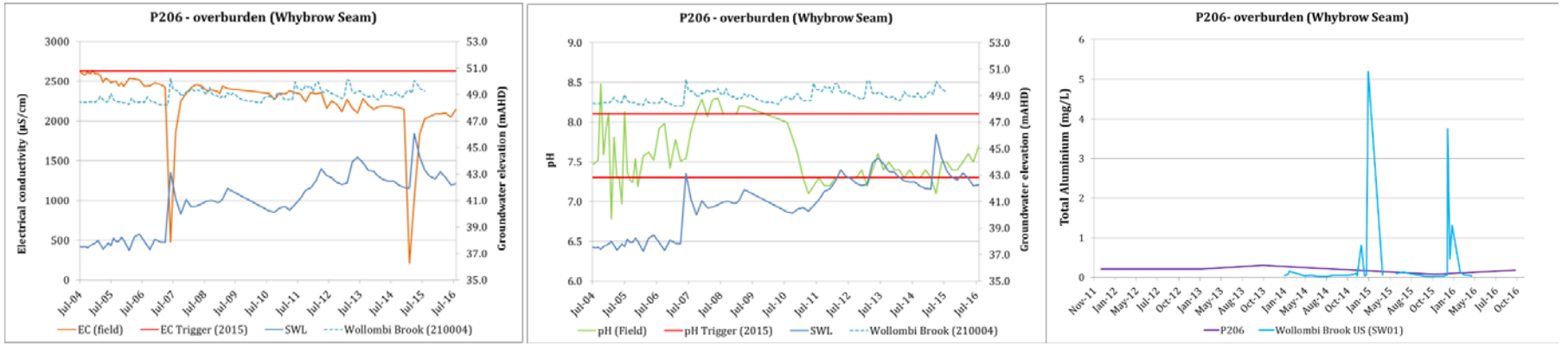

Figure 5 Permian coal measures bore P206: EC (left), pH (middle) and water level trends versus 2015 trigger levels and total aluminium trends (right)

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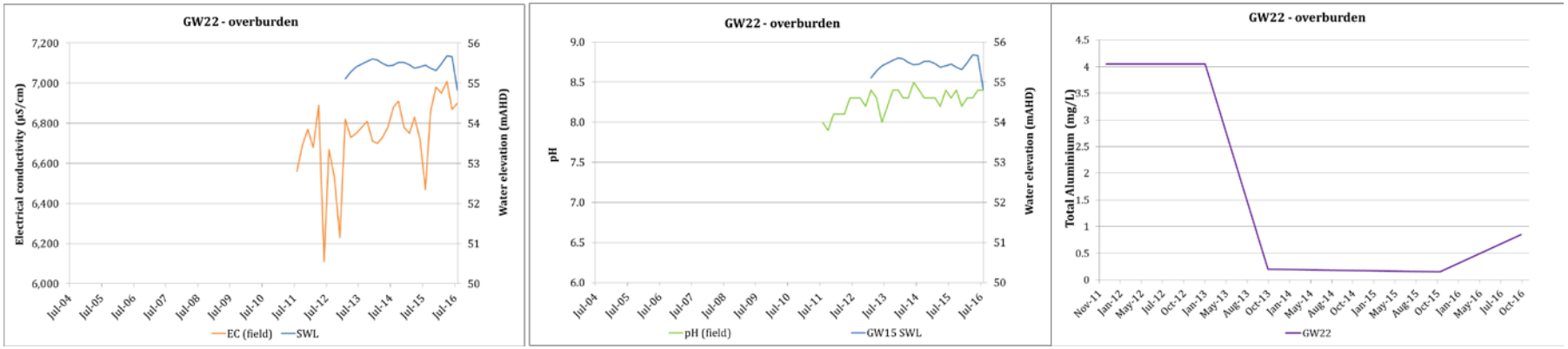

Figure 6 Permian coal measures bore GW22: EC (left), pH (middle) and water level trends and total aluminium trends (right)

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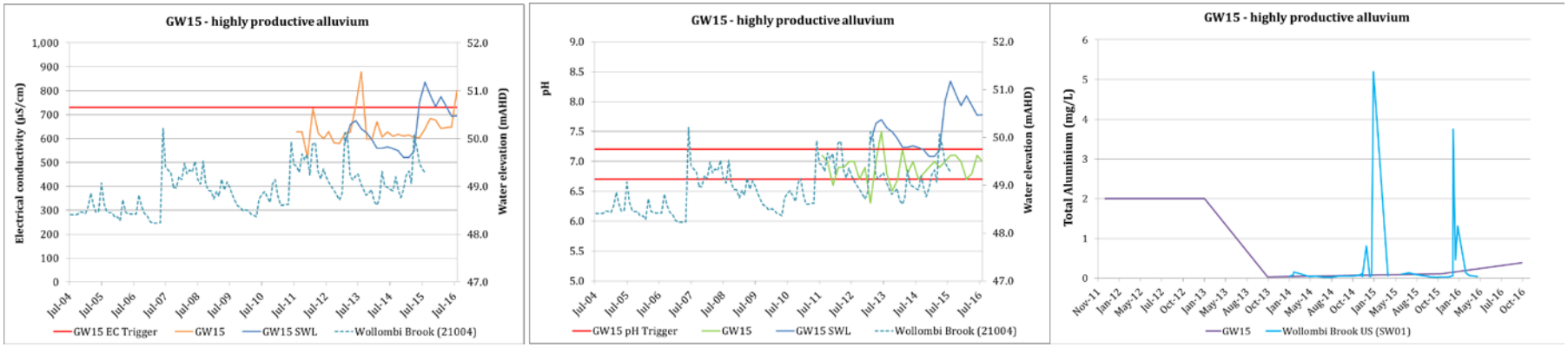

Figure 7 Highly productive alluvium bore GW15: EC (left), pH (middle) and water level trends versus 2015 trigger levels and total aluminium trends (right)

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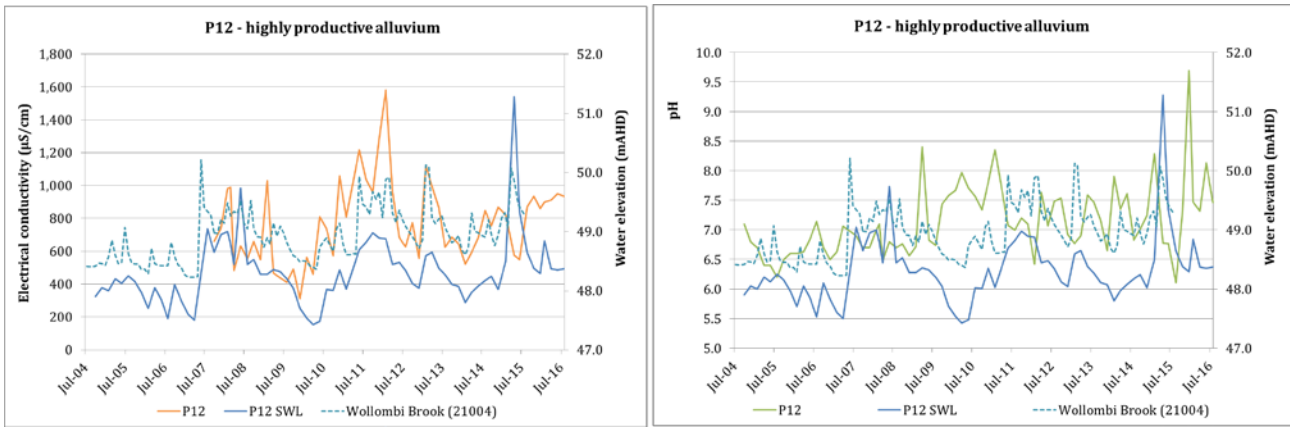

Figure 8 Highly productive alluvium bore P12: EC, pH and water level trends (no triggers)

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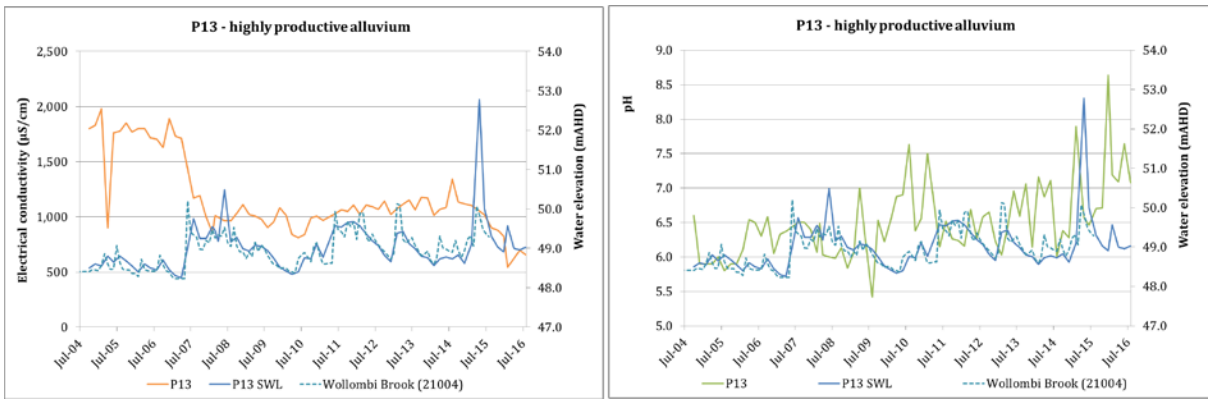

Figure 9 Highly productive alluvium bore P13: EC, pH and water level trends (no triggers)

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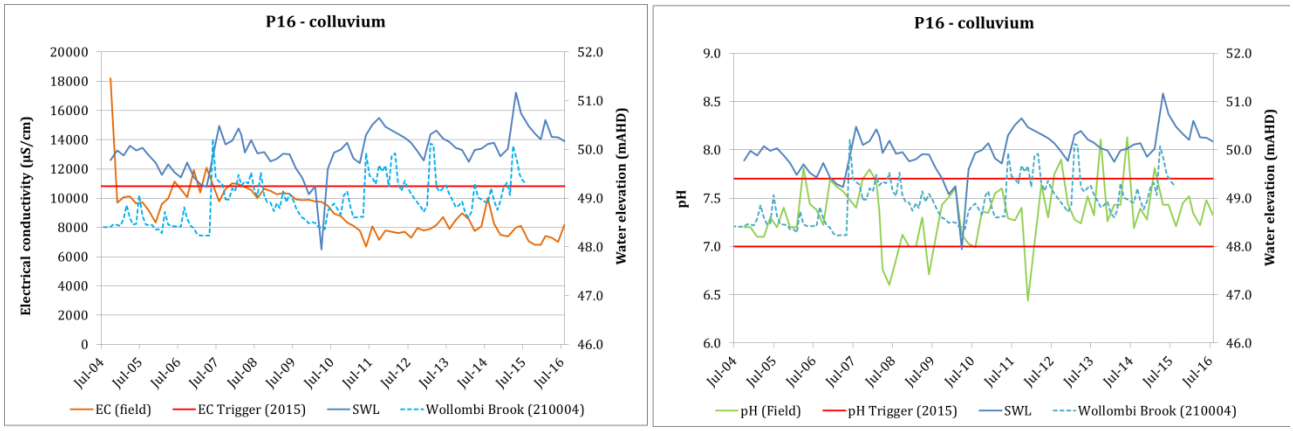

Figure 10 Colluvial bore P16: EC, pH and water level trends versus 2015 trigger levels

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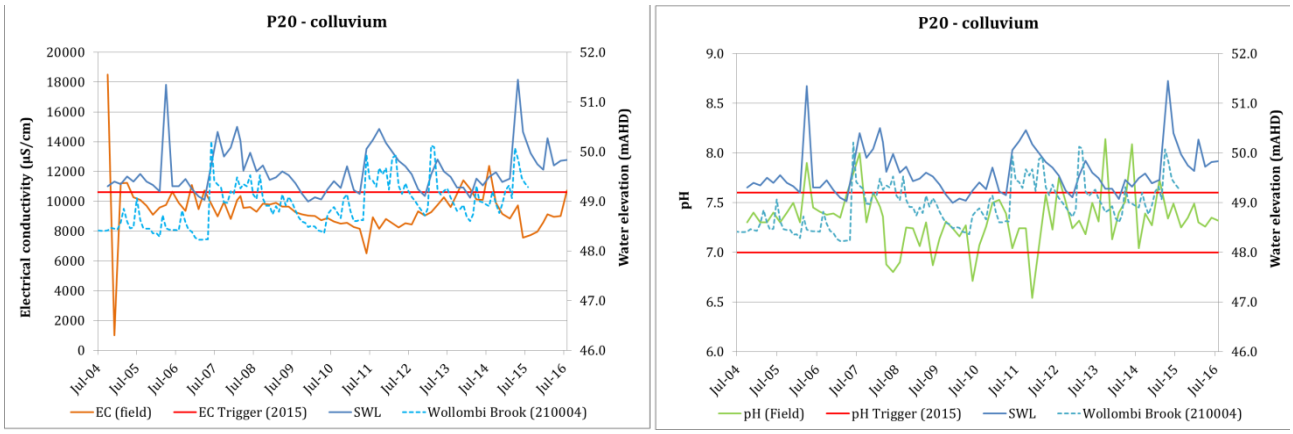

Figure 11 Colluvial bore P20: EC, pH and water level trends versus 2015 trigger levels

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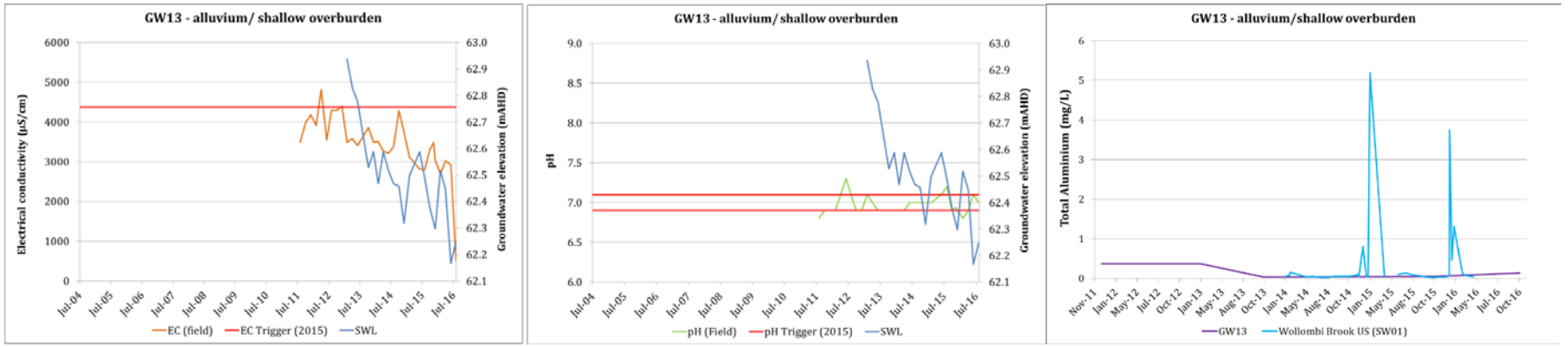

Figure 12 Less productive alluvium bore GW13: EC (left), pH (middle) and water level trends versus 2015 trigger levels and total aluminium trends (right)

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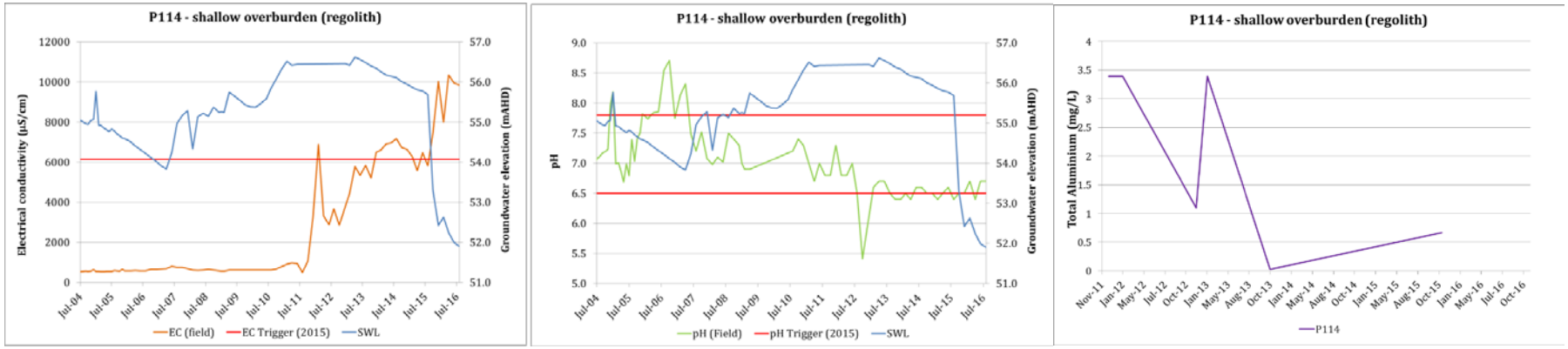

Figure 13 Regolith bore P114: EC (left), pH (middle) and water level trends versus 2015 trigger levels and total aluminium trends (right)

© AGE, 2017

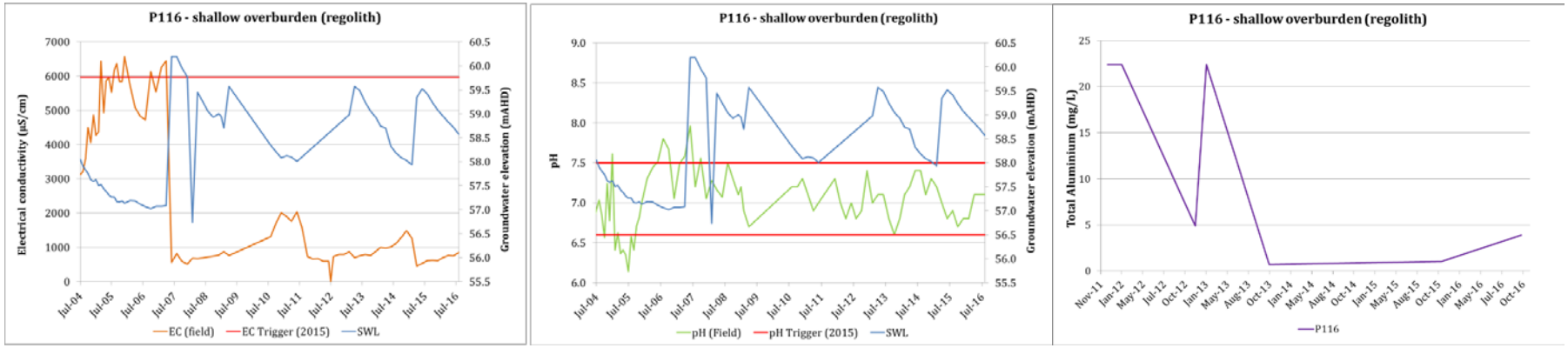

Figure 14 Regolith bore P116: EC (left), pH (middle) and water level trends versus 2015 trigger levels and total aluminium trends (right)

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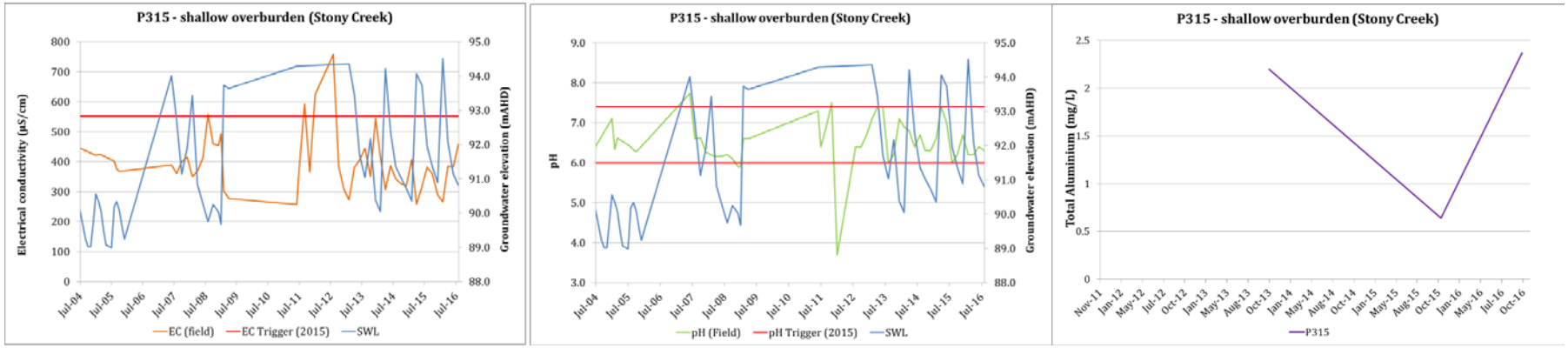

Figure 15 Regolith bore P315: EC (left), pH (middle) and water level trends versus 2015 trigger levels and total aluminium trends (right)

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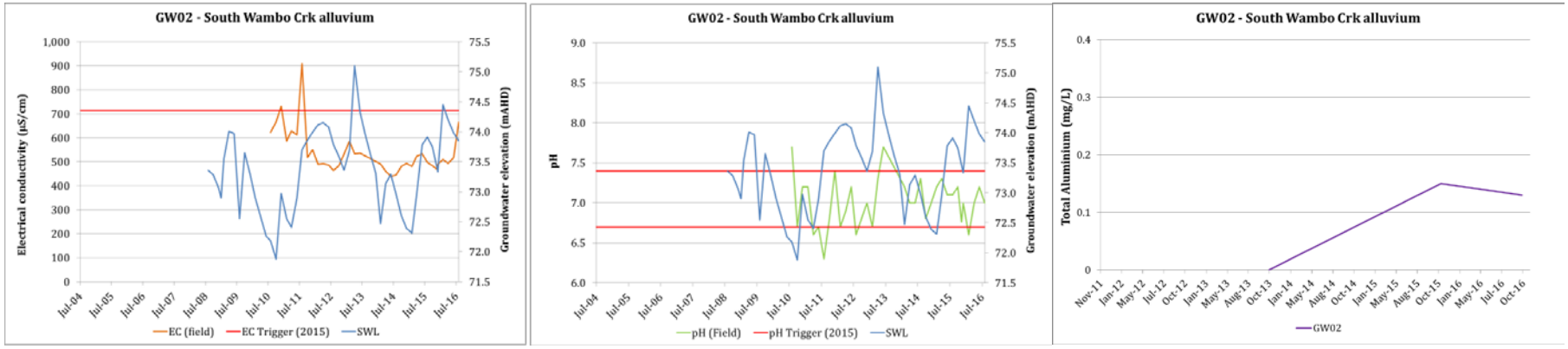

Figure 16 Less productive alluvium bore GW02: EC (left), pH (middle) and water level trends versus 2015 trigger levels and total aluminium trends (right)

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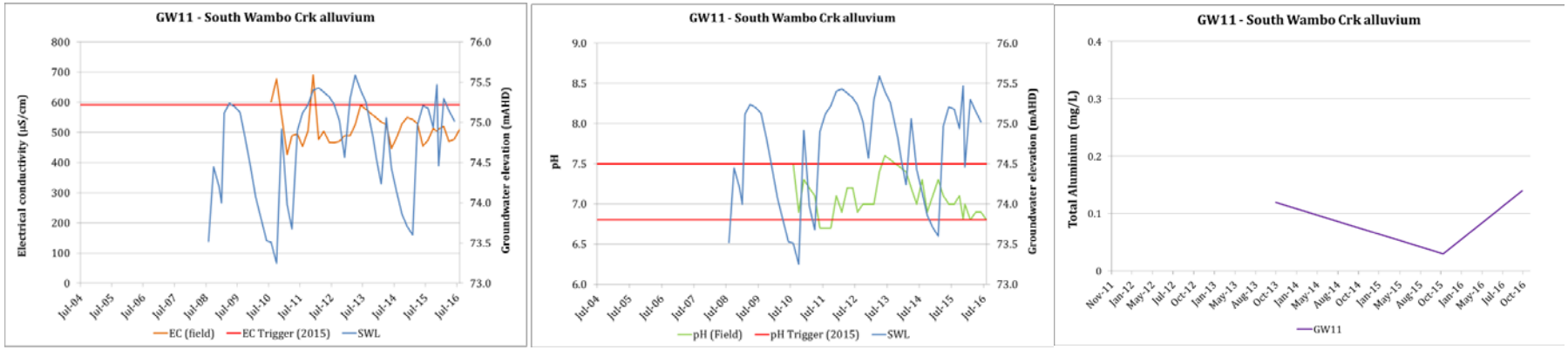

Figure 17 Less productive alluvium bore GW11: EC (left), pH (middle) and water level trends versus 2015 trigger levels and total aluminium trends (right)

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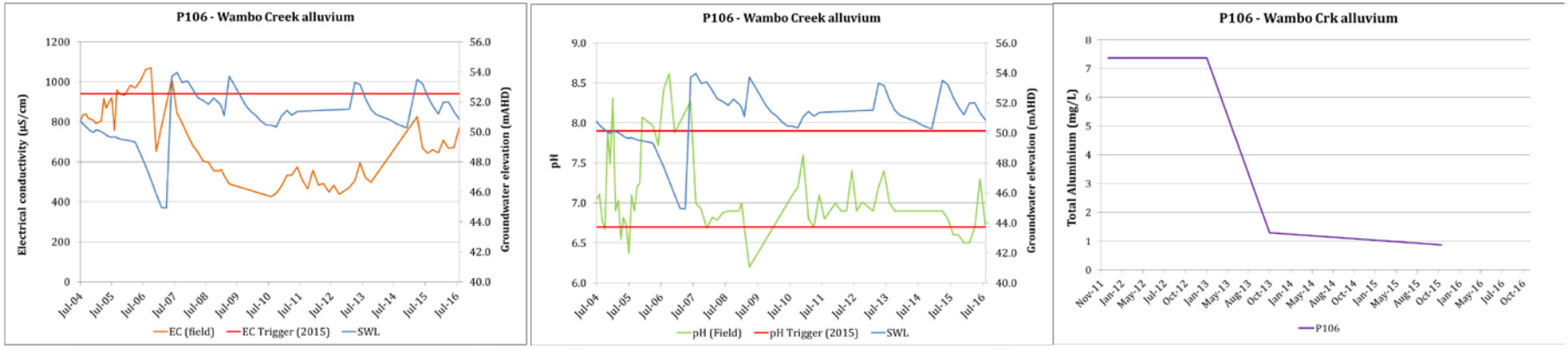

Figure 18 Less productive alluvium bore P106: EC (left), pH (middle) and water level trends versus 2015 trigger levels and total aluminium trends (right)

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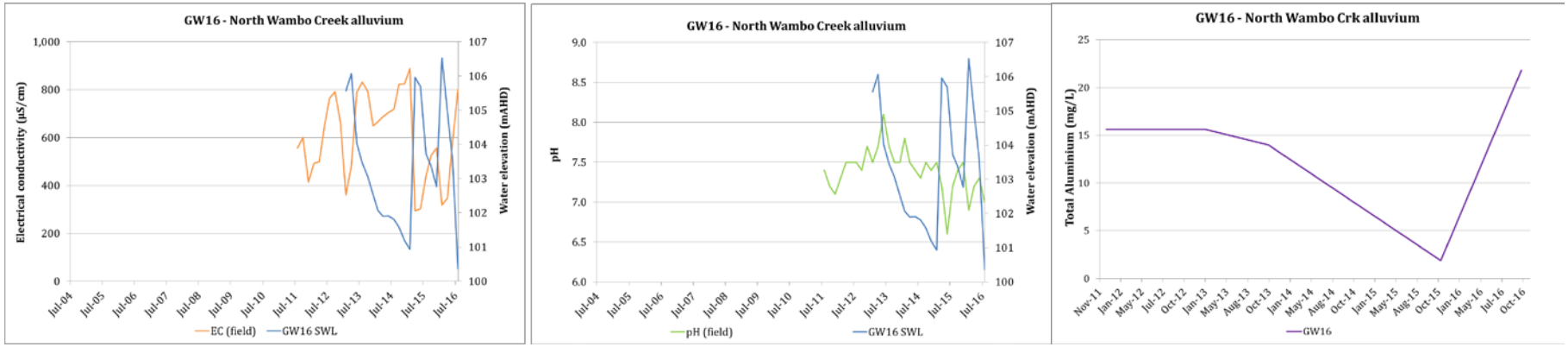

Figure 19 Less productive alluvium bore GW16: EC (left), pH (middle) and water level trends and total aluminium trends (right)

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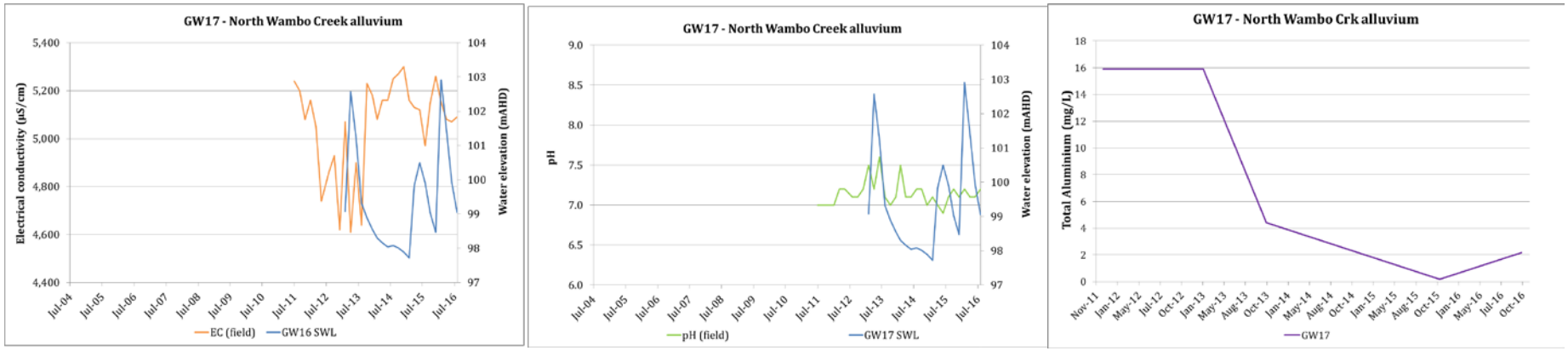

Figure 20 Less productive alluvium bore GW17: EC (left), pH (middle) and water level trends and total aluminium trends (right)

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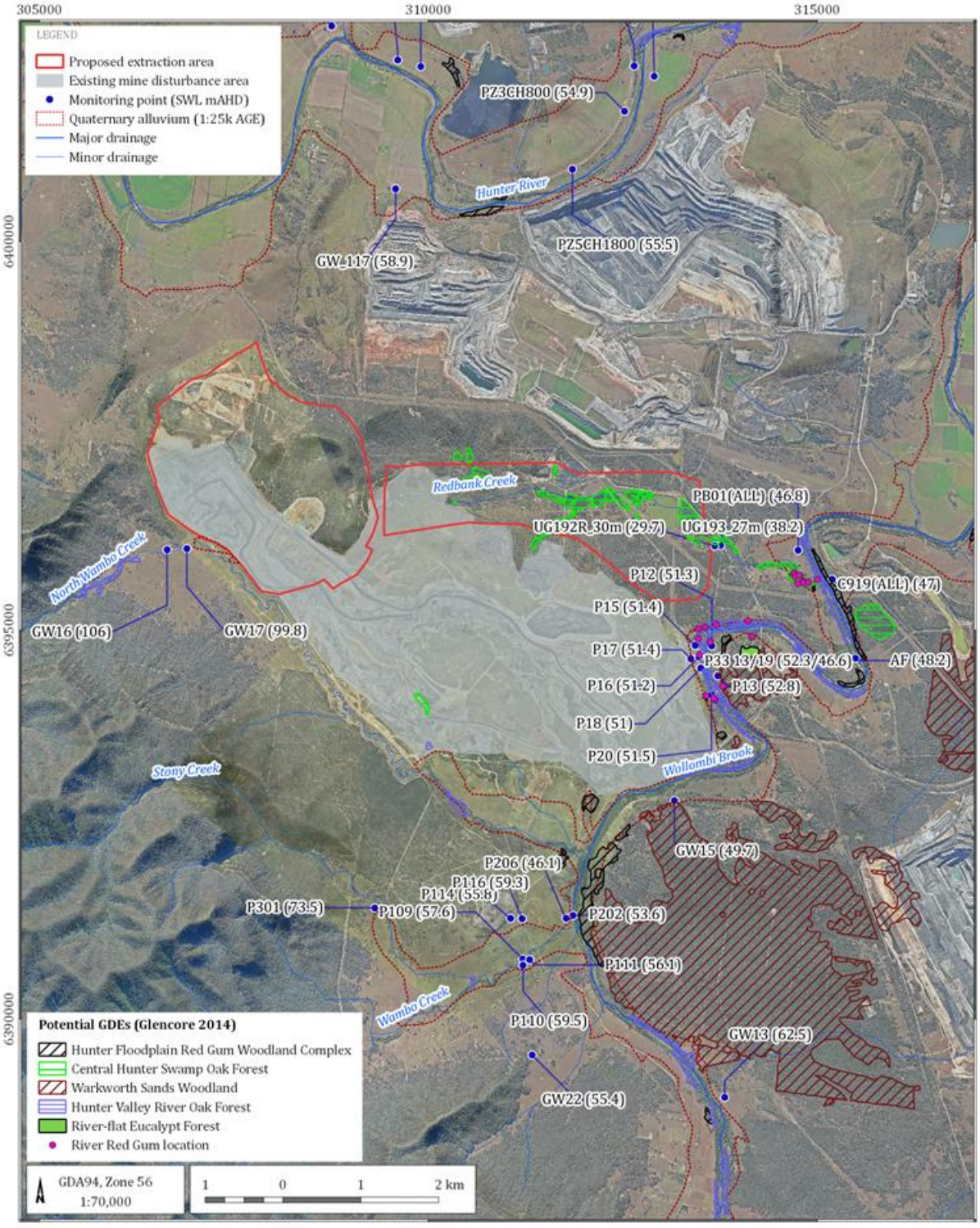

Figure 21 Groundwater levels – alluvium and shallow overburden

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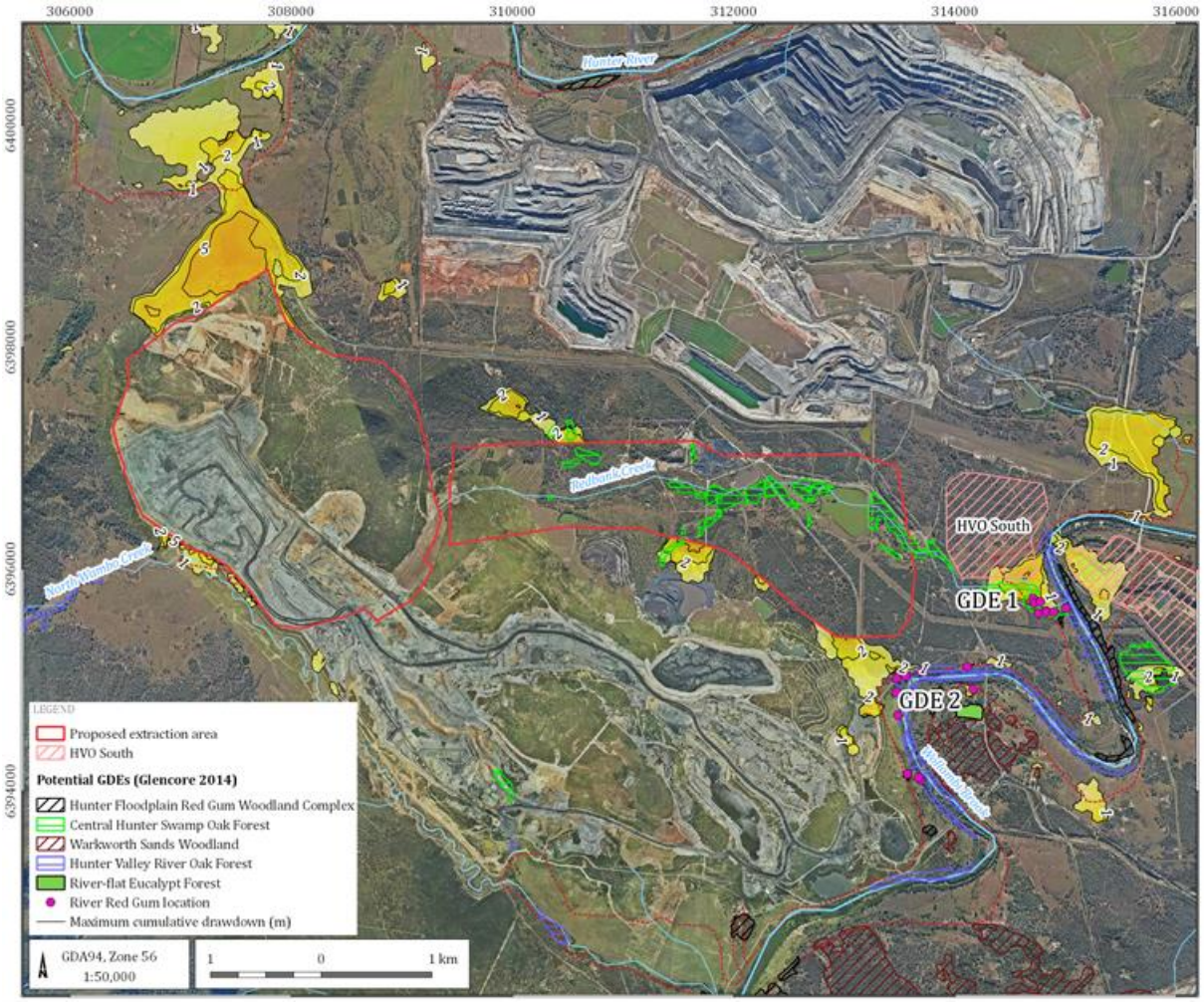

Figure 22 Predicted drawdown within saturated alluvium and shallow overburden – based on interpolated 2015 saturated extent

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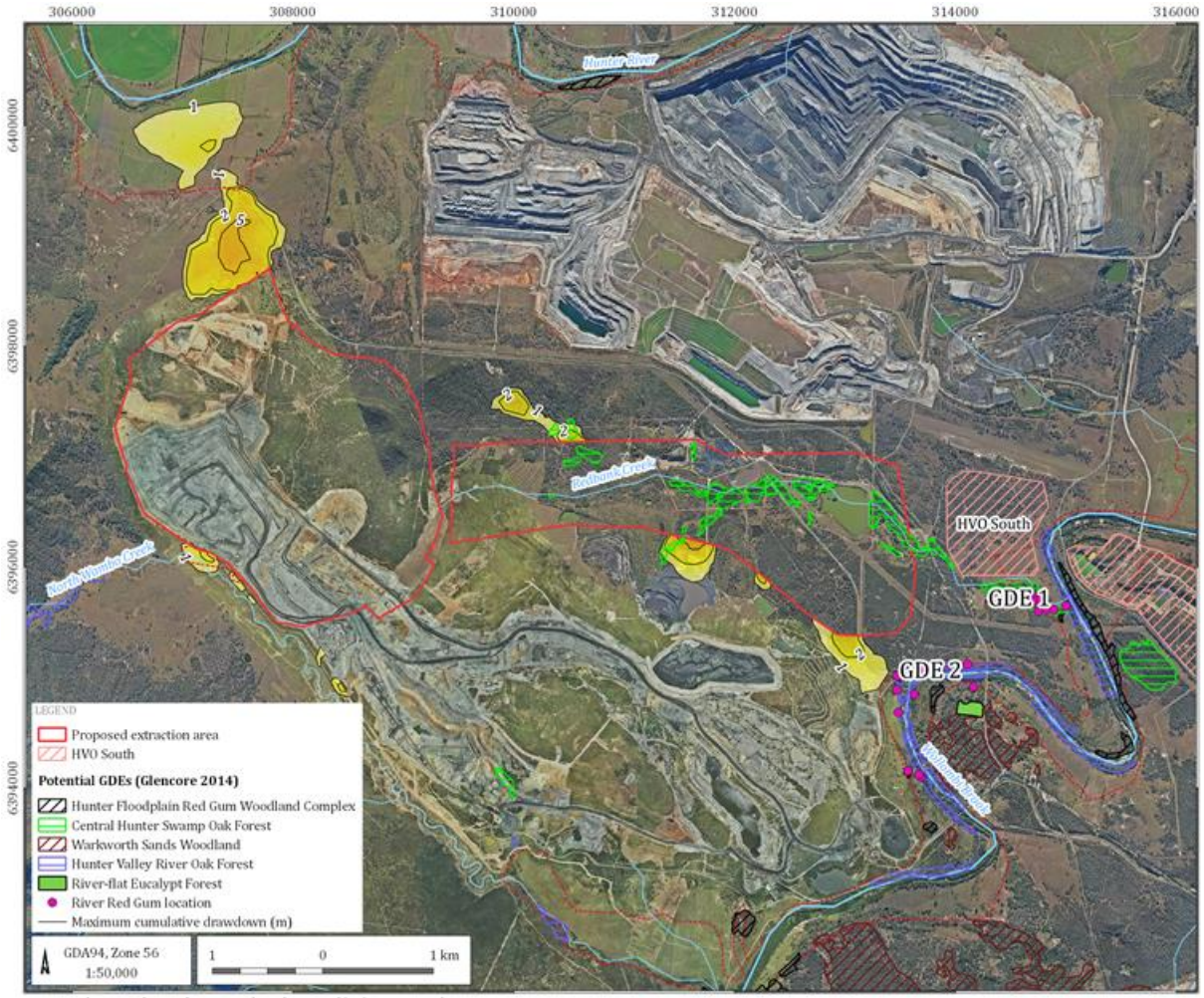

Figure 23 Predicted drawdown within saturated alluvium and shallow overburden – factoring cumulative effects

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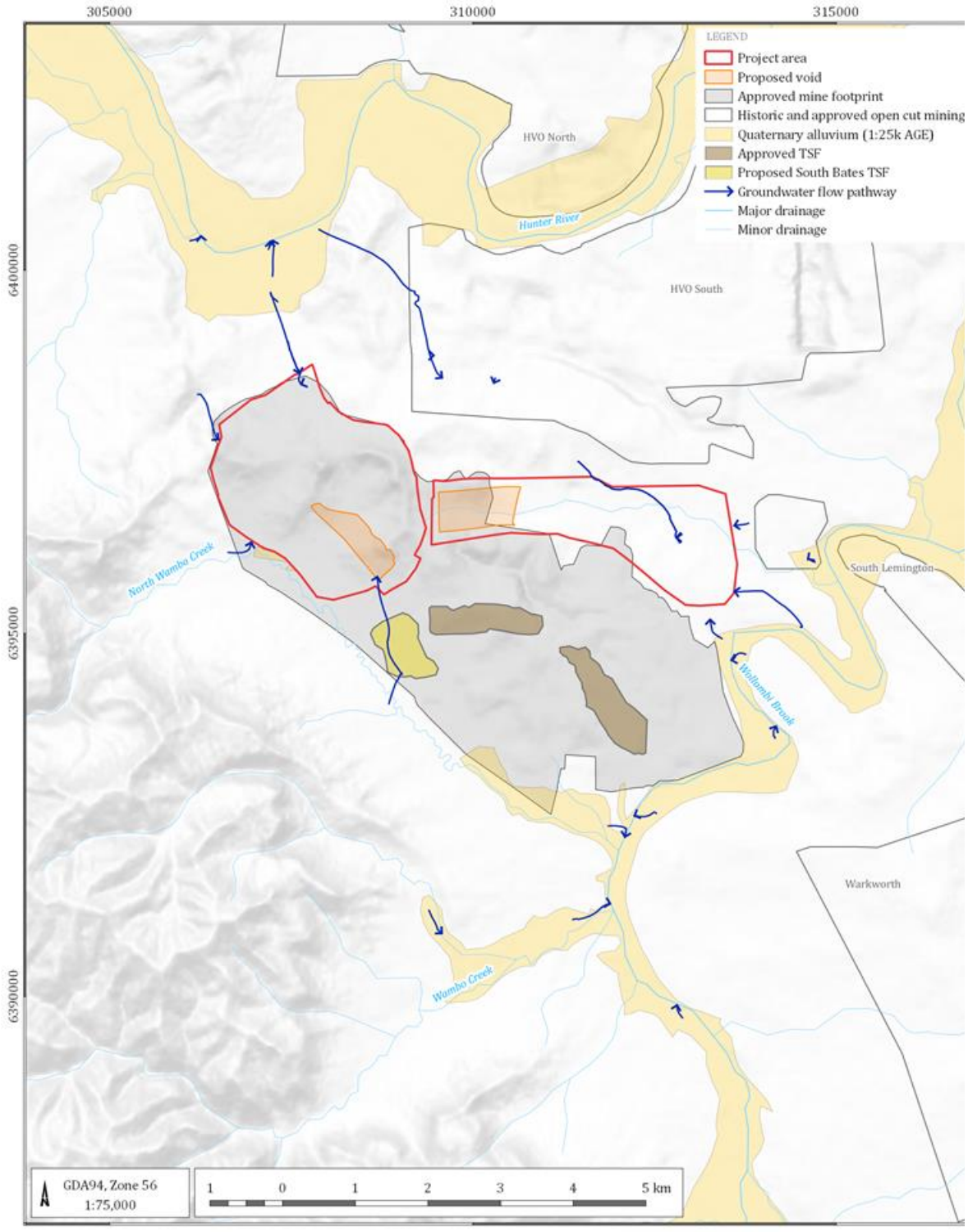

Figure24 Recovery groundwater flow pathway – alluvium and shallow overburden

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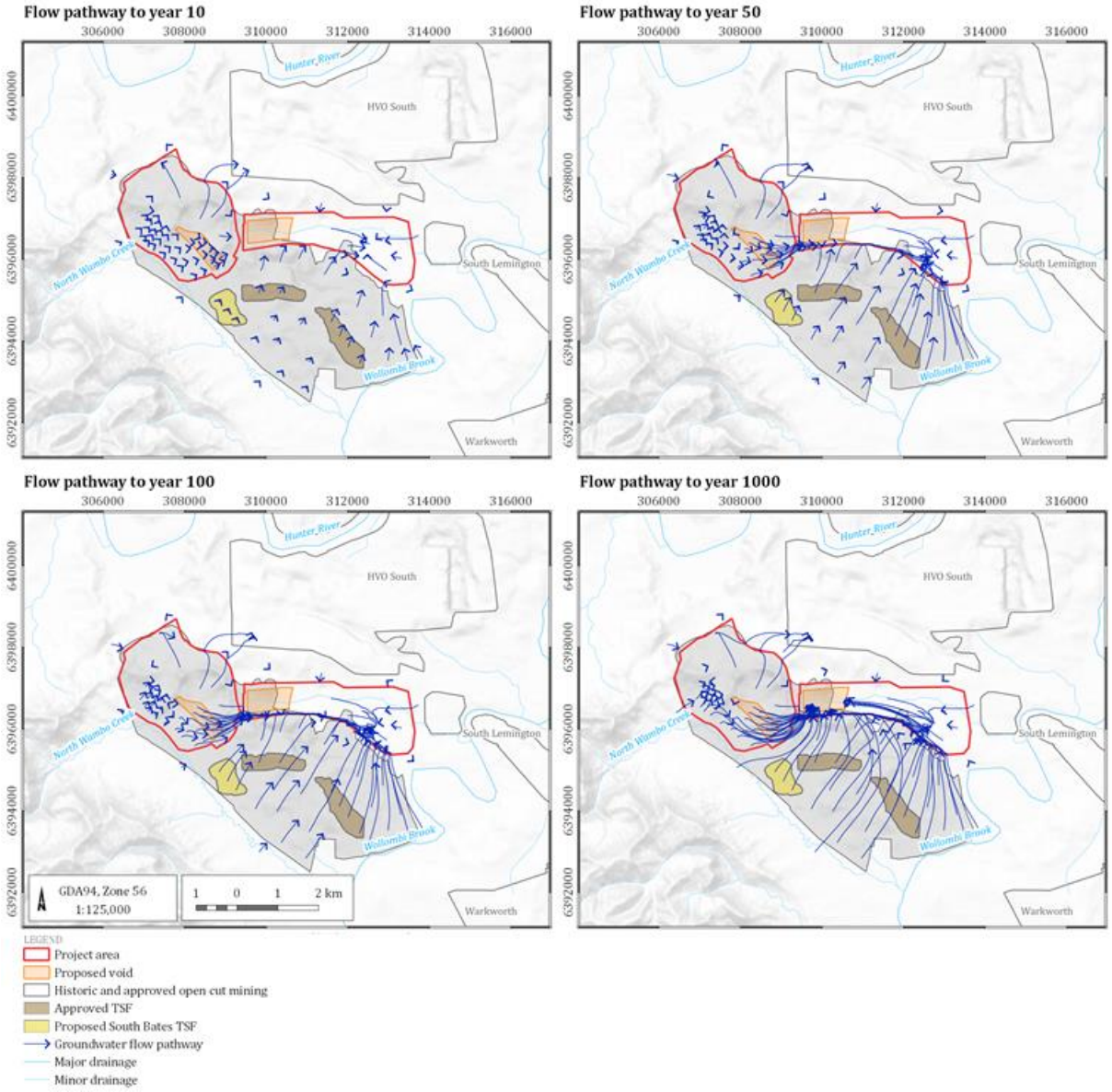

Figure 25 Recovery groundwater flow pathway – Permian coal measures

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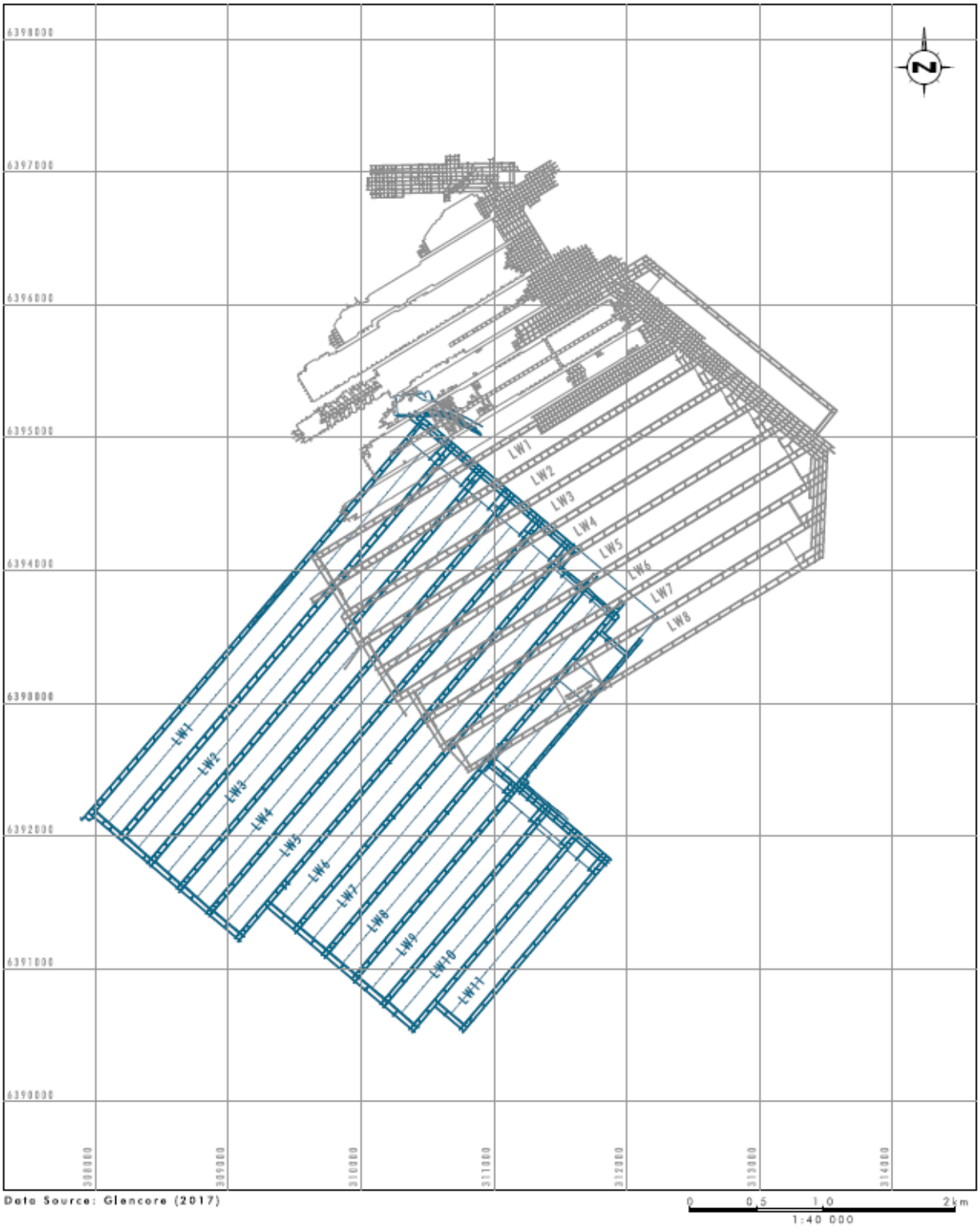


Figure 26 Positioning of United Underground and North Wambo Underground

© Glencore, 2017

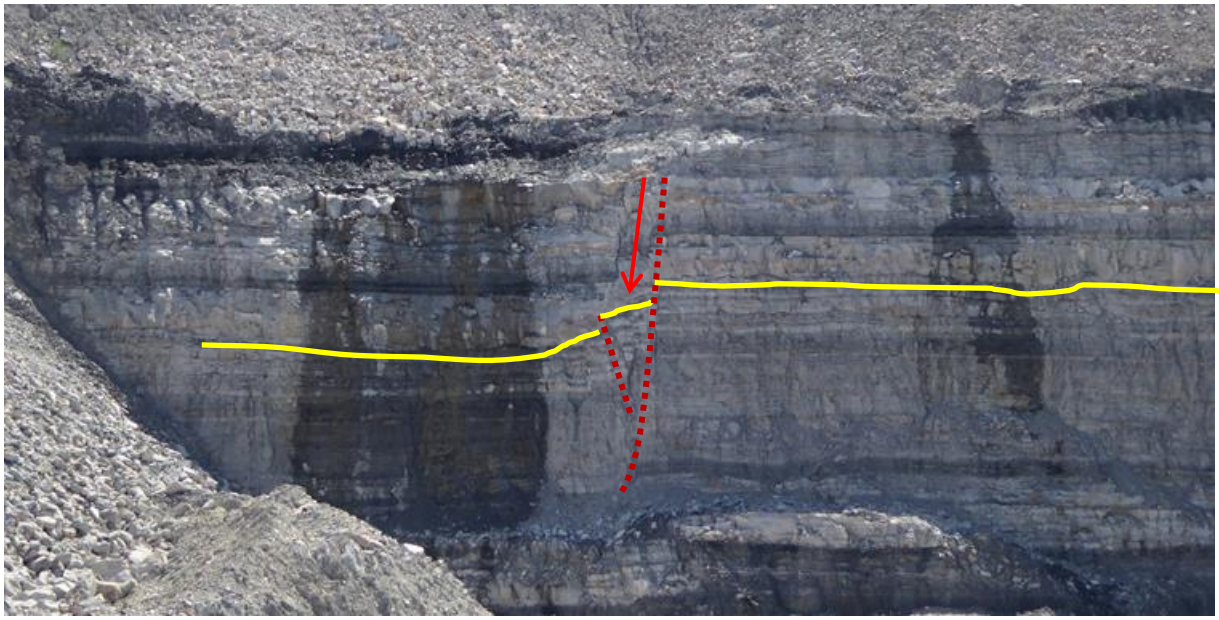


Figure 27 Photo of horst and graben structures at Wollombi Mine (northern highwall) – photo taken 2/12/2016

© Umwelt, 2017

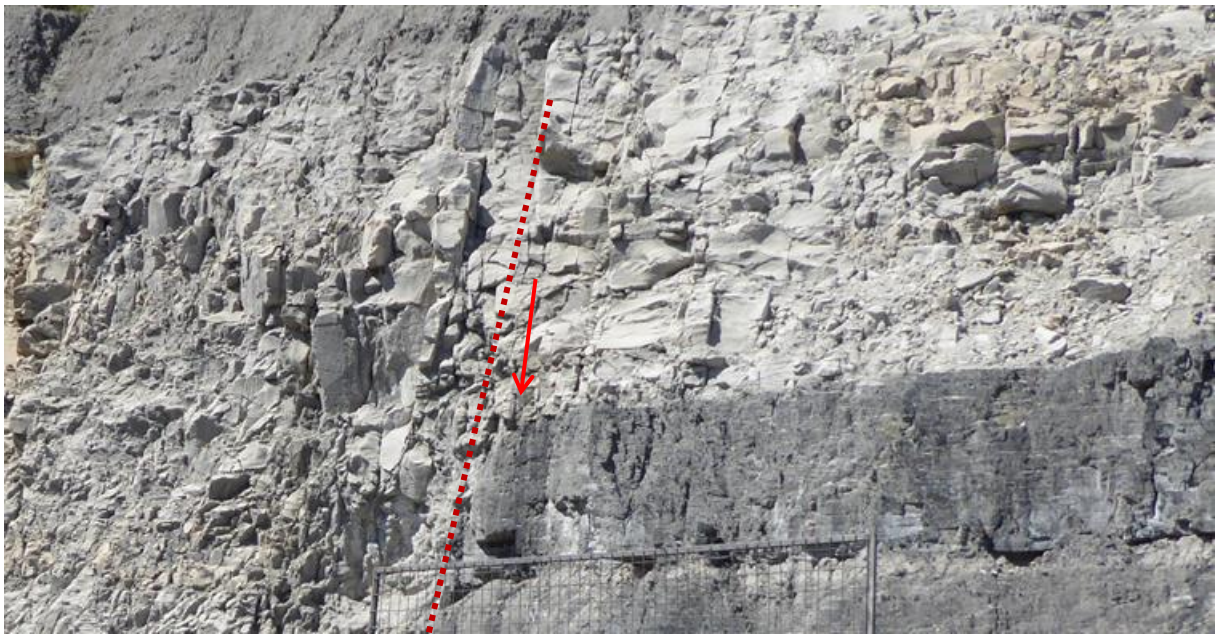
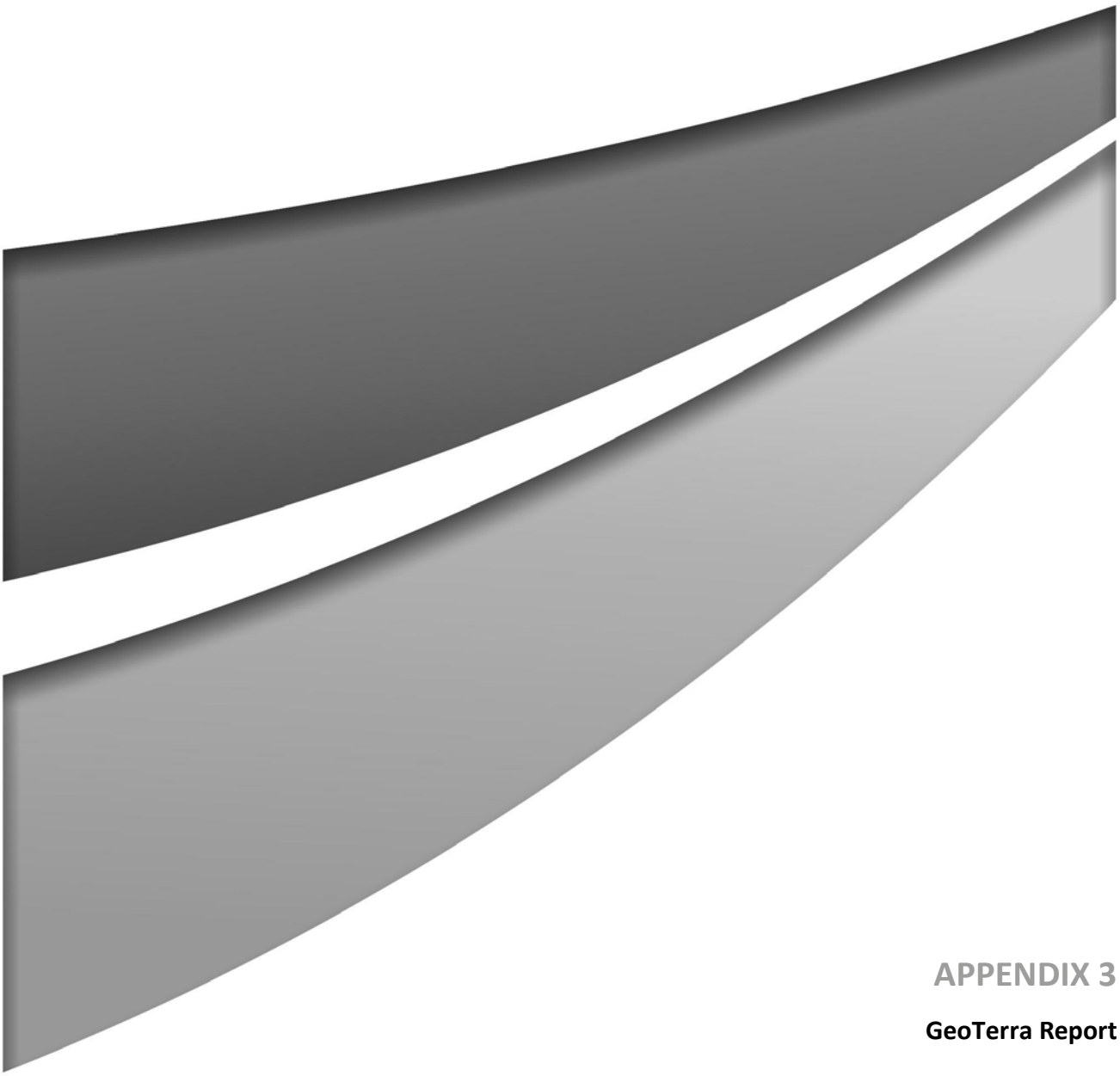


Figure 28 Photo of horst and graben structures at Wollombi Mine (northern highwall) – photo taken 2/12/2016

© AGE, 2017



APPENDIX 3

GeoTerra Report

GeoTerra

UNITED COLLIERIES PTY LTD

UNITED WAMBO
OPEN CUT COAL MINE PROJECT
WASTE ROCK / TAILINGS
GEOCHEMICAL CHARACTERISATION AND ACID & METALLIFEROUS DRAINAGE ASSESSMENT

Warkworth, NSW

UNi2-R1B
20 March 2017

GeoTerra PTY LTD **ABN 82 117 674 941**

Suite 204, 1 Erskineville Road Newtown NSW

PO Box 530 Newtown NSW 2042

Phone: 02 9519 2190 Mobile: 0417 003 502 Email: geoterra@iinet.net.au

UNil2-R1B (20 March 2017)

GeoTerra

United Collieries Pty Ltd
134 Jerrys Plains Road
Warkworth NSW 2330

Attention: Aislinn Farnon

Aislinn,

RE: United Wambo Open Cut Project Waste Rock / Tailings Geochemical Characterisation and Acid & Metalliferous Drainage Update Assessment

Please find enclosed a copy of the above mentioned report.

Yours faithfully

GeoTerra Pty Ltd

Andrew Dawkins (AuSIMM CP-Env)

Principal Hydrogeologist / Geochemist

Distribution: Original GeoTerra Pty Ltd
1 electronic copy Glencore Coal Pty Ltd (United Colliery)

GeoTerra PTY LTD **ABN 82 117 674 941**

Suite 204, 1 Erskineville Road Newtown NSW

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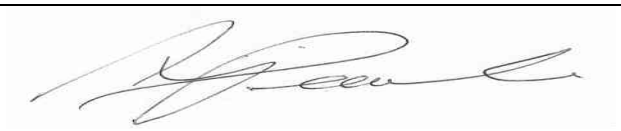
Phone: 02 9519 2190 Mobile: 0417 003 502 Email: geoterra@iinet.net.au

Authorised on behalf of GeoTerra Pty Ltd:	
Name:	Andrew Dawkins
Signature:	
Position:	Principal Hydrogeologist / Geochemist

Date	Rev	Comments
04.02.2017		Initial Draft
09.02.2017	A	Incorporate reviewer comments
20.03.2017	B	Incorporate reviewer comments

GeoTerra PTY LTD **ABN 82 117 674 941**

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APPENDICES

Appendix A AMD, Waste Rock and Leachate Analyses

GLOSSARY OF TERMS

ABCC	Acid buffering characteristic curve measures the readily available portion of the inherent acid neutralising capacity (ANC) of a sample by slow acid titration to a set end-point and then calculation of the amount of acid consumed and evaluation of the resultant titration curve.
Acid	A measure of hydrogen ion (H^+) concentration; generally expressed as pH
Acid Base Account	Evaluation of the balance between acid generation and acid neutralisation processes. Generally determines the maximum potential acidity (MPA) and the inherent acid neutralising capacity (ANC), as defined below.
AMD	Acid and metalliferous drainage caused by exposure of sulfide minerals in mine waste materials to oxygen and water. Typically characterised by low pH and elevated concentrations of salts, sulfate and metals.
ANC	Acid neutralising capacity of a sample as kg H_2SO_4 per tonne of sample.
ANC/MPA Ratio	Ratio of the acid neutralising capacity and maximum potential acidity of a sample. Used to assess the risk of a sample generating acid conditions.
CHPP	Coal handling and preparation plant.
EC	Electrical conductivity, expressed as µS/cm.
CEC	Cation exchange capacity provides a measure of the amount of exchangeable cations (Ca, Mg, Na and K) in a sample.
ESP	Exchangeable sodium percentage provides a measure of the sodicity of a materials and propensity to erode.
Interburden	Waste rock material that lies within a coal seam.
KLC test	Kinetic leach column tests are procedures used to measure the geochemical/ weathering behaviour of a sample of mine material overtime.
MPA	Maximum potential acidity calculated by multiplying the total sulfur content of a sample by 30.6 (stoichiometric factor) and expressed as kg H_2SO_4 per tonne.
NAF	Non-acid forming. Geochemical classification criterion for a sample that will not generate acid conditions.
NAG test	Net acid generation test. Hydrogen peroxide solution is used to oxidise sulfides in a sample, then any acid generated through oxidation may be consumed by neutralising components in the sample. Any remaining acidity is expressed as kg H_2SO_4 per tonne.
NAPP	Net acid producing potential expressed as kg H_2SO_4 per tonne. Calculated by subtracting the ANC from the MPA.
Overburden	Material that overlies a coal resource and must be removed to mine the coal.
PAF	Potentially acid forming. Geochemical classification criterion for a sample that has the potential to generate acid conditions.
(Coal) Reject	Mixture of coarse and finely ground materials from which the desired mineral (coal) values have been largely extracted.
Static test	Procedure for characterising the geochemical nature of a sample at one point in time. Static tests may include measurements of mineral and chemical composition of a sample and the Acid Base Account.
(Coal) Tailing	Finely ground materials from which the desired mineral (coal) values have been largely extracted.
TSF	Tailing storage facility designed for the storage of tailing (fine reject) materials produced during coal processing at the CHPP. Supernatant water may be recycled back to the CHPP from a decant pond.
Total Sulfur	Total sulfur content of a sample generally measured using a 'Leco' analyser expressed as % sulfur.
Uncertain	Geochemical classification criterion for a sample where the potential to generate acid conditions remains uncertain and may require further analysis.
Underburden	Waste rock material that lies beneath a coal seam.

1. INTRODUCTION

GeoTerra Pty Ltd (GeoTerra) were commissioned by Glencore on behalf of the United Wambo Open Cut Project (the Project) to:

- conduct a historical review of previous geochemical asessments at the Wambo and United mines;
- conduct a historical review of groundwater chemistry associated with the United and Wambo operational areas;
- collect drill core and tailings samples for laboratory analysis, and to;
- provide an interpretation of the Project waste rock / tailings geochemistry and the potential for acid & metalliferous drainage (AMD) for the Project.

In November 2014, a 50:50 Joint Venture between United Collieries Pty Limited (United Collieries) and Wambo Coal Pty Limited (Wambo Coal) was announced which combines the extraction and exploration rights for a number of mining tenements at United and Wambo. The Joint Venture will look to develop the Project, which combines the existing open cut operations within the Wambo lease area with a proposed new open cut coal mine in the United lease area.

The site is located near the village of Warkworth, approximately 15km west of Singleton in the Hunter Valley of New South Wales.

1.1 Study Objectives

The objective of the study is to understand the historic and potential future waste rock and tailings geochemistry, as well as the AMD potential of the overburden, coal, pit floor rock, tailings and coarse reject materials associated with the Project.

1.2 Historic Mining Operations

The United and Wambo coal mining operations were established in 1989 and the late 1960's,respectively, with a range of underground and open cut coal mining operations being conducted at the Project site.

Open cut coal mining has previously been conducted at United, however over the last two decades the focus has been on underground longwall mining until March 2010 when the mine entered a period of care and maintenance. Following that time, exploration and feasibility works have been conducted to assess the potential for future mining.

The United Open cut targeted the Whynot and Wambo seams between 1989 and 1992, whilst the United Underground used continuous miner, bord and pillar and chain haulage systems to mine the Arrowfield Seam (Woodlands Hill) until 2002.

From 2002 to 2010, longwall mining was conducted by United in Longwalls 1 to 10 within the Arrowfield Seam.

Coarse rejects and fine tailings were disposed in the United reject emplacement area, including Tailings Dam 1 (TD1) and Tailings Dam 2 (TD2).

The current existing and approved Wambo open cut coal mine adjoins the United operations, with mining conducted using a truck and excavator operation, with run-of-mine (ROM) coal crushed and washed at a coal handling and preparation plant (CHPP).

The current and historic open cut operations comprise 14 pits that have excavated down to the Whybrow, Redbank, Wambo and Whynot seams.

Wambo Mine has three main in-pit reject emplacement areas (Homestead, Hunter and Main Homestead).

1.3 Proposed Project

The Project includes open cut mining from the proposed United Open Cut and modified operations in the approved Wambo Open Cut for a period of approximately 23 years.

The United Open Cut and Wambo Open Cut are proposed to be extended to the base of the Vaux Seam and Warkworth Seam respectively, as shown in **Figure 1**.

The existing Wambo Coal Handling and Preparation Plant (CHPP) will be used for coal preparation for the Project with no proposed operational modification, whilst also receiving coal from the current Wambo underground.

The Project also proposes to utilise an in-pit tailings facility within the South Bates Pit and to form final voids within the United and Wambo open cuts.

The proposal would extend the life of the mine by 23 years and is anticipated to produce approximately 1.023 billion bank cubic meters (bcm) of waste rock, which would be disposed of through:

- backfilling open cut voids;
- placement in existing and new out-of-pit mine waste rock emplacements; and
- incorporation and encapsulation with CHPP rejects in purpose-built emplacements.

Approximately 58.2Mt of rejects, comprising 45.4 Mt coarse and 12.8Mt fine rejects are anticipated to be produced by the CHPP, with the coarser fraction being similar to waste rock that will be disposed of generally using the same methodologies as for waste rock. The finer rejects (tailings) will be placed in purpose-built emplacements involving progressive incorporation and encapsulation and/or capping with waste rock.

The overall objective is to achieve landforms that are integrated with the surrounding rehabilitated land surface and maintain a sustaining vegetation cover in the long-term.

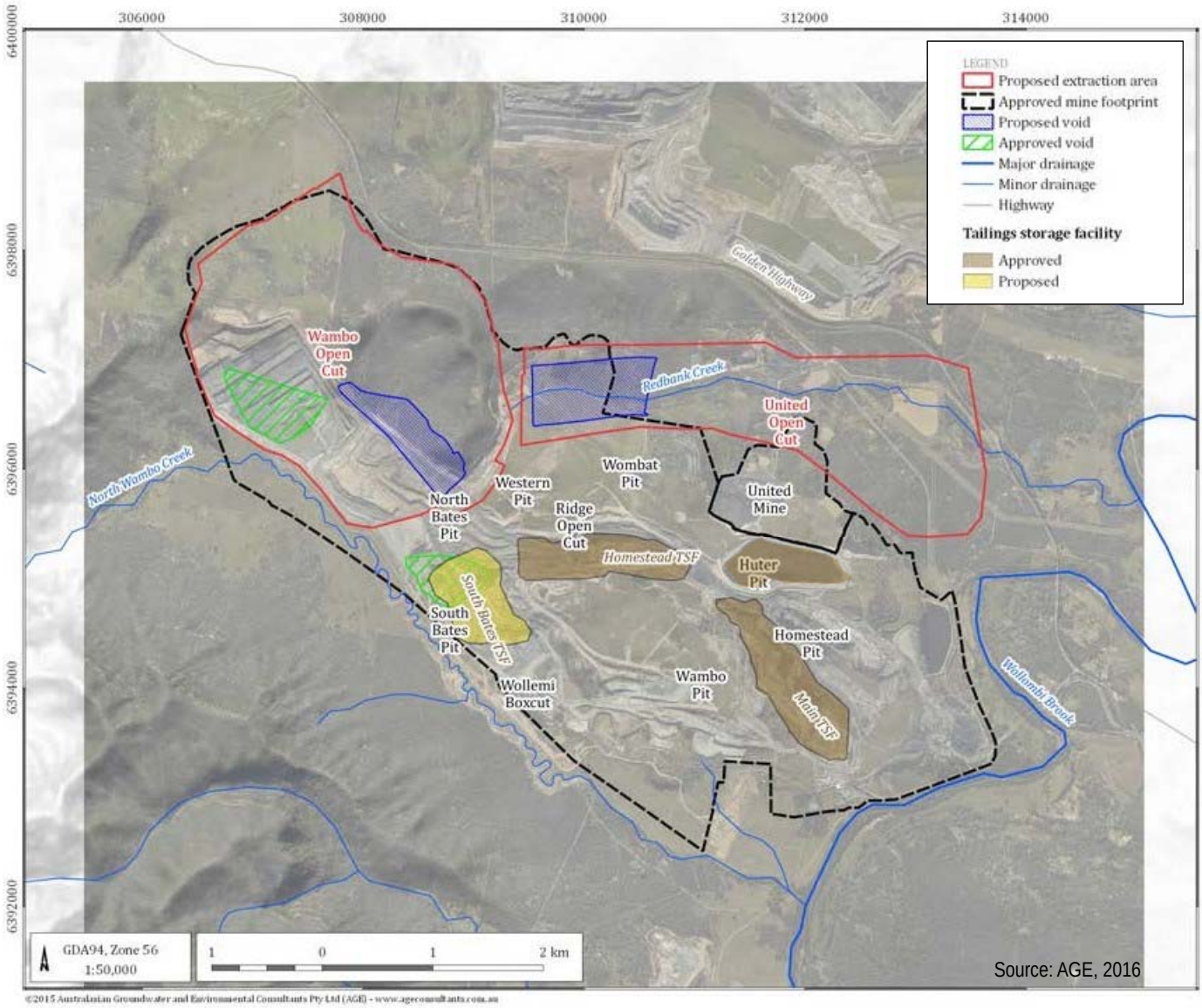


Figure 1 Proposed and Historic Mining Operations

2. ASSOCIATED STUDIES

Previous AMD / geochemistry assessments have been conducted for both the United and Wambo sites as summarised below and detailed in the references section;

- Resource Strategies, 2003 Wambo Development Project Waste Rock and CHPP Rejects and Tailings Management – conducted an AMD assessment of waste rock, tailings and coarse reject associated with an application to expand operations at the Wambo mine;
- Geo-Environmental Management, 2009 Wambo Coal Mine Expansion Project Geochemical Sampling (unpub) – further AMD assessment of waste rock, tailings and coarse reject associated with the 2003 investigation;
- GeoTerra, 2010 United Bore UG129 AMD Investigation (unpub) – NAPP assessment of borehole UG129 core

- GeoTerra, 2016 United Project Rock Analyses (unpub) – a study limited to assess major elements within waste rock that may be contained in dust from the proposed United Wambo Joint Venture waste rock dumps.

All of the results and conclusions from these above mentioned studies have been incorporated into the overall report assessment.

3. GEOLOGY

The Project involves open cut mining of several coal seams from the Wittingham Coal Measures, which, with the Wollombi Coal Measures, form the Singleton Supergroup as shown in **Figure 2**.

The Wittingham Coal Measures are divided into the Jerrys Plains Subgroup, Denman Formation, Archerfield Sandstone and Vane Subgroup. The Jerrys Plains Subgroup contains eight Formations with 15 named coal seams. The overlying Wollombi Coal Measures and Widden Brook Conglomerate, which outcrop in the south-west of the Wambo mine area, do not occur in the Project area.

Quaternary alluvium occurs along creeks draining the United and Wambo mine areas and consist of relatively shallow bands of silt, sand and gravel (DMR, 1993).

The Project would involve some removal of Redbank Creek Quaternary alluvium within the United Open Cut.

The vertical and lateral association of sedimentary rocks in the Jerrys Plains Subgroup indicates that the sequence developed primarily as several pro-grading, river dominated delta lobe-like landforms which began and ended with marine incursions (Beckett, 1988). The major episodes of delta formation originated from source materials eroded from the New England area to the north of the Sydney Basin.

The Jerrys Plains Subgroup is up to 800 metres (m) thick and generally consists of relatively coarse clastic sediments (DMR, 1993).

The sedimentary rock layers above (i.e. overburden) and between (i.e. interburden) coal seams are typically lithic sandstone, siltstone and conglomerate. Additionally, minor carbonaceous claystone and tuff occurs through the sequence.

All units are conformable and in many cases the boundaries between formations are gradational.

Waste rock types within the Project mining area include mudstones, siltstones, sandstones, shales and conglomerates.

It should be noted that coal seam nomenclature differs for some seams between the Wambo and United operations, as illustrated in **Table 1**, which requires care in discussing particular seams at each site.

SUPERGROUP	GROUP	SUBGROUP	FORMATION	SEAM
SINGLETON SUPERGROUP	NARRABEEN GROUP	WIDDEN BROOK CONGLOMERATE		
	WOLLOMBI COAL MEASURES	GLEN GALLIC SUBGROUP	Greigs Creek Coal	
			Redmanvale Creek Formation	
			Dights Creek Coal	
		DOYLES CREEK SUBGROUP	Waterfall Gully Formation	
			Pinegrove Formation	
		HORSESHOE CREEK SUBGROUP	Lucernia Coal	
			Strathmore Formation	
			Alcheringa Coal	
			Clifford Formation	
		APPLETREE FLAT SUBGROUP	Charlton Formation	
			Abbey Green Coal	
		WATTS SANDSTONE		
	WITTINGHAM COAL MEASURES	DENMAN FORMATION		
		JERRYS PLAINS SUBGROUP	Mount Leonard Formation	*Whybrow Seam 1,2*
			Althorpe Formation	
			Malabar Formation	*Redbank Creek Seam 1,2*
				Wambo Seam1,2
				Whynot Seam 1,2
				Blakefield Seam
			Mount Ogilvie Formation	*Glen Munro Seam*
				Woodlands Hill Seam
			Milbrodale Formation	
			Mount Thorley Formation	*Arrowfield Seam2*
				Bowfield Seam2
				Warkworth Seam
			Fairford Formation	
			Burnamwood Formation	*Mount Arthur Seam*
				Piercefield Seam
				Vaux Seam
				Broonie Seam
				Bayswater Seam
		ARCHERFIELD SANDSTONE		
			Bulga Formation	

Figure 2 Project Site Stratigraphic Column

Table 1 Wambo and United Coal Seam Nomenclature

Wambo Coal Seam Name	United Coal Seam Name
Whybrow / Redbank Ck / Wambo / Whynot	Whybrow / Redbank Ck / Wambo / Whynot
Blakefield	Unnamed A, B (part)
Glen Munro	Unnamed B (part), C, D (part)
Woodlands Hill	Unnamed D (part), Unnamed E, Blakefield, Glen Munro
Arrowfield	Woodlands Hill
Bowfield / Warkworth / Mt Arthur / Piercefield / Vaux	Bowfield / Warkworth / Mt Arthur / Piercefield / Vaux

3.1 Palaeo - Environment and Sulfur Implications

The percentage of pyrite in sedimentary rocks is limited principally by available sulfur during diagenesis, which is generally a function of the available sulfate in water under favourable anoxic, reducing conditions. Sedimentary pyrite mineralisation occurs, when Fe^{2+} and H_2S formed by sulfate reduction in the presence of decomposing organic material and water react to form FeS and S_0, which subsequently form FeS_2 (pyrite).

The availability of sulfur in a freshwater environment is much less than from sea water due to the much lower concentrations of dissolved sulfates. As a result, during diagenesis, the net formation of pyrite within a freshwater or fluvial environment is often much less than in marine environments.

Furthermore, a greater percentage of sulfur in freshwater environments has a tendency to be bound up organically within coal, reducing the potential for AMD in the waste.

The Hunter Valley palaeo-environment is extensively fluvial sedimentary with generally low to medium in-situ sulfur coal content, as observed through assessment at other Hunter Valley mining operations.

Permian coals in Australia generally show a correlation between palaeo-environment and sulfur content and supports the influence of marine environments on elevated seam sulfur contents. Coal deposited in lower delta plain facies typically has average raw sulfur contents >0.55%, braided fluvial facies and more distal marine palaeo-environments typically have <0.55% sulfur whilst upper delta plain palaeo-environments typically have intermediate sulfur contents (Hunt and Hobday, 1984).

Coal seams in the Project site have total sulfur of 0.10 - 0.72%, which is typical of braided fluvial facies.

Oxidation of pyritic sulfides produces soluble and solid iron hydroxides and sulfates, with the main oxidation occurring above the regional (historical and current) water table, thereby lowering the “fresh” sulfide content of the overburden / interburden rock.

Carbonaceous material is prevalent in the overburden and it can have an elevated sulfide content, particularly where a sample is adjacent to a coal seam.

4. CURRENT WASTE ROCK AND CHPP REJECT MANAGEMENT PRACTICES

4.1 Waste Rock

Waste rock is generated from open cuts through the overburden and interburden removal process.

Mining methods used immediately adjacent to the coal seams may handle material at smaller unit rates (blocks) than those used for overburden and interburden removal (e.g. truck and shovel vs face shovel).

There is therefore the potential to handle waste rock near a seam with greater selectivity.

Interburden of sufficient thickness that allows selective mining is removed as waste rock, whilst thinner interburden and minor quantities of rock adjacent to seams are extracted with the coal and then screened out during coal processing and report as rejects from the CHPP.

Waste rock is either used to backfill previous open cuts, placed in nearby out-of-pit mine emplacements or incorporated and encapsulated and/or capped with CHPP rejects in purpose-built emplacements.

The actual disposal methodology depends on factors such as the availability of open cut areas, haulage efficiency and de-commissioning requirements for CHPP rejects.

Out-of-pit mine waste rock emplacements are typically constructed in 10 - 15m lifts and are progressively re-shaped and rehabilitated subject to the mining schedule and equipment availability.

The re-shaping process involves dozers to create final landforms that are adequately drained and have outer batters at a maximum slope of 10 degrees. Where long slopes exist, contour drains or deep staggered rips are installed.

The waste rock is typically alkaline and slightly sodic which is common for the Hunter Valley (SPCC, 1983). If inappropriately managed, soil / waste rock sodicity has the potential to impede re-vegetation due to poor soil structure, surface crusting, low infiltration and increased erosion potential. Where necessary, ameliorative measures are used to improve the characteristics of near-surface waste rock materials before re-vegetation.

Once re-shaping is complete, the waste rock emplacements are covered, where available, with previously stockpiled topsoil and re-vegetated.

Where insufficient topsoil is available, chemical amelioration of the waste rock may be required to improve its chemical and nutrient properties.

Where topsoil testing indicates revegetation success would be sub-optimal, then lime, gypsum and/or fertiliser treatment may be required to improve the chemical and/or nutrient properties to optimise the potential for achieving rehabilitation objectives and maintaining a stable, sustaining vegetation cover.

To date, no acid forming strata have been identified at Wambo or United and there is no evidence of acidic leachate from waste rock emplacements or CHPP rejects.

Surface water and groundwater monitoring indicates pH is typically near neutral to alkaline, with surface water ranging from 6.3 to 9.6 and groundwater 5.9 – 8.5.

As such, the majority of the Project waste rock material is anticipated to be alkaline and sodic as has been observed in previous Wambo and United waste assessments and therefore existing waste rock management practices should continue for the Project.

4.2 Coal

ROM coal can be stockpiled prior to processing through the CHPP and can be a temporary AMD source before it is processed in the CHPP and transported offsite as product coal, however, generally ROM coal is not stockpiled for long periods of time therefore the potential for AMD from the ROM stockpile is very low.

4.3 CHPP Rejects

The current CHPP treats Run of Mine (ROM) coal to produce a high energy steaming coal, with the by-product comprising coal and waste rock which represent approximately 25% of the processed ROM coal and is classified as either coarse or fine.

Coarse rejects typically represent two-thirds of the material and are mostly made up of cobble-sized fragments of coal, sandstone, mudstone and gravels.

The other third consists of fine rejects thickened into a tailings slurry with a solids content of approximately 30% by weight with an anionic flocculant at pH 8 added during the process. The tailings solids primarily comprise very fine coal, sands and clay.

Historically the clays are predominantly very fine sodium montmorillonite with hydrophilic (water affinity) properties. This changed after 2002 when the Wollemi Underground closed as it mined the Whybrow seam with a 300mm band of the sodium montmorillonite clay.

Whilst the underground had to extract the entire seam and clay parting, open cut mining can remove this material thereby providing tailings which drain similarly to other Hunter Valley mining operations.

4.3.1 CHPP Rejects

Disposal of coarse reject is similar to waste rock management practices where it is used to backfill open cuts or incorporated and encapsulated with fine CHPP rejects in purpose-built emplacements.

Coarse rejects are selectively handled and often used to cover existing tailings slurry ponds, then covered by ROM waste rock, prior to site rehabilitation.

4.3.2 Tailings

Fine reject disposal involves pumping the slurry to open cut voids for evaporation and solar desiccation prior to incorporation and encapsulation and/or capping with waste rock and/or coarse rejects in purpose-built emplacements.

Where capping is used, once the surface capping layer is completed, a minimum 5m ROM waste rock thickness is placed over the surface of the purpose-built emplacement with maximum 1:3 slopes before topsoil is applied and the area is seeded with plant species.

The 5m waste rock cover is used to meet DMR decommissioning criteria (WCPL, 2002b) and minimise the potential for plant roots reaching the underlying capping layer.

With the re-introduction and expansion of open cut mining and since closure of the Wollemi Underground Mine, the tailings are now relatively free-draining.

When a disposal area is filled to capacity, it is allowed to drain prior to capping and/or incorporation and encapsulation with coarse rejects and waste rock.

The final surface of the purpose-built emplacement is designed to be compatible with the surrounding rehabilitated landform (WMC, 2002).

A long-term settling allowance of between 10 - 15% of the tailings thickness is also allowed for in the final surface of the purpose-built emplacement (PSM, 2001).

5. SUMMARY OF PREVIOUS GEOCHEMICAL ASSESSMENTS

Historical studies have been conducted at Wambo and United as described in the following sections, with the sampled borehole locations shown in **Figure 3**.

5.1 Resource Strategies, 2003

The 2003 assessment tested 19 overburden and interburden waste rock and 2 Quaternary alluvium samples from North Wambo Creek, as it was planned to be partially removed as overburden. The following tests were conducted:

- pH and electrical conductivity (EC) determination on 1 part solid to 2 parts de-ionised water;
- acid-base account analysis (total sulphur, acid neutralising capacity (ANC), net acid producing potential [NAPP])
- static net acid generation (NAG) tests;
- alkalinity, cation exchange capacity (CEC), sodium adsorption ratio (SAR) and exchangeable sodium percentage (ESP) calculations;
- multi-element scans on solids, and;
- shake solubility tests combining solid samples with distilled water in a 1:20 ratio, sealing and tumbling for 18 hours, settling and the supernatant liquor poured off, then filtered and analysed.

The tests indicated:

- pH of the overburden and interburden ranged from 6.8 to 9.6, which is typical of unweathered rocks in the Singleton Coal Measures (SPCC, 1983);
- the two North Wambo Creek alluvium samples had slightly acidic pH (5.6 - 6.6);
- the paste EC of all waste rock samples was low to very low (21 - 1,170µS/cm);
- all but one sample was classified as non-acid forming (NAF) due to the very low sulphur content (19 of 21 samples had total sulphur < 0.1%, with the majority below the 0.01% detection limit. Sample WJ30-3 was classified as potentially acid forming – low capacity (PAF-LC) with a total sulphur of 0.37% (with half being sulphate sulphur) from mudstone;
- the overburden / interburden alkalinity ranged from 15 - 40 meq/kg, indicating a moderate buffering capacity whilst the alluvium had relatively low alkalinity (4 - 10 meq/kg);
- CEC of the interburden and overburden samples were moderate, while the SAR and ESP values indicated a degree of sodicity for most samples which are typical for the Project area;
- multi-element scans and shake solubility tests indicated that under laboratory-simulated leaching conditions, metal concentrations were below the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC, 2000), and;
- the predominant NAF behaviour of the waste rock inferred a limited probability of heavy metals becoming available to plants or occurring in waste rock or tailings leachate.

5.2 Geo-Environmental Management, 2009

The 2009 assessment tested 31 footwall, hanging wall and interburden core samples with regard to the potential expansion of the Wambo Coal Mine into the Montrose open cut and Bates underground workings.

The following tests were conducted:

- pH and electrical conductivity (EC) determination on 1 part solid to 2 parts de-ionised water;
- acid-base account analysis (total sulphur, chromium reducible sulfur, acid neutralising capacity [ANC], net acid producing potential [NAPP]) and static net acid generation (NAG) tests;
- sodicity calculations;
- multi-element scans on solids; and
- 1:2 (solid/water) leachate multi element scans.

The tests indicated:

- the pH of the overburden and interburden ranged from 7.4 to 9.5, which is typical of unweathered rocks in the Singleton Coal Measures (SPCC, 1983).
- the leachate EC of the waste rock samples was low (258 – 749 µS/cm);
- all samples were classified as non-acid forming (NAF) due to their low to very low total sulphur (0.01 – 0.45, median 0.04%) and elevated ANC (9 - 50.8, median 20.6 kgH_2SO_4/t);
- ESP values are moderately sodic for most samples, with a lesser component being strongly sodic;
- The SAR is dominated by sodium in all extracts and presents an elevated soil sodicity risk;
- multi-element scans and leachate solubility tests indicated that under laboratory-simulated conditions, metal concentrations exceeded Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC, 2000) for South East Australian slightly disturbed ecosystems and 95% Protection of Freshwater Species for Al, As, Cu, Pb, Zn, Ni, Cd, Co, and Se, however;
- as all the samples are predominantly NAF there is limited probability of heavy metals becoming available to plants or occurring in waste rock or tailings leachate.

5.3 GeoTerra, 2010

The 2010 assessment tested 87 overburden and interburden cored samples with regard to the potential AMD characteristics of bore UG129 within the central eastern area of the proposed United open cut to 241mbgl.

The following tests were conducted:

- Acid - base account analysis (total sulphur, acid neutralising capacity (ANC) and net acid producing potential (NAPP).

The tests indicated all samples except one (claystone / siltstone at 39.35 – 39.98mbgl) were classified as non-acid forming (NAF) due to their low to very low total sulphur (0.01 – 0.77, median 0.016%) and moderately elevated ANC (0.4 – 3.4, median 0.84 kgH_2SO_4/t);

5.4 GeoTerra, 2016

The 2016 assessment tested 23 overburden and interburden cored samples from bores UG190, 202, 204 and 237A located within the proposed United Open Cut with regard to the elemental composition of dust that may blow off waste dumps associated with the proposed workings.

The multi-element scans on crushed core indicated that the metal concentrations did not exceed the Assessment of Site Contamination (ASC) National Environment Protection Measure (NEPM) Excel based toolbox derived Ecological Investigation Level (EIL) soil criteria for fresh soil in an Urban Residential and Open Public Space environment.

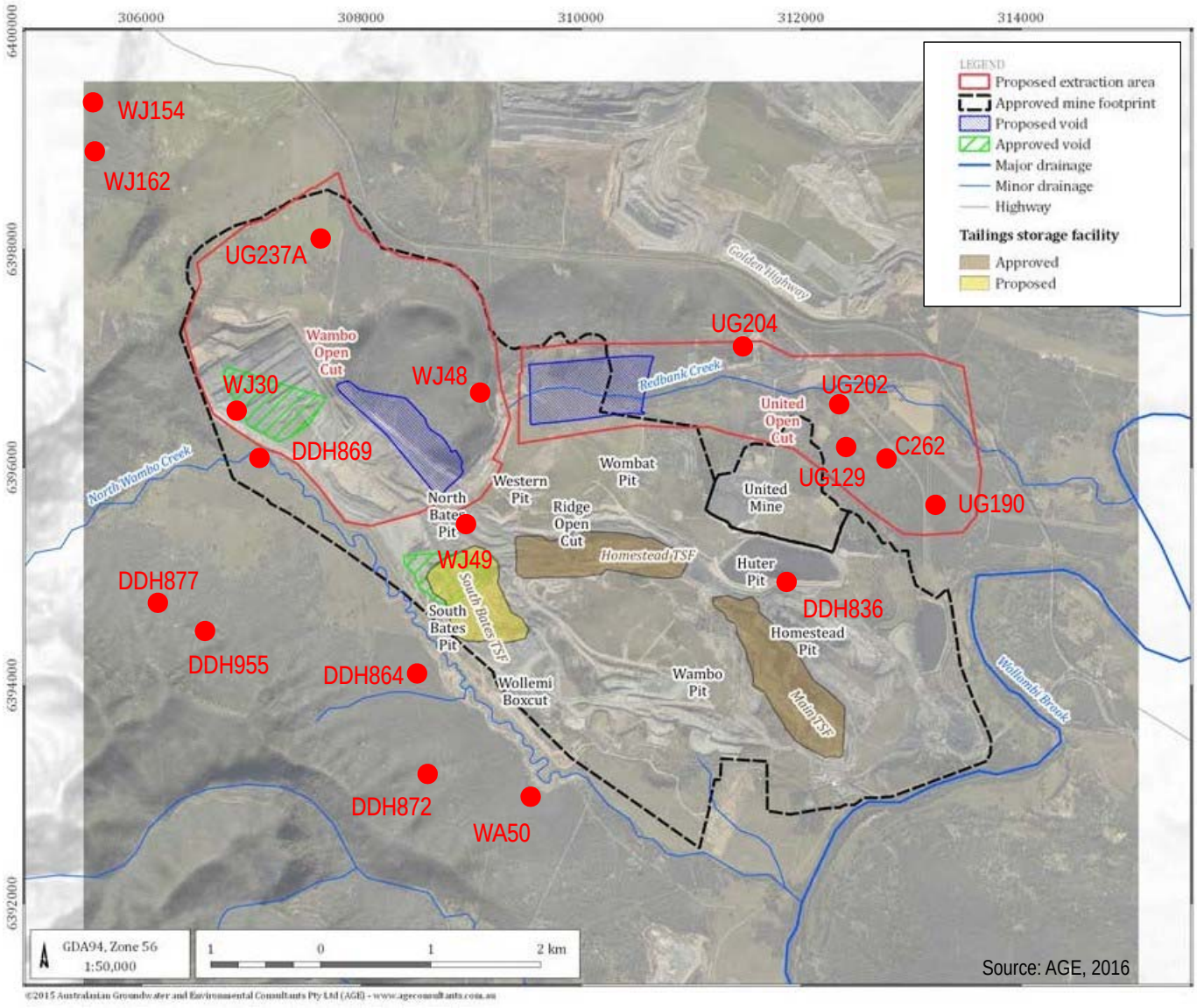


Figure 3 Sampled Borehole Locations

5.5 Historical Mine Site Groundwater Geochemistry

A compendium of field and groundwater geochemistry assessments and reports completed between 2001 and 2005 has been conducted, with the assessment focussing on a west to east flow path from North Wambo Creek to Wollombi Brook, through piezometers within the Wambo and United mining areas that primarily no longer exist within the open cut workings area.

Although monitoring has persisted to the present date in piezometers to the east of the open cut workings, this is not assesed for this exercise as the full transect of monitoring sites no longer exists.

As can be seen in **Figure 4**, the transect pH along the regional groundwater flow path, from the North Wambo Creek Quaternary alluvium recharge area in the east, through the coal measures under and in the vicinity of the mine area, to the coal measures down gradient (east) of the mine area and into Wollombi Brook via a general acidification trend.

Figure 5, for the same transect, shows the groundwater salinity, as measured by electrical conductivity (EC), is relatively brackish in the North Wambo Creek alluvium (<3800µS/cm), becoming more saline with passage downgradient through / under the mine area and toward Wollombi Brook (<18,500uS/cm), then becomes brackish (<7200uS/cm) under the recharge influence of Wollombi Brook.

Piezometer locations are shown in **Figure 6**.

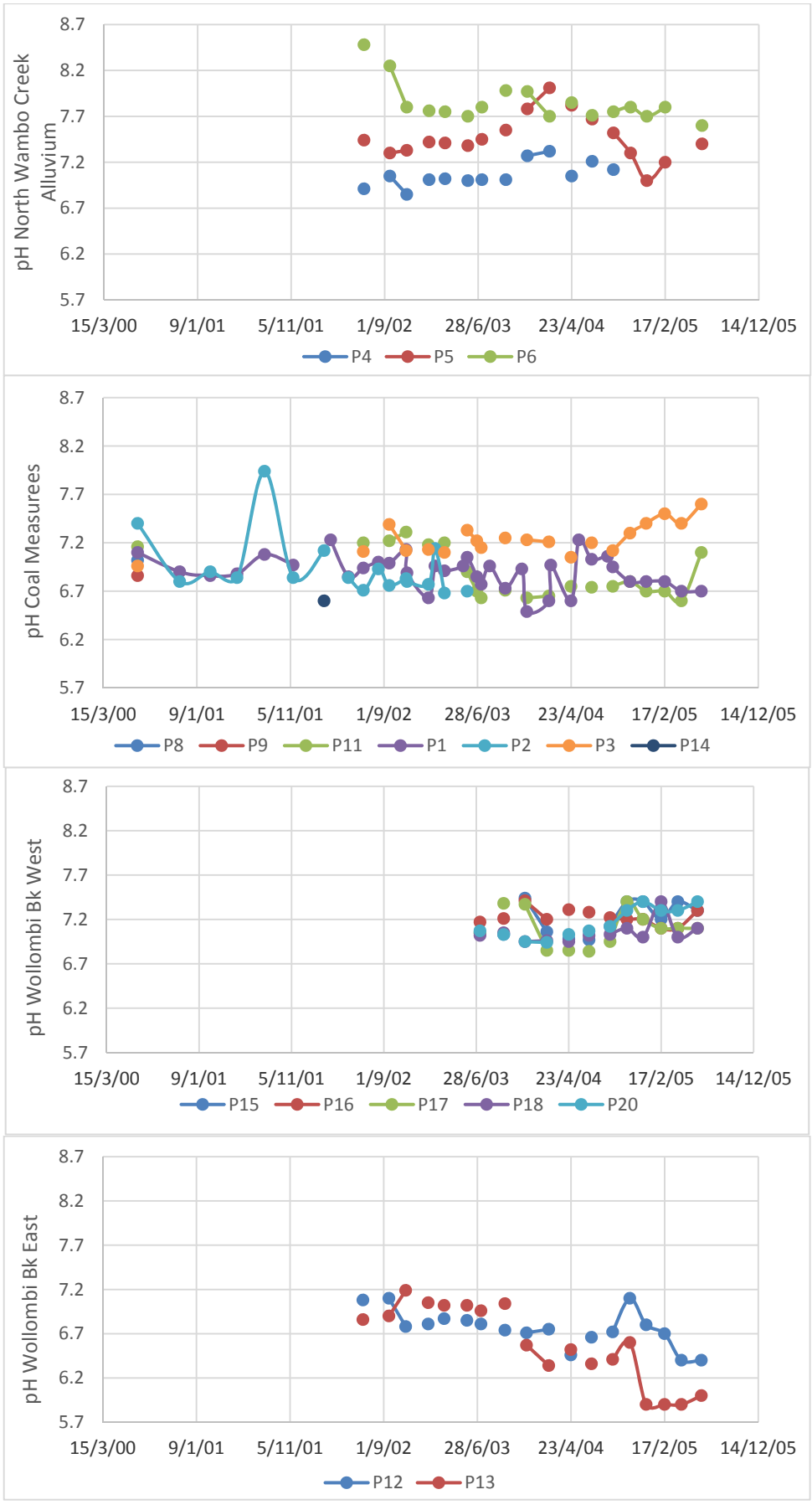


Figure 4 West to East Groundwater Transect - pH

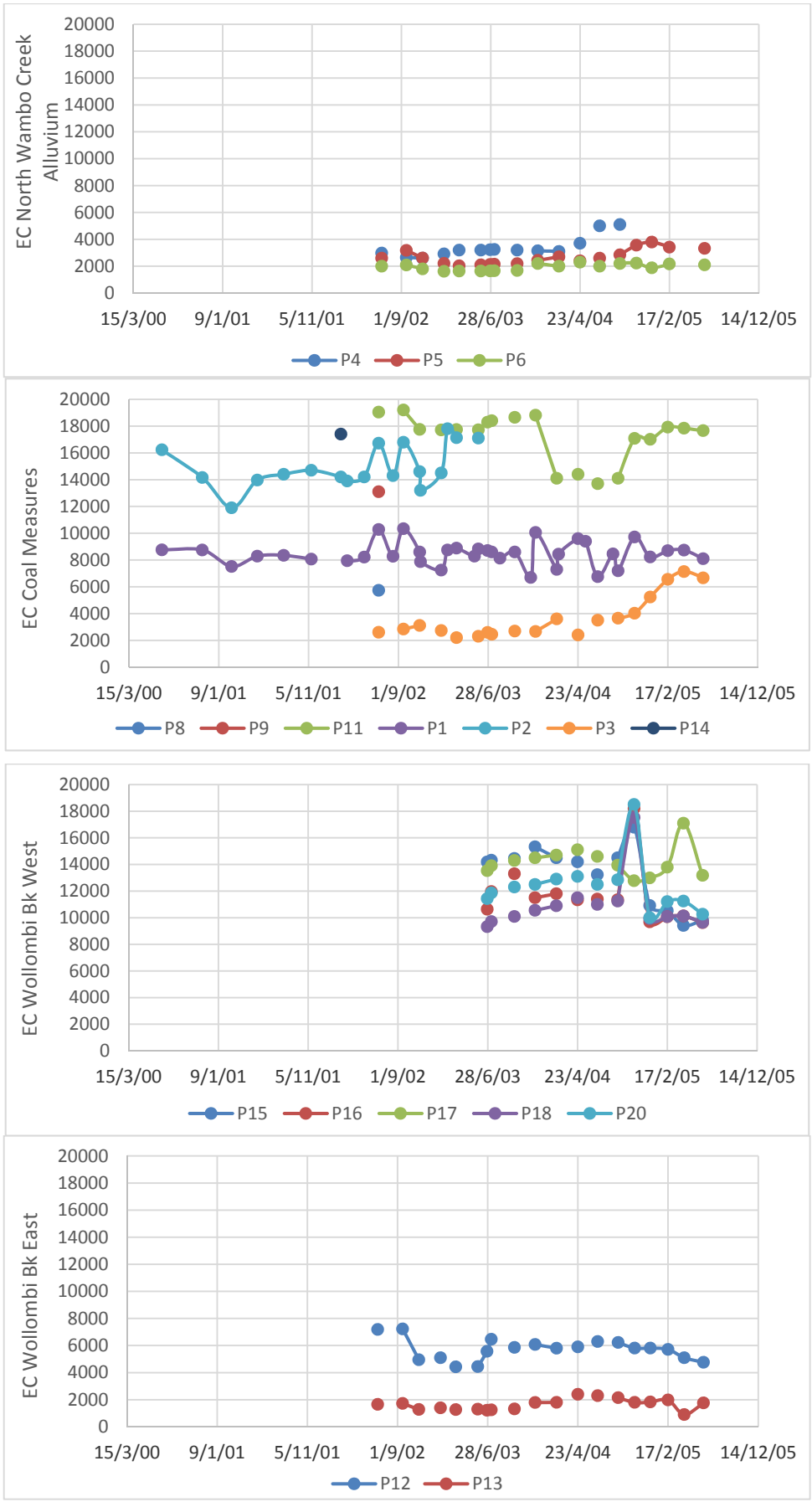


Figure 5 West to East Groundwater Transect - EC

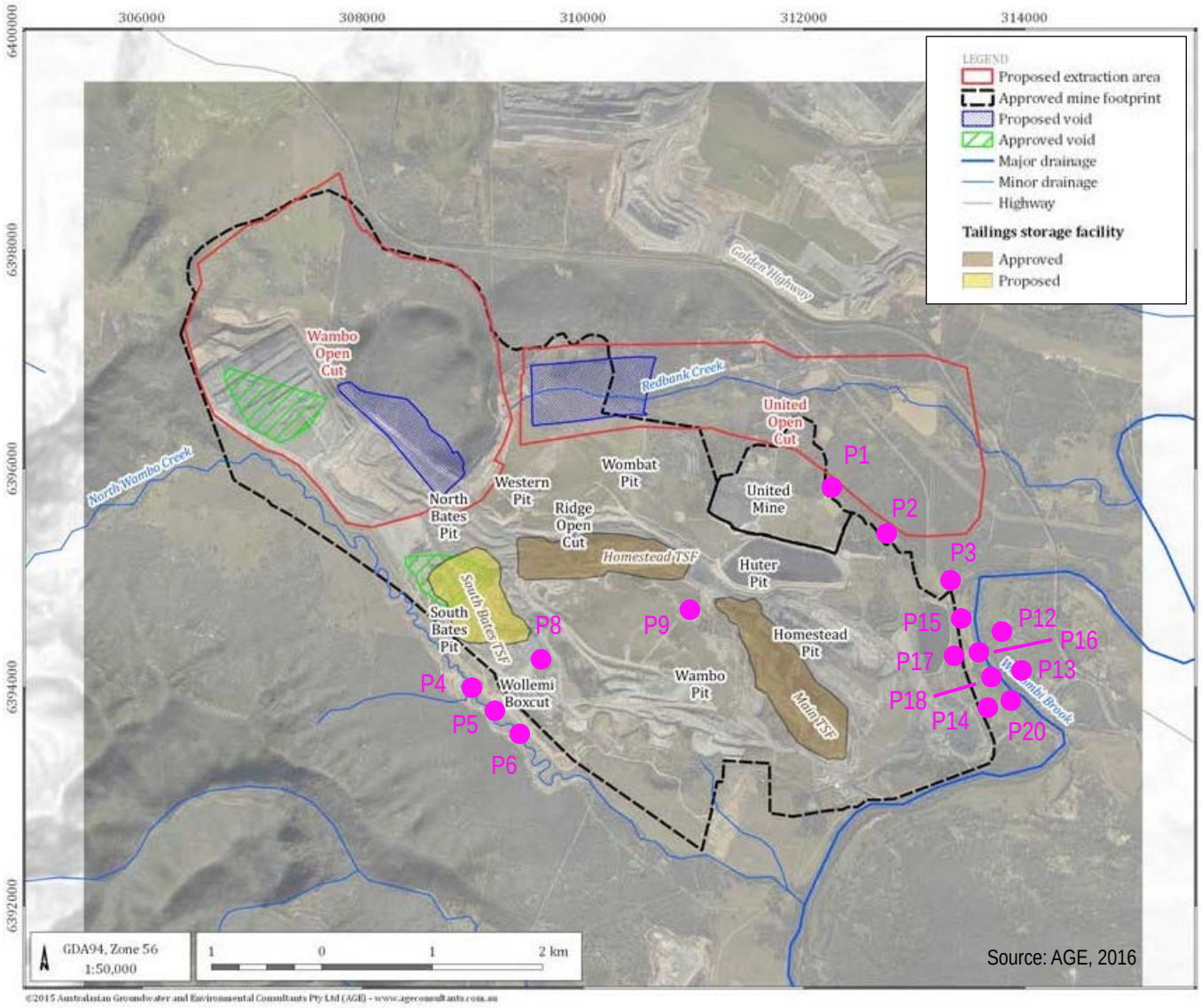


Figure 6 Selected Monitoring Piezometers

6. DRILL CORE AND OTHER SAMPLE LOCATIONS

Locations of the workings and sample core holes are shown in **Figure 6** and **Table 2**.

Table 2 Previous Geochemical Cored Bore and Sample Locations

Core / Sample	Location	Northing	Easting	Total Depth (m)
Resource Strategies, 2003				
WJ30	central west edge of Wambo O/C	6396463	306869	124.2
WJ48	central east edge of Wambo O/C	6396886	309062	310
WJ49	375m south east of Wambo O/C	6395391	308954	511
WA50	between Homestead and United longwall wkgs	6393105	309888	316.7
DDH836	over United Longwall 3, 760m SE of United O/C	6394997	312099	70.4
North Wambo Creek	North Wambo Creek	n.a.	n.a.	0
Coarse Reject	CHPP	-	-	-
Thickener Underflow	CHPP	-	-	-
Thickener Overflow	CHPP	-	-	-
Geo-Environmental Management, 2009				
DDH864	NW of Wollemi boxcut, 980m sth of Wambo O/C	6394501	308501	202.2
DDH869	250m sth of central Wambo O/C	6395980	307041	148.2
DDH872	west of Homestead u/g, 1.8km sth of Wambo O/C	6393499	308507	254.6
DDH877	1.5km south west of Wambo O/C	6395012	306014	253.15
WJ154	2.4km NW of Wambo O/C	6399633	304787	321.6
WJ162	2.25km NW of Wambo O/C	6399254	304749	101.66
GeoTerra, 2010				
UG129	central east of United O/C	6396332	312313	240.3
GeoTerra, 2016				
UG190	south east of United O/C	6395745	313281	246.7
UG202	centre of United O/C	6396646	312302	228.8
UG204	central west of United O/C	6396928	311247	259.4
UG237A	north west of Wambo O/C	6397650	307725	286.6
GeoTerra, 2017				
C262	central east of United O/C	6396163	312830	237
DDH955	1.5km south west of Wambo O/C	6394773	306401	227
Homestead Pit TSF	Homestead TSF beach near CHPP outlet	6393864	312670	surface
Homestead Pit TSF	mid-western Homestead TSF edge	6394314	312092	5m

7. SAMPLE PREPARATION AND LABORATORY ANALYSIS

All laboratory work and data analysis for the current study was conducted according to procedures outlined in the Australian Coal Association Research Project C15034 (Environmental Geochemistry International et al, 2008) as well as (AMIRA, 2002) and (Price, W.A, 2009).

7.1 Overburden

Seventeen overburden rock core samples from bores C262 and DDH955 were used in the current study.

The core samples were crushed and split into -75µm and -4mm fractions, then despatched for laboratory analysis.

Spare splits of each sample were retained in case follow up testing was required.

The 75µm overburden component was sequentially analysed for:

- total sulfur (TS) by the Leco method;
- if TS >0.05%, then the samples were re-tested for chromium reducible sulfur (CrS) to differentiate between pyritic (acid forming) sulfur and non-acid forming sulfate species, and;
- acid neutralising capacity (ANC).

The net acid production potential (NAPP) was then calculated using the ANC / TS or ANC / CrS, and based on the above results, if any samples exceeded 0.05% CrS, they were subsequently analysed for:

- Net Acid Generation (NAG) or Extended Boil NAG (for high carbon samples), or;
- calculated NAG assessment through analysis of sulfur, calcium, magnesium, sodium, potassium and chloride in the NAG leachate.

Selected overburden solids samples were also tested for cation exchange capacity (CEC) and exchangeable sodium percentage (ESP).

The seventeen (4mm crushed rock) samples were batch leach tested in a 1 part solid to 2 part de-ionised water ratio for at least 1 week, with daily pH and electrical conductivity recorded.

Of the 17 overburden batch leached samples, eleven were then selected to represent the various rock types and depth and analysed for total dissolved solids (TDS), sulfate, total and filtered iron and manganese and filtered selected metals.

The eleven overburden leachates were also assessed for sodium adsorption ratio (SAR).

7.2 Coal

Sulfide minerals that form through sulfate reduction in coal seams as well as immediately above and below a seam can have elevated sulfide contents compared to the rest of the coal measures strata. However, no coal samples were available for geochemical assessment in the current study as the samples had all been removed for coal quality analysis. In most cases, the product coal and the immediate roof and floor had been removed for metallurgical / washability analysis prior to the geochemical / AMD assessment process. As such, the presence or absence of pyrite in those seams and adjoing lithologies

was not assessd for this study.

7.3 Tailings

Tailngs samples for analysis were sourced as outlined below;

- 9 crushed drill core (-200µm) samples from the Blakefield, Woodlands Hill, Warkworth, Mt Arthur, Piercefield and Vaux seams from drill hole C262 after the samples had undergone CHPP washability trials;
- 5 hand augered samples from the Homestead Tailngs Storage Facility (TSF) collected from 0 - 5m below surface of the current TSF which represent the washed coal waste fines from the Whybrow, Redbank Creek, Wambo and Whynot Seams;
- one grab sample from the current TSF beach at the CHPP discharge point, which represents the Whynot AB Seam (and partings).

The tailings samples represent material that are currently, or are proposed to be in the fines waste stream from the CHPP.

The tailings solids sample component was sequentially analysed for:

- total sulfur (TS) by the Leco method;
- if TS >0.05%, then the samples were re-tested for chromium reducible sulfur (CrS) to differentiate between pyritic (acid forming) sulfur and non-acid forming sulfate species, and;
- acid neutralising capacity (ANC).

The net acid production potential (NAPP) was then calculated using the ANC / TS or ANC / CrS, and based on the above results, if any samples exceeded 0.05% CrS, they were subsequently analysed for:

- Net Acid Generation (NAG) or Extended Boil NAG (for high carbon samples), or;
- calculated NAG assessment through analysis of sulfur, calcium, magnesium, sodium, potassium and chloride in the NAG leachate.

Nine hand augered, grab and crushed core tailings samples were batch leach tested (where there was sufficient sample) in a 1 part solid to 2 part de-ionised water ratio for at least 1 week, with the daily pH and electrical conductivity recorded and comprised the following samples:

- 5 samples from the 0, 1, 2, 3, 4 & 5mbgl TSF augered hole;
- 1 sample from the current CHPP outlet TSF beach, and;
- 3 -200µm composite samples from the C262 crushed drill core tailings comprising the;
    - Blakefield Seam, 32.88 – 38mbg;
    - Warkworth Seam, 130.34 – 169.1mbgl, and the;
    - Mt Arthur Seam, 174.5 – 177.27mbgl.

Of the nine leached samples, the hand augered and beach Homestead Pit TSF and 3 post CHPP washability testing samples were analysed for total dissolved solids (TDS), sulfate, total and filtered iron and manganese and filtered selected metals.

The three CHPP washability sample leachates were sent for laboratory analysis, but it should be noted that they had effectively been “rinsed” out a number of times in the trials and their EC is low. In the washability tests, most of the soluble fraction from the solid samples is washed out and discarded during the test, whereas in the “real life” TSF, the solid fines and washed leachate all report to the TSF. As a result, the leachates are considered to under-estimate the salinity, major ions and metals of an actual TSF situation.

7.4 CHPP Reject

Eight -200µm crushed core coarse reject samples were tested from drill hole C262 that were sourced from the same intervals as the CHPP washability tailings samples.

The coarse reject crushed core samples were batch leach tested in a 1 part solid to 2 part de-ionised water ratio for at least 1 week, with the daily pH and electrical conductivity recorded.

The solids sample component was sequentially analysed for:

- total sulfur (TS) by the Leco method;
- if TS >0.05%, then the samples were re-tested for chromium reducible sulfur (CrS) to differentiate between pyritic (acid forming) sulfur and non-acid forming sulfate species, and;
- acid neutralising capacity (ANC).

The net acid production potential (NAPP) was then calculated using the ANC / TS or ANC / CrS, and based on the above results, if any samples exceeded 0.05% CrS, they were subsequently analysed for:

- Net Acid Generation (NAG) or Extended Boil NAG (for high carbon samples), or;
- calculated NAG assessment through analysis of sulfur, calcium, magnesium, sodium, potassium and chloride in the NAG leachate.

No leachate samples were generated or analysed from the C262 coarse reject CHPP washability trial samples as insufficient mass was available for both solids and leachate laboratory assessment.

A flow chart of the solids sample screening assessment process is shown in **Figure 5**, whilst the NAG assessment process is shown in **Figure 6**.

Tables 3 and **4** summarise the number of studied samples and tests.

Table 3 Solids Test Summary

Hole	Total Sulfur	Cr Red. Sulfur	ANC / NAPP	NAG Tests	Total Metals	CEC / ESP
Overburden						
C262	10	2	10	0	10	8
DDH955	7	0	7	0	7	7
TOTAL	**17**	**2**	**17**	**0**	**17**	**15**
Tailings and Rejects						
TSF Beach	1	0	1	0	1	0
TSF Auger	5	5	5	0	5	0
C262	17	13	17	9	17	0
TOTAL	**23**	**18**	**23**	**9**	**23**	**0**

Table 4 Leachate Test Summary

Hole	Batch Leach Test	Major Ions and Metals	SAR
Overburden			
C262	10	10	10
DDH955	7	7	7
TOTAL	**17**	**17**	**17**
Tailings			
TSF Beach	1	1	1
TSF Auger	5	5	5
C262	3	3	3
TOTAL	**9**	**9**	**9**

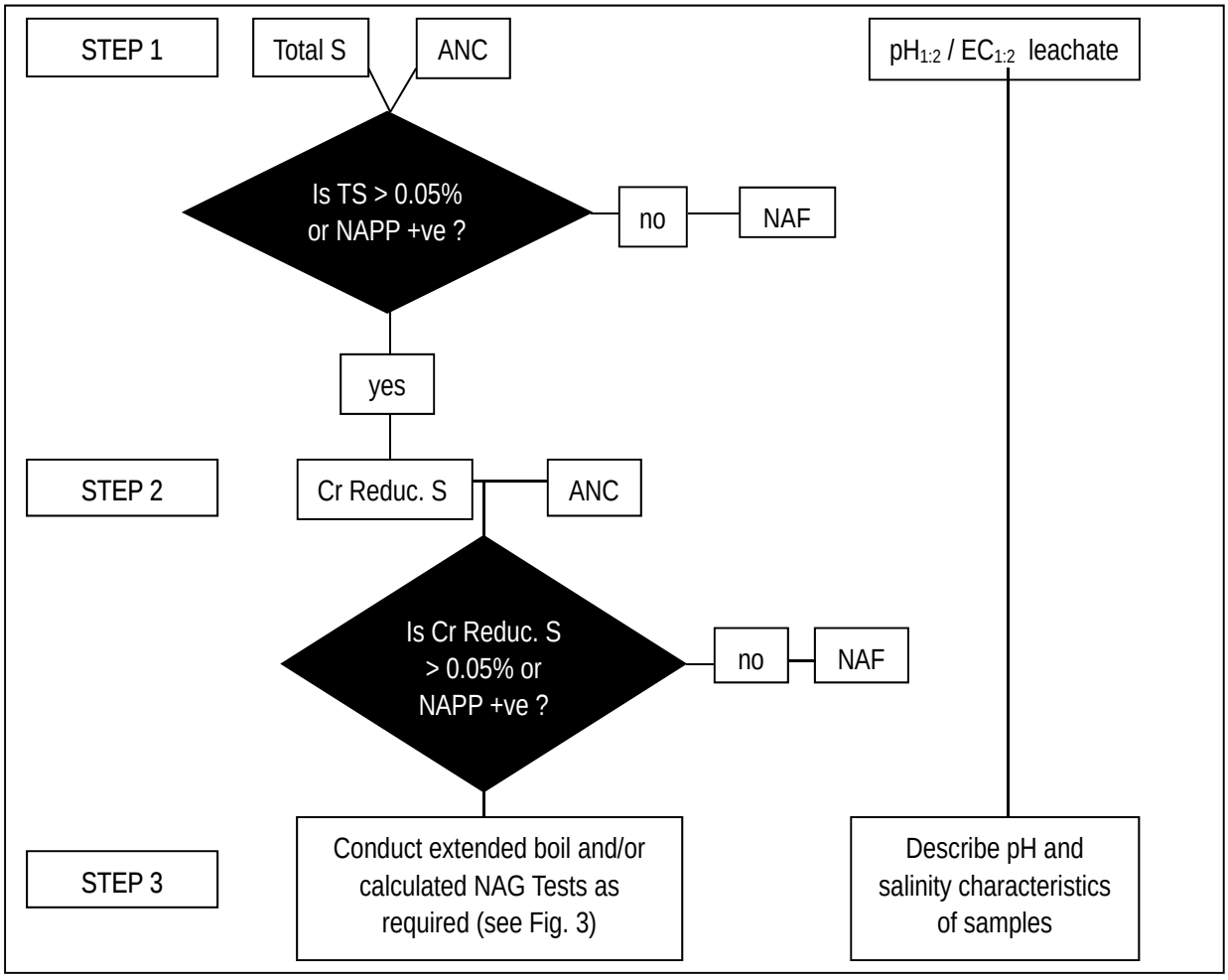


Figure 7 Solids Sample Test Screening Protocol

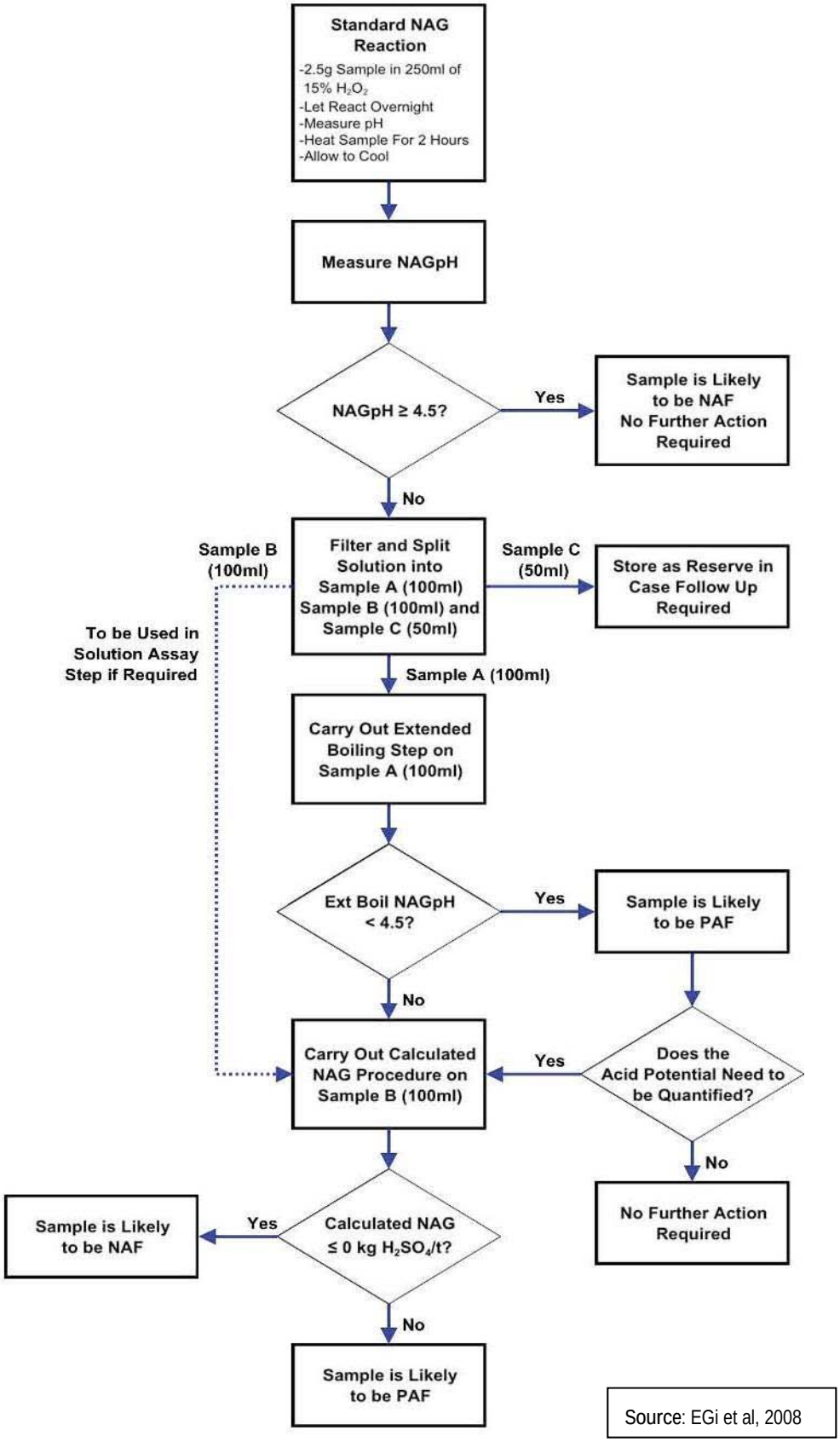


Figure 8 Extended Boil and Calculated NAG Test Protocol

8. WASTE ROCK GEOCHEMISTRY / AMD ASSESSMENT

8.1 Acid Neutralisation, Sulfur and Net Acid Production Potential

Potential sources of AMD from waste rock within the Project Site include:

- overburden and interburden;
- open pit floors, and;
- raw coal and product coal stockpiles.

8.1.1 Acid Neutralisation Capacity

The acid neutralisation capacity (ANC) of the 17 samples ranged up to a low value of 2.8% $CaCO_3$ (which is equivalent to 5.9kg H_2SO_4/t), with a median of 1.3%.

8.1.2 Sulfur

Total sulfur (TS) in the 17 samples ranged up to a low value of 0.072%.

Of the two TS samples that exceeded 0.05%, the maximum chromium reducible sulfur (CrS), which represesents sulfide sulfur (i.e. excluding sulfate and organic sulfur), ranged from 0.013 – 0.015%.

As shown in **Appendix A**, TS and CrS is highest in the more carbonaceous lithologies.

Note that the CrS value should be treated as a guide to the pyrite content in a sample due to issues with variability and repeatability with the CrS method.

In general, the total sulfur values include sulfur present as low AMD risk organic and non-acid forms of sulfate sulfur species as summarised in **Table 5**.

Table 5 Waste Rock ANC and Sulfur Maximum Values

Hole (DDH)	ANC (as $CaCO_3$)	Total Sulfur %	Chromium Reducible Sulfur %
C262	2.8	0.072	0.015
DDH955	2.6	0.041	n/a*

NOTES: * all samples were below 0.05% TS so no further testwork required

8.1.3 Net Acid Production Potential

A plot of the samples tested for total sulfur / ANC indicates the samples have a negative NAPP potential for acid drainage, which represents the balance between MPA and ANC as shown in **Figure 9**.

Appendix A includes a re-calculated NAPP based on the proportion of CrS and ANC which in all cases have a lower NAPP than for the TS assessment.

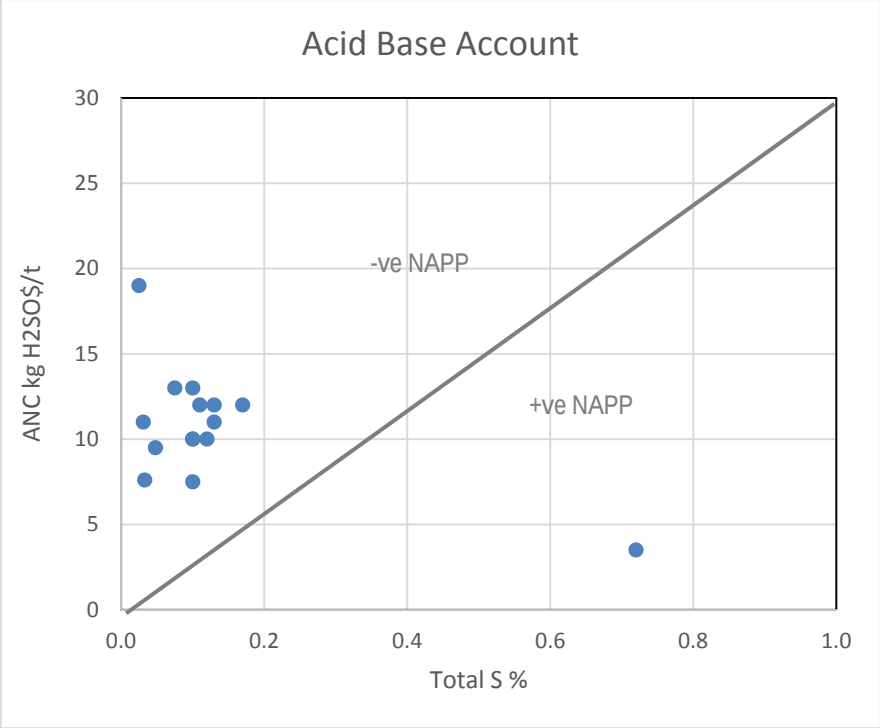


Figure 9 Overburden Acid Base Account

8.1.4 NAG or Extended Boil NAG Tests

As the TS or CrS results did not exceed 0.05% sulfur, and as the NAPP results did not indicate an acid generation potential and because the batch leach tests were all alkaline, no Net Acid Generation (NAG) or Extended Boil NAG tests were conducted.

8.2 AMD Classification

The AMD classifications provided in **Appendix A** are based on results and discussions outlined in the previous sections.

All samples with less than or equal to 0.05% TS and < 0.05% CrS were classified NAF due to the negligible risk of acid formation and no further test work was conducted. tests.

A summary of the overburden AMD classification is shown in **Table 6**, which is based on the sequential test results shown in **Appendix A**.

Table 6 Overburden AMD Classification Summary

Category	Number of Samples	% of Samples
Non-acid Forming (NAF)	17	100
Potentially Acid Forming – Low Capacity (PAF-LC)	0	0
Potentially Acid Forming	0	0

Based on all studies done to date at Wambo and United, the Project Site waste rock has a

TS maximum of 0.45% and median maximum of 0.04, which indicates a non-acid forming (NAF) low risk of AMD generation.

The overall sample suite also has a moderately elevated acid neutralisation capacity (ANC), with a maximum of 2.8 – 20.4% $CaCO_3$ and a median range of 0.76 – 2.6% $CaCO_3$ across all the studies.

Overall, the waste rock contains relatively low pyritic sulfur, which means a low AMD potential.

Due to the moderately elevated ANC, and, as a result, its relatively elevated buffering potential, acid buffering characteristic curve (ABCC) testing was not conducted on any samples.

Due to the low acid production potential, the moderately elevated ANC and the alkaline batch leach tests, it is considered the Project Site waste rock has a low likelihood of AMD generation.

8.3 Waste Rock Elemental Abundance

Laboratory analysis of waste rock was conducted to determine the elemental abundance in a sample.

Dissolution was by either acid digest, or where samples contain greater than 3% organic carbon, aqua regia was used. Aqua regia is less aggressive and does not dissolve silicates as much in the matrix.

A direct comparison of the measured abundances of the elements was made with the average abundance of elements in sediment documented by Bowen (1979).

As the abundance of elements varies many-fold, a log base 2 index known as the global abundance index (GAI) was developed to simplify comparison of measured abundances with average abundances (Förstner 1993).

The GAI indicates which elements are ‘enriched’ in a sample with respect to a reference average abundance. The GAI is calculated using the following formula:

$$GAI = \log_2 (C/(1.5*S))$$

An example of the GAI range is shown in **Table 7**.

Table 7 Range of Measured Elemental Concentrations and GAI

GAI	Multiple of Median Soil Content
0	<3
1	3 – 6
2	6 – 12
3	12 - 24
4	24 – 48
5	48 – 96
6	>96

Zero or positive GAI values indicate enrichment of an element compared to average-crustal abundances. As a general rule, a GAI of 3 or higher signifies enrichment that warrants further evaluation.

As summarised in **Appendix A**, elements identified as being enriched within the Project Site were:

- cadmium 3 - 12 x enriched, and, to a lesser degree;
- arsenic / mercury / bismuth up to 3 x enrichment.

Whilst these elements are partially enriched, no further evaluation of their leachability is required due to the alkaline pH of the waste rock and associated leachate.

8.4 Waste Rock Dispersivity, Sodicity and Erosion Potential

The long term stability of waste rock emplacements can be impacted through erosive tunnelling and/or gullying in sodic, dispersive soils, along with severe surface crusting, low water infiltration, low hydraulic conductivity, formation of hard, dense subsoils and restricted plant growth.

Sodic soils are dispersive and should not be used as construction materials since they are prone to tunnelling and collapse.

Sodic soils can be dispersive when wet. In non-dispersive soils, the clay fraction remains flocculated in still water and the water needs to be flowing above a threshold velocity to cause erosion. By contrast, there is no threshold velocity for dispersive soil as the clay is in suspension and the soil is highly susceptible to erosion and piping.

Precaution should be taken to prevent water contact with dispersive materials, whilst storage of material with high potential for dispersion should be contained within the core of waste rock emplacements where possible.

The potential for dispersivity is determined by the mineralogy and chemistry of the clay fraction and by dissolved salts in the pore space and eroding fluids.

The presence of exchangeable sodium in soil is the principal chemical factor contributing to dispersion, with the exchangeable sodium percentage (ESP) determined by measuring all exchangeable cations in a sample through cation exchange capacity (CEC) analysis then expressing the exchangeable sodium as a percentage of the CEC.

Total dissolved salts (TDS), which can be indirectly evaluated via electrical conductivity (EC) in the connate or eroding water can also affect the erosive potential of soils, with lower salinity generating a higher susceptibility of sodium saturated soils to dispersion. Soils with high content of dissolved salts may remain flocculated even if the ESP is high. A high dissolved salt content may also mask the effect of the high sodium content, which can cause soils with a high ESP to behave as a non-dispersive material.

Therefore the boundary between flocculated and de-flocculated (when dispersion can occur) states depends on the mineralogy and sodium content of the clay, as well as the pore and eroding water salt content.

Dispersivity can be assessed by chemical and physical tests to ascertain the potential for dispersion, with a useful approach being to conduct a variety of tests, with variability between different test results being common.

Three methods were used in this study to assess the erosive potential of the tested samples:

- ESP and CEC;
- paste EC, and;
- simulated accelerated weathering.

For the ESP and CEC a sub-sample of the crushed core was dried and pulverised to -75µm, with the ESP calculated via the equation:

ESP = exchangeable ((Na) / Ca + Mg + K + Na)) x 100 (in %)

An ESP less than 6% indicates non-dispersive / non-sodic properties and 6- 25% indicates sequentially higher dispersive properties as shown in **Table 8**, with the test results shown in **Table 9**.

Table 8 ESP Classification (%)

Exchangeable	Non sodic	Sodic	Moderately Sodic	Strongly Sodic	Very Strongly Sodic
Sodium	<6	6-10	10-15	15-25	>25

Factors such as clay type (determined indirectly via CEC) and total dissolved salts (via EC) can govern the overall behaviour of clay based soil.

Table 9 Potential Waste Rock Erosivity Factors

HOLE	Depth	Lithology	CEC (meq%)	ESP (%)	EC 1:2 uS/cm
262	**18.54 - 20**	carb. siltstone	16.6	4.2	757
	25.14 - 26	fine sandstone	10.7	14.6	542
	48 - 48.3	fine carb. sandstone	11.1	9.5	523
	103.57 - 104	carb. siltstone	11.2	19.8	379
	128.5 - 129	carb. med. sandstone	12.9	6.2	661
	155.2 - 155.4	carb. siltstone	8.3	17.9	626
	188.7 - 188.9	tuff	19.3	87.5	669
	192.4 - 192.6	coaly siltstone	13.6	23.7	423
955	**157 - 157.3**	carb. siltstone	15.9	19.4	998
	177.1 - 177.3	med. sandstone	14.2	10.6	774
	190 - 190.4	coarse sandstone	12.7	9.6	784
	203 - 203.3	carb. siltstone	15.2	14.5	822
	209.1 - 209.3	coarse sandstone	16.0	11.6	788
	244.2 - 244.5	coaly conglomerate	14.9	12.1	618
	249.1 - 249.3	coaly siltstone	13.5	25.5	339

The tested waste rock samples contained low to moderate salinity, with the finer grain lithologies, in general, having higher salinity.

All but one of the samples had ESP greater than 6% and vary from sodic to very strongly sodic with ESP values ranging from 4.2 – 87.5% along with low to moderate CECs.

Around half the fresh samples are sodic to very strongly sodic, mainly comprising claystone, siltstone and tuff, with the coarser grained sandstone and conglomerates tending to be less sodic due to their lower clay content.

Simple accelerated weathering testing (AWT) was conducted through submerging a sample in water then wetting and drying it, with the tuff showing a very high erosive and dispersive character.

The dispersive properties of the samples was also measured using a dispersion percent test which presents the ratio of clay dispersed in de-ionised water as a percentage of the total sample mass. A dispersion percent above 50% is considered high.

Of the 17 samples, 3 showed strongly dispersive results (C262 @ 188.7 and 192.4m as well as DDH955 @ 157m), whilst 4 were moderately dispersive and the remainder were clear, with clay particles settling out with time and no remnant suspension.

The tuff and carbonaceous siltstone generally had a dispersive nature, whilst the sandstone and conglomerate showed low to no dispersivity.

The simulated weathering indicated that the carbonaceous siltstone has moderate potential for deterioration with exposure to water.

Although fresh rock may not currently be dispersive, it may not be durable and may degrade over time and become more prone to erosion than fresh rock.

The more weathered material is generally more sodic and more dispersive and may be subject to surface crusting and enhanced erosion.

Materials with sodic/dispersion potential may need to be treated with gypsum or lime if used as a plant growing horizon, exposed on dump surfaces or used in engineered structures.

8.5 Overburden Leachate Results

The results outlined below provide an indication of the water quality generated with the selected samples and form an initial assessment of the potential waste dump runoff water quality, however, the actual water quality will be affected by as yet undefined rain, seepage dilution and evaporation effects.

The physical and chemical conditions of the leach test are not likely to be equivalent to the in-situ environment due to solubility constraints, a variable liquid to solid ratio and greater in-situ particle size etc., then the test composition is not purported to be fully representative of the field environment. The results cannot be directly extrapolated to equate to the dump seepage, but provide an indication of the possible leachate water quality that may occur.

As the results are derived from pulverised samples, where the surface area in contact with water is much greater than in a typical overburden emplacement area, and that additional dilution is likely in the field due to mixing with rainfall and clean surface runoff, the laboratory based results are likely to represent a potential ‘worst case' scenario.

8.5.1 Leachate pH and Salinity

The $pH_{1:2}$ of the crushed core leachates are all alkaline and ranged from 7.98 – 9.16, with a median of 8.92, indicating no potential acidity. The samples with the lowest pH were associated with carbonaceous siltstone.

As summarised in **Table 10**, $EC_{1:2}$ values ranged from 339 - 998µS/m with a median of 661µS/m, indicating that the overburden, as represented by the selected samples, is likley

to contain low salinity.

The results shown in **Appendix A** indicate that the overburden, as represented by the samples, is not likely to generate acidic leachate or be particularly saline.

Table 10 Overburden Leachate Summary

Hole	pH	EC µS/cm
C262	7.98 – 9.16	379 - 704
DDH955	8.54 – 9.16	339 - 998

8.5.2 Major Ions and Metals

Laboratory analysis for the selected samples from the one:two ratio solid:water overburden samples shown in **Appendix A** and are compared to the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC/ARMCANZ 2000).

The ANZECC/ARMCANZ (2000) freshwater trigger values (95% level of protection) were selected as the area is moderately disturbed, whilst the ANZECC/ARMCANZ (2000) guidelines for upland rivers in south-east Australia are also referenced as the site is above 150m altitude.

The parameters exceeding the trigger values for freshwater upland streams and protection of 95% of aquatic species were: Al, As and Cu and to a lesser degree, Ni and Zn.

On this basis, the risk of metalliferous runoff and seepage above the ANZECC 2000 criteria from the overburden and wallrock is anticipated to be moderate for Al, As and Cu, and low for Ni and Zn.

9. TAILINGS GEOCHEMISTRY / AMD ASESSMENT

One beach grab and 5 augered tailings samples within the currently active Homestead TSF as well as nine potential tailings from CHPP laboratory trials were obtained from drill hole C262 from the Unnamed E, Blakefield, Glen Munro, Woodlands Hill, Warkworth, Mt Arthur, Piercefield and Vaux Seams within the proposed United Open Cut, as outlined in **Table 2**.

The acid forming characteristics of the tailings samples are presented in **Appendix A**, and were analysed for total S, chromium reducible sulfur, ANC, NAPP, $pH_{1:2}$ and $EC_{1:2}$ leachate tests.

Five tailings from C262 were subsequently tested for the Extended Boil NAG test.

9.1 Acid Neutralisation, Sulfur and Net Acid Production Potential

9.1.1 Acid Neutralisation Capacity

The sample ANC ranged up to a relatively low value of 19.0kg H_2SO_4/t.

9.1.2 Sulfur

Total sulfur ranged from 0.03 - 0.072%, with a median of 0.10%.

Of the 15 samples, 11 exceeded 0.05% total sulfur.

For the sulfide sulfur tests, as represented by chromium reducible sulfur analysis, the sulfur content ranged from 0.02 – 0.067%, with a median of 0.05%.

A plot of total and CrS (sulfide) sulfur against ANC indicates that all samples except the Blakefield have –ve NAPP as shown in **Figure 10**.

Total sulfur is highest in the Blakefield, followed by the Glen Munro, the beach and augered Homestead TSF and then the Piercefield and Vaux Seams.

Results show that plotting the chromium reducible (sulfide) sulfur, as opposed to total sulfur, against ANC, did not change the overall assessment, although the PAF capacity of the Balkefield sample was slightly lower.

The sulfide sulfur assessment is a better representative of what sulfuric acid based runoff could occur from the tailings, as the total sulfur based values also include the oxidised sulfate and organic forms of sulfur, which do not form sulfuric acid.

The highest NAPP using total sulfur was 18.5kg H_2SO_4/t in the Blakefield Seam which reduced slightly using chromium reducible sulfide sulfur to 17.1kg H_2SO_4/t.

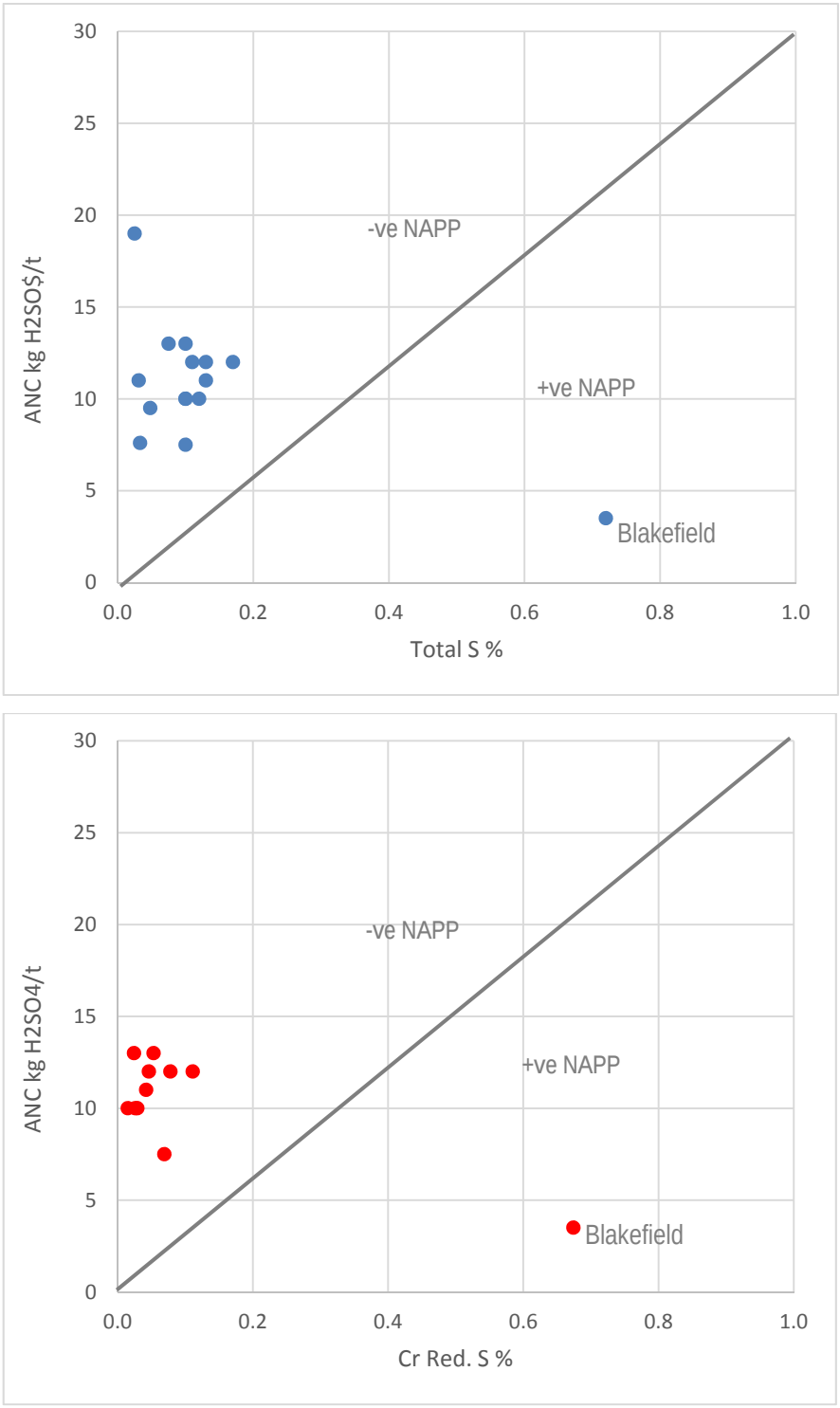


Figure 10 Tailings Acid Base Account Extended Boil NAG

9.2 Extended Boil NAG Test

Further investigation was conducted to determine the acid production potential of the coal seam composite tailings samples using an Extended Boil NAG test.

The single addition net acid generation (NAG) test is generally used to measure how a sample reacts under highly oxidising conditions using hydrogen peroxide, which oxidises sulfides and generates sulfuric acid. Concurrently, neutralising minerals react to consume any generated acid until the acid neutralisation capacity (ANC) of the sample is consumed. Following a predetermined contact time, the solution pH (NAG pH) is recorded and the NAG acidity of the sample is quantified by titration with sodium hydroxide.

There is, however, a potential for generation of organic acids in the single addition NAG test due to partial oxidation of carbonaceous materials, which does not occur naturally. This can lead to erroneous low NAG pH values and high acidities which are unrelated to sulfide oxidation acid generation, which can lead to misclassification of a sample. This is most likely to occur where the organic carbon exceeds 7% and pyrite is less than 0.7%, i.e. as is found in coal tailings dams.

The extended boil NAG test is used to provide a more reliable measure of the acid forming potential of a carbonaceous sample and is used if the NAG pH of the single addition NAG test is less than 4.5. Additional hydrogen peroxide is added to a split of the NAG solution, which is boiled vigorously for several hours followed by further pH measurement. A sample is classified as acid producing if the solution pH is still less than 4.5.

The acid potential of the sample is uncertain if the pH is greater than 4.5 and a solution assay step can be conducted on a split of the NAG solution for main cations generated from acid generating (S) and acid neutralising (Ca, Mg, Na, K) processes. The net acid potential can then be estimated from the NAG solution composition.

The Extended Boil procedure had pHs from 2.9 to 5.15, which indicates Potentially Acid Forming (PAF) to Potentially Acid Forming – Uncertain (PAF-UC) charactersitics of the tested samples.

Titration to pH 4.5 generally accounts for acidity attributable to free acid (H_2SO_4) and ferric iron generated during the oxidation of sulfide minerals that have not been neutralised by the ANC. A further titration from pH 4.5 to pH 7 generally accounts for acidity associated with some metals, such as copper, that are mostly soluble at pH 4.5 but practically insoluble at pH 7. Acidity attributed to unoxidised ferrous iron will also be accounted for up to pH 7 as ferrous iron (Fe^{2+}) remains soluble at pH 4.5, however, oxidation to ferric iron (Fe^{3+}) by atmospheric oxygen accelerates as the pH increases.

Figure 11 illustrates the difference in the NAG liquor after the samples were titrated to pH 4.5 and pH 7.0 and indicates the majority of acidity is from metals, such as copper and unoxidised Fe^{2+}.

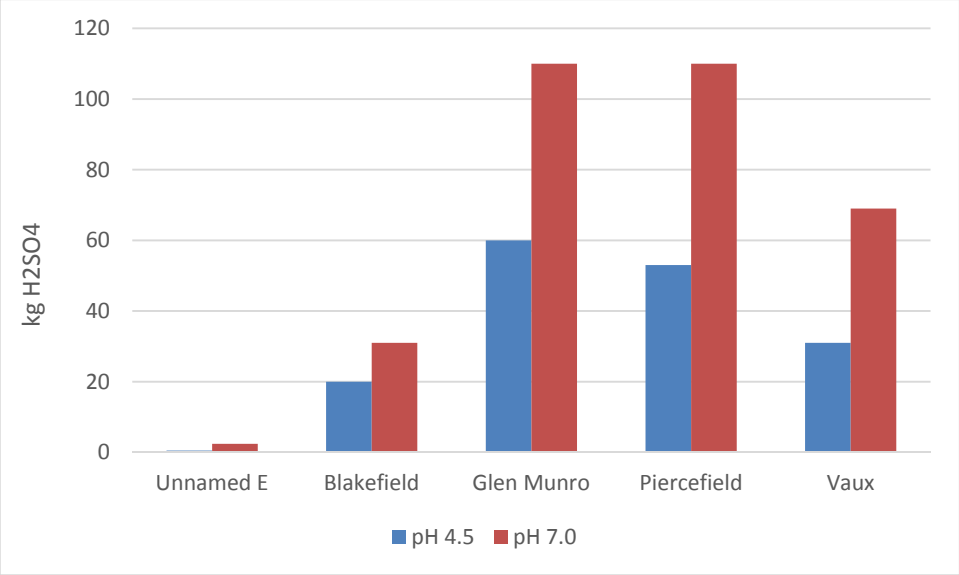


Figure 11 Tailings Extended Boil NAG pH 4.5 and 7.0

Figure 12 illustrates the relative content of sulfur species in the tested samples and shows that the beach and augered Homestead TSF samples have higher oxidised than pyritic sulfur.

The drill core samples, which were obtained after they were assessed for CHPP washability, indicate the pyritic sulfur exceeds the oxidised species, and quite significantly in the Blakefield Seam.

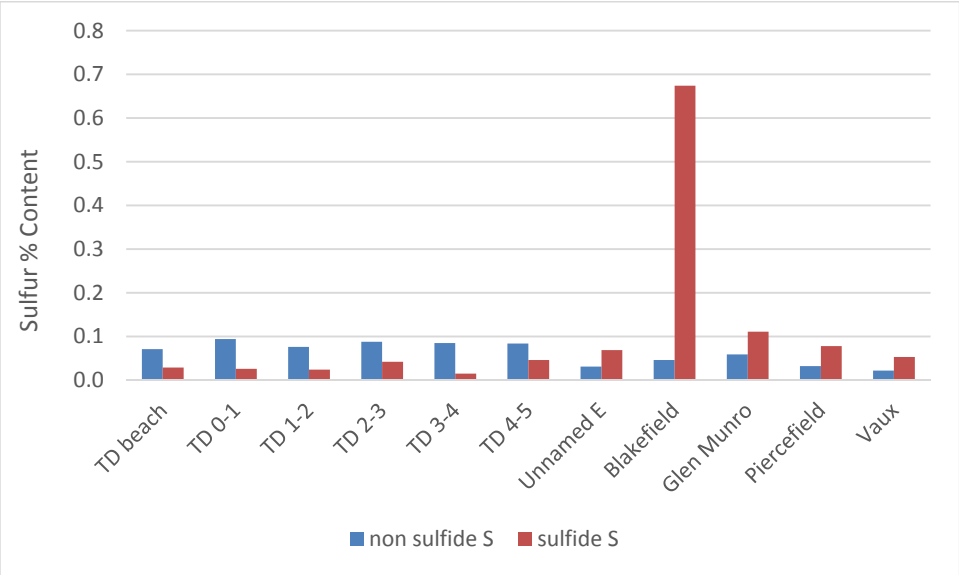


Figure 12 Tailings Extended Boil Sulfur Species

9.3 Tailings AMD Classification

The potential acid and metalliferous drainage (AMD) classifications of tailings are provided in **Appendix A** based on results and discussions outlined in the previous sections.

The samples were classified according to the scheme shown in **Table 11**, which is a combination of AMIRA (2002) with a minor change to the definition of UC (PAF) as used by EGi (2005) for higher sulfur contents.

Table 11 Acid - Base Accounting Classification

Class	Sub - Class	Description
NAF	**NAF**	negative NAPP and NAG pH of ≥4.5
	NAF - Barren	As above, plus low ANC (≤5 kgH_2SO_4/t)
PAF	**PAF**	positive NAPP and NAG pH of <4.5
	PAF - LC	As above plus low NAG acidity (NAG pH 4.5 < 5 kgH_2SO_4/t)
Uncertain	**PAF - UC**	negative NAPP with NAG pH <4.5 and NAPP ≥0 or NAG pH ≥4.5 and total S > 1%
	NAF - UC	NAPP ≥0 with NAG pH ≥4.5 and total S ≤ 1%S, with some sulfur possibly being non-pyritic

Notes: ANC = acid neutralisation capacity NAPP = net acid producing potential
NAG pH = pH measured during net acid generation test

All of the six grab and augered Homestead TSF tailings contained above 0.05% total S but below 0.05% CrS and had negative NAPP, which means they are non acid forming (NAF).

The nine crushed core samples supplied for AMD assessment after they had been tested for CHPP washability trials indicate that;

- 1 is potentially acid forming (PAF) in the Blakefield Seam;
- 3 are PAF Uncertain (PAF – UC) in the Glen Munro, Piercefield and Vaux Seams, and;
- 4 are NAF in the Woodlands Hill, Warkworth, and Mt Arthur Seams (2 samples)

The tailings AMD classification is shown in **Appendix A** and summarised in **Table 12**.

Table 12 Tailings AMD Classification Summary

Category	% of samples
Non-acid Forming (NAF)	73%
Potentially Acid Forming – Uncertain (PAF - UC)	20%
Potentially Acid Forming (PAF)	7%

Overall, the results indicate that the tailings should be non-acid forming, with a low, temporary potential for being acid forming when the Blakefield tailings are discharged to the Tailings Storage Facility (TSF) and PAF – UC when the Glen Munro, Piecefield and Vaux tailings are discharged to the TSF.

The compound TSF geochemistry and the overall bulk alkalinity of the material stored when all the tailings are contained in the TSF is anticiapted to generate an overall NAF characteristic due to the low chromium reducible sulfur levels (ie low pyrite), with the highest tested result (0.674%) in the Blakefield Seam sample from borehole C262.

It is likely that, overall, AMD generation will not occur from the TSF due to operational mixing over the life of the TSF as approximately 75% of the tailings are NAF, even though the ANC is not high (<13kg H_2SO_4/t - median 11.0kg H_2SO_4/t).

Due to the low acid neutralisation capacity (ANC) values, and, as a result, their low buffering potential, acid buffering characteristic curve (ABCC) testing was not conducted.

Although there is not a signifcant excess of ANC compared to MPA (using CrS), due to the proportiuonally low potential acid production potential of the positive NAPP results, it is considered there is a low likelihood of AMD developing from tailings represented by these samples.

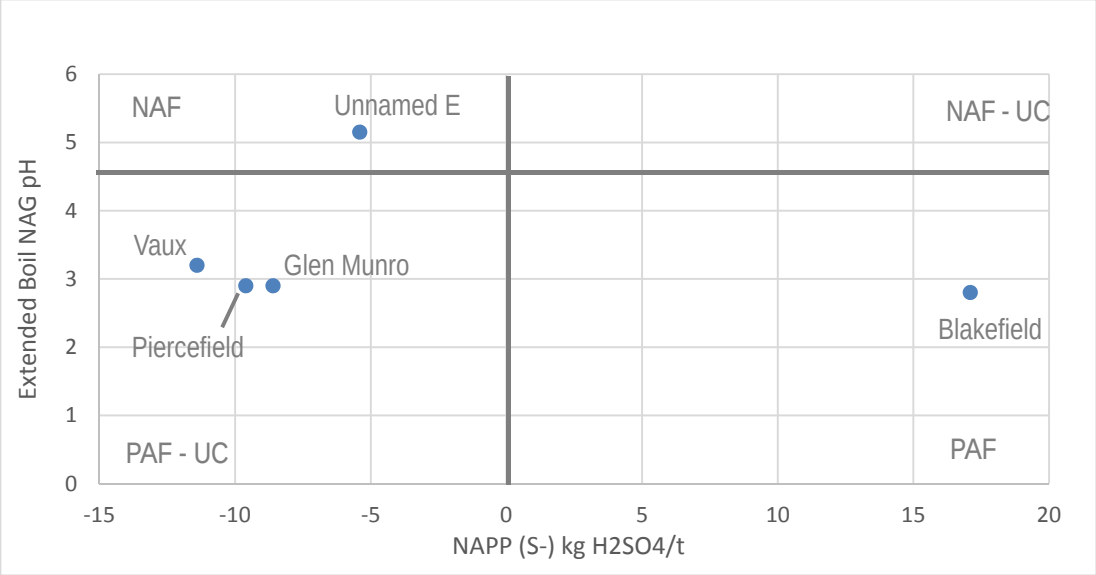


Figure 13 Tailings AMD Classification

9.4 Tailings Leachate Results

The batch leach ($pH_{1:2}$) ranged from 6.69 – 8.83, with a median of 7.89 for the nine tested tailings samples, which indicates the tailings are circum – neutral to predominantly alkaline.

The $EC_{1:2}$ ranged from 5,120 – 7,220µS/cm for the Homestead TSF beach and augered samples. However, the crushed core samples provided for geochemistry assessment after they had been tested for CHPP washability trials had a significantly lower $EC_{1:2}$, with a range of 335 – 368µS/cm, as shown in **Appendix A**.

It should be noted that six of the nine crushed core (post CHPP washability test) samples provided were not sufficient to conduct both batch leach tests as well as analyse the solid sample for laboratory geochemical analysis.

It should also be noted that as the salinity results are derived from small volume, highly pulverised samples, where the surface area in contact with water is much greater than would occur in a tailings emplacement, and anticipating that further dilution is likely in the field, these laboratory based results are likely to represent a “worst case” scenario.

On this basis, the risk of acidic, saline and metalliferous seepage from the TSF is anticipated to be low.

The tested lithologies and parameters which exceed the ANZECC/ARMCANZ (2000) trigger values for freshwater upland streams and Protection of 95% of Aquatic Species, as shown in **Appendix A**, include;

- As, Cu and Ni in the Homestead TSF, and;
- Cu in the C262 crushed core (after CHPP washability tests)

10. TAILINGS REJECT GEOCHEMISTRY / AMD ASESSMENT

Eight potential tailings rejects from CHPP laboratory trials were obtained from drill hole C262 from the Unnamed E, Blakefield, Woodlands Hill, Warkworth, Mt Arthur, Piercefield and Vaux Seams within the proposed United Open Cut, as outlined in **Table 2**.

The acid forming characteristics of the tailings reject samples are presented in **Appendix A**, and were analysed for total S, chromium reducible sulfur, ANC, NAPP, $pH_{1:2}$ and $EC_{1:2}$ leachate tests.

Four tailings rejects from C262 were subsequently tested for the Extended Boil NAG test.

10.1 Acid Neutralisation, Sulfur and Net Acid Production Potential

10.1.1 Acid Neutralisation Capacity

The sample ANC ranged up to a low to moderate value of 32.0kg H_2SO_4/t.

10.1.2 Sulfur

Total sulfur ranged from 0.02 – 1.4%, with a median of 0.10%.

Of the 8 samples, 4 exceeded 0.05% total sulfur.

For the sulfide sulfur tests, as represented by chromium reducible sulfur analysis, the sulfur content ranged from 0.09 – 1.17%, with a median of 0.38%.

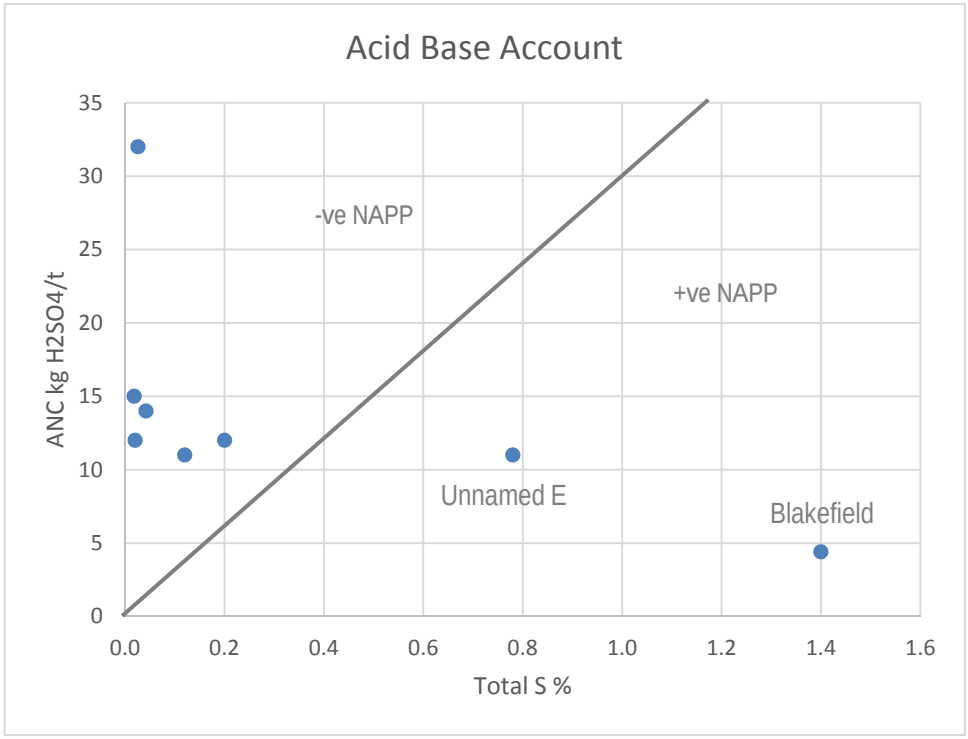
A plot of total and CrS (sulfide) sulfur against ANC indicates that all samples except the Blakefield and Unnamed E have –ve NAPP as shown in **Figure 14**.

Total sulfur is highest in the Blakefield, followed by the unnamed E, then the Piercefield and Vaux Seams.

Results show that plotting the chromium reducible (sulfide) sulfur, as opposed to total sulfur, against ANC, did not change the overall assessment, although the PAF capacity of the Balkefield sample was slightly lower.

The sulfide sulfur assessment is a better representative of what sulfuric acid based runoff could occur from the tailings rejects, as the total sulfur based values also include the oxidised sulfate and organic forms of sulfur, which do not form sulfuric acid.

The highest NAPP using total sulfur was 38.4kg H_2SO_4/t in the Blakefield Seam which reduced slightly using chromium reducible sulfide sulfur to 31.4kg H_2SO_4/t.



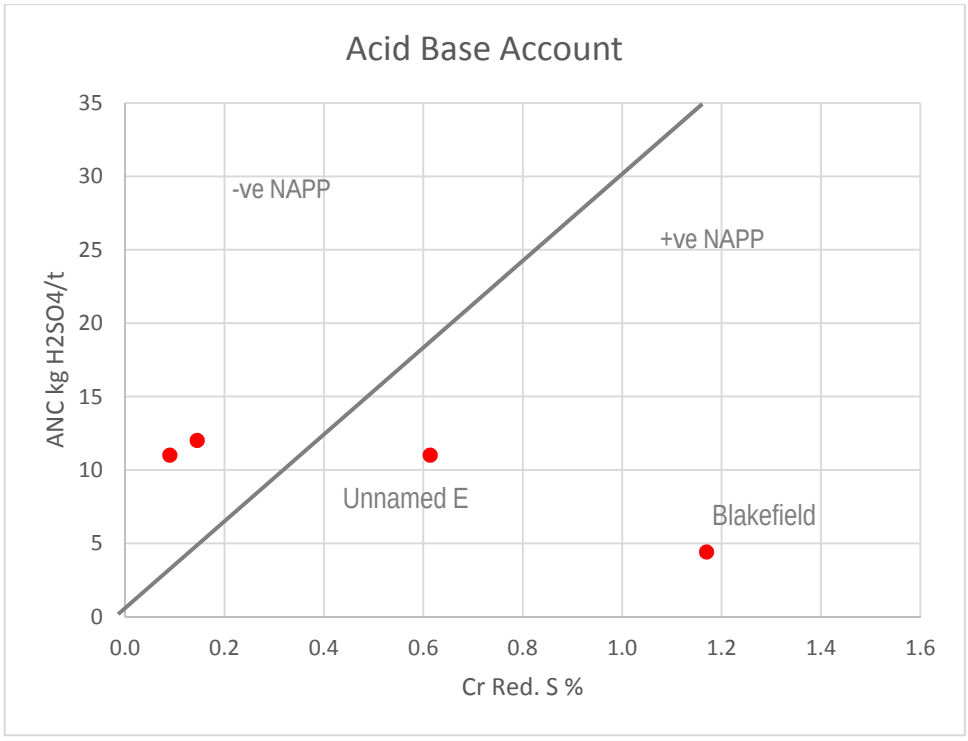


Figure 14 Tailings Reject Acid Base Account Extended Boil NAG

10.2 Extended Boil NAG Test

Further investigation was conducted to determine the acid production potential of the coal seam composite tailings reject samples using an Extended Boil NAG test.

The Extended Boil procedure had pHs from 2.5 to 6.4, which indicates Potentially Acid Forming (PAF) to Potentially Acid Forming – Uncertain (PAF - UC) charactersitics of the tested samples.

Figure 15 illustrates the difference in the NAG liquor after the samples were titrated to pH 4.5 and pH 7.0 and indicates the majority of acidity is from metals, such as copper and unoxidised Fe^{2+}.

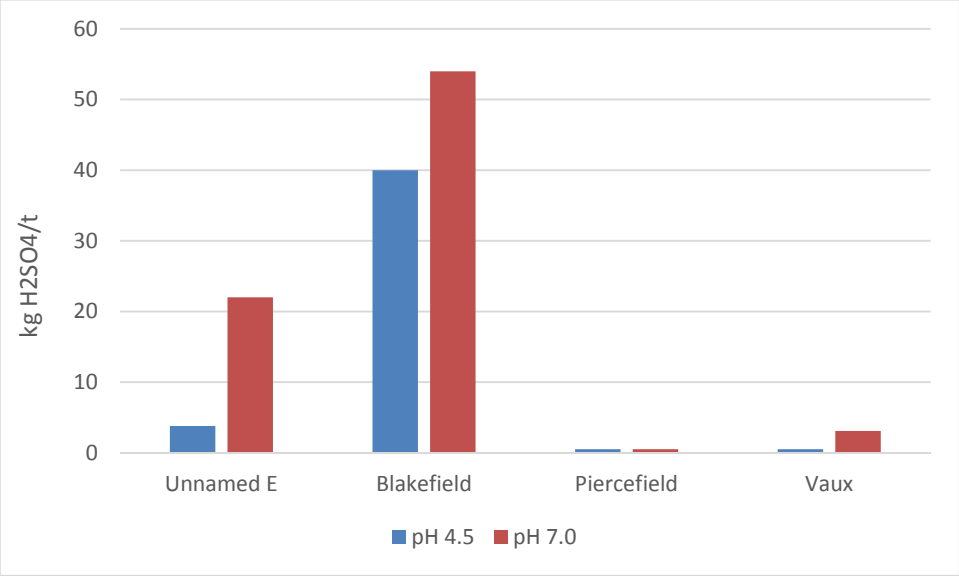


Figure 15 Tailings Reject Extended Boil NAG pH 4.5 and 7.0

Figure 16 illustrates the relative content of sulfur species in the tested samples and shows that the drill core samples, which were obtained after they were assessed for CHPP washability, indicate the pyritic sulfur exceeds the oxidised species, and quite significantly in the Blakefield and unnamed E Seams.

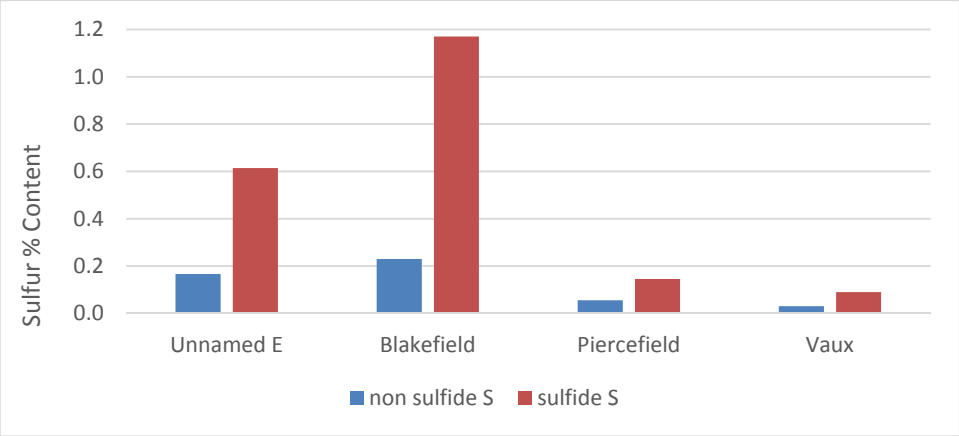


Figure 16 Tailings Reject Extended Boil Sulfur Species

10.3 Tailings Reject AMD Classification

The potential acid and metalliferous drainage (AMD) classifications of tailings rejects are provided in **Appendix A** based on results and discussions outlined in the previous sections.

The samples classified according to the scheme in **Table 11** from crushed core samples supplied for AMD assessment after they had been tested for CHPP washability trials indicate that;

- 2 are potentially acid forming (PAF) - Blakefield Seam and Unnamed E, and;
- 6 are NAF in the Woodlands Hill, Warkworth, and Mt Arthur Seams (2 samples), Piercefield and Vaux.

The tailings AMD classification is shown in **Appendix A** and summarised in **Table 13**.

Table 13 Tailings Rejects AMD Classification Summary

Category	% of samples
Non-acid Forming (NAF)	25%
Potentially Acid Forming (PAF)	75%

Overall, the results indicate that the tailings rejects should be non-acid forming, with a low, temporary potential for being acid forming when the Blakefield and unnamed E rejects are placed either in completed open cuts or co-disposed in waste rock emplacements.

The compound rejects geochemistry and the overall bulk alkalinity of the stored material is anticipated to generate an overall NAF characteristic due to the moderate chromium reducible sulfur levels (ie pyrite), with the high tested result (1.17%) in the Blakefield and 0.614% in the unnamed E Seam samples from borehole C262.

It is likely that, overall, AMD generation will not occur from the reject emplacement as approximately 75% of the rejects are NAF, and the 25% PAF fraction has a low to moderate acid production potential, whilst the ANC is relatively low to moderate (<32kg H_2SO_4/t - median 12.0kg H_2SO_4/t).

Due to the low to moderate acid neutralisation capacity (ANC), and, as a result, their low buffering potential, acid buffering characteristic curve (ABCC) testing was not conducted.

Although there is not a signifcant excess of ANC compared to MPA (using CrS), due to the proportionally low potential acid production potential of the positive NAPP results, it is considered there is a low likelihood of AMD developing from the reject emplacement by these samples.

The unnamed E and Blakefield seams comprise 4.3% and 11.2% of the total quantity of coal to be extracted (and by extrapolation, the same proportions of tailings) and the same percentages for CHPP rejects for the entire Project.

Additional investigations of the unnamed E and Blakefield tailings rejects in the future, or prior to mining those seams could be used to gain a broader understanding of the likley risk of AMD production and management requirements.

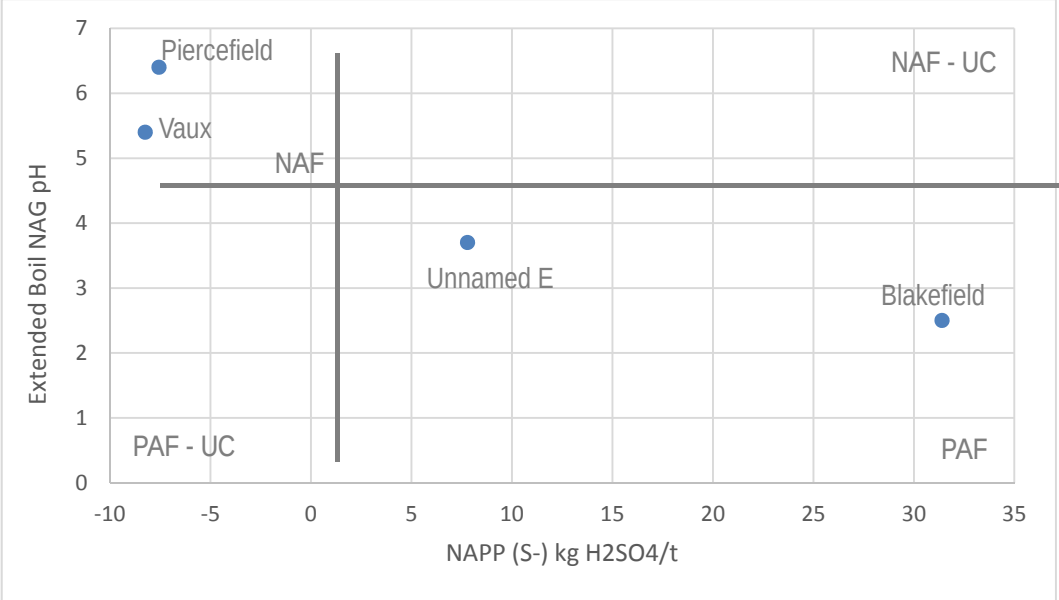


Figure 17 Tailings Reject AMD Classification

10.4 Tailings Reject Leachates

Although insufficient samples were available after the CHPP washability trials to conduct both solids geochemistry laboratory analysis and to produce batch test leachates, the degree of test work is considered adequate to assessthe potential for AMD leachate generation from the TSFs.

11. FINDINGS SUMMARY

The findings of the combined assessments conducted since 2003 at Wambo and United are discussed in the following sections.

11.1 Overburden

Since 2003, a total of 177 overburden, interburden and pit wall and floor samples have been tested at United and Wambo collieries.

The results indicate that the overburden is non-acid forming (NAF), with a very limited occurrence of PAF or PAF – UC associated with coal seams and associated overburden, and interburden carbonaceous material.

The economic coal seams and their associated carbonaceous lithologies with the higher total sulfur content will predominantly be extracted, washed in the CHPP and sold as product coal, with the tailings placed in Tailings Storage Facilities (TSFs) in approved reject emplacement areas.

The remainder of the uneconomic coal and carbonaceous units will be placed on waste rock emplacements.

It is anticipated that although limited sulfuric acid drainage from oxidation of pyritic material may occur, it is likely to be predominantly from the uneconomic coal seams and associated overburden and seam interburden.

Although current data indicates the remaining waste has low ANC, mixing of mined waste material should limit any isolated AMD that may be generated primarily from the uneconomic coal and carbonaceous wastes.

Salinity is low for the overburden waste, with the more elevated leachates generally sourced from the weathered overburden or carbonaceous siltstone. Overall, the median leachate generated from the overburden is anticipated to range up to 1,170µS/cm.

The overburden leachate pH ranges from 6.8 – 9.6.

The overburden Global Abundance Index indicates that As, Bi, Cd, Fe, Sr, Se and Zn are up to 12 times elevated within the overburden compared to the average soil content (Bowen, 1979), however this does not necessarily equate to the metals being able to leach out in significant quantities into the surface water or groundwater systems.

Al, As, Cu, Pb, Zn, Ni, Cd, Co and Se were present in isolated, individual overburden leachates that exceed, or, in the case of pH, were outside the ANZECC/ARMCANZ (2000) upland stream or 95% Protection of Aquatic Species trigger values. However, the available analyses indicates that, on bulk, the overburden emplacements are not anticipated to generate leachate water quality in excess of the relevant criteria. This assessment is derived on the basis that the 1:2 leachate test potentially over-estimates the in-situ waste dump leachate quality as the laboratory test utilises a smaller grain size than would be present in the actual dump, and doesn't factor in dilution by rainfall and runoff.

The laboratory tests represent pore water chemistry from pulverised samples, whilst the coarse rock waste emplacement will contain grain sizes up to large rocks, with a resultant reduced interaction with drainage passing through the material.

On this basis, the overburden is likely to contain low concentrations of dissolved metals and generate an alkaline, low salinity leachate.

Past experience with similar waste emplacements and similar AMD characteristics indicates

that dilution from rainfall infiltration and surface runoff mixing are likely to occur in the field, and as a result, the “field” dissolved metal concentration and salinity (as opposed to laboratory test results) in discharge from the overburden are likely to present insignificant bulk discharge surface water quality environmental risk.

Analysis of waste rock sodicity, exchangeable sodium percentage (ESP), cation exchange capacity (CEC), simulated weathering and dispersivity indicate the risk of waste rock emplacement erosion and tunnelling is low to moderate. As a result, based on the conducted tests, amelioration of the erosive potential of the waste rock emplacements may be required with gypsum or lime as they may be subject to surface crusting and enhanced erosion.

The current waste dump management practices should be maintained for the proposed additional mining.

11.2 CHPP Rejects

11.2.1 Tailings

The potential tailings from the proposal are likely to be non-acid forming (NAF) and should not require any special handling for AMD control.

Tailings placed in a TSF may be Potentially Acid Forming from the Blakefield Seam, and PAF – UC from the Glen Munro, Piercefield and Vaux Seams, however the bulk alkalinity and Non Acid Forming (NAF) nature of tailings from other seams is anticipated to buffer and neutralise the potential risk of overall Acid and Metalliferous Drainage (AMD) from the TSF.

It is anticipated that minor sulfuric acid drainage from oxidation of pyritic material may occur and that these leachates are likely to be isolated. Monitoring of the current Homestead TSF indicates the tailings are NAF.

Median leachate generated from the current Homestead TSF has a moderate salinity of 5,520µS/cm, whilst the crushed core based samples obtained after CHPP washability trials indicate a much lower salinity median of 350µS/cm. The disparity between the two groups is principally due to the numerous phases of washing and discarding the leachant in the CHPP washability trials, wheres the actuall CHPP tailings and associated leachate all report to the TSF.

The potential overburden leachate $pH_{1:2}$ ranges from 6.8 – 9.6.

Although As, Cu and Ni can be present in isolated tailings leachates that exceeded the metals trigger values, and/or were outside pH range specified in the ANZECC/ARMCANZ (2000) upland stream or 95% protection of aquatic species, the combined bulk leachate from the TSF is not anticipated to generate significant exceedance of the ANZECC/ARMCANZ (2000) water quality trigger values.

The leachate tests were conducted on pulverised samples which could therefore overestimate, or represent a “worst case” scenario, of the actual tailings emplacement leachate.

Dilution effects from rainfall and natural attenuation are likely to occur in the field, the dissolved metal concentrations in runoff or seepage from the tailings are unlikely to present any significant environmental issues in terms of the potential bulk discharging surface water quality from the TSF in relation to the ANZECC/ARMCANZ (2000) upland stream or 95% Protection of Aquatic Species trigger values.

As PAF material was identified from the Blakefield Seam tailings and PAF – UC from the Glen Munro, Piercefield and Vaux Seams, there is a potential for dissolved metals to be contained in TSF stored water and seepage, and as a result, the tailings from these seams should be blended and well managed in the TSF.

Past experience with similar tailings emplacements and similar AMD characteristics indicates that dilution from rainfall infiltration and surface water mixing are likely to occur in the field, and as a result, the “field” dissolved metal concentration (as opposed to laboratory test results) in discharge from the tailings are unlikely to present significant bulk discharge surface water quality environmental issues.

11.2.2 Tailings Reject

The potential tailings from the proposal are likely to be non-acid forming (NAF) and should not require any special handling for AMD control.

Tailings rejects placed in a overburden emplacement area may be Potentially Acid Forming from the Unnamed E and Blakefield Seam, however the bulk alkalinity and Non Acid Forming (NAF) nature of the reject from other seams as well as physical dilution within the overburden waste material is anticipated to buffer and neutralise the potential risk of overall Acid and Metalliferous Drainage (AMD).

It is anticipated that minor sulfuric acid drainage from oxidation of pyritic material may occur and that these leachates are likely to be isolated. Monitoring of the current reject emplacements indicates the tailings are NAF.

Insufficient samples were available to conduct batch leahate tests in order to assess the potential pH, EC and elemental / metals content of the rejects leachate.

As PAF material was identified from the Unnamed E and Blakefield Seam rejects, there is a potential for dissolved metals to be contained in the reject emplacement stored water and seepage, and as a result, the rejects from these seams should be blended and well managed in the storage emplacement.

Past experience with similar reject emplacements and similar AMD characteristics in the Hunter Valley indicates that dilution from rainfall infiltration and surface water mixing are likely to occur in the field, and as a result, the “field” dissolved metal concentration in discharge from the reject emplacements are unlikely to present significant bulk discharge surface water quality environmental issues.

12. CONCLUSIONS

Based on the existing data from the current and historical studies, no specific overburden or tailings waste management handling, storage or testing procedures are considered to be required in regard to AMD management, although additional ongoing AMD testing during the mining process would confirm (or modify) this conclusion in relation to the uneconomic coal seams and associated lithologies.

Although the bulk of the rejects are NAF, the potential AMD from rejects associated with the Unnamed E and Blakefield Seams could be further investigated prior to their emplacement to ascertain if any particular management techniques are required.

The vast bulk of waste emplacement tested samples are NAF, indicating that the overburden is not anticipated to require special “bulk” handling for AMD control, although the NAF material may be required to assist with management of the very limited potential PAF-LC, and the infrequent to rare PAF material, if they are encountered during mining.

If required, and if ongoing AMD test work is inconsistent with the current findings, possible management strategies for PAF or PAF-UC tailings or overburden could include:

- placement of PAF / PAF - UC material below the water table to allow inundation and prevent further exposure to atmospheric oxidation; or
- construction of a NAF cover zone designed to limit oxygen diffusion and infiltration into PAF / PAF - UC material.

The run of mine and product coal stockpiles are not anticipated to generate AMD assuming typical residence times and reaction rates, and therefore, provision for capture of runoff/leachate, monitoring and lime treatment associated with the ROM stockpiles is not an anticipated requirement.

A program of routine sampling and testing of tailings and overburden/interburden materials should be implemented during active placement to monitor any variation in acid potential and to better define the low potential AMD in the overburden, tailings and rejects.

To assess the performance of any management strategies that may be required, and to determine the need and/or refinement of AMD management / treatment requirements, water quality monitoring of seepage and runoff from pit walls and floors, waste rock emplacements, ROM stockpiles and tailings disposal areas should be conducted.

Routine site water quality monitoring programmes should include pH, EC, acidity/alkalinity, sulfate, Al, As, Co, Cu, Fe, Mn, Ni and Zn to monitor for any effects of pyrite oxidation and AMD generation.

13. RECOMMENDATIONS

Water quality monitoring of key seepage, pit water and drainage from the overburden, tailings and reject emplacements should be routinely carried out for indicators of AMD as well as salinity and pH, to confirm the expected benign nature of these materials and to provide advance warning of any anomalous pyritic material contained within the waste. These procedures should be outlined in a relevant management plan.

Additional chromium reducible sulfur, ANC, NAPP (using both total and sulfide sulfur) and Extended Boil NAG diagnostic tests could be conducted on selected bulk samples during mining or prior to final rehabilitation in the waste emplacements to obtain an ongoing assessment of the potential acid generation and buffering capacity of the waste as it is generated.

Notwithstanding that more analyses could be conducted, it is our assessment that this does not invalidate the overall conclusion of the report, in that AMD is not anticipated to be an issue of concern at the Project Site.

On-going monitoring of the leachate generated from the waste emplacements should include pH, salinity (EC), sulfate and acidity/alkalinity, with follow up multi-element testing if any low pH conditions are detected to ensure that key water quality parameters remain within appropriate criteria.

For the management of tailthe waste ings, it is recommended that the Proponent considers:

- placement of NAF coal reject materials in the open pit and/or co-disposal with overburden;
- in-pit burial of any blended coal reject materials identified as PAF / PAF-UC. Where this is not possible, and out-of-pit disposal of PAF / PAF-UC rejects in overburden encapsulated cells may need to be considered until sufficient capacity in the open pit becomes available. Further ongoing testing during mining would be required to clarify this possibility;
- deep (in-pit) burial of any PAF / PAF-UC roof and floor materials that do not report as waste in the CHPP. Out-of-pit disposal of PAF / PAF-UC roof and floor materials in overburden encapsulated cells may need to be considered until sufficient capacity in the open pit becomes available;
- covering of PAF / PAF-UC coal reject and roof and floor material as soon as practical with at least 5 metres of overburden to minimise the length /availability of exposure to oxidising conditions and to minimise the potential for AMD generation;
- for any co-disposal that may be conducted, placement of NAF coal reject material in a manner that limits the risk of erosion; and;
- verifying the geochemical characteristics of blended coal reject materials using standard static geochemical tests when bulk samples become available from the CHPP or similar process.

Surface water runoff and seepage from coal tailings material should be monitored to ensure that key water quality parameters remain within appropriate criteria.

It is therefore recommended that the Proponent monitors standard runoff/seepage from waste emplacement areas (pH, EC and TSS) and also dissolved metals, as required.

If required, possible management strategies for PAF / PAF-UC tailings or overburden/interburden could include:

- limestone treatment and interim compaction of PAF / PAF-UC materials to increase lag times before onset of acid conditions to manage AMD during operations or until implementation of closure strategies;
- When sufficient in-pit storage is available, PAF / PAF-UC materials are placed below the water table to allow inundation and prevent further exposure to atmospheric oxidation; or
- construction of a NAF clay-based cover zone designed to limit oxygen diffusion and infiltration into PAF / PAF-UC materials (where water and oxygen flux modelling will be required to determine the best approach under the local climatic conditions).

The monitoring results should be reviewed periodically to enable corrective actions to be implemented in the event that acid generating materials are identified which cannot be successfully managed as per the existing waste rock and CHPP tailings / reject management strategies.

Results of this monitoring should be reported in the Annual Environmental Management Report.

14. REFERENCES

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LIMITATIONS

This report was prepared in accordance with the scope of services set out in the contract between GeoTerra Pty Ltd (GeoTerra) and the client, or where no contract has been finalised, the proposal agreed to by the client. To the best of our knowledge the report presented herein accurately reflects the client's requirements when it was printed. However, the application of conditions of approval or impacts of unanticipated future events could modify the outcomes described in this document.

In preparing this report, GeoTerra has relied upon information and documentation provided by the client and / or third parties. GeoTerra did not attempt to independently verify the accuracy or completeness of that information. To the extent that the conclusions and recommendations in this report are based in whole or in part on such information, they are contingent on its validity. GeoTerra assume the client will make their own enquiries in regard to conclusions and recommendations made in this document. GeoTerra accept no responsibility for

any consequences arising from any information or condition that was concealed, withheld, misrepresented, or otherwise not fully disclosed or available to GeoTerra.

The findings contained in this report are the result of discrete / specific methodologies used in accordance with normal practices and standards. To the best of our knowledge, they represent a reasonable interpretation of the general condition of the site in question. Under no circumstances, however, can it be considered that these findings represent the actual state of the site at all points.

Interpretations and recommendations provided in this report are opinions provided for our Client's sole use in accordance with the specified brief. As such they do not necessarily address all aspects of water, soil or rock conditions on the subject site. The responsibility of GeoTerra is solely to its client and it is not intended that this report be relied upon by any third party. This report shall not be reproduced either wholly or in part without the prior written consent of GeoTerra.

APPENDIX A

AMD, Waste Rock and Leachate Analyses

TAILINGS AND REJECTS (SOLIDS) ANALYSES

SEAM	S	ANC	As	Ba	Cd	Co	Cr	Cu	Fe	Hg	Mn	Ni	Pb	Sb	Sn	Sr	Zn	Na	Ca	K	Mg	P
TAILINGS	**%**	**%CaCO3**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**
Unnamed E Tail	0.10	0.75	2.0	16	<0.5	17	3.5	28	0.48	0.010	40	19	12	<0.5	<1	19	44	420	1160	1000	1570	12
Blakefield Tail	0.72	0.35	2.5	18	<0.5	7.5	4.0	26	0.88	0.020	51	6.0	12	<0.5	<1	21	77	530	1300	780	990	7.5
Glen Munro Tail	0.17	1.2	2.5	27	<0.5	2.5	4.0	17	0.53	0.020	33	4.5	11	<0.5	<1	30	30	1040	2700	340	1470	20
Woodlands Hill Tail	0.048	0.95	2.0	29	<0.5	2.0	3.5	16	0.49	0.025	32	3.5	10	<0.5	<1	27	37	1820	1840	420	1290	12
Warkworth Tail	0.031	1.1	2.5	36	<0.5	3.5	6.5	18	0.30	0.010	22	4.0	10	<0.5	<1	25	30	3640	1910	540	950	8.0
Mt Arthur Tail	0.025	1.9	3.0	47	<0.5	2.5	3.5	14	0.52	0.010	49	3.5	11	<0.5	<1	68	26	5950	6200	480	1600	52
Mt Arthur Tail	0.033	0.76	2.5	17	<0.5	6.5	4.0	9.0	0.22	0.015	14	6.5	8.0	<0.5	<1	18	20	2000	840	170	390	12
Piercefield Tail	0.11	1.2	3.0	30	<0.5	9.0	5.5	20	0.57	0.005	37	10	12	<0.5	<1	25	55	4500	1940	510	1360	7.0
Vaux Tail	0.075	1.3	2.5	31	<0.5	3.5	4.5	18	0.38	0.015	34	4.5	10	<0.5	<1	15	22	3820	2850	620	850	8.5
REJECTS	**%**	**%CaCO3**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**
Unnamed E Reject	0.78	1.1	4.0	24	<0.5	19	3.5	24	3.8	0.015	380	22	22	<0.5	<1	35	105	610	1860	810	3750	28
Blakefield Reject	1.4	0.44	2.5	16	<0.5	6.5	3.0	30	1.4	0.010	50	5.5	18	<0.5	<1	22	71	540	960	730	1070	6.5
Woodlands Hill Reject	0.020	1.2	2.5	40	<0.5	1.5	3.5	19	2.1	0.020	89	2.5	12	<0.5	<1	27	83	1120	1880	690	2860	19
Warkworth Reject	0.018	1.5	2.5	43	<0.5	2.5	3.0	23	1.4	0.020	105	3.0	15	<0.5	<1	49	46	2200	4050	1180	2960	7.0
Mt Arthur Reject	0.026	3.2	3.0	125	<0.5	2.5	5.0	13	2.6	0.015	420	2.5	20	<0.5	<1	82	31	2240	76000	610	7950	60
Mt Arthur Reject	0.042	1.4	3.0	39	<0.5	3.5	2.5	22	1.8	0.015	270	5.0	19	<0.5	<1	46	54	2960	3610	900	1840	23
Piercefield Reject	0.20	1.2	3.5	35	<0.5	8.0	4.0	25	1.4	0.010	72	12	18	<0.5	<1	32	72	3280	1980	1020	1810	6.5
Vaux Reject	0.12	1.1	2.5	30	<0.5	6.5	3.5	22	1.2	0.015	57	5.5	17	<0.5	<1	20	48	3750	1190	890	1570	6.5

GAI - Waste Rock	As	Ba	Cd	Co	Cr	Cu	Fe	Hg	Mn	Ni	P	Pb	Sb	Sn	Sr	Zn	S	Na	Ca	K	Mg
262/18.54																					
262/25.14			0.93																		
262/48.0			0.93				0.57								0.06						0.16
262/76.0																					
262/103.57																					
262/128.5																			0.47		0.51
262/155.2							1.34														0.07
262/182.5			0.93																1.07		1.43
262/188.7			1.93													0.25					
262/192.4			0.93																		
955/157.0																					
955/177.1			0.93															0.07			
955/190.0																		0.63			
955/203.0			1.51																0.29		0.63
955/209.1																		0.17			
955/244.2			0.93															0.65			
955/249.1			1.51	0.50																	
LEGEND	**GAI**	**0 =**	**<3 x**		**1 =**	**3-6 x**		**2 =**	**6-12 x**		**3 =**	**12-24x**									

GAI - Tailings / Rejects	As	Ba	Cd	Co	Cr	Cu	Fe	Hg	Mn	Ni	P	Pb	Sb	Sn	Sr	Zn	S	Na	Ca	K	Mg
TD/BEACH																		0.29			
TD/0-1																	0.19				
TD/1-2																					
TD/2-3																	0.31				
TD/3-4																					
TD/4-5																	0.31				
Unnamed E Tail				0.50																	
Blakefield Tail																	2.78				
Glen Munro Tail																	0.70				
Woodlands Hill Tail																					
Warkworth Tail																					
Mt Arthur Tail																					
Mt Arthur Tail																					
Piercefield Tail																	0.07				
Vaux Tail																					
Unnamed E Reject				0.66													2.89				
Blakefield Reject																	3.74				
Woodlands Hill Reject																					
Warkworth Reject																					
Mt Arthur Reject																			1.76		0.08
Mt Arthur Reject																					
Piercefield Reject																	0.93				
Vaux Reject																	0.19				
LEGEND	GAI	0 =	<3 x		1 =	3-6 x		2 =	6-12 x		3 =	12-24x									

UNITED WAMBO LEACHATES

	Na	Ca	K	Mg	Cl	F	HCO3	CO3	SO4	Al	As	Cd	Co	Cr	Cu	Fe	Mn	Ni	Pb	Sb	Se	Sr	Zn
WASTE ROCK																							
262 18.54-20	150	0.8	4.8	1.4	125	3.7	120	<1	75	0.04	<0.01	<0.0002	<0.01	<0.01	**0.005**	0.02	<0.01	0.01	<0.001	<0.01	<0.01	0.019	0.004
262 48-48.3	130	0.5	3.5	1.1	58	2.3	175	3	38	0.05	**0.04**	<0.0002	<0.01	<0.01	**0.002**	<0.01	<0.01	<0.01	<0.001	<0.01	<0.01	0.013	0.002
262 103.57-104	98	0.3	1.9	0.5	21	2.4	185	<1	21	**0.06**	**0.03**	<0.0002	<0.01	<0.01	**0.003**	0.02	<0.01	<0.01	<0.001	<0.01	<0.01	0.006	0.002
262 155.2-155.4	160	0.3	1.8	0.7	14	1.0	385	<1	12	0.02	<0.01	<0.0002	<0.01	<0.01	0.001	0.01	<0.01	<0.01	<0.001	<0.01	<0.01	0.008	0.001
262 188.7-188.9	155	0.1	1.8	0.2	21	0.26	235	51	51	0.05	<0.01	<0.0002	<0.01	<0.01	<0.001	0.01	<0.01	<0.01	<0.001	<0.01	<0.01	0.002	<0.001
955 157-157.3	250	0.3	2.3	0.6	7	1.5	505	7	130	**0.07**	**0.17**	<0.0002	<0.01	<0.01	**0.002**	<0.01	<0.01	<0.01	<0.001	<0.01	<0.01	0.006	0.001
955 177.1-177.3	180	0.2	3.1	0.2	10	1.2	320	62	37	**0.17**	**1.4**	<0.0002	<0.01	<0.01	**0.003**	0.08	<0.01	<0.01	<0.001	<0.01	0.03	0.002	0.005
955 190-190.4	215	0.1	2.5	0.1	13	0.57	410	69	25	**0.31**	**0.32**	<0.0002	<0.01	<0.01	**0.002**	0.02	<0.01	<0.01	<0.001	<0.01	<0.01	0.002	0.001
955 203-203.2	190	<0.1	2.2	<0.1	25	5.2	275	91	31	**0.22**	<0.01	<0.0002	<0.01	<0.01	0.001	0.05	<0.01	<0.01	<0.001	<0.01	<0.01	0.001	0.001
955 244.2-244.5	175	0.2	4.4	<0.1	7	0.26	280	52	26	**0.20**	<0.01	<0.0002	<0.01	<0.01	0.001	0.03	<0.01	<0.01	<0.001	<0.01	<0.01	0.002	0.001
955 249.1-249.3	84	0.1	3.0	0.2	9	2.0	160	5	26	**0.32**	<0.01	<0.0002	<0.01	<0.01	**0.004**	0.36	<0.01	<0.01	<0.001	<0.01	<0.01	0.002	**0.015**
TAILINGS																							
TD Beach	1600	9.3	29	21	795	4.7	1680	96	820	<0.01	**0.03**	<0.0002	<0.01	<0.01	**0.002**	<0.01	<0.01	0.01	<0.001	<0.01	<0.01	0.29	0.003
TD 0-2	1530	7.5	22	23	880	6.5	1660	<1	780	0.02	<0.01	<0.0002	<0.01	<0.01	**0.004**	0.01	<0.01	**0.02**	<0.001	<0.01	<0.01	0.29	0.002
TD 2-5	1790	5.3	22	26	1080	8.8	1360	295	910	<0.01	0.02	<0.0002	<0.01	<0.01	**0.003**	<0.01	<0.01	**0.02**	<0.001	<0.01	<0.01	0.20	0.003
Blakefield	46	14	8.0	9.2	16	0.69	115	<1	62	0.02	<0.01	<0.0002	<0.01	<0.01	**0.002**	0.01	<0.01	<0.01	<0.001	<0.01	<0.01	0.15	0.006
Warkworth	63	7.8	9.6	3.7	10	0.45	185	<1	9	0.05	<0.01	<0.0002	<0.01	<0.01	**0.002**	0.01	<0.01	<0.01	<0.001	<0.01	<0.01	0.063	0.002
Mt Arthur	62	17	4.1	3.5	22	0.41	180	<1	13	0.04	<0.01	<0.0002	<0.01	<0.01	0.001	0.01	<0.01	<0.01	<0.001	<0.01	<0.01	0.14	0.003

ANZECC 2000	_	_	_	_	_	_	_	_	_	**0.055**	**0.024**	**0.0002**	_	**0.001**	**0.0014**	_	**1.9**	**0.011**	**0.0034**	_	**0.011**	_	**0.008**

WASTE ROCK AMD SUMMARY

HOLE	Depth	Lithology	Tot S	CRS	ANC	NAPP (TS)	NAPP (S-)	Leach	Leach	NAG	AMD
	mbgl		%	%	kg H2SO4/t	kg H2SO4/t	kg H2SO4/t	pH 1:2	EC 1:2 uS/cm	Test	Classification
262	18.54 - 20	carb. siltstone	0.032	_	24	-23.0	_	8.29	757	not done as TS / CrS<0.05%	NAF
	25.14 - 26	fine sandstone	0.018	_	6	-5.4	_	8.58	542	a/a	NAF
	48 - 48.3	fine carb. sandstone	0.020	_	14	-13.4	_	8.48	523	a/a	NAF
	76 - 78	carb. siltstone	0.012	_	9.1	-8.7	_	8.88	433	a/a	NAF
	103.57 - 104	carb. siltstone	0.015	_	6.6	-6.1	_	8.45	379	a/a	NAF
	128.5 - 129	carb. med. sandstone	0.053	0.013	24	-22.4	-23.6	9.14	661	a/a	NAF
	155.2 - 155.4	carb. siltstone	0.016	_	8.9	-8.4	_	7.98	626	a/a	NAF
	182.5 - 183	carb. siltstone	0.072	0.015	28	-25.8	-27.5	9.16	704	a/a	NAF
	188.7 - 188.9	tuff	0.024	_	4.4	-3.7	_	8.99	669	a/a	NAF
	192.4 - 192.6	coaly siltstone	0.011	_	7.6	-7.3	_	8.95	423	a/a	NAF
955	157 - 157.3	carb. siltstone	0.025	_	13	-12.2	_	8.7	998	a/a	NAF
	177.1 - 177.3	med. sandstone	0.010	_	13	-12.7	_	9.06	774	a/a	NAF
	190 - 190.4	coarse sandstone	0.015	_	18	-17.5	_	9.16	784	a/a	NAF
	203 - 203.3	carb. siltstone	0.041	_	26	-24.7	_	8.92	822	a/a	NAF
	209.1 - 209.3	coarse sandstone	0.025	_	18	-17.2	_	8.92	788	a/a	NAF
	244.2 - 244.5	coaly conglomerate	0.036	_	20	-18.9	_	9.08	618	a/a	NAF
	249.1 - 249.3	coaly siltstone	0.028	_	8.6	-7.7	_	8.54	339	a/a	NAF
			>0.05%					<4.5	>1000		

Max	0.072	0.015	28.00	-3.7	-23.6	9.16	998
Min	0.010	0.013	4.40	-25.8	-27.5	7.98	339
Av	0.027	0.014	14.66	-13.8	-25.6	8.78	638
Median	0.024	0.014	13.00	-12.7	-25.6	8.92	661

WASTE ROCK EROSIVITY ANLYSES

HOLE	Depth	Lithology	CEC (meq%)	ESP (%)	EC 1:2 uS/cm
262	18.54 - 20	carb. siltstone	16.6	4.2	757
	25.14 - 26	fine sandstone	10.7	14.60	542
	48 - 48.3	fine carb. sandstone	11.1	9.5	523
	103.57 - 104	carb. siltstone	11.2	19.8	379
	128.5 - 129	carb. med. sandstone	12.9	6.2	661
	155.2 - 155.4	carb. siltstone	8.3	17.9	626
	188.7 - 188.9	tuff	19.3	87.5	669
	192.4 - 192.6	coaly siltstone	13.6	23.7	423
955	157 - 157.3	carb. siltstone	15.9	19.4	998
	177.1 - 177.3	med. sandstone	14.2	10.6	774
	190 - 190.4	coarse sandstone	12.7	9.6	784
	203 - 203.3	carb. siltstone	15.2	14.5	822
	209.1 - 209.3	coarse sandstone	16.0	11.6	788
	244.2 - 244.5	coaly conglomerate	14.9	12.1	618
	249.1 - 249.3	coaly siltstone	13.5	25.5	339

Max	19.3	87.5	998
Min	8.3	4.2	339
Av	13.7	19.1	647
Median	13.6	14.5	661

TAILINGS AMD SUMMARY

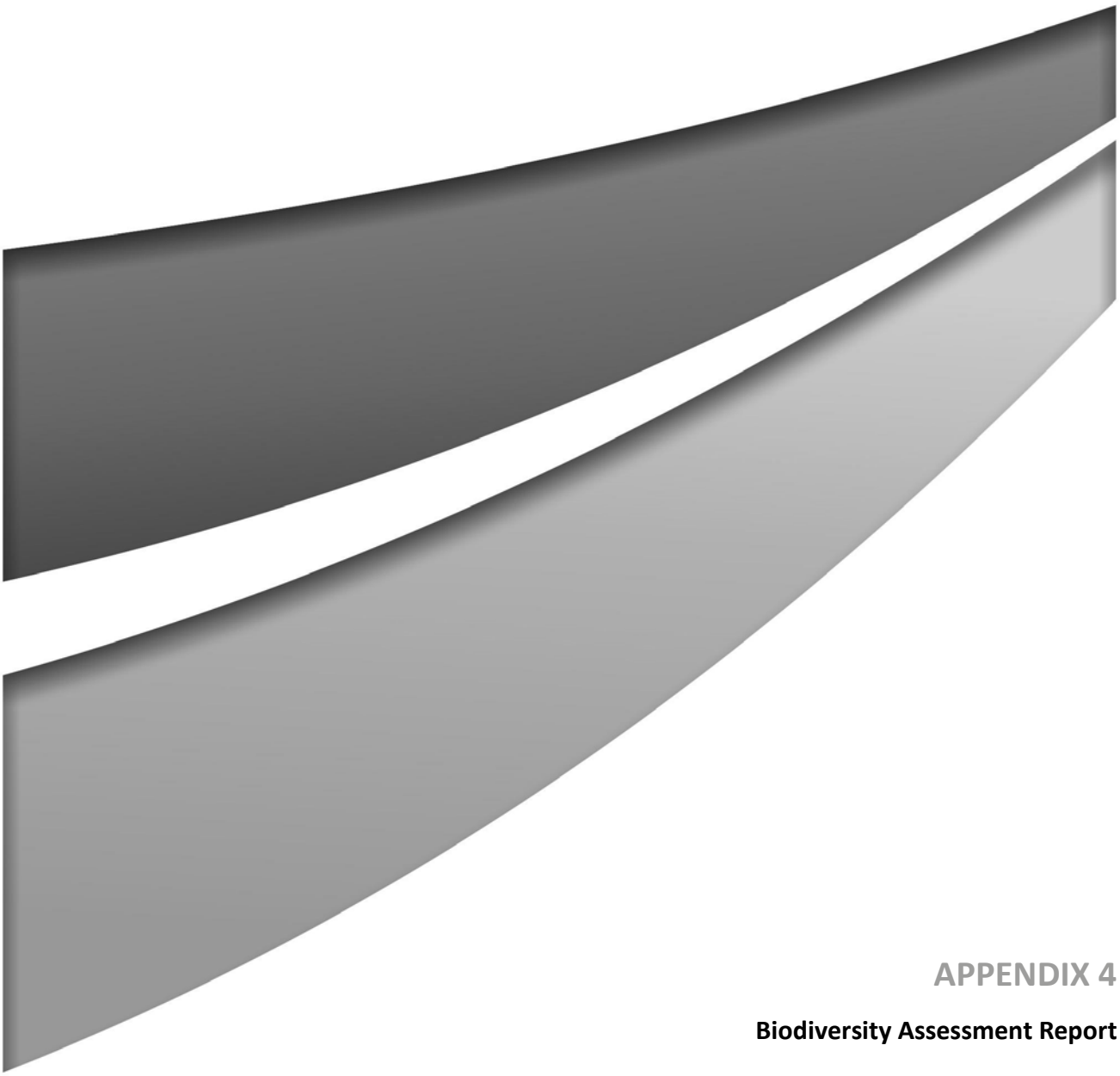
		Tot S	CRS	ANC	NAPP (TS)	NAPP (S-)	Leach	Extnd Boil NAG	Extnd Boil NAG pH 4.5	Extnd Boil NAG pH7	Leach	AMD
	Depth (mbgl)	%	%	kg H2SO4/t	kg H2SO4/t	kg H2SO4/t	pH 1:2	pH	kg H2SO4/t	kg H2SO4/t	EC 1:2 uS/cm	Classification
TD beach	0	0.100	0.029	10.0	-6.9	-9.1	8.15	_	_	_	6070	NAF
TD	0 - 1	0.120	0.026	10.0	-6.3	-9.2	7.17	_	_	_	6210	NAF
TD	1 - 2	0.100	0.024	13.0	-9.9	-12.3	8.48	_	_	_	5920	NAF
TD	2 - 3	0.130	0.042	11.0	-7.0	-9.7	8.74	_	_	_	7220	NAF
TD	3 - 4	0.100	0.015	10.0	-6.9	-9.5	8.83	_	_	_	6510	NAF
TD	4 - 5	0.130	0.046	12.0	-8.0	-10.6	8.72	_	_	_	5120	NAF
Unnamed E	21.04 - 22.30	0.100	0.069	7.5	-4.4	-5.4	_	5.15	<0.5	2.7	_	NAF
Blakefield	32.88 - 38.00	0.720	0.674	3.5	18.5	17.1	6.69	2.8	20	31	349	PAF
Glen Munro	60.44 - 61.78	0.170	0.111	12.0	-6.8	-8.6	_	2.9	60	110	_	PAF - UC
Woodlands Hill	95.55 - 99.05	0.048	_	9.5	-8.0	_	_	_	_	_	_	NAF
Warkworth	130.34 - 169.10	0.031	_	11.0	-10.1	_	7.3	_	_	_	335	NAF
Mt Arthur	169.91 - 172.89	0.025	_	19.0	-18.2	_	7.19	_	_	_	368	NAF
Mt Arthur	174.50 - 177.27	0.033	_	7.6	-6.6	_	_	_	_	_	_	NAF
Piercefield	189.67 - 190.67	0.110	0.078	12.0	-8.6	-9.6	_	2.9	53	110	_	PAF - UC
Vaux	217.20 - 218.80	0.075	0.053	13.0	-10.7	-11.4	_	3.2	31	69	_	PAF - UC

LEGEND		>0.05	>0.05				<4.5				>1000uS/cm	
	Max	0.72	0.67	19.0	18.5	17.1	8.83	5.2	60.0	110.0	7220	
	Min	0.03	0.02	3.5	-18.2	-12.3	6.69	2.8	20.0	2.7	335	
	Av	0.14	0.11	10.8	-6.7	-6.9	7.89	3.4	41.0	64.5	4004	
	Median	0.10	0.05	11.0	-7.5	-9.6	7.89	2.9	42.0	69.0	5520	

CHPP REJECT AMD SUMMARY

		Tot S	CRS	ANC	NAPP (TS)	NAPP (S-)	Leach	Extnd Boil NAG	Extnd Boil NAG pH 4.5	Extnd Boil NAG pH7	Leach	AMD
	Depth (mbgl)	%	%	kg H2SO4/t	kg H2SO4/t	kg H2SO4/t	pH 1:2	pH	kg H2SO4/t	kg H2SO4/t	EC 1:2 uS/cm	Classification
Unnamed E	**21.04 - 22.30**	0.780	0.614	11	12.9	7.8	_	3.7	3.8	22	_	PAF
Blakefield	**32.88 - 38.00**	1.400	1.170	4.4	38.4	31.4	_	2.5	40	54	_	PAF
Woodlands Hill	**95.55 - 99.05**	0.020	_	12	-11.4	_	_	_	_	_	_	NAF
Warkworth	**130.34 - 169.10**	0.018	_	15	-14.4	_	_	_	_	_	_	NAF
Mt Arthur	**169.91 - 172.89**	0.026	_	32	-31.2	_	_	_	_	_	_	NAF
Mt Arthur	**174.50 - 177.27**	0.042	_	14	-12.7	_	_	_	_	_	_	NAF
Piercefield	**189.67 - 190.67**	0.200	0.145	12	-5.9	-7.6	_	6.4	<0.5	<0.5	_	NAF
Vaux	**217.20 - 218.80**	0.120	0.090	11	-7.3	-8.2	_	5.4	<0.5	3.1	_	NAF

LEGEND		>0.05					<4.5				>1000	
	Max	1.40	1.17	32.0	38.4	31.4		6.4	40.0	54.0		
	Min	0.02	0.09	4.4	-31.2	-8.2		2.5	3.8	3.1		
	Av	0.33	0.50	13.9	-4.0	5.8		4.5	21.9	26.4		
	Median	0.08	0.38	12.0	-9.4	0.1		4.6	21.9	22.0		

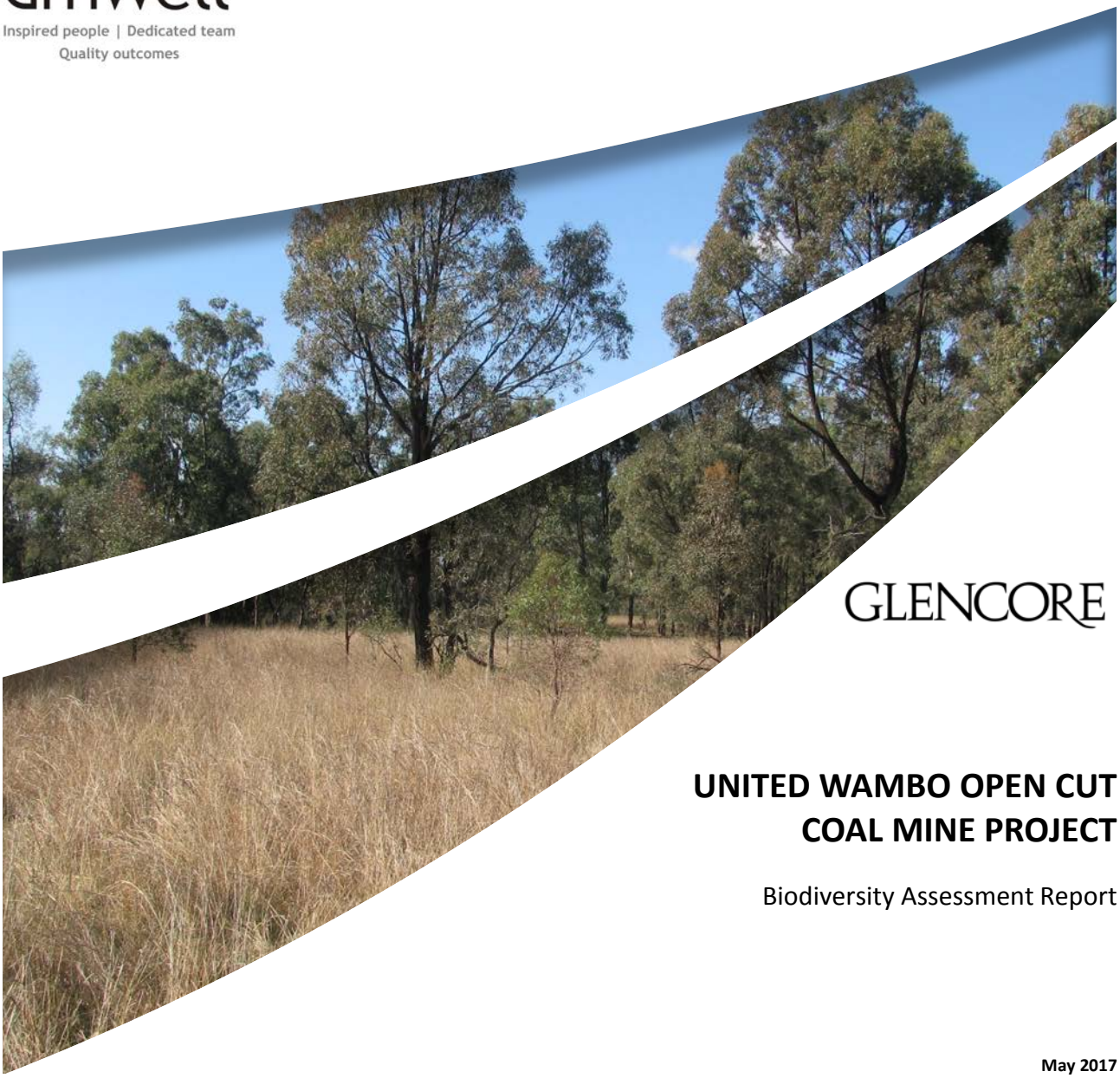


APPENDIX 4

Biodiversity Assessment Report

umwelt

Inspired people | Dedicated team
Quality outcomes



GLENCORE

UNITED WAMBO OPEN CUT COAL MINE PROJECT

Biodiversity Assessment Report

May 2017

GLENCORE

UNITED WAMBO OPEN CUT COAL MINE PROJECT

Biodiversity Assessment Report

FINAL

Prepared by
Umwelt (Australia) Pty Limited
on behalf of
United Collieries Pty Ltd

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This report was prepared using Umwelt's ISO 9001 certified Quality Management System.

Executive Summary

United Collieries Pty Limited (United) the operator of United mine and Wambo Coal Pty Limited (Wambo) the operator of Wambo mine, have formed a Joint Venture which includes the proposed development of the United Wambo Open Cut Coal Mine Project (the Project). The Project proposes open cut coal mining for a period of 23 years, with mining in a new open cut mine at United (the United Open Cut) combined with ongoing mining at the existing, approved Wambo Open Cut under a modified mine plan. The Project will optimise future mining operations across these two adjoining open cut mining areas, maximising coal recovery and the efficient use of existing mining infrastructure, while providing the operational flexibility required to actively manage the mine to minimise environmental impacts.

It was originally intended that the biodiversity impacts of the Project would be assessed under the Upper Hunter Strategic Assessment (UHSA). It was expected that the UHSA process would have been finalised by the time the EIS was submitted for public exhibition. This did not occur and at the time of publishing of this report the UHSA remains un-finalised with the draft UHSA Biodiversity Plan yet to be subject to public exhibition.

In the absence of a final UHSA Biodiversity Plan and to provide certainty for the progression of the approval process for the Project, this Biodiversity Assessment Report (BAR) has been prepared on behalf of United to assess the potential ecological impacts of the proposal in accordance with the Framework for Biodiversity Assessment – *NSW Biodiversity Offsets Policy for Major Projects* (FBA).

Following the application of appropriate avoidance and mitigation measures, the BioBanking Assessment identified the following biodiversity credits required to offset the impacts of the Project:

- 26,625 ecosystem credits for six native plant community types occurring within the Development Footprint including impacts on the *Central Hunter Valley Eucalypt Forest and Woodland critically endangered community* (CEEC) under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).
- 562 species credits for the southern myotis (*Myotis macropus*).

United is committed to delivering a biodiversity offset strategy that appropriately compensates for the unavoidable loss of ecological values as a result of the Project. The biodiversity offset strategy for the Project has been developed in accordance with the FBA and includes:

- In-perpetuity conservation achieved through the retirement of biodiversity credits through the establishment of the following BioBank Sites:
  - Wambo BioBank Site
  - Highfields BioBank Site
  - Mangrove BioBank Site
- Restoration of up to 878 hectares of native vegetation communities (including Central Hunter Valley Eucalypt Forest and Woodland CEEC) as part of ecological mine rehabilitation.

The above offsets to do fully satisfy the offset needs of the Project as determined under the FBA and United is undertaking works to secure the remaining offsets required using the range of offset options available under the FBA policy.

Glossary

BAR	Biodiversity Assessment Report
BCAM	Biodiversity Certification Assessment Methodology
BBAM	BioBanking Assessment Methodology
BBCC	BioBanking Credit Calculator
BVT	Biometric Vegetation Type
CEEC	Critically Endangered Ecological Community
CFMEU	Construction, Forestry, Mining and Energy Union
CMA	Catchment Management Authority Area
DECC	NSW Department of Environment and Climate Change (now OEH)
Development Site	The wider Project Area as is shown in the Response to Submissions.
Development Footprint	The total impact zone associated with the Project being the 'Conceptual Additional Disturbance Area' that is shown in the Response to Submissions.
DoE	Commonwealth Department of the Environment
DNG	Derived Native Grasslands
Ecosystem credit	A measurement of the value of EECs, CEECs and threatened species habitat for species that can be reliably predicted to occur with a PCT. Ecosystem credits measure the loss in biodiversity values at a development site and the gain in biodiversity values at an offset site.
EEC	Endangered Ecological Community
EIS	United Wambo Coal Mine Project Environmental Impact Statement (Umwelt 2016)
EP	Endangered Population
EP&A Act	NSW *Environmental Planning and Assessment Act 1979*
EPBC Act	Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*
FBA	Framework for Biodiversity Assessment
GDEs	Groundwater-dependent Ecosystems
Glencore	Glencore Coal Pty Limited
GIS	Geographical Information System
IBRA	Interim Biogeographic Regionalisation for Australia (Version 7)
LGA	Local Government Area
MGA	Map Grid of Australia
MOP	Mining Operations Plans
Mtpa	Million tonnes per annum
MNES	Matters of National Environmental Significance
NSW	New South Wales
OEH	NSW Office of Environment and Heritage
PCT	Plant Community Type

Peabody	Peabody Energy Australia Pty Limited
PMST	Protected Matters Search Tool
Project	United Wambo Open Cut Coal Mine Project
ROM	Run of Mine
SAT	Spot Assessment Technique
SEARs	Secretary of the Department of Planning and Environment
Species credit	The class of biodiversity credits created or required for the impact on threatened species that cannot be reliably predicted to use an area of land based on habitat surrogates. Species that require species credits are listed in the Threatened Species Profile Database.
Strahler Stream Order	Classification system that gives a waterway an 'order' according to the number of tributaries associated with it.
TEC	Threatened Ecological Community
TSC Act	NSW *Threatened Species Conservation Act 1995*
TSPD	Threatened Species Profile Database
UHSA	Upper Hunter Strategic Assessment
Umwelt	Umwelt (Australia) Pty Limited
United	United Collieries Pty Limited
VEC	Vulnerable Ecological Community
VIS	Vegetation Information System
Wambo	Wambo Coal Pty Limited

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1 Introduction

The United and Wambo coal mines are neighbouring mining operations located approximately 16 kilometres (km) west of Singleton in the Hunter Valley region of New South Wales (NSW) (refer to **Figure 1.1**). United Collieries Pty Limited (United) the operator of United mine and Wambo Coal Pty Limited (Wambo) the operator of Wambo mine, have formed a Joint Venture which includes the proposed development of the United Wambo Open Cut Coal Mine Project (the Project).

The Project proposes open cut coal mining for a period of 23 years, with mining in a new open cut mine at United (the United Open Cut) combined with ongoing mining at the existing, approved Wambo Open Cut under a modified mine plan. The Project will optimise future mining operations across these two adjoining open cut mining areas, maximising coal recovery and the efficient use of existing mining infrastructure, while providing the operational flexibility required to actively manage the mine to minimise environmental impacts.

The Project is State Significant Development as defined under State Environmental Planning Policy (State and Regional Development) 2011 and requires development consent under Part 4 of the *Environmental Planning and Assessment Act 1979* (EP&A Act). The Project will also require a modification to the existing Wambo development consents under section 75W of the EP&A Act to harmonise these consents with the Project. An Environmental Impact Statement (EIS) has been prepared to accompany these applications.

This Biodiversity Assessment Report (BAR) has been prepared by Umwelt (Australia) Pty Limited (Umwelt) to assess the biodiversity impacts of the United Wambo Open Cut Coal Mine Project ('the Project'). The BAR forms part of the environmental impact assessment of the Project. It has been prepared in accordance with the NSW Biodiversity Offsets Policy for Major Projects (OEH 2014a) and the Framework for Biodiversity Assessment (FBA) (OEH 2014b) which sits under the policy. This report has been prepared to accompany the application for approval of the Project.

It was originally intended that the biodiversity impacts of the Project would be assessed under the Upper Hunter Strategic Assessment which is a joint Commonwealth/State government initiative to strategically assess the cumulative impacts of coal mining on biodiversity in the Upper Hunter region. At the time the EIS for the Project was prepared it was expected that the UHSA process would have been finalised by the time the EIS was submitted for public exhibition. This did not occur and at the time of publishing of this report the UHSA remains un-finalised with the draft UHSA Biodiversity Plan yet to be subject to public exhibition. In the absence of a final UHSA Biodiversity Plan and to provide certainty for the progression of the approval process for the Project, in addition to the UHSA assessment provided as part of the EIS this biodiversity assessment has been prepared in accordance with the FBA.

1.1 The Project

Mining has been occurring at Wambo since the late 1960s and at United since 1989, with both mines previously undertaking both open cut and underground mining operations. Over this time the two mines have regularly cooperated, including sharing access to coal resources where appropriate, to provide for more efficient recovery of the State's coal resources. The two mines have also shared some mining infrastructure, including the joint use of the Wambo train loading facility, and share water to minimise external water demand.

Building on this long history of cooperative operations, in November 2014 United and Wambo announced a 50:50 Joint Venture between the two companies. The Joint Venture agreement outlines how the two companies will work together to further develop open cut coal resources held by the two mines.

Whilst open cut coal mining has previously been undertaken at United, over the last two decades the focus has been on underground mining. Underground longwall mining operations were approved to provide up to 2.95 million tonnes per annum (Mtpa) of saleable coal. Mining operations were suspended at United in March 2010 with the mine entering a period of care and maintenance. At that time, exploration and pre-feasibility works were commenced to determine the potential for future mining activities within United's mining lease. Ongoing exploration has identified substantial reserves of coal suitable for open cut mining.

Ongoing open cut and underground mining is occurring at Wambo, with the mine having approval to extract up to 8 million tonnes per annum (Mtpa) of run of mine (ROM) coal by open cut methods. The combined Wambo underground and open cut operations have approval to extract up to 14.7 Mtpa ROM coal, and to transport up to 15 Mtpa of product coal via the train loading facility.

As discussed above, the Project includes open cut mining operations in two areas, the proposed United Open Cut and modified operations in the approved Wambo Open Cut for a period of approximately 23 years. The existing Wambo Open Cut was granted approval for continued open cut mining until 2020 in December 2016. Due to the progression of mining being slower than originally planned, there will be substantial coal resources remaining in this approved mining area in 2020 and the Project proposes to continue mining in this approved area. The Project also seeks some minor extensions to the approved Wambo Open Cut surface mining area and will seek approval to mine deeper resources below the approved Wambo Open Cut area.

The Project will produce up to 10 Mtpa of ROM coal. The existing Wambo CHPP and train loading facility will be utilised for the Project. These facilities will also continue to receive coal from the ongoing Wambo underground mine (that is not the subject of this Project).

The Project also requires a number of changes to the layout of existing mining, public and private infrastructure within the Project Area (hereafter referred to as the Development Site as per FBA terminology).

The key aspects of the Project are shown on **Figure 1.2** and a summary of the key Project details is provided in **Table 1.1**.

Table 1.1 Summary of Key Project Details

Key Project Components/Aspects	Proposed Operations
Key feature of the Project	The operation of a multi-seam open cut mining operation integrating the existing and approved Wambo Open Cut under a modified mine plan and the proposed United Open Cut.
Total Economically Recoverable Reserve	Approximately 176 Mt of ROM coal recovered from the two open cut mining operations, made up of: • approximately 110 Mt of ROM coal from the United Open Cut • approximately 66 Mt of ROM coal in total from the Wambo Open Cut, including an additional 40 Mt accessed from the increased depth of mining.
Extraction Rates	Up to 10 Mtpa ROM coal.
Life-of- Mine	Approximately 23 years from the date of Project approval.
Operating Hours	24 hours per day, 7 days per week.
Number of Employees	Up to approximately 500 total operational positions (at peak production).

Key Project Components/Aspects	Proposed Operations
Mining Methods	Open cut mining using a truck and excavator/shovel fleet.
Extent of Mining Areas	Refer to **Figure 1.2** for the proposed extent of open cut mining. The Project proposes to modify the Wambo Open Cut boundary to maximise resource recovery. The modification to the approved Wambo Open Cut boundary will result in a minor surface adjustment of approximately 3.8 hectares of additional disturbance. The modification also includes accessing deeper seams within the existing Wambo Open Cut.
Infrastructure	Initial use and upgrades of existing United Mine Infrastructure Area prior to its decommissioning and demolition/removal due to the progression of the United Open Cut. Construction of temporary facilities during the construction phase of the Project. Ongoing use, expansion and upgrade of the Wambo Mining Infrastructure Area. Use of existing Wambo CHPP and train loading facility within their currently approved annual capacities of 14.7 Mtpa ROM coal and 15 Mtpa product coal respectively.
Tailings and Rejects Strategy	Decommissioning and capping of existing tailings storage facilities located in areas proposed for overburden emplacement and ongoing use of existing tailings storage facilities and storages established in other mine voids as required. Coarse rejects from coal preparation to be transported by truck to the open cut overburden areas for emplacement and subsequent covering by overburden material. Coarse rejects will continue to be co-disposed within the open cut overburden areas for the life of operations.
External Coal Transport	Product coal will continue to be transported off site via train from the existing Wambo train loading facility. Product coal transport rates proposed to increase from a maximum of six to eight trains per day. No change to total approved 15 Mtpa product coal tonnage transported by train.
Roads	Realignment of a 2 kilometre section of the Golden Highway to accommodate the proposed United Open Cut. The main entrance to the Project will be via the existing entrance to Wambo. The existing United access road will be used in the initial phase of the Project for construction and ancillary services with limited ongoing use as a property access point.
Power Infrastructure	An existing 330 kV transmission line which traverses the proposed United Open Cut mining area is proposed to be relocated as part of the Project (refer to **Figure 1.2**). Several other 66 kV and 11kV power lines will also require relocation to outside of proposed mining areas. Some existing telecommunications and associated infrastructure are located adjacent to the existing alignment of the Golden Highway and will also require relocation as part of the Project.
Water Management	Construction of mine water management controls including dams. Use of the previously mined United underground voids for water storage.

United is owned 95 per cent by Abelshore Pty Limited, a wholly owned subsidiary of Glencore Coal Pty Limited (Glencore) and 5 per cent by the Construction, Forestry, Mining and Energy Union (CFMEU) and is managed by Glencore. Wambo is a subsidiary of Peabody Energy Australia Pty Limited (Peabody).

1.2 Purpose and Scope of this Report

This report provides the findings of the Biodiversity Assessment of the Project. It addresses the specific requirements of the FBA (OEH 2014b).

Specifically, this assessment:

- describes the existing terrestrial environment of the Development Footprint (see **Section 1.3**; being the disturbance area of the Project that was referred to as the "Conceptual Additional Disturbance Area" in the Response to Submissions report).
- identifies flora and fauna species and ecological communities within the Development Site that have the potential to be impacted by the Project
- determines the presence or likelihood of occurrence of threatened flora and fauna species and populations and Threatened Ecological Communities (TECs) listed under the *Threatened Species Conservation Act 1995* (TSC Act) and *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act)
- calculates the offset credit requirements for ecosystem credits and species credits generated as a result of the permanent impacts of the Project in accordance with the FBA (OEH 2014b)
- provides an assessment of Matters of National Environmental Significance under the EPBC Act and
- describes the offset strategy to satisfy Stage 1 impacts of the Project.

FIGURE 1.1

United Wambo Open Cut Coal Mine Project
- Locality Plan

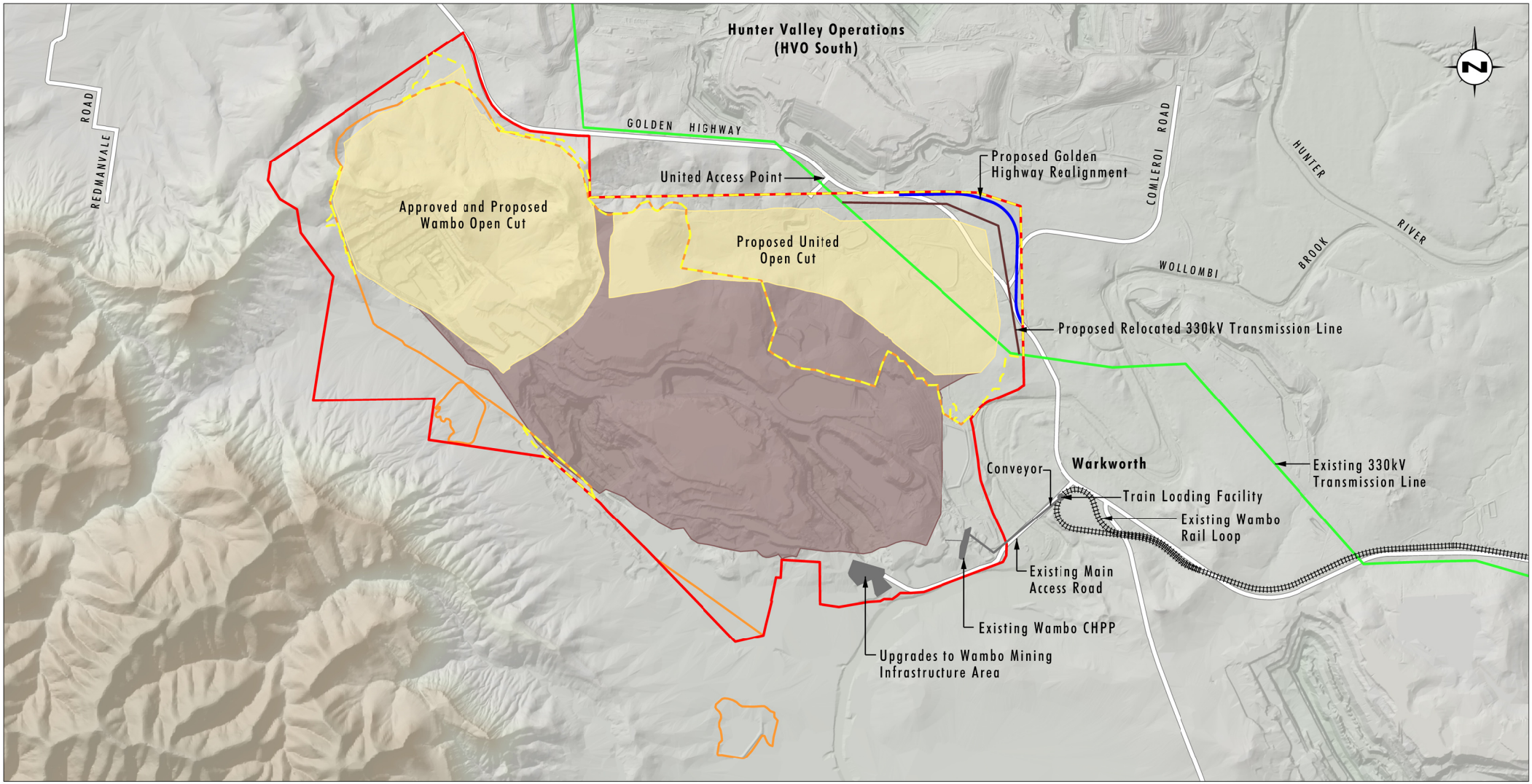

Image Source: United LiDAR (2015)
Data Source: Glencore (2015)

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Legend

- Development Site
- Development Footprint
- Proposed Conceptual Extraction Area
- Active Mining Area
- Approved Wambo Surface Development Area
- Proposed Golden Highway Realignment
- Existing 330kV Transmission Line
- Proposed Relocated 330kV Transmission Line

FIGURE 1.2

United Wambo Open Cut Coal Mine Project

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20170320 14.12

1.3 Development Site Information

For the purposes of this BAR, the Development Site for the Project represents the wider Project Area for the Project as shown in **Figure 1.2**.

The Development Footprint represents the portion of the Development Site that will be subject to permanent impact and for which ecosystem and threatened species credits have been calculated in accordance with the FBA. This was referred to as the "Conceptual Additional Disturbance Area" in the Response to Submissions. The Development Footprint will be subjected to a range of disturbances as outlined in **Section 5.0**.

1.3.1 Location

The Development Site is situated approximately 16 kilometres west of Singleton in the Hunter Valley of NSW (refer to **Figure 1.1**) within the Sydney Basin IBRA bioregion and the Hunter IBRA subregion. Refer to **Figures 1.3** to **1.5** for the location of the Development Site and other relevant landscape features that pertain to the FBA assessment.

Table 1.2 Development Site Location in the Landscape

United Wambo Open Cut Coal Mine	
IBRA Bioregion	Sydney Basin
IBRA Subregion	Hunter
Major Catchment Area	Hunter Catchment Management Authority
Mitchell Landscape	Central Hunter Foothills
LGA	Singleton Shire Council

1.3.2 Size

The Development Site covers approximately 3,014 hectares.

The Development Footprint (referred to as the conceptual additional disturbance area in the Response to Submissions Report) covers approximately 677 hectares.

1.3.3 Topography and Natural Features

The topography of the Development Site is characterised by an undulating and hilly landscape with lower topographic areas associated with drainage lines. The foothills of the Wollemi National Park lie to the west of the existing Wambo Open Cut mine (approximately 0.5 kilometres to the west of the Development Site at the closest point) and form the dominant landscape feature surrounding the Development Site.

An important local topographic feature is a minor ridgeline to the northwest of the Development Site which extends to a height of approximately 200 mAHD. This ridgeline provides a topographic barrier between the area proposed for the open cut operations at United and the private land to the northwest, including the township of Jerrys Plains. The remaining surrounding topography is characterised by gently sloping alluvial plains and undulating hills.

The Development Site is located within the catchments of Wollombi Brook and Waterfall Creek, both tributaries of the Hunter River. Wollombi Brook is located to the east of the Development Site and flows into the Hunter River approximately 5 kilometres northeast of the Development Site. Waterfall Creek is a minor tributary of the Hunter River and flows into the Hunter River approximately 4 kilometres northwest of the Development Site. The Development Site is within the Hunter Catchment Management Authority (CMA) region of the Hunter Valley of NSW.

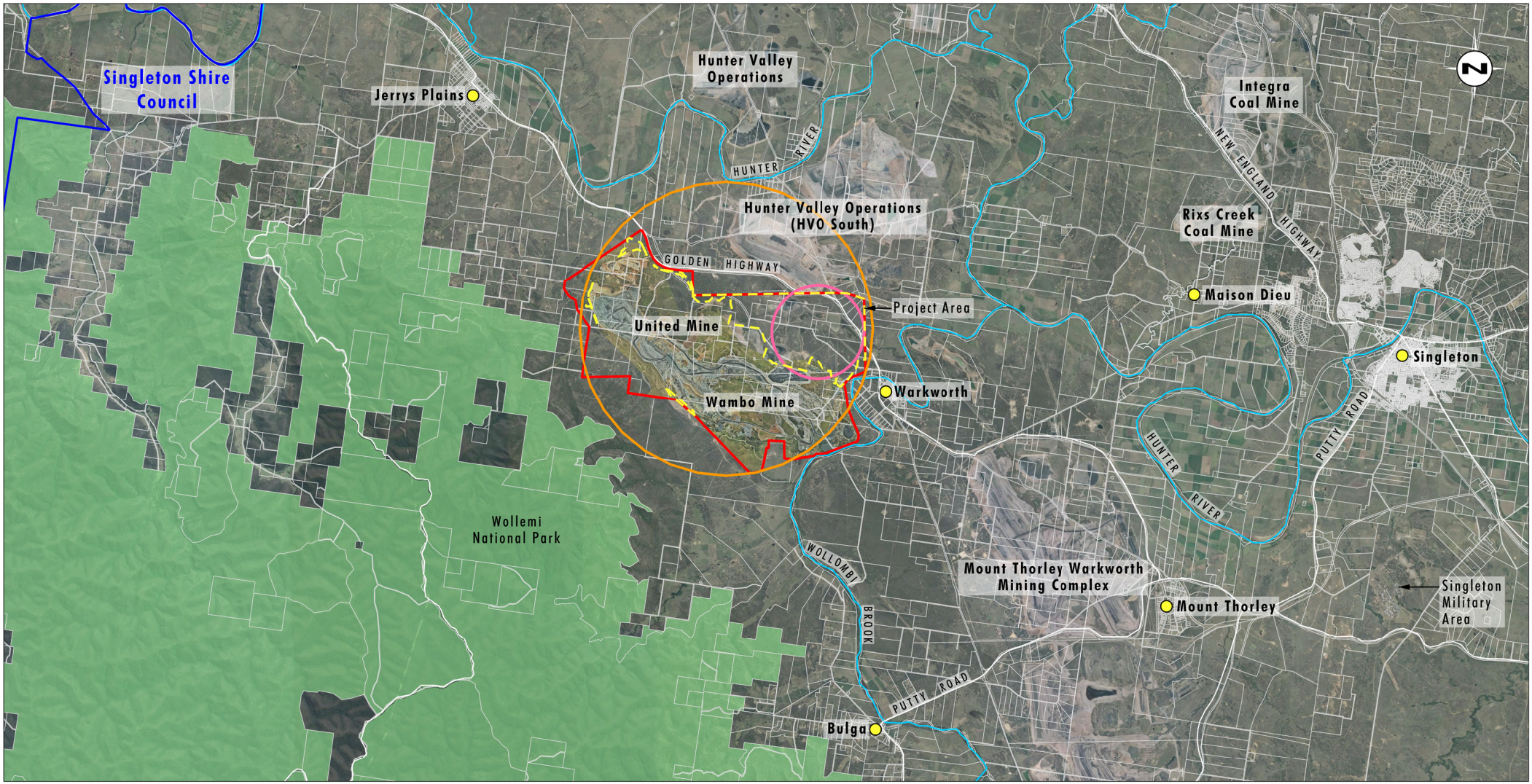

Image Source: AAM (2012), United (2015), Google Earth - CNES/Astrium 2016, Sinclair Knight Merz 2016, (2008)
Data Source: Glencore (2015), Minview (2015)

0 2.5 5.0 7.5km
1:150 000

Legend

- Development Site
- Development Footprint
- 500ha Assessment Circle
- 5000ha Assessment Circle
- National Park
- Local Government Area
- Road
- River

FIGURE 1.3

Site Map

File Name (A4): R01/3890_031.dgn
20170519 14.43

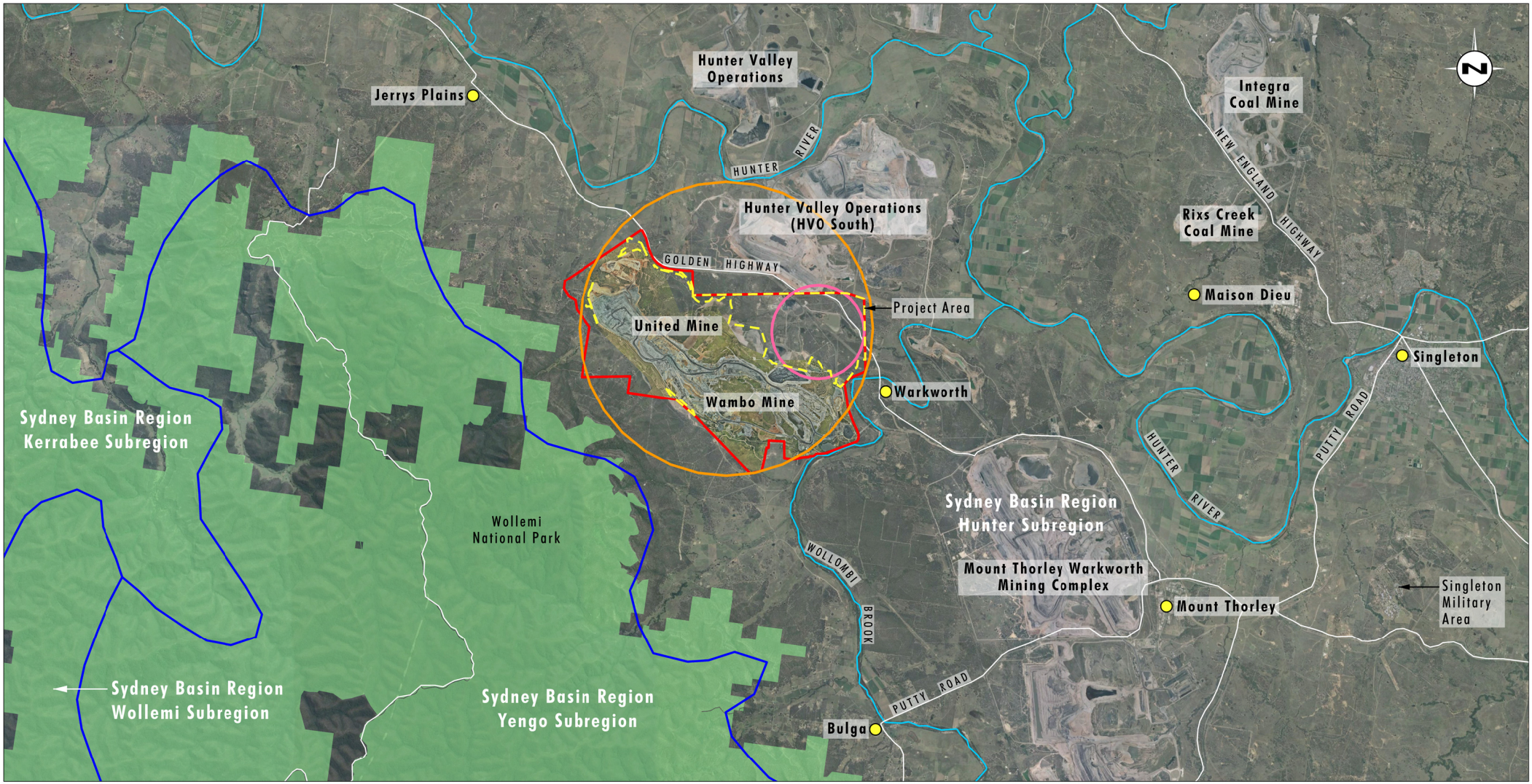

Image Source: AAM (2012), United (2015), Google Earth - CNES/Astrium 2016, Sinclair Knight Merz 2016, (2008)
Data Source: Glencore (2015), Minview (2015)

0 2.5 5.0 7.5km
1:150 000

Legend

- Development Site
- Development Footprint
- 5000ha Assessment Circle
- 500ha Assessment Circle
- National Park
- IBRA V7 Region/Subregion
- Road
- River

FIGURE 1.4

Location Map
IBRA V7 Regions/Subregions

File Name (A4): R01/3890_006.dgn
20170519 14.45

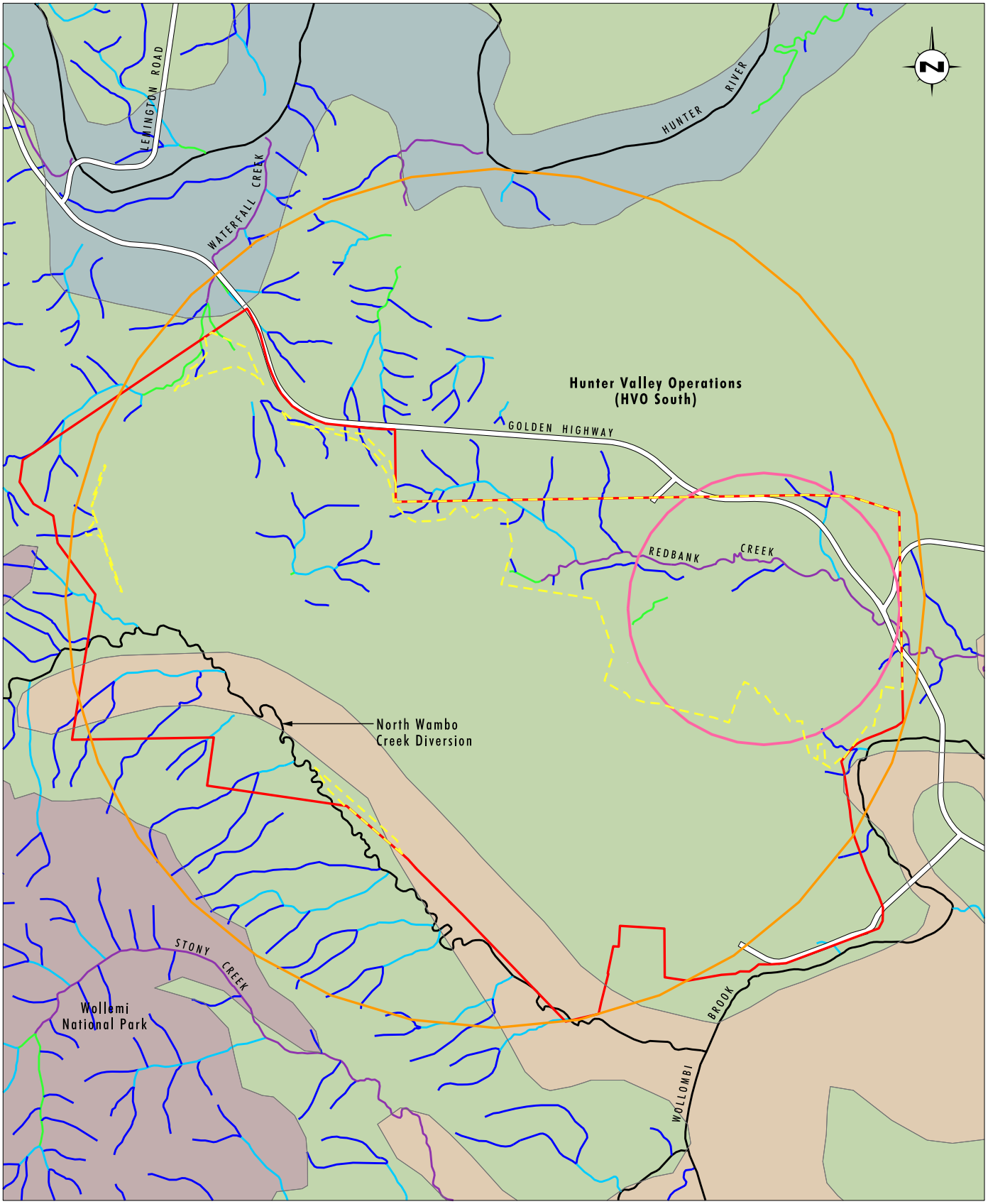

Image Source: AAM (2012), United (2015)
Data Source: Glencore (2014)

0 1.0 2.0 2.5km
1:50 000

Legend

- Development Site
- Development Footprint
- 500ha Assessment Circle
- 5000ha Assessment Circle

Mitchell Landscape:
- Central Hunter Foothills
- Central Hunter Alluvial Plains
- Upper Hunter Channels and Floodplain
- Yengo Plateau

Stream Order:
- 1st Order Stream
- 2nd Order Stream
- 3rd Order Stream
- 4th Order Stream
- 5th Order Stream or Greater

FIGURE 1.5

Location Map
Landscape Features

File Name (A4): R01/3890_005.dgn
20170519 14.52

1.4 Key Resources, Policies and Documents

The following key resources, policies and documents were used during the preparation of this BAR for the Project:

- NSW Biodiversity Offsets Policy for Major Projects (OEH 2014a)
- Framework for Biodiversity Assessment (OEH 2014b)
- Credit Calculator for Major Projects and BioBanking Operational Manual (OEH 2016a)
- BioBanking Assessment Methodology 2014 (OEH 2014c)
- Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities –Working Draft (DEC 2004)
- BioBanking Credit Calculator (Major Project Assessment Type) (BBCC 2016), accessed in November 2016
- BioNet Atlas of NSW Wildlife database and mapping tool (OEH 2017a), accessed March 2017
- OEH Threatened Species Profile Database (TSPD) (OEH 2017b), accessed March 2017
- Vegetation Information System (VIS) Classification Database (OEH 2017c), accessed March 2017
- NSW Guide to Surveying Threatened Plants (OEH 2016b) and
- Department of the Environment and Energy (DoEE) Protected Matters Database (DoEE 2017), accessed March 2017.

1.5 Report Preparation

This BAR was prepared by Kate Connolly and Bill Wallach (Senior Ecologists), with review and technical direction from Travis Peake (Practice Leader Ecology). Field surveys have been completed by a large number of Umwelt ecologists, primarily by Ryan Parsons (Senior Ecologist – Botanist), Amy Nelson (Ecologist), Rhys Osborne (Ecologist), Bill Wallach and Kate Riley (Ecologist). Kate Connolly, Bill Wallach, Travis Peake, Ryan Parsons and Amy Nelson are all accredited under the TSC Act as BioBanking Assessors. **Table 1.3** below outlines the details of the accredited BioBanking Assessors involved in the survey, calculations and reporting for this Project.

Table 1.3 Accredited BioBanking Assessors and their Role on this Project

Name	Assessor ID	Role on Project
Travis Peake **Principal Ecologist**	020	• Review and technical direction
Kate Connolly **Senior Ecologist**	177	• Application of the BBCC • Report preparation

Name	Assessor ID	Role on Project
Bill Wallach **Senior Ecologist**	223	• Application of the BBCC • Report preparation • Field surveys and biometric data collection
Ryan Parsons **Senior Ecologist - Botanist**	113	• Field surveys and biometric data collection
Amy Nelson **Ecologist**	230	• Field surveys and biometric data collection

1.5.1 Structure of the Report

The structure of the report is outlined below as per the requirements of Appendix 7 of the FBA (OEH 2014b):

- **Stage 1:**
  - Section 1 – provides the introduction to the report
  - Section 2 – outlines the methods used in the assessment
  - Section 3 - outlines the results of the field surveys and BioBanking credit calculator application
- **Stage 2:**
  - Section 4 – describes the avoidance measures implemented and minimisation of impacts as part of the Project
  - Section 5 – provides a summary of impacts in accordance with the FBA
  - Section 6 – summarises the credit requirements for the Project
- **Stage 3:**
  - Section 7 – outlines the Biodiversity Offset Strategy
- **Other sections:**
  - Section 8 – provides an assessment of Matters of National Environmental Significance (MNES)
  - Section 9 - provides a list of references used throughout the report and assessment.

2 Methods

2.1 Landscape Features

2.1.1 Identifying Landscape Features

Landscape features within the Development Site and the inner and outer assessment circles were determined through reviewing aerial photography and relevant GIS layers. Landscape features that were reviewed included:

- IBRA bioregions and IBRA subregions
- Mitchell landscapes
- Rivers, streams and estuaries (using the Strahler (1952) ordering system)
- Wetlands
- Native vegetation extent, and
- State and/or Regional Biodiversity Links.

2.1.2 Determining Landscape Value

Determining the 'Landscape Value' of the Development Site is calculated by assessing the following landscape attributes:

- Per cent Native Vegetation Cover
- Connectivity Value, and
- Patch Size.

2.1.2.1 Per cent Native Vegetation Cover

'Per cent Native Vegetation Cover' is determined by the current per cent native vegetation cover and the future per cent native vegetation cover within the outer assessment circle. This was determined using digital aerial photography interpretation using the Manifold GIS software package. Aerial photographs captured during 2016 were used to digitise all native vegetation within the outer assessment circle. Further refinement of these areas was undertaken following field surveys of the Development Site.

The inner and outer assessment circles must be at a 1:10 ratio and one of the combinations from Table 8 of Appendix 4 of the FBA (OEH 2014b). Due to the size and configuration of the Development Site, it was determined that a 500 hectare inner assessment circle and 5000 hectare outer assessment circle was the most appropriate combination. The outer circle was centred on the Development Site, with the inner circle centred on the native vegetation area most impacted by the Project.

2.1.2.2 Connectivity Value

To determine the connectivity value, the Development Site was assessed for the presence of native vegetation connecting links, state, regional or local biodiversity links as required by the FBA (OEH 2014b).

Connecting links are present when an area of native vegetation in a Development Site is adjoined to and it is:

- in moderate to good condition, and
- has a patch size of > 1 hectare, and
- is separated by a distance of < 100 metres (or ≤ 30 metres for non-woody ecosystems), and
- is not separated by a large waterbody, dual carriageway, wider highway or similar hostile link.

State biodiversity links are defined as links which have been identified as important on a state scale. State biodiversity links are identified in a plan approved by the Chief Executive of OEH or are a riparian buffer either side of a 6th order stream (using the Strahler (1952) ordering system), or greater or either side of an important wetland or estuarine area.

Regional biodiversity links are recognised as important links at a regional scale. Regional biodiversity links are identified in a plan approved by the Chief Executive of OEH or are a riparian buffer either side of a 4th or 5th order stream.

2.1.2.3 Patch Size

A 'Patch' is an area of native vegetation that:

- occurs on the Development Site, and
- is in moderate to good condition, and
- includes native vegetation that has a gap of less than 100 metres from the next area of moderate to good condition native vegetation (or ≤ 30 metres for non-woody vegetation).

For site-based developments, the patch size is calculated for the Mitchell Landscape occurring within the Development Footprint. The patch may extend onto adjoining land that is not part of the Development Site. An assessment of the patch size class and the patch size score was then determined using Table 15 of the FBA (OEH 2014b).

2.2 Native Vegetation Assessment

2.2.1 Literature and Database Review

A review of previous documents and reports relevant to the Project was undertaken. This included regional and sub-regional vegetation mapping reports, site-specific monitoring surveys, ecological surveys undertaken in the vicinity of the Development Site and also relevant ecological database searches. The information obtained was used to inform survey design, and was also used to assist in the assessment of potentially occurring threatened and migratory species, endangered populations (EPs) and Threatened Ecological Communities (TECs). Relevant documents included:

- United Wambo Open Cute Coal Mine Project – Environmental Impact Statement (Umwelt 2016a)
- United Wambo Open Cut Coal Mine Project : Upper Hunter Strategic Assessment Statement of Consistency Report – August 2016 (Umwelt 2016b)
- Upper Hunter Strategic Assessment – United Collieries Biodiversity Certification Assessment Report (Umwelt 2015)
- Upper Hunter Strategic Assessment – Wambo Coal Biodiversity Certification Assessment Report (Niche 2014)
- United Colliery Annual Ecological Monitoring Reports (Umwelt 2009-2016)
- The Vegetation of the Central Hunter Valley, NSW (Peake 2006)
- Greater Hunter Native Vegetation Mapping (Sivertsen *et al* 2011)
- VIS Classification Database (OEH 2017c), accessed March 2017
- OEH Threatened Species Profile Database (OEH 2017b) for known/predicted Threatened Ecological Communities (TECs) in the Hunter IBRA subregion, accessed March 2017
- DoEE Protected Matters Search Tool for known/predicted EPBC Act-listed TECs, accessed March 2017.

2.2.2 Digital Aerial Photograph Interpretation

Digital imagery (aerial photographs) of the Development Site was viewed prior to and after vegetation survey to identify spatial patterns in vegetation, land use and landscape features. These informed field survey design and implementation, ecological assessment and vegetation community mapping of the Development Site.

Vegetation communities in the Development Site were mapped on-screen overlaying the 2016 high resolution aerial photographs provided by Glencore. Mapping was undertaken using the Manifold System 8.0 Enterprise Edition GIS in a 32 bit mode. Use of GIS allowed zooming to a relatively large scale. Generally the minimum mapping unit for a vegetation zone was 0.1 hectare, however mapping was completed at a finer scale in order to map narrow bands of disturbed land along access tracks and haul roads, where relevant.

2.2.3 Systematic Plot/Transect Surveys

A total of 53 systematic plots/transect surveys were conducted across the Development Footprint during the surveys undertaken for this assessment (refer to **Figure 2.1**). These surveys have been undertaken across multiple years with 22 days and 12 survey periods, being:

- 11 to 12 February, 24 April and 5 May 2009
- 26 to 28 February, 18 to 20 March, 23 to 24 September and 9 to 10 October 2013
- 5 to 7 March 2014
- 27 May 2015
- 9 to 10 July 2015
- 14 April 2016, and
- 7 November 2016.

Furthermore, rapid vegetation assessments were undertaken in each of these survey periods (refer to **Section 2.2.4**).

2.2.3.1 Plot/Transect Selection and Stratification of the Development Site

Designing an appropriate survey requires consideration of both survey methods and effort. Reference was made to the VIS Classification Database to identify Plant Community Types (PCTs), as well as reviews of other regional and local vegetation mapping and reporting (refer to **Section 2.3.1**) when designing the field survey. The PCTs were further stratified into Vegetation Zones (condition states) in accordance with the FBA (OEH 2014b) following previous field surveys of the site to determine the appropriate number of transect/plots required. This requirement is outlined in **Table 2.1**.

Table 2.1 Minimum Number of Plots/Transects Required per Zone Area (OEH 2014b)

Vegetation Zone Area (ha)	Minimum Number of Plot/Transect
0-4	1 transect/plot per 2 ha (or part thereof) or 1 transect/plot if vegetation is in low condition
>4-20	3 transects/plots or 2 transects/plots if vegetation is in low condition
>20-50	4 transects/plots or 3 transects/plots if vegetation is in low condition
>50-100	5 transects/plots or 3 transects/plots if vegetation is in low condition
>100-250	6 transects/plots or 4 transects/plots if vegetation is in low condition
>250-1000	7 transects/plots or 5 transects/plots if vegetation is in low condition (More transects/plots may be needed if the condition of the vegetation is variable across the zone)

Vegetation Zone Area (ha)	Minimum Number of Plot/Transect
>1000	8 transects/plots or 5 transects/plots if vegetation is in low condition or in a homogenous landscape in the Western Division (More transects/plots may be needed if the condition of the vegetation is variable across the zone)

Table 2.2 below outlines the adequacy of the plot/transect flora survey with respect to the FBA Methodology (OEH 2014b) pertinent to the Development Site.

Table 2.2 Adequacy of Vegetation Survey in the Development Site

Veg Zone	PCT ID (BVT IDs) and PCT Name *Condition Class*	Area in the Development Site (ha)	Number of Biometric Plots/Transects	
			Required FBA (OEH 2014b)	Undertaken During Survey
1	HU812 – Moderate to Good Condition Forest Red Gum grassy open forest on floodplains of the lower Hunter	0.29	1	1
2	HU816 – Moderate to Good Condition – Plantation/Rehabilitation Spotted Gum - Narrow-leaved Ironbark shrub - grass open forest of the central and lower Hunter	29.42	4	4
3	HU869 – Moderate to Good Condition Grey Box - Slaty Box shrub - grass woodland on sandstone slopes of the upper Hunter and Sydney Basin	1.56	1	2
4	HU905 – Moderate to Good Condition – Derived Native Grassland Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter	93.81	5	7
5	HU905 – Moderate to Good Condition	149.28	6	10
6	HU905 – Moderate to Good Condition – Cooba Open Shrubland	80.45	5	8
7	HU905 – Moderate to Good Condition – Regeneration	26.55	4	4
8	HU905 - Moderate to Good Condition - Thinned Canopy	0.08	1	1

Veg Zone	PCT ID (BVT IDs) and PCT Name *Condition Class*	Area in the Development Site (ha)	Number of Biometric Plots/Transects	
			Required FBA (OEH 2014b)	Undertaken During Survey
9	HU906 – Moderate to Good Condition Bull Oak grassy woodland of the central Hunter Valley	117.67	6	10
10	HU945 – Moderate to Good Condition Swamp Oak - Weeping Grass grassy riparian forest of the Hunter Valley	31.61	4	6
-	Cleared land (including disturbed land, mixed species revegetation plantation and water bodies)	146.67	N/A	N/A
Total		**677.40**	**37**	**53**

2.2.3.2 Plot/Transect Data Collected

At each plot/transect data was recorded according to Section 5 of the FBA (OEH 2014b). This involved setting out 20 x 50 metre and 20 x 20 metre plots and a 50 metre transect. The location of each quadrat was recorded using a hand-held GPS with accuracy of ± 5 metres. The Map Grid of Australia (MGA) coordinate system was used. The location of the 53 plots/transects undertaken within the Development Site is shown in **Figure 2.1**.

At each plot/transect, roughly 45 to 60 minutes was spent searching for all vascular flora species present within the 20 x 20 metre plot. Searches of each 20 x 20 metre plot were generally undertaken through parallel transects from one side of the plot to another. Most effort was spent on examining the groundcover, which usually supported well over half of the species present, however the composition of the shrub, mid-storey, canopy and emergent layers were also thoroughly examined. Effort was made to search the tree canopy and tree trunks for mistletoes, vines and epiphytes.

For each flora species recorded in the plot, the following data was collected in accordance with Table 1 of the FBA (OEH 2014b):

- stratum/layer in which the species occurs
- growth form
- scientific name and common name
- cover
- abundance.

At each standard flora plot, 10 points along a 50 metre transect were assessed for:

- percentage native overstorey cover
- percentage native mid-storey cover.

In addition, 50 points along a 50 metre transect were assessed for:

- percentage native groundcover (grass)
- percentage native groundcover (shrubs)
- percentage native ground cover (other)
- percentage exotic plant cover.

Additional details were also recorded in each quadrat, including soil texture, drainage and depth; site disturbances; physiography (position in the landscape); and vegetation structure (strata percentage covers, heights and dominant species). Photographic records were also taken at each site.

2.2.4 Qualitative Rapid Sampling

Qualitative rapid assessments were also completed during the 2016 surveys to assist with mapping areas added to the Project after the majority of it had been mapped (see **Figure 2.1**). Each comprised the recording of the dominant canopy and understorey species. The qualitative rapid assessments utilised a qualitative sampling approach, as this method was designed to allow rapid collection of non-quantitative species dominance data across the Development Footprint within limited timeframes. The data from the qualitative rapid assessments was primarily used to provide assistance in the delineation and refinement of vegetation mapping.

2.2.5 Meandering Transects

Meandering transects were walked through vegetation units across much of the Development Site (refer to **Figure 2.1**). Opportunistic sampling of vegetation was undertaken along these transects, particularly searches for threatened and otherwise significant species, endangered populations and threatened ecological communities (TECs). Meandering transects enable floristic sampling across a much larger area than plot-based survey, especially where the number of plots is limited. Records along transects supplemented floristic sampling carried out in plots, however, the data collected are in the form of presence records, rather than semi-quantitative cover abundance scores.

Meandering transects provided invaluable information on spatial patterns of vegetation that informed vegetation community mapping of the Development Site.

2.2.6 Plant Identification and Nomenclature Standards

All vascular plants recorded or collected within plots and on meandering transects were identified using keys and nomenclature in Harden (1992, 1993, 2000 and 2002). Where known, changes to nomenclature and classification have been incorporated into the results. Updated taxonomy has been derived from PlantNET (Botanic Gardens Trust 2017).

Common names used follow Harden (1992, 1993, 2000 and 2002) where available, and draw on other sources such as local names where these references do not provide a common name.

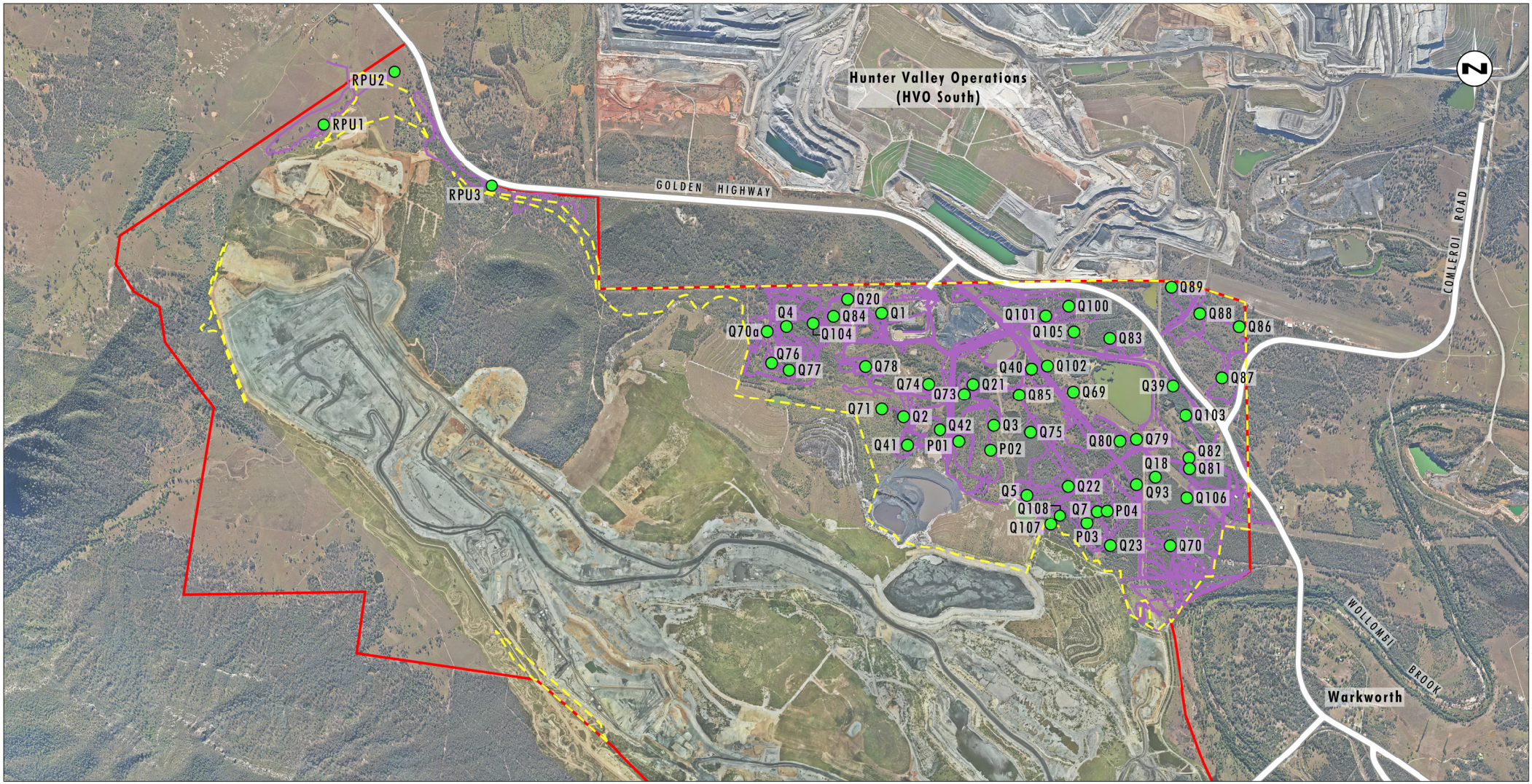

Image Source: AAM (2012), United (2016)
Data Source: Glencore (2014)

0 0.5 1.0 2.0km
1:40 000

Legend

- Development Site
- Development Footprint
- Targeted Threatened Flora Searches
- Plot and Transect Locations

FIGURE 2.1

Flora Survey Effort

File Name (A4): R01/3890_008.dgn
20170405 13.00

2.2.7 Vegetation Mapping

Vegetation mapping was undertaken using best-practice techniques to delineate vegetation communities across the Development Site. Vegetation mapping involved the following key steps:

- preliminary review of digital airborne imagery to explore vegetation distribution patterns as dictated by change in canopy texture, tone and colour, as well as topography
- predicting the distribution of particular vegetation communities based on understanding the distribution of Biometric vegetation types (OEH 2017c) and plant communities as described by the Greater Hunter Native Vegetation Mapping (Sivertsen *et al* 2011) project
- preparation of a draft vegetation community map based on interpretation of digital airborne imagery and preliminary delineation of vegetation community floristics
- ground-truthing of the vegetation map based on survey effort documented in **Section 2.2.3** to **2.2.5.**
- revision of vegetation community floristic delineations based on plot data, and
- revision of the vegetation map based on ground-truthing.

Vegetation communities were delineated through the identification of repeating patterns of plant species assemblages in each of the identified strata. Communities were named in accordance with their site character, with consideration of the naming conventions of those vegetation communities identified by the VIS Classification Database (OEH 2017c).

2.2.8 Threatened Ecological Community Delineation Techniques

Vegetation communities identified in the Development Site were compared to TECs listed under the Commonwealth EPBC Act and NSW TSC Act and an assessment of similarity with the NSW Scientific Committee Final Determinations and the Commonwealth Threatened Species Scientific Committee Listing and Conservation Advice. The following approach was used:

- full-floristic quadrat assessment, rapid assessments and meandering survey to determine floristic composition and structure of each ecological community
- comparison with published species lists, including lists of 'important species' as identified on the listing advice provided by the NSW Scientific Committee and/or Commonwealth Threatened Species Scientific Committee
- comparison with habitat descriptions and distributions for listed TECs
- assessment using guidelines and recovery plans published by the Commonwealth DoE and the NSW OEH
- comparison with other assessments of TECs in the region.

2.2.9 Plant Community Type (PCT)/Biometric Vegetation Type (BVT) Allocation

Each of the vegetation communities described within the Development Site were aligned with an equivalent PCT/BVT as detailed in the VIS Classification Database (OEH 2017c). For each vegetation community described in the Development Site, the dominant and characteristic species were entered into the online plant community identification tab and an initial list of PCTs/BVTs was generated. The profiles for each of the possible PCT/BVT were then interrogated and the most appropriate match assigned based on floristic, structure, soil, landform and distribution details.

Further details regarding this allocation for individual PCT/BVTs is outlined in **Section 3.2.1.**

2.3 Threatened Species

2.3.1 Literature and Database Review

A review of previous documents and reports relevant to the Project was undertaken. This included ecological reports, previous ecological surveys undertaken in the vicinity of the Development Site and also relevant ecological database searches. The information obtained was used to inform survey design, and was also used to assist in the assessment of potentially occurring ecosystem-credit and species-credit species. Relevant documents and resources included:

- OEH Threatened Species Profile Database (OEH 2017b) for known/predicted threatened species in the Hunter IBRA subregion, accessed March 2017
- OEH BioNet Atlas of NSW Wildlife database and mapping tool (OEH 2017a), accessed March 2017
- PlantNET (Botanic Gardens Trust) database search for Rare or Threatened Australian Plant species within the Singleton LGA, accessed March 2017
- DoEE Protected Matters Search Tool (DoEE 2017) for known/predicted EPBC Act-listed TECs, accessed March 2017
- Upper Hunter Strategic Assessment – United Collieries Biodiversity Certification Assessment Report (Umwelt 2015)
- Upper Hunter Strategic Assessment – Wambo Coal Biodiversity Certification Assessment Report (Niche 2014)
- United Colliery Annual Ecological Monitoring Reports (Umwelt 2009-2016).

A preliminary assessment using the TSPD was undertaken which provided a list of species-credit species that might require survey and the suitable survey periods for each species as part of the UHSA (Umwelt 2015). The results of updated database searches, literature review and TSPD review were used to design the survey requirements for species-credit species so that adequate surveys were undertaken as part of the FBA.

Note: Ecosystem-credit species are predicted by the landscape attributes and are not required to be specifically targeted during field surveys.

The *Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities – Working Draft* (DEC 2004) and Commonwealth Threatened Species Survey and Assessment Guidelines were considered when undertaking the threatened species surveys in the Development Site.

2.3.2 Species-credit Flora Surveys

Species-credit flora surveys were undertaken over 24 days and 12 survey periods, being:

- 11 to 12 February, 24 April and 5 May 2009
- 26 to 28 February, 18 to 20 March, 11, 12, 23 and 24 September and 9 to 10 October 2013
- 5 to 7 March 2014
- 27 May and 9 and 10 July 2015
- 14 April 2016 and
- 7 November 2016.

A preliminary list of species-credit flora species with potential to occur in the Development Site was generated during the literature review, completion of database searches, review of the Attachment B of the SEARs (refer to **Section 1.3**) and the TSPD. Searches of the TSPD were undertaken by the Hunter IBRA subregion and Hunter CMA region.

Table 2.3 identifies the species-credit flora species that were determined to potentially occur in the Development Site and therefore require targeted and seasonal surveys. **Appendix A** outlines the species-credit species identified in the literature review that were not considered likely to occur and therefore did not warrant targeted survey effort as per Section 6.5.1.6 of the FBA (OEH 2014b).

Targeted surveys were undertaken for the species listed in **Table 2.3** and included targeted on-ground searches in suitable habitat throughout the Development Site. Searches for these species were undertaken in suitable habitat along numerous walking meandering transects and within the plot/transect surveys. These generally involved walking suitable habitat areas and searching for the targeted species within the Development Footprint. The seasonal survey requirements for all species-credit flora species with the potential to occur within the Development Site were met during the 2009, 2013, 2014, 2015 and 2016 survey periods.

Table 2.3 Species-credit Flora Species Requiring Targeted Survey

Common Name *Scientific Name*	TSC Status	EPBC Status	Required Survey Period^	Survey Technique, Timing and Location
Denman pomaderris ***Pomaderris reperta***	CE	CE	All year	Targeted threatened flora searches and opportunistic observations were completed in suitable habitat throughout all Umwelt survey periods.

Common Name *Scientific Name*	TSC Status	EPBC Status	Required Survey Period^	Survey Technique, Timing and Location
large-leafed monotaxis *Monotaxis macrophylla*	E	-	June - November	Targeted threatened flora searches were completed in suitable habitat during September/October 2013, July 2015 and November 2016 surveys. Opportunistic observations undertaken throughout all Umwelt survey periods.
leafless tongue orchid *Cryptostylis hunteriana*	V	V	November - February	Targeted threatened flora searches were completed in suitable habitat during February 2009, February 2013 and November 2016 surveys. Opportunistic observations undertaken throughout all Umwelt survey periods.
Illawarra greenhood *Pterostylis gibbosa*	E	E	June - September	Targeted threatened flora searches were completed in suitable habitat during September and July 2015. Opportunistic observations undertaken throughout all Umwelt survey periods.
Ozothamnus tesselatus	V	V	All year	Targeted threatened flora searches and opportunistic observations were completed in suitable habitat throughout all Umwelt survey periods.
pine donkey orchid *Diuris tricolor*	V		September - October	Targeted threatened flora searches in suitable habitat were undertaken in September 2013 throughout the Development Footprint. Opportunistic observations were also undertaken throughout all Umwelt survey periods.
scant pomaderris *Pomaderris queenslandica*	E		All year	Targeted threatened flora searches and opportunistic observations were completed in suitable habitat throughout all Umwelt survey periods.

Common Name *Scientific Name*	TSC Status	EPBC Status	Required Survey Period^	Survey Technique, Timing and Location
Singleton mint bush ***Prostanthera cineolifera***	V	V	All year	Targeted threatened flora searches and opportunistic observations were completed in suitable habitat throughout all Umwelt survey periods.
slaty red gum ***Eucalyptus glaucina***	V	V	All year	Targeted threatened flora searches and opportunistic observations were completed in suitable habitat throughout all Umwelt survey periods.
small snake orchid ***Diuris pedunculata***	E	E	September - November	Targeted threatened flora searches in suitable habitat were undertaken in September/October 2013 and November 2016 throughout the Development Footprint. Opportunistic observations were also undertaken throughout all Umwelt survey periods.
tall knotweed ***Persicaria elatior***	V	V	December - May	Targeted threatened flora searches were completed in suitable habitat during February 2009, February and March 2013, March 2014 and May 2015 surveys. Opportunistic observations undertaken throughout all Umwelt survey periods.
Weeping Myall population in the Hunter catchment	EP		All year	Targeted threatened flora searches and opportunistic observations were completed in suitable habitat throughout all Umwelt survey periods.
Wollemi mint-bush ***Prostanthera cryptandroides* subsp. *cryptandroides***	V	V	All year	Targeted threatened flora searches and opportunistic observations were completed in suitable habitat throughout all Umwelt survey periods.

^ Months that surveys are required according to the Threatened Species Profile Database for the Hunter CMA (OEH 2017b).
* Narrow goodenia (*Goodenia macbarronii*) was identified within the TSPD for the Hunter CMA however is not currently listed under the TSC Act or EPBC Act.

2.3.3 Species-credit Fauna Surveys

Species-credit fauna surveys were undertaken over seven survey periods, being:

- 10 – 14 March 2014
- June, July or August of 2010, 2011, 2012, 2013, 2014 and 2016.

A preliminary list of species-credit fauna species with potential to occur in the Development Site was generated during the literature review, completion of database searches and review of the TSPD. Searches of the TSPD were undertaken by the Hunter IBRA subregion and Hunter CMA region.

Table 2.4 identifies the species-credit fauna species that were considered to potentially occur in the Development Site and that required targeted surveys. **Appendix A** outlines the species-credit species identified in the literature review that were not considered likely to occur and therefore did not warrant targeted survey effort as per Section 6.5.1.6 of the FBA (OEH 2014b).

Targeted surveys were undertaken for the species listed in **Table 2.4** and included a range of survey techniques including targeted searches, Anabat recorders, call playback and spotlighting. The seasonal survey requirements for all species-credit fauna species with the potential to occur within the Development Site were met during the July, November and December 2015 survey periods. The details of the targeted surveys are discussed in **Sections 2.3.3.1** to **2.3.3.7** below and specific survey locations are shown on **Figure 2.2**.

Table 2.4 Species-credit Fauna Species Requiring Targeted Survey

Common Name *Scientific Name*	TSC Status	EPBC Status	Required Survey Period^	Survey Technique, Timing and Location
brush-tailed phascogale *Phascogale tapoatafa*	V	-	All year	Targeted remote camera surveys were undertaken at 20 locations across the Development Site in March 2014. Cameras were set at each site for between three and four 24 hour periods.
eastern pygmy-possum *Cercartetus nanus*	V	-	All year	Targeted remote camera surveys were undertaken at 20 locations across the Development Site in March 2014. Cameras were set at each site for between three and four 24 hour periods.
green and golden bell frog *Litoria aurea*	E	V	August – March	Targeted searching and call playback surveys were undertaken at eight dam locations in March 2014.

Common Name *Scientific Name*	TSC Status	EPBC Status	Required Survey Period^	Survey Technique, Timing and Location
koala ***Phascolarctos cinereus***	V	V	All year	Targeted surveys for signs of the presence of koalas were undertaken at 20 locations across the Development Site in March 2014 using the Spot Assessment Technique (SAT). Searches were undertaken on and around the base of 30 trees at each survey site. The searches focused on signs of presence including scats at the base of trees and characteristic scratches on tree trunks.
regent honeyeater ***Anthochaera phrygia***	CE	CE	All year	Winter bird surveys targeting this species were undertaken by two ecologists during June, July or August in 2010, 2011, 2012, 2013, 2014 and 2016 comprising a total of 106.6 person hours of survey across the Development Site.
southern myotis ***Myotis macropus*** **(breeding habitat)**	V	-	October-March	Anabat echolocation recording surveys were undertaken in March 2014. Targeted habitat searches were undertaken adjacent to creek lines with permanent, or close to permanent, water to identify any potential hollow roosting habitat in April and May 2016.

^ Months that surveys are required according to the Threatened Species Profile Database for the Hunter CMA (OEH 2017b).

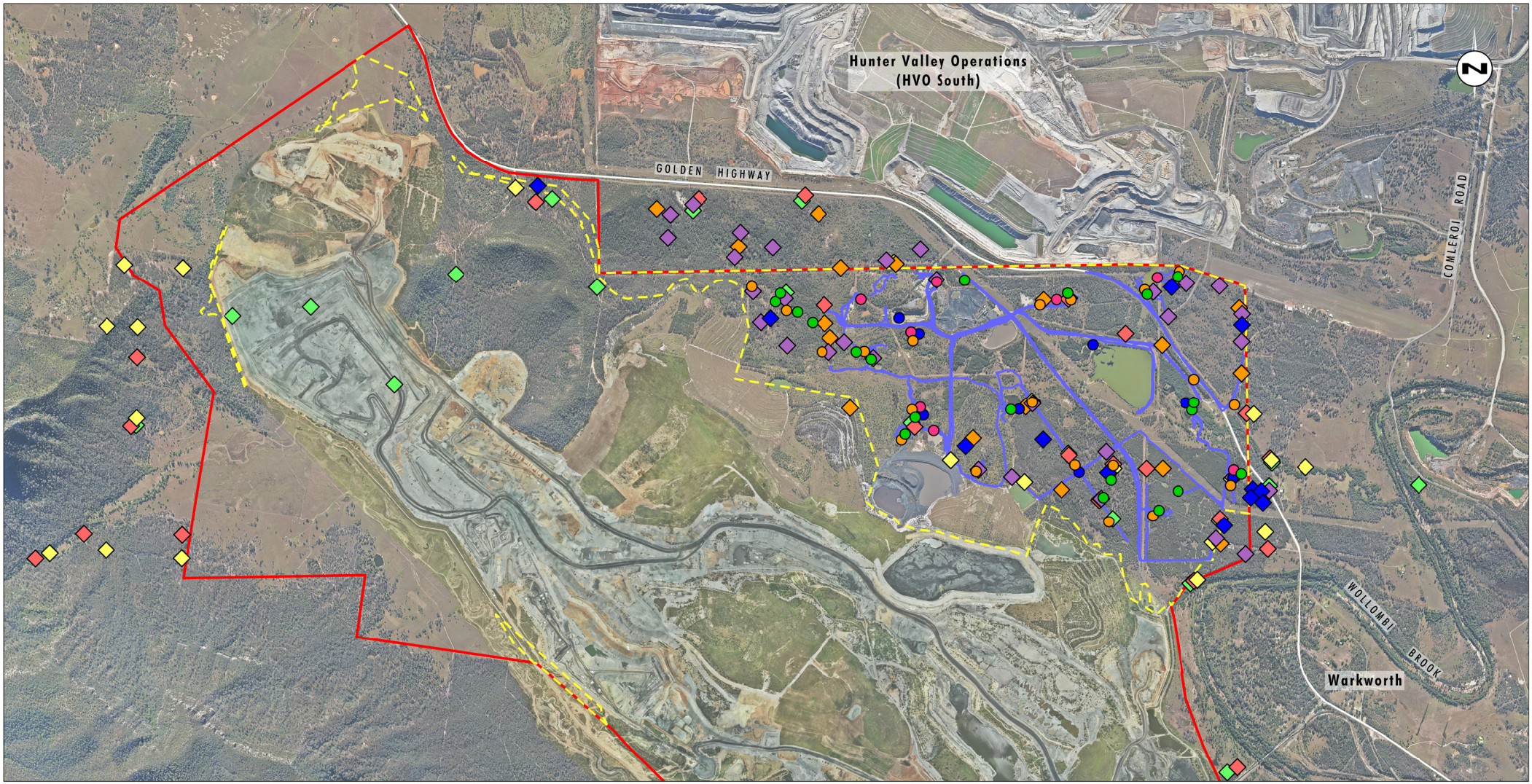

Image Source: AAM (2012), United (2016)
Data Source: Glencore (2014)

0 0.5 1.0 2.0km
1:40 000

Legend

- Development Site
- Development Footprint
- Spotlighting Transects (Brush-tailed Phascogale, Eastern Pygmy Possum and Koala)
- Remote Camera Location (Brush-tailed Phascogale and Eastern Pygmy Possum)
- Green and Golden Bell Frog Survey
- Anabat Survey
- Koala SAT Searches
- 2010 Regent Honeyecter and Swift Parrot Survey
- 2011 Regent Honeyecter and Swift Parrot Survey
- 2012 Regent Honeyecter and Swift Parrot Survey
- 2013 Regent Honeyeater and Swift Parrot Survey
- 2014 Regent Honeyeater and Swift Parrot Survey
- 2016 Regent Honeyeater and Swift Parrot Survey

FIGURE 2.2

Fauna Survey Effort

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20170321 15.41

2.3.3.1 Brush-tailed Phascogale and Eastern Pygmy Possum Surveys

Nocturnal spotlighting searches for brush-tailed phascogale and eastern pygmy possum was undertaken in targeted areas between the hours of 8.00 pm and midnight using 30 watt Lightforce hand-held spotlights. The surveys were undertaken over two nights with approximately four person hours completed each night. Areas targeted for spotlighting primarily comprised woodland patches dominated by eucalypt species.

These species were targeted using remote camera surveys at 20 locations across the Development Site in March 2014. Bushnell Trophy Cam HD cameras were used for the remote camera surveys. At each site, a remote camera was mounted approximately one metre above the ground on a tree trunk and positioned towards a bait station containing chicken meat, oats and honey. Cameras were set to take three photos in quick succession when movement was detected. Remote cameras were set at each site for between three and four 24 hour periods.

Opportunistic observations were also recorded throughout the survey period.

The locations of the spotlighting and remote camera surveys are shown on **Figure 2.2**.

2.3.3.2 Green and Golden Bell Frog Surveys

Green and golden bell frog surveys were undertaken at eight targeted dam locations across the Development Site in March 2014. Each survey commenced with 5 minutes of call playback of the species, followed by 5 minutes of listening for vocalising males. Directly following the call playback, 30 minutes of spotlighting was undertaken by two ecologists (a total of one person hour) at each site. These surveys involved searching along the edge of open water and through fringing vegetation for individuals and listening for vocalisation by males.

Opportunistic observations were also recorded throughout the survey period.

The locations of the green and golden bell frog surveys are shown on **Figure 2.2**.

2.3.3.3 Koala Surveys

Searches for signs of the presence of koalas were undertaken at 20 locations across the Development Site in March 2014 using the Spot Assessment Technique (SAT). The koala SAT was undertaken in eucalypt dominated sites only as per the technique outlined in Phillips and Callaghan (2011). Searches were undertaken on and around the base of 30 trees at each survey site. The searches focused on signs of presence including scats at the base of trees and characteristic scratches on tree trunks.

Furthermore, driving spotlighting surveys for koalas was undertaken in targeted areas between the hours of 8.00 pm and midnight using 30 watt Lightforce hand-held spotlights. The surveys were undertaken over two nights with approximately four person hours completed each night. Areas targeted for spotlighting primarily comprised woodland patches dominated by eucalypt species.

Opportunistic observations were also recorded throughout the survey period.

The locations of spotlighting surveys and koala SAT searches are shown on **Figure 2.2**.

2.3.3.4 Regent Honeyeater Surveys

Targeted winter bird surveys were undertaken across the Development Site during 2010, 2011, 2012, 2013, 2014 and 2016. Winter bird surveys targeting the regent honeyeater (*Anthochaera phrygia*) and swift parrot (*Lathamus discolor*) were undertaken by two ecologists during June, July or August each year, and comprised a total of 106.6 person hours of survey (refer to **Table A.6**).

Surveys comprised a combination of predetermined sites and sites positioned during the surveys in areas of eucalypt flowering (refer to **Figure 2.2**). Each survey consisted of a 5 minute period of call playback for the species followed by at least 20 minutes of searching, which consisted of a slow walking transect within an approximate two hectare area within suitable vegetation types. Surveys were undertaken during early to mid-morning and mid to late afternoon. Bird species were identified from characteristic calls and by observation using binoculars with magnification up to 10 x.

Table 2.5 Targeted Winter Bird Survey Effort

Year	Number of Sites	Approximate Time at each Site	Total Person Hours
2010	20	40 person minutes	13.3
2011	20	40 person minutes	13.3
2012	22	1 person hour	22.0
2013	17	1 person hour	17.0
2014	31	1 person hour	31.0
2016	4	0.5 person hours	2
2016	8	1 person hour	8
		Total Person Hours	**106.6**

2.3.3.5 Southern myotis (*Myotis macropus*) Breeding Habitat Surveys

Targeted habitat searches for the southern myotis (*Myotis macropus*) were undertaken adjacent to creek lines with permanent, or close to permanent, water to identify any potential hollow roosting habitat (hollow bearing trees). Areas of woodland within 200 metres of permanent, or close to permanent, water bodies along streams and containing hollow bearing trees were recorded.

In early 2016, OEH released UHSA guidelines relating to the calculation of credits for southern myotis (*Myotis macropus*) breeding habitat (OEH 2016c). These guidelines help to tailor the identification of southern myotis breeding habitat to riparian vegetation within 200 metres of permanent water sources where potential roosting hollows have been identified. On 19 and 21 April, and 3 May 2016, United Environmental staff undertook a survey of relevant creeklines previously mapped as southern myotis breeding habitat in the United UHSA BCAM report (Umwelt 2015). The surveys were conducted along Redbank Creek and its tributaries in the previously-mapped area and constituted assessments and measurement of pond dimensions, average streambank width and water flow. Historic analysis of water flow indicates that Redbank Creek is not, in this area, a perpetually flowing stream.

Furthermore, Anabat echolocation surveys were undertaken at eight locations across the Development Site during March 2014. Calls were recorded using an Anabat SD1 device (hereafter referred to as an 'Anabat'). At each site, the Anabat was positioned at an approximate 30 degree angle and 1 metre above the ground

in a waterproof housing. Each detector was positioned towards potential micro-bat flight paths or over water-bodies to increase the likelihood of detecting micro-bat species. The Anabat detector was programmed to start recording from one hour before sunset to one hour after sunrise.

Recordings of bat calls were analysed by Glenn Hoye of Fly By Night Bat Surveys Pty Ltd (a recognised expert in the identification of micro-bat calls). The echolocation calls of species were identified to one of three confidence levels:

- confident
- probable, and
- possible.

All three levels of confidence were treated as positive identifications for the purposes of this ecological assessment. The locations of the micro-bat echolocation surveys are shown on **Figure 2.2**.

3 Results

3.1 Landscape Value

3.1.1 Landscape Features

The outer assessment circle contains the 4th order stream Redbank Creek (and higher level streams such as Wollombi Brook). The outer assessment circle also covers multiple Mitchell landscapes (but clear majority in Central Hunter Foothills) and an extensive area of native vegetation in the north, south and west of the circle. These landscape features are shown in **Figure 3.1**.

Landscape features that were considered in the connectivity value scores for the Development Site are outlined in **Table 3.1** below.

Table 3.1 Landscape Features in the Development Footprint

Landscape Feature	Development Footprint
Mitchell Landscapes	Central Hunter Foothills
Rivers, Streams, Estuaries	4th order streams: • Redbank Creek
Wetlands	None identified
Native Vegetation	300 hectares in the inner assessment circle 1,850 hectares in the outer assessment circle
State or Regional Biodiversity Links	None identified

3.1.2 Landscape Value Scores

3.1.2.1 Per cent Native Vegetation Cover

Table 3.2 details the percent native vegetation cover before and after the proposed disturbance in the Development Footprint and the native vegetation per cent class entered into the BioBanking Calculator as per Table 9 of Appendix 4 of the FBA (OEH 2014b). The post-development calculations do not include the provision of ecological mine rehabilitation.

Table 3.2 Native Vegetation Cover in Buffer Area

Assessment Circle	Pre-Development			Post-Development		
	Area of Native Veg (ha)	Native Veg Cover (%)	Native Veg Per cent Class	Area of Native Veg (ha)	Native Veg Cover (%)	Native Veg Per cent Class
Outer (5000 ha)	1,850	37	36-40	1,407	28	26-30
Inner (500 ha)	300	60	56-60	18.7	3.7	<=5

3.1.2.2 Connectivity Value

No state or regional significant biodiversity links were identified within a plan approved by the Chief Executive of OEH in the Sydney Basin IBRA Bioregion. However, the Development Site contains part of a Regionally significant biodiversity link in the form of a riparian buffer 20 m either side of a 4th or 5th order stream as defined under the FBA (OEH 2014b) (refer to **Figure 3.1**).

Details of the connectivity value scores applicable for entry to the BBCC are shown in bold in **Table 3.3** below.

Table 3.3 Connectivity Value Score

Highest Category of Connecting Link	Connectivity Score	Definition	Description
Regionally Significant Biodiversity Link	**9**	An area identified by the assessor as being part of a regionally significant biodiversity link in a plan approved by the Chief Executive of OEH OR	Not identified
		A riparian buffer 20m either side of a 4th or 5th order stream OR	**Redbank Creek**
		A riparian buffer 30m around a regionally significant wetland	Not identified

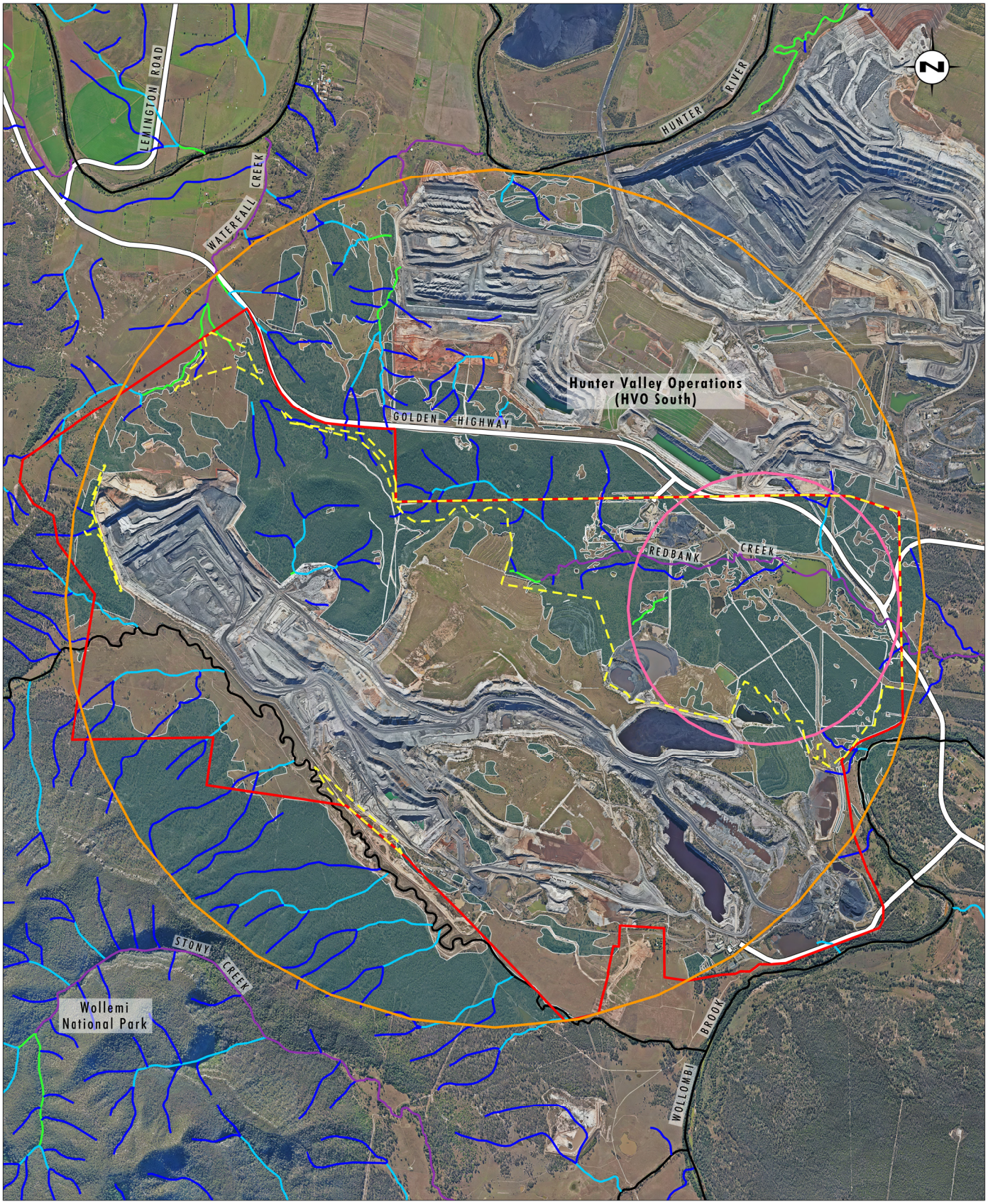

Image Source: AAM (2012), United (2016)
Data Source: Glencore (2014)

0 1.0 2.0 2.5km
1:50 000

Legend

- Development Site
- Development Footprint
- Native Vegetation
- 500ha Assessment Circle
- 5000ha Assessment Circle

Stream Order:

- 1st Order Stream
- 2nd Order Stream
- 3rd Order Stream
- 4th Order Stream
- 5th Order Stream or Greater

FIGURE 3.1

Connectivity Value

3.1.2.3 Patch Size

Table 3.4 below details the parameters that determined the Patch Size score as per Table 15 of Appendix 4 of the FBA (OEH 2014b).

Table 3.4 Patch Size Score Parameters

Mitchell Landscape	Central Hunter Foothills
Percent Native Vegetation Cleared	75%
Patch Size Class	>1001
Patch Size Score	**12**

3.1.2.4 Landscape Value Score

The landscape value score for the Development Site is 29.80, as calculated by the BBCC.

3.2 Native Vegetation within the Development Site

3.2.1 Biometric Vegetation Types and Vegetation Zones

Surveys of the Development Site identified six Plant Community Types (PCTs) across 10 condition classes being:

- HU812 Forest Red Gum grassy open forest on floodplains of the lower Hunter
  - *Moderate to Good Condition*
- HU816 Spotted Gum - Narrow-leaved Ironbark shrub - grass open forest of the central and lower Hunter
  - *Moderate to Good Condition – Plantation/Rehabilitation*
- HU869 Grey Box - Slaty Box shrub - grass woodland on sandstone slopes of the upper Hunter and Sydney Basin
  - *Moderate to Good Condition*
- HU905 Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter
  - *Moderate to Good Condition – Derived Native Grassland*
  - *Moderate to Good Condition*
  - *Moderate to Good Condition – Cooba Open Shrubland*
  - *Moderate to Good Condition – Thinned Canopy*
  - *Moderate to Good Condition – Regeneration*

- HU906 Bull Oak grassy woodland of the central Hunter Valley
    - *Moderate to Good Condition*
- HU945 Swamp Oak - Weeping Grass grassy riparian forest of the Hunter Valley
    - *Moderate to Good Condition.*

These PCTs were aligned with types described as part of the VIS Classification Database (OEH 2017c). The PCTs were then categorised into 10 vegetation zones (refer to **Figure 3.2**). The composition of these vegetation zones is outlined in **Sections 3.2.1.1** to **3.2.1.10** below and a flora species list for all plots surveyed is included in **Appendix A**.

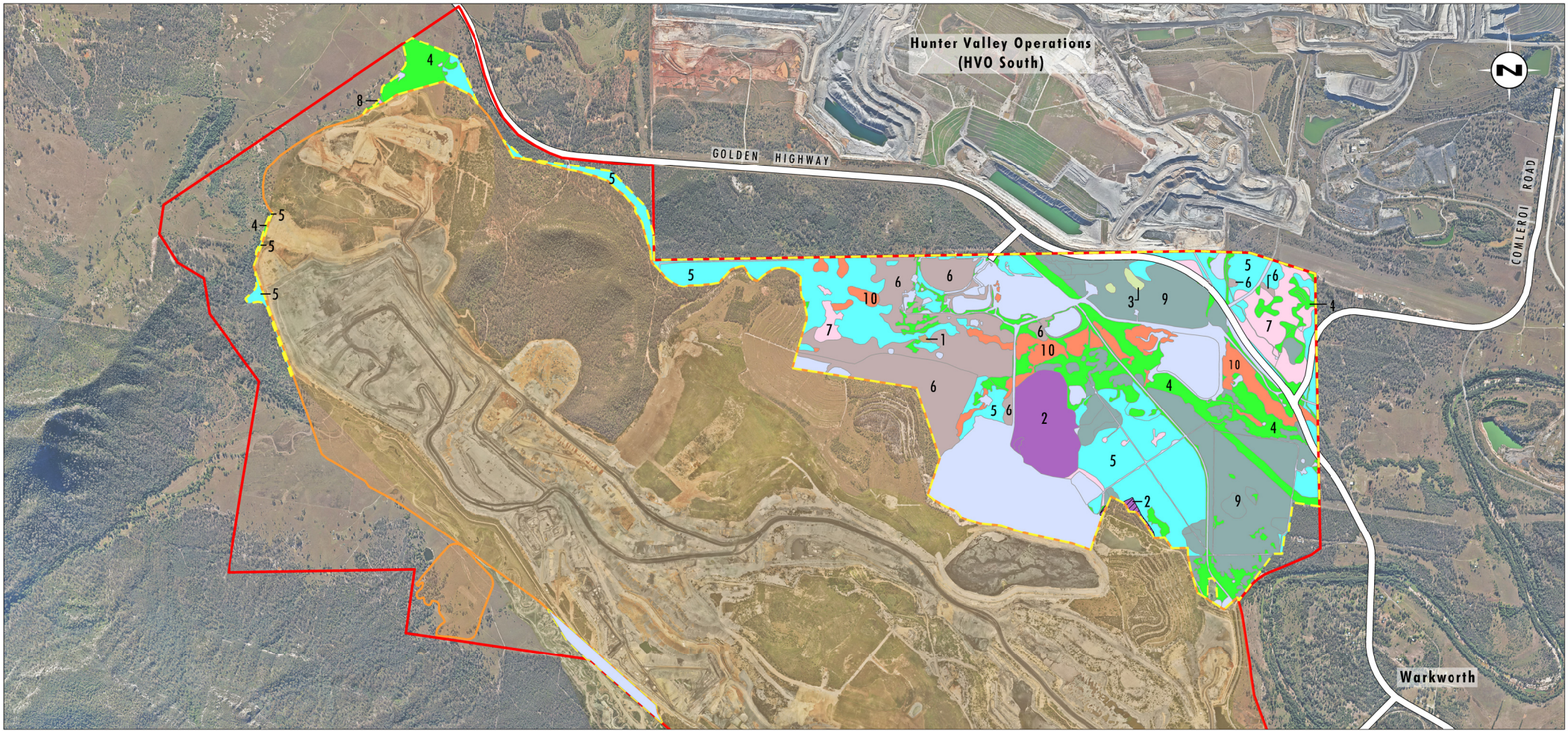

Image Source: AAM (2012), United (2016)
Data Source: Glencore (2014)

Legend

- Development Site
- Development Footprint
- Approved Wambo Surface Development Area
- 1 - HU812 - Forest Red Gum Grassy Open Forest on Floodplains of the Lower Hunter - Moderate to Good Condition
- 2 - HU816 - Spotted Gum - Narrow-leaved Ironbark Shrub - Grass Open Forest on Slopes of the Upper Hunter and Sydney Basin - Moderate to Good Condition - Plantation/Rehabilitation
- 3 - HU869 - Grey Box - Slaty Box Shrub - Grass Woodland on Sandstone Slopes of the Upper Hunter and Sydney Basin - Moderate to Good Condition
- 4 - HU905 - Narrow-leaved Ironbark - Grey Box grassy Woodland of the Central and Upper Hunter - Derived Native Grassland
- 5 - HU905 - Moderate to Good Condition
- 6 - HU905 - Moderate to Good Condition - Cooba Open Shrubland
- 7 - HU905 - Moderate to Good Condition - Regeneration
- 8 - HU905 - Moderate to Good Condition - Thinned Canopy
- 9 - HU906 - Bull Oak Grassy Woodland of the Central Hunter Valley - Moderate to Good Condition
- 10 - HU945 - Swamp Oak - Weeping Grass Grassy Riparian Forest of the Hunter Valley - Moderate to Good Condition
- Cleared Land
- Wambo Mine Rehabilitation

FIGURE 3.2

Vegetation Zones in the Development Footprint

File Name (A4): R01/3890_004.dgn
20170519 14.55

3.2.1.1 Zone 1 - HU812 – Forest Red Gum Grassy Open Forest on Floodplains of the Lower Hunter – Moderate to Good Condition

PCT Name	Forest Red Gum Grassy Open Forest on Floodplains of the Lower Hunter	
Condition	**Moderate to Good Condition**	
PCT Number	HU812	
Area (ha)	0.29	
Plots/Transects	One (P78)	
GHNVM Map Unit (Sivertsen *et. al* 2011)	MU080 Forest Red Gum Grassy Open Forest on Floodplains of the Lower Hunter	
HRVP Map Unit (Peake 2006)	MU24 – Hunter Lowlands Red Gum Forest	
General Description	This vegetation zone occurred as a single small patch within the Development Footprint, along Redbank Creek. This section of the Redbank Creek is ephemeral and was dry at the time of survey.	
Canopy Description	This vegetation zone had a sparse canopy between 14 and 18 metres in height, dominated solely by forest red gum (*Eucalyptus tereticornis*).	
Mid-storey Description	The mid-storey was sparse and approximately 10 metres in height, comprising younger forest red gum and cooba (*Acacia salicina*), while bulloak (*Allocasuarina luehmannii*) also occurred on the ecotone with adjacent vegetation zones.	
Shrub Layer Description	A very sparse shrub layer of bead bush (*Spartothamnella juncea*), coffee bush (*Breynia oblongifolia*) and the introduced species African olive (*Olea europea* subsp. *cuspidata*) was recorded within this vegetation zone. The shrub layer was between 1 and 3 metres in height.	
Ground Cover Description	This vegetation zone was characterised by a diverse, closed ground layer less than 1.5 metres in height. Common herbs and sub-shrubs included native wandering Jew (*Commelina cyanea*), ruby saltbush (*Enchylaena tomentosa*), purple burr-daisy (*Calotis cuneifolia*), kidney weed (*Dichondra repens*), variable glycine (*Glycine tabacina*), corrugated sida (*Sida corrugata*), rock fern (*Cheilanthes sieberi* subsp. *sieberi*), blue trumpet (*Brunoniella australis*), twining glycine (*Glycine clandestina*), forest nightshade (*Solanum prinophyllum*), *Oxalis perennans* and common woodruff (*Asperula conferta*). Native grasses included slender bamboo grass (*Austrostipa verticillata*), weeping grass (*Microlaena stipoides* var. *stipoides*), tall chloris (*Chloris ventricosa*), red grass (*Bothriochloa macra*), wallaby grass (*Rytidosperma bipartitum*), *Paspalum distans*, couch (*Cynodon dactylon*), barbed wire-grass (*Cymbopogon refractus*) and hairy panic (*Panicum effusum*).	
Introduced Species	The introduced species Paddys lucerne (*Sida rhombifolia*), African olive (*Olea europea* subsp. *cuspidata*), common prickly pear (*Opuntia stricta* var. *stricta*), scarlet pimpernel (*Anagallis arvensis*), fireweed (*Senecio madagascariensis*), galenia (*Galenia pubescens*) were reasonably common in the understorey of this vegetation zone.	

PCT Name	Forest Red Gum Grassy Open Forest on Floodplains of the Lower Hunter
Condition	Moderate to Good Condition
PCT Allocation	Vegetation Zone 1 was aligned with HU812 as it supports many of the species and stratum specifics identified for the PCT as listed on the VIS Classification Database (OEH 2017c). Of the 15 flora species listed on the database as characteristic for HU812, Vegetation Zone 1 supports 5 of them (33 per cent). This includes the canopy being dominated by forest red gum, coffee bush being dominant in the shrub layer and weeping grass, barbed wire grass and rock fern occurring within the ground cover.
TSC Act Status	This vegetation zone is consistent with the *Hunter Floodplain Red Gum Woodland in the NSW North Coast and Sydney Basin Bioregions* EEC listed under the TSC Act. For further information, refer to **Section 3.2.3.3**. The vegetation zone was also compared to *Hunter Lowland Redgum Forest in the Sydney Basin and NSW North Coast bioregions* EEC listed under the TSC Act, refer to **Section 3.2.3.3**. This vegetation zone was found to be more consistent with the *Hunter Floodplain Red Gum Woodland in the NSW North Coast and Sydney Basin Bioregions* EEC than the *Hunter Lowland Redgum Forest in the Sydney Basin and NSW North Coast bioregions* EEC.
EPBC Act Status	This vegetation zone is not consistent with any TEC listed under the EPBC Act.

3.2.1.2 Zone 2 - HU816 – Spotted Gum – Narrow-leaved Ironbark Shrub – Grass Open Forest of the Central and Lower Hunter – Moderate to Good Condition Plantation

PCT Name	Spotted Gum - Narrow-leaved Ironbark Shrub - Grass Open Forest of the Central and Lower Hunter	
Condition	**Moderate to Good Plantation**	
PCT Number	HU816	
Area (ha)	29.42	
Plots/Transects	Four (P03, P107, 3890_P01, 3890_P02	
GHNVM Map Unit (Sivertsen *et. al* 2011)	MU084 Spotted Gum/Narrow-leaved Ironbark Shrub/Grass Open Forest of the Central and Lower Hunter	
HRVP Map Unit (Peake 2006)	MU27 – Central Hunter Ironbark – Spotted Gum – Grey Box Forest	
General Description	This vegetation zone was confined to the lower slopes of the Development Footprint in isolated areas of rehabilitation. This vegetation was characterised by a relatively open (young) canopy supported by a shrubby understorey.	
Canopy Description	This vegetation zone supported a variable canopy that was very sparse to sparse in cover and between 5 to 11 metres in height. The canopy layer was dominated by spotted gum (*Corymbia maculata*) and hickory wattle (*Acacia implexa*), with some occurrences of introduced sugar gum (*Eucalyptus cladocalyx*).	
Mid-storey Description	The mid-storey was mid-dense and dominated by native blackthorn (*Bursaria spinosa* subsp. *spinosa*), bulloak (*Allocasuarina luehmannii*), hopbush (*Dodonaea triangularis*), prickly moses (*Acacia ulicifolia*), currawang (*Acacia doratoxylon*), kurrajong (*Brachychiton populneus* subsp. *populneus*) and black wattle (*Acacia decurrens*). The height of the mid-storey ranged from 2 to 8 metres in height.	
Shrub Layer Description	A shrub layer was commonly absent due to the dominance of the mid-storey. When present, the shrub layer comprised regenerating species from the mid-storey, fan wattle (*Acacia amblygona*) and gorse bitter pea (*Daviesia ulicifolia*).	
Ground Cover Description	This vegetation zone was characterised by a mid-dense ground layer to 1 metre in height. Common herbs and sub-shrubs included kidney weed (*Dichondra repens*), ruby saltbush (*Enchylaena tomentosa*), shade plantain (*Plantago debilis*), many-flowered mat-rush (*Lomandra multiflora* subsp. *multiflora*), berry saltbush (*Einadia hastata*), variable glycine (*Glycine tabacina*), blue trumpet (*Brunoniella australis*), purple burr-daisy (*Calotis cuneifolia*), twining glycine (*Glycine clandestina*), native sarsaparilla (*Hardenbergia violacea*), common everlasting (*Chrysocephalum apiculatum*), rock fern (*Cheilanthes sieberi* subsp. *sieberi*), *Phyllanthus virgatus,* amulla (*Eremophila debilis*), small St Johns wort (*Hypericum gramineum*) and pale mat-rush (*Lomandra glauca*). Native grasses included barbed wire-grass (*Cymbopogon refractus*), purple wiregrass (*Aristida ramosa*), *Paspalidium distans*, hairy panic (*Panicum effusum*), windmill grass (*Chloris truncata*), weeping grass (*Microlaena stipoides* var. *stipoides*), Queensland bluegrass	

PCT Name	Spotted Gum - Narrow-leaved Ironbark Shrub - Grass Open Forest of the Central and Lower Hunter
Condition	**Moderate to Good Plantation**
	(*Dichelachne sericeum*), *Bothriochloa* sp., *Aristida* sp. and *Austrostipa* sp.
Introduced Species	The introduced species scarlet pimpernel (*Anagallis arvensis*), Rhodes grass (*Chloris gayana*), galenia (*Galenia pubescens*), golden wreath wattle (*Acacia saligna*), common sowthistle (*Sonchus oleraceus*), narrow-leaved cotton bush (*Gomphocarpus fruticosus*), veined verbena (*Verbena rigida*), creeping pear (*Opuntia humifusa*) and *Richardia stellaris* were recorded in moderate abundance in this vegetation zone.
PCT Allocation	Vegetation Zone 2 was aligned with HU816 as it supports many of the species and stratum specifics identified for the PCT as listed on the VIS Classification Database (OEH 2017c). Of the 15 flora species listed on the database as characteristic for HU816, Vegetation Zone 2 supports 7 of them (46 per cent). This includes the canopy being dominated by spotted gum and narrow-leaved ironbark, and weeping grass, barbed wire grass, blue trumpet, many-flowered mat-rush and rock fern occurring within the ground cover.
TSC Act Status	This vegetation zone is consistent with *Central Hunter Ironbark – Spotted Gum – Grey Box Forest in the NSW North Coast and Sydney Basin Bioregion* EEC listed under the TSC Act. For further information refer to **Section 3.2.3.5**.
EPBC Act Status	A total of 1.17 hectares of this vegetation zone is consistent with the Central Hunter Valley Eucalypt Forest and Woodland CEEC listed under the EPBC Act. For further information refer to **Section 3.2.3.1**.

3.2.1.3 Zone 3 – HU869 – Grey Box – Slaty Box Shrub – Grass Woodland on Sandstone Slopes of the Upper Hunter and Sydney Basin – Moderate to Good Condition

PCT Name	Grey Box - Slaty Box Shrub - Grass Woodland on Sandstone Slopes of the Upper Hunter and Sydney Basin	
Condition	Moderate to Good	
PCT Number	HU869	
Area (ha)	1.56	
Plots/Transects	Two (P100, P101)	
GHNVM Map Unit (Sivertsen *et. al* 2011)	MU137 Grey Box/Slaty Box Shrub/Grass Woodland on sandstone slopes of the upper Hunter and Sydney Basin	
HRVP Map Unit (Peake 2006)	MU7 – Narrabeen Footslopes Slaty Box Woodland.	
General Description	This vegetation zone was confined to two reasonably small patches in the north-east of the Development Footprint. The zone was characterised by a more or less natural woodland structure dominated by relatively dense young to middle aged eucalypt trees amongst a sparsely scattered old mature canopy trees.	
Canopy Description	This vegetation zone supported a sparse to mid-dense canopy dominated by slaty box *Eucalyptus dawsonii*). Height of the canopy ranges from 12 to 14 metres.	
Mid-storey Description	The mid-storey was variable, ranging from very sparse to sparse. Dominant species included bulloak (*Allocasuarina luehmannii*), velvet mock olive (*Notelaea microcarpa* var. *microcarpa*), cherry ballart (*Exocarpos cupressiformis*), shiny-leaved canthium (*Psydrax odoratum*), hickory wattle (*Acacia implexa*) as well as regenerating canopy species. The height of the mid-storey ranged between 2 to 6 metres.	
Shrub Layer Description	The shrub layer as very sparse, with just a few individuals of the above listed mid-storey species. The shrub layer was approximately 1 metre in height.	
Ground Cover Description	This vegetation zone was characterised by a sparse ground layer up to 1 metre in height. Common herbs and sub-shrubs included slender stackhousia (*Stackhousia viminea*), kidney weed (*Dichondra repens*), blue trumpet (*Brunoniella australis*), *Lomandra filiformis*, gorse bitter pea (*Daviesia ulicifolia*), corrugated sida (*Sida corrugata*), climbing saltbush (*Einadia nutans* subsp. *nutans*), common everlasting (*Chrysocephalum apiculatum*), cobblers tack (*Glossocardia bidens*), solenogyne (*Solenogyne bellioides*), caustic weed (*Chamaesyce drummondii*), variable glycine (*Glycine tabacina*), pale vanilla-lily (*Arthropodium milleflorum*), lemon beauty-heads (*Calocephalus citreus*), many-flowered mat-rush (*Lomandra multiflora* subsp. *multiflora*), purple burr-daisy (*Calotis cuneifolia*), common fringe-sedge (*Fimbristylis dichotoma*), twining glycine (*Glycine clandestina*) and amulla (*Eremophila debilis*). Native grasses included threeawn speargrass (*Aristida vagans*), purple wiregrass (*Aristida ramosa*), wallaby grass (*Rytidosperma fulvum*), windmill grass (*Chloris truncata*), *Paspalidium distans* and couch (*Cynodon dactylon*).	

PCT Name	Grey Box - Slaty Box Shrub - Grass Woodland on Sandstone Slopes of the Upper Hunter and Sydney Basin
Condition	**Moderate to Good**
Introduced Species	The introduced species, lambs tongues (*Plantago lanceolata*), common prickly pear (*Opuntia stricta* var. *stricta*), narrow-leaved cotton bush (*Gomphocarpus fruticosus*) and African olive (*Olea europea* subsp. *cuspidata*) were recorded in moderate abundance in this vegetation zone.
PCT Allocation	Vegetation Zone 3 was aligned with HU869 as it supports many of the species and stratum specifics identified for the PCT as listed on the VIS Classification Database (OEH 2017c). Of the 14 flora species listed on the database as characteristic for HU869, Vegetation Zone 3 supports 6 of them (42 per cent). This includes the canopy being dominated by slaty box, velvet mock olive being dominant in the mid storey layer and purple wire grass, threeawn speargrass, kidney weed and corrugated sida occurring within the ground cover.
TSC Act Status	This vegetation zone is consistent with the vulnerable ecological community (VEC) *Hunter Valley Footslopes Slaty Gum Woodland in the Sydney Basin Bioregion* listed under the TSC Act. For further information refer to **Section 3.2.3.6**.
EPBC Act Status	A total of 1.13 hectares of this vegetation zone is consistent with the Central Hunter Valley Eucalypt Forest and Woodland CEEC listed under the EPBC Act. For further information refer to **Section 3.2.3.1**.

3.2.1.4 Zone 4 – HU905 – Narrow-leaved Ironbark – Grey Box Grassy Woodland of the Central and Upper Hunter – Moderate to Good Condition – Derived Native Grassland

PCT Name	Narrow-leaved Ironbark – Grey Box Grassy Woodland of the Central and Upper Hunter
Condition	**Moderate to Good – Derived Native Grassland**
PCT Number	HU905
Area (ha)	93.81
Plots/Transects	Seven (P69, P73, P79, P82, P85, P86, RPU2)
GHNVM Map Unit (Sivertsen *et. al* 2011)	Derived form of MU173 *Eucalyptus crebra – Eucalyptus moluccana* Grassy Woodland of the Central and Upper Hunter.
HRVP Map Unit (Peake 2006)	Derived form of MU10 – Central Hunter Box – Ironbark Woodland.
General Description	This vegetation zone was identified as the sole grassland community within the Development Footprint, and occurs throughout much of the area.
Tree Canopy Description	Not present.
Mid-storey Description	A mid-storey was generally absent from this vegetation zone. Where it did occur, it was very sparse and comprised regenerating bulloak (*Allocasuarina luehmannii*) and cooba (*Acacia salicina*) less than 2 metres in height.
Shrub Layer Description	The shrub layer was generally absent from this vegetation zone. Where it did occur, it was very sparse and comprised the above mentioned mid-storey species as well as gorse bitter pea (*Daviesia ulicifolia*) and velvet mock olive (*Notelaea microcarpa* var. *microcarpa*). The shrub layer was less than 1 metre in height.
Ground Cover Description	This vegetation zone was characterised by a diverse and dense ground layer generally less than 1 metre in height. Common herbs and sub-shrubs included common fringe-sedge (*Fimbristylis dichotoma*), kidney weed (*Dichondra repens*), common everlasting (*Chrysocephalum apiculatum*), rock fern (*Cheilanthes sieberi* subsp. *sieberi*), common woodruff (*Asperula conferta*), *Carex inversa* and *Glycine tabacina*. Native grasses included barbed wire grass (*Cymbopogon refractus*), purple wiregrass (*Aristida ramosa*), red grass (*Bothriochloa macra*), *Bothriochloa decipiens* var. *decipiens*, Queensland bluegrass (*Dichanthium sericeum* subsp. *sericeum*), weeping grass (*Microlaena stipoides* var. *stipoides*), couch (*Cynodon dactylon*), hairy panic (*Panicum effusum*), slender rats tail grass (*Sporobolus creber*),cotton panic grass (*Digitaria brownii*), tall chloris (*Chloris ventricosa*), threeawn speargrass (*Aristida vagans*), paddock lovegrass (*Eragrostis leptostachya*), early spring grass (*Eriochloa pseudoacrotricha*) and wallaby grass (*Rytidosperma bipartitum*).
Introduced Species	The following introduced species were recorded in low abundance in this vegetation zone, namely golden wreath wattle (*Acacia saligna*), *Setaria parviflora*, veined verbena (*Verbena rigida*), narrow-leaved cotton bush (*Gomphocarpus fruticosus*), cobblers pegs (*Bidens pilosa*), scarlet pimpernel (*Anagallis arvensis*), catsear (*Hypochaeris radicata*), lambs tongue

PCT Name	Narrow-leaved Ironbark – Grey Box Grassy Woodland of the Central and Upper Hunter
Condition	**Moderate to Good – Derived Native Grassland**
	(*Plantago lanceolata*) and fireweed (*Senecio madagascariensis*).
PCT Allocation	Vegetation Zone 4 was aligned with HU905 as it supports many of the species and stratum specifics identified for the PCT as listed on the VIS Classification Database (OEH 2017c). Of the 13 flora species listed on the database as characteristic for HU905, Vegetation Zone 4 supports 8 of them (61 per cent). As this zone is a grassland form, all five groundcover species listed in the VIS occur in the ground stratum which is 55 per cent of that listed on the database. This includes velvet mock olive in the shrub layer, amulla, weeping grass, purple wiregrass, barbed wire grass, tall chloris paddock lovegrass, and kidney weed occurring within the ground cover. In addition to these species that were recorded in this vegetation zone, it is also believed to have previously contained many of the species within Vegetation Zone 5 as it has been identified as being derived from it. This includes canopy, mid, shrub and ground stratum species.
TSC Act Status	This vegetation zone is not consistent with the EEC *Central Hunter Grey Box – Ironbark Woodland in the NSW North Coast and Sydney Basin Bioregions* listed under the TSC Act. The final determination for this EEC does not include native grasslands that are derived from the removal remnant woodland. For further information refer to **Section 3.2.3.4**. This vegetation zone is not consistent with any TEC listed under the TSC Act.
EPBC Act Status	A total of 10.49 hectares of this vegetation zone is consistent with the *Central Hunter Valley Eucalypt Forest and Woodland CEEC* listed under the EPBC Act. For further information refer to **Section 3.2.3.1**.

3.2.1.5 Zone 5 – HU905 – Narrow-leaved Ironbark – Grey Box Grassy Woodland of the Central and Upper Hunter – Moderate to Good Condition

PCT Name	Narrow-leaved Ironbark – Grey Box Grassy Woodland of the Central and Upper Hunter	
Condition	**Moderate to Good**	
PCT Number	HU905	
Area (ha)	149.28	
Plots/Transects	Ten (P04, P05, P07, P22, P23, P41, P88, P89, P108, RPU3)	
GHNVM Map Unit (Sivertsen *et. al* 2011)	MU173 *Eucalyptus crebra* – *Eucalyptus moluccana* Grassy Woodland of the Central and Upper Hunter	
HRVP Map Unit (Peake 2006)	MU10 – Central Hunter Box – Ironbark Woodland	
General Description	This was the dominant vegetation zone across the Development Footprint, occurring on most of the mid slopes. This vegetation zone was distinguished from other condition types (Regeneration and Cooba Open Shrubland) of this PCT based on its more natural woodland structure and generally intact tree canopy.	
Canopy Description	Sparse to mid-dense canopy dominated by grey box (*Eucalyptus moluccana*), narrow-leaved ironbark (*Eucalyptus crebra*) and bulloak (*Allocasuarina luehmannii*). The height of the canopy ranged from 10 to 18 metres.	
Mid-storey Description	A very sparse mid-storey was often present, common species were the above mentioned canopy species, native blackthorn (*Bursaria spinosa* subsp. *spinosa*), native mock olive (*Notelaea microcarpa* var. *microcarpa*), cooba (*Acacia cooba*), sticky hop-bush (*Dodonaea viscosa*) and *Melaleuca decora*. The mid-storey ranged from 2 to 8 metres in height.	
Shrub Layer Description	The shrub layer was very sparse to sparse. Common shrubs were regenerating individuals of those above-mentioned mid-storey species. The shrub layer generally ranged from 1 to 3 metres in height.	
Ground Cover Description	This vegetation zone was characterised by a sparse to dense ground layer generally less than 1 metre in height. Common herbs and sub-shrubs included purple burr-daisy (*Calotis cuneifolia*), many-flowered mat-rush (*Lomandra multiflora* subsp. *multiflora*), corrugated sida (*Sida corrugata*), kidney weed (*Dichondra repens*), fuzzweed (*Vittadinia cuneata*), large tick-trefoil (*Desmodium brachypodium*), blue trumpet (*Brunoniella australis*), amulla (*Eremophila debilis*), fan wattle (*Acacia amblygona*), rock fern (*Cheilanthes sieberi* subsp. *sieberi*), yellow burr-daisy (*Calotis lappulacea*), fuzzweed (*Vittadinia pustulata*) and hill hibiscus (*Hibiscus sturtii* var. *sturtii*). Native grasses included tall chloris (*Chloris ventricosa*), purple wiregrass (*Aristida ramosa*), red grass (*Bothriochloa decipiens*), barbed wire grass (*Cymbopogon refractus*), red grass (*Bothriochloa macra*), wallaby grass (*Rytidosperma bipartitum*), wallaby grass (*Rytidosperma fulvum*), speargrass (*Austrostipa scabra*), weeping grass (*Microlaena stipoides* var. *stipoides*) and hairy panic (*Panicum effusum*).	

PCT Name	Narrow-leaved Ironbark – Grey Box Grassy Woodland of the Central and Upper Hunter
Condition	**Moderate to Good**
Introduced Species	The following introduced species blackberry nightshade (*Solanum nigrum*), common prickly pear (*Opuntia stricta* var. *stricta*), lambs tongues (*Plantago lanceolata*), spear thistle (*Cirsium vulgare*), creeping pear (*Opuntia humifusa*) and fireweed (*Senecio madagascariensis*) were recorded in low abundance in this vegetation zone.
PCT Allocation	Vegetation Zone 5 was aligned with HU905 as it supports many of the species and stratum specifics identified for the PCT as listed on the VIS Classification Database (OEH 2017c). Of the 13 flora species listed on the database as characteristic for HU905, Vegetation Zone 5 supports 12 of them (92 per cent). This includes the canopy being dominated by narrow-leaved ironbark, grey box and kurrajong in the canopy stratum, native mock olive in the shrub layer, and amulla, purple wiregrass, barbed wiregrass, tall chloris, yellow burr-daisy, kidney weed, weeping grass and slender bamboo grass occurring within the ground cover
TSC Act Status	This vegetation zone is consistent with the EEC *Central Hunter Grey Box – Ironbark Woodland in the NSW North Coast and Sydney Basin Bioregions* listed under the TSC Act. For further information refer to **Section 3.2.3.4**. In addition, a small portion (approximately 0.2 hectares) of this vegetation zone in the furthest west portion of the Development Site has some affinities to the EEC *Hunter Valley Vine Thicket in the NSW North Coast and Sydney Basin Bioregions* under the TSC Act. However, given the small size and the similarities to *Central Hunter Grey Box – Ironbark Woodland in the NSW North Coast and Sydney Basin Bioregions* it has not been mapped separately as part of this assessment.
EPBC Act Status	A total of 143.62 hectares of this vegetation zone is consistent with the *Central Hunter Valley Eucalypt Forest and Woodland CEEC* listed under the EPBC Act. For further information refer to **Section 3.2.3.1**.

3.2.1.6 Zone 6 – HU905 – Narrow-leaved Ironbark – Grey Box Grassy Woodland of the Central and Upper Hunter – Moderate to Good Condition – Cooba Open Shrubland

PCT Name	Narrow-leaved Ironbark – Grey Box Grassy Woodland of the Central and Upper Hunter	
Condition	**Moderate to Good – Cooba Open Shrubland**	
PCT Number	HU905	
Area (ha)	80.45	
Plots/Transects	Eight (P20, P42, P74, P77, P84, P01, P02, P71)	
GHNVM Map Unit (Sivertsen *et. al* 2011)	MU173 *Eucalyptus crebra* – *Eucalyptus moluccana* Grassy Woodland of the Central and Upper Hunter.	
HRVP Map Unit (Peake 2006)	MU10 – Central Hunter Box – Ironbark Woodland.	
General Description	This vegetation zone occurred on the mid to upper slopes of the Development Footprint in undisturbed and revegetation areas. This vegetation zone was separated from other areas of this PCT (Moderate to Good and Moderate to Good – Regeneration) as the revegetation has focussed largely on mid-storey and shrub species while relying on canopy species to naturally regenerate from nearby.	
Canopy Description	This vegetation zone comprised a very sparse to sparse canopy of relatively young bulloak (*Allocasuarina luehmannii*), cooba (*Acacia salicina*) and hickory wattle (*Acacia implexa*) between 5 to 10 metres in height.	
Mid-storey Description	A very sparse to sparse mid-storey was also present in this vegetation zone, comprising the above listed canopy species. The mid-storey ranged from 2 to 4 metres in height.	
Shrub Layer Description	This vegetation zone supports a very sparse shrub layer, up to 2 metres in height. Common shrub species included bead bush (*Spartothamnella juncea*), native olive (*Notelaea microcarpa* var. *microcarpa*), sticky hop-bush (*Dodonaea viscosa*) and fan wattle (*Acacia amblygona*).	
Ground Cover Description	This vegetation zone was characterised by a diverse mid-dense to dense ground layer generally less than 1 metre in height. Common herbs and sub-shrubs included common everlasting (*Chrysocephalum apiculatum*), native pennyroyal (*Mentha satureioides*), common fringe-sedge (*Fimbristylis dichotoma*), rock fern (*Cheilanthes sieberi* subsp. *sieberi*), *Glycine tabacina*, kidney weed (*Dichondra repens*), *Zornia dyctiocarpa*, blue trumpet (*Brunoniella australis*), golden weather-grass (*Hypoxis hygrometrica*), purple burr-daisy (*Calotis cuneifolia*), bristly cloak fern (*Cheilanthes distans*) and *Goodenia* sp. Native grasses included barbed wire grass (*Cymbopogon refractus*), *Aristida personata*, red grass (*Bothriochloa macra*), weeping grass (*Microlaena stipoides* var. *stipoides*), slender rats tail grass (*Sporobolus creber*), purple wiregrass (*Aristida ramosa*), tall chloris (*Chloris ventricosa*), paddock lovegrass (*Eragrostis leptostachya*), slender bamboo grass (*Austrostipa verticillata*), red grass (*Bothriochloa decipiens* var. *decipiens*), Yadbila grass (*Panicum queenslandicum*), Queensland bluegrass (*Dichanthium sericeum* subsp. *sericeum*), shorthair plumegrass (*Dichelachne micrantha*) and speargrass (*Austrostipa scabra*).	

PCT Name	Narrow-leaved Ironbark – Grey Box Grassy Woodland of the Central and Upper Hunter
Condition	Moderate to Good – Cooba Open Shrubland
Introduced Species	The following introduced species were recorded in low abundance in this vegetation zone: golden wreath wattle (*Acacia saligna*), veined verbena (*Verbena rigida*), narrow-leaved cotton bush (*Gomphocarpus fruticosus*), cobblers pegs (*Bidens pilosa*), scarlet pimpernel (*Anagallis arvensis*), lambs tongue (*Plantago lanceolata*), red Natal grass (*Melinis repens*), fireweed (*Senecio madagascariensis*), Paddys lucerne (*Sida rhombifolia*) and saffron thistle (*Carthamus lanatus*).
PCT Allocation	Vegetation Zone 6 was aligned with HU905 as it supports many of the species and stratum specifics identified for the PCT as listed on the VIS Classification Database (OEH 2017c). Of the 13 flora species listed on the database as characteristic for HU905, Vegetation Zone 6 supports 11 of them (84 per cent). This includes the presence of grey box in the canopy, native olive being dominant in the shrub layer, amulla, purple wiregrass, barbed wiregrass, tall chloris, yellow burr-daisy, kidney weed, paddock lovegrass, weeping grass and slender bamboo grass occurring within the ground cover
TSC Act Status	This vegetation zone is not consistent with the EEC *Central Hunter Grey Box – Ironbark Woodland in the NSW North Coast and Sydney Basin Bioregions* listed under the TSC Act due to the lack of intact canopy. For further information refer to **Section 3.2.3.4**. This vegetation zone is not consistent with any TEC listed under the TSC Act.
EPBC Act Status	This vegetation zone is not consistent with any TEC listed under the EPBC Act.

3.2.1.7 Zone 7 – HU905 – Narrow-leaved Ironbark – Grey Box Grassy Woodland of the Central and Upper Hunter – Moderate to Good Condition – Regeneration

PCT Name	Narrow-leaved Ironbark – Grey Box Grassy Woodland of the Central and Upper Hunter	
Condition	Moderate to Good Regeneration	
PCT Number	HU905	
Area (ha)	26.55	
Plots/Transects	Four (P76, P70A, 3890_P04, 3890_P03)	
GHNVM Map Unit (Sivertsen *et. al* 2011)	MU173 *Eucalyptus crebra* – *Eucalyptus moluccana* Grassy Woodland of the Central and Upper Hunter	
HRVP Map Unit (Peake 2006)	MU10 – Central Hunter Box – Ironbark Woodland	
General Description	This vegetation zone occurs predominantly in the north-eastern extent of the Development Footprint, while additional smaller patches occur in the west and central areas. Occurring on the lower to mid-slopes, this vegetation zone was separated from other areas of this PCT based on the thinned nature of the canopy and subsequent high density of regenerating canopy species.	
Canopy Description	The vegetation zone comprised a very sparse to sparse canopy of grey box (*Eucalyptus moluccana*), narrow-leaved ironbark (*Eucalyptus crebra*) and bulloak (*Allocasuarina luehmannii*), ranging from 8 to 12 metres in height.	
Mid-storey Description	The sparse mid-storey was dominated by hickory wattle (*Acacia implexa*), cooba (*Acacia salicina*), an introduced shrub golden wreath wattle (*Acacia saligna*) as well as a hybrid between the latter two species (*Acacia salicina × saligna*). The mid-storey ranged from 2 to 6 metres in height.	
Shrub Layer Description	The shrub layer was absent to sparse in this vegetation zone. Shrubs species include those species identified in the mid-storey up to 2 metres in height.	
Ground Cover Description	This vegetation zone was characterised by a diverse mid-dense to dense ground layer generally less than 1 metre in height. Common herbs and sub-shrubs included kidney weed (*Dichondra repens*), blue trumpet (*Brunoniella australis*), native pennyroyal (*Mentha satureioides*), *Glycine tabacina*, purple burr-daisy (*Calotis cuneifolia*), amulla (*Eremophila debilis*), corrugated sida (*Sida corrugata*), rock fern (*Cheilanthes sieberi* subsp. *sieberi*), solenogyne (*Solenogyne bellioides*), yellow burr-daisy (*Calotis lappulacea*), common fringe-sedge (*Fimbristylis dichotoma*), common everlasting (*Chrysocephalum apiculatum*) and lemon beauty-heads (*Calocephalus citreus*). Native grasses included barbed wire grass (*Cymbopogon refractus*), weeping grass (*Microlaena stipoides* var. *stipoides*), slender bamboo grass (*Austrostipa verticillata*), *Aristida personata*, tall chloris (*Chloris ventricosa*), red grass (*Bothriochloa macra*), slender rats tail grass (*Sporobolus creber*) and hairy panic (*Panicum effusum*).	
Introduced	Galenia (*Galenia pubescens*), narrow-leaved cotton bush (*Gomphocarpus fruticosus*), lambs tongues (*Plantago lanceolata*), scarlet pimpernel (*Anagallis arvensis*), *Richardia stellaris*,	

PCT Name	Narrow-leaved Ironbark – Grey Box Grassy Woodland of the Central and Upper Hunter
Condition	Moderate to Good Regeneration
Species	common prickly pear (*Opuntia stricta* var. *stricta*), Rhodes grass (*Chloris gayana*), Paddys lucerne (*Sida rhombifolia*) and fireweed (*Senecio madagascariensis*) were recorded in low abundance in this vegetation zone.
PCT Allocation	Vegetation Zone 7 was aligned with HU905 as it supports many of the species and stratum specifics identified for the PCT as listed on the VIS Classification Database (OEH 2017c). Of the 13 flora species listed on the database as characteristic for HU905, Vegetation Zone 7 supports 11 of them (84 per cent). This includes the regenerating canopy being dominated by narrow-leaved ironbark and grey box, native olive occurring in the shrub layer, amulla, purple wiregrass, barbed wiregrass, tall chloris, yellow burr-daisy, kidney weed, weeping grass and slender bamboo grass occurring within the ground cover
TSC Act Status	This vegetation zone is consistent with the EEC *Central Hunter Grey Box – Ironbark Woodland in the NSW North Coast and Sydney Basin Bioregions* listed under the TSC Act. For further information refer to **Section 3.2.3.4**.
EPBC Act Status	A total of 22.79 hectares of this vegetation zone is consistent with the *Central Hunter Valley Eucalypt Forest and Woodland CEEC* listed under the EPBC Act. For further information refer to **Section 3.2.3.1**.

3.2.1.8 Zone 8 – HU905 – Narrow-leaved Ironbark – Grey Box Grassy Woodland of the Central and Upper Hunter – Moderate to Good Condition – Thinned Canopy

PCT Name	Narrow-leaved Ironbark – Grey Box Grassy Woodland of the Central and Upper Hunter	
Condition	**Moderate to Good – Thinned Canopy**	
PCT Number	HU905	
Area (ha)	0.08	
Plots/Transects	One (RPU1)	
GHNVM Map Unit (Sivertsen *et. al* 2011)	MU173 *Eucalyptus crebra* – *Eucalyptus moluccana* Grassy Woodland of the Central and Upper Hunter.	
HRVP Map Unit (Peake 2006)	MU10 – Central Hunter Box – Ironbark Woodland.	
General Description	Confined to the north-western portion of the Development Footprint along the edges of Waterfall Creek. Separated from other condition types of this PCT based on the scattered distribution of mature trees.	
Tree Canopy Description	Very sparse to sparse canopy dominated by grey box (*Eucalyptus moluccana*), narrow-leaved ironbark (*Eucalyptus crebra*) and bulloak (*Allocasuarina luehmannii*), with occurrences of rough-barked apple (*Angophora floribunda*). The height of the canopy ranged from 15 to 18 metres.	
Mid-storey Description	A very sparse midstorey was present, particularly along the main drainage line, and comprised cooba (*Acacia salicina*) up to 8 metres in height.	
Shrub Layer Description	The shrub layer was generally absent from this vegetation zone. Where it did occur, it was very sparse and comprised native olive (*Notelaea microcarpa* var. *microcarpa*) and Geijera salicifolia. The shrub layer was between 1 to 1.5 metres in height.	
Ground Cover Description	This vegetation zone was characterised by a diverse and dense ground layer generally less than 1 metre in height. Common herbs included ruby saltbush (*Enchylaena tomentosa*), rock fern (*Cheilanthes sieberi* subsp. *sieberi*) and climbing saltbush (*Einadia nutans* subsp. *nutans*). Native grasses included purple wiregrass (*Aristida ramosa*), red grass (*Bothriochloa macra*), *Bothriochloa decipiens* var. *decipiens*, couch (*Cynodon dactylon*), tall chloris (*Chloris ventricosa*), slender rats tail grass (*Sporobolus creber*) and speargrass (*Austrostipa scabra*).	
Introduced Species	The following introduced species were recorded in moderate abundance in this vegetation zone, including African boxthorn (*Lycium ferocissimum*), pepper tree (*Schinus areira*), Paddys lucerne (*Sida rhombifolia*), galenia (*Galenia pubescens*) and red-flowered mallow (*Modiola caroliniana*).	
PCT Allocation	Vegetation Zone 8 was aligned with HU905 as it supports many of the species and stratum specifics identified for the PCT as listed on the VIS Classification Database (OEH 2017c). Of the 13 flora species listed on the database as characteristic for HU905, Vegetation Zone 8 supports 6 of them (46 per cent). This includes the thinned canopy being dominated by narrow-leaved ironbark, native olive occurring in the shrub layer, amulla, purple wiregrass,	

PCT Name	Narrow-leaved Ironbark – Grey Box Grassy Woodland of the Central and Upper Hunter
Condition	**Moderate to Good – Thinned Canopy**
	tall chloris and slender bamboo grass occurring within the ground cover In addition to the species that were recorded in this vegetation zone, it is also believed to have previously contained many of the species within Vegetation Zone 5 as it has been identified as being derived from it. This includes canopy, mid, shrub and ground stratum species.
TSC Act Status	This vegetation zone is consistent with the EEC *Central Hunter Grey Box – Ironbark Woodland in the NSW North Coast and Sydney Basin Bioregions* listed under the TSC Act. For further information refer to **Section 3.2.3.4**.
EPBC Act Status	This vegetation zone is consistent with *Central Hunter Valley Eucalypt Forest and Woodland CEEC* listed under the EPBC Act. For further information refer to **Section 3.2.3.1**.

3.2.1.9 Zone 9 – HU906 – Bull Oak Grassy Woodland of the Central Hunter Valley – Moderate to Good Condition

PCT Name	Bull Oak Grassy Woodland of the Central Hunter Valley	
Condition	**Moderate to Good**	
PCT Number	HU906	
Area (ha)	117.67	
Plots/Transects	Ten (P18, P70, P75, P80, P81, P83, P87, P93, P105, P106)	
GHNVM Map Unit (Sivertsen *et. al* 2011)	MU174 Bulloak Grassy Woodland of the Central Hunter Valley.	
HRVP Map Unit (Peake 2006)	MU32 – Central Hunter Bulloak Forest Regeneration.	
General Description	This vegetation zone occurred in the eastern half of the Development Footprint on the lower slopes. There were two prominent patches, one along the northern boundary and the other in the south eastern corner.	
Canopy Description	This vegetation zone supported a mid-dense canopy dominated by bulloak (*Allocasuarina luehmannii*), although grey box (*Eucalyptus moluccana*), narrow-leaved ironbark (*Eucalyptus crebra*) and *Melaleuca decora* also occurred in low numbers throughout the zone. The canopy of this vegetation zone ranged from 4 to 16 metres in height.	
Mid-storey Description	Not present.	
Shrub Layer Description	The shrub layer was generally absent from this vegetation zone. Where it did occur, it was very sparse and comprised regenerating bulloak (*Allocasuarina luehmannii*), as well as native blackthorn (*Bursaria spinosa* subsp. *spinosa*), fan wattle (*Acacia amblygona*) and gorse bitter pea (*Daviesia ulicifolia*). The shrub layer was less than 1 metre in height.	
Ground Cover Description	This community was characterised by a sparse and relatively species poor ground layer less than 1 metre in height. Common herbs and sub-shrubs included many-flowered mat-rush (*Lomandra multiflora* subsp. *multiflora*), *Lomandra filiformis* subsp. *filiformis*, variable glycine (*Glycine tabacina*), blue trumpet (*Brunoniella australis*), climbing saltbush (*Einadia nutans* subsp. *nutans*), spiny-headed mat-rush (*Lomandra longifolia*), common everlasting (*Chrysocephalum apiculatum*), rock fern (*Cheilanthes sieberi* subsp. *sieberi*), common fringe-sedge (*Fimbristylis dichotoma*), corrugated sida (*Sida corrugata*), purple burr-daisy (*Calotis cuneifolia*), slender stackhousia (*Stackhousia viminea*) and ruby saltbush (*Enchylaena tomentosa*) and *Phyllanthus virgatus*. Native grasses included purple wiregrass (*Aristida ramosa*), red grass (*Bothriochloa macra*), couch (*Cynodon dactylon*), barbed wire grass (*Cymbopogon refractus*), Jericho wiregrass (*Aristida jerichoensis* var. *jerichoensis*), *Paspalidium distans*, threeawn speargrass (*Aristida vagans*), slender chloris (*Chloris divaricata* var. *divaricata*), Browns lovegrass (*Eragrostis brownii*), weeping grass (*Microlaena stipoides* var. *stipoides*) and *Rytidosperma monticola*.	

PCT Name	Bull Oak Grassy Woodland of the Central Hunter Valley
Condition	**Moderate to Good**
Introduced Species	The introduced species *Richardia stellaris*, creeping pear (*Opuntia humifusa*), fireweed (*Senecio madagascariensis*), golden wreath wattle (*Acacia saligna*), common prickly pear (*Opuntia stricta* var. *stricta*) and tiger pear (*Opuntia aurantiaca*) were recorded in low abundance in this vegetation zone.
PCT Allocation	Vegetation Zone 9 was aligned with HU906 as it supports many of the species and stratum specifics identified for the PCT as listed on the VIS Classification Database (OEH 2017c). Vegetation Zone 9 supports all of the 9 flora species listed on the database as characteristic for HU906. This includes the canopy being dominated by bulloak and weeping grass, barbed wire grass, common couch, threeawn speargrass, paddock lovegrass, purple wiregrass, red grass and Brown's lovegrass occurring within the ground cover
TSC Act Status	Following a site inspection, OEH required that a small area of the vegetation zone (3.1 hectares) in the northern portion of the Development Footprint was identified as EEC *Central Hunter Grey Box – Ironbark Woodland in the NSW North Coast and Sydney Basin Bioregions* listed under the TSC Act. For further information refer to **Section 3.2.3.4**. The remainder of this vegetation zone is not consistent with any TEC listed under the TSC Act.
EPBC Act Status	A total of 10.19 hectares of this vegetation zone is consistent with the *Central Hunter Valley Eucalypt Forest and Woodland CEEC* listed under the EPBC Act. For further information refer to **Section 3.2.3.1**.

3.2.1.10 Zone 10 – HU945 – Swamp Oak – Weeping Grass Grassy Riparian Forest of the Hunter Valley – Moderate to Good Condition

PCT Name	Swamp Oak - Weeping Grass Grassy Riparian Forest of the Hunter Valley	
Condition	**Moderate to Good**	
PCT Number	HU945	
Area (ha)	31.61	
Plots/Transects	Six (P21, P39, P40, P102, P103, P104)	
GHNVM Map Unit (Sivertsen *et. al* 2011)	MU213 Swamp Oak – Weeping Grass Grassy Riparian Forest of the Hunter Valley.	
HRVP Map Unit (Peake 2006)	MU28 – Central Hunter Swamp Oak Forest.	
General Description	This vegetation zone was confined to the riparian zone along Redbank Creek running centrally through the Development Footprint from west to east.	
Canopy Description	This vegetation zone supported a sparse to mid-dense canopy dominated entirely by swamp oak (*Casuarina glauca*). The native needle-leaf mistletoe (*Amyema cambagei*) and *Lysiana linearifolia* were also relatively common within the swamp oak canopy. The canopy of this vegetation zone ranged from 8 to 16 metres in height.	
Mid-storey Description	A sparse mid-storey was present, which was dominated by young swamp oak (*Casuarina glauca*) and shiny-leaved canthium (*Psydrax odorata*), 1 to 7 metres in height.	
Shrub Layer Description	The shrub layer was generally absent, however in some areas a very sparse shrub layer occurred, comprising bead bush (*Spartothamnella juncea*), native olive (*Notelaea microcarpa* var. *microcarpa*), and regenerating swamp oak (*Casuarina glauca*) generally 1 to 1.5 metres in height.	
Ground Cover Description	This vegetation zone was characterised by a dense ground layer generally less than 1 metre in height. Common herbs and sub-shrubs included rock fern (*Cheilanthes sieberi* subsp. *sieberi*), kidney weed (*Dichondra repens*), bristly cloak fern (*Cheilanthes distans*), berry saltbush (*Einadia hastata*), amulla (*Eremophila debilis*), blue trumpet (*Brunoniella australis*), corrugated sida (*Sida corrugata*), purple burr-daisy (*Calotis cuneifolia*) and small-leaf bluebush (*Maireana microphylla*). Weeping grass (*Microlaena stipoides* var. *stipoides*), slender bamboo grass (*Austrostipa verticillata*) and purple wiregrass (*Aristida ramosa*) were the dominant native grasses.	
Introduced Species	The introduced species galenia (*Galenia pubescens*), veined verbena (*Verbena rigida*), scarlet pimpernel (*Anagallis arvensis*), cobblers pegs (*Bidens pilosa*), fireweed (*Senecio madagascariensis*), mother-of-millions (*Bryophyllum delagoense*), Paddys lucerne (*Sida rhombifolia*), common prickly pear (*Opuntia stricta* var. *stricta*), African olive (*Olea europaea* subsp. *cuspidata*), common sowthistle (*Sonchus oleraceus*) and narrow-leaved cotton bush (*Gomphocarpus fruticosus*) were recorded in moderate abundance in this vegetation zone.	

PCT Name	Swamp Oak - Weeping Grass Grassy Riparian Forest of the Hunter Valley
Condition	Moderate to Good
PCT Allocation	Vegetation Zone 10 was aligned with HU945 as it supports many of the species and stratum specifics identified for the PCT as listed on the VIS Classification Database (OEH 2017c). Of the 9 flora species listed on the database as characteristic for HU945, Vegetation Zone 10 supports 6 of them (66 per cent). This includes the canopy being dominated by swamp oak, forest nightshade within the mid-stratum, weeping grass, kidney weed, slender bamboo grass and whiteroot occurring within the ground cover.
TSC Act Status	This vegetation zone is not consistent with the EEC *Swamp Oak Floodplain Forest of the NSW North Coast Sydney Basin and South East Corner Bioregions* listed under the TSC Act. For further information refer to **Section 3.2.3.7**. This vegetation zone is not consistent with any TEC listed under the TSC Act.
EPBC Act Status	This vegetation zone is not consistent with any TEC listed under the EPBC Act.

3.2.1.11 Cleared Land

All other areas not mapped as part of a vegetation zone satisfied the definition of 'cleared land'. Cleared Land does not meet the definition of 'native vegetation' under the *Native Vegetation Act 2003* and therefore could not be aligned with a PCT or vegetation zone and is excluded from further assessment as per Section 9.5 of the FBA (OEH 2014b). Cleared land is land on which the native overstorey has been completely removed and there is no native mid-storey, and less than 50 per cent of the ground cover vegetation is indigenous species, or less than 10 per cent of the ground cover is present (whether dead or alive). Areas mapped as cleared land comprised disturbed land, grassland rehabilitation areas, woodland rehabilitation areas with poor or absent understorey and ground cover layers, mixed species revegetation plantation and water bodies. It includes areas of revegetation that are dominated by tree and shrub species not native to the region. Water bodies include all open water bodies within the Development Footprint, including dams and detention basins. Cleared land totalled 146.67 hectares within the Development Footprint.

3.2.2 Current Site Value

Table 3.5 below details the current site value scores for each of the vegetation zones in the Development Footprint. The raw site condition attribute data for each of the vegetation zones is provided in **Appendix B**.

Table 3.5 Vegetation Zone Site Value Scores

Veg Zone	PCT Name	Current Site Value Score
1	HU812 Forest Red Gum grassy open forest on floodplains of the lower Hunter *Moderate to Good Condition*	80.00
2	HU816 Spotted Gum - Narrow-leaved Ironbark shrub - grass open forest of the central and lower Hunter *Moderate to Good Condition – Plantation/Rehabilitation*	57.29
3	HU869 Grey Box - Slaty Box shrub - grass woodland on sandstone slopes of the upper Hunter and Sydney Basin *Moderate to Good Condition*	82.00
4	HU905 Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter *Moderate to Good Condition – Derived Native Grassland*	26.56
5	HU905 Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter *Moderate to Good Condition*	75.52
6	HU905 Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter *Moderate to Good Condition – Cooba Open Shrubland*	34.90

Veg Zone	PCT Name	Current Site Value Score
7	HU905 Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter *Moderate to Good Condition – Regeneration*	49.65
8	HU905 Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter *Moderate to Good Condition – Thinned Canopy*	39.06
9	HU906 Bull Oak grassy woodland of the central Hunter Valley *Moderate to Good Condition*	67.71
10	HU945 Swamp Oak - Weeping Grass grassy riparian forest of the Hunter Valley *Moderate to Good*	80.00

3.2.3 Threatened Ecological Communities

Eight of the vegetation zones described above and mapped within the Development Footprint conform to State and Commonwealth listed TECs, comprising:

- HU812 Forest Red Gum grassy open forest on floodplains of the lower Hunter - Moderate to Good Condition:
  - *Hunter Floodplain Red Gum Woodland in the NSW North Coast and Sydney Basin Bioregions EEC* (TSC Act)
- HU816 Spotted Gum - Narrow-leaved Ironbark shrub - grass open forest of the central and lower Hunter - Moderate to Good Condition – Plantation/Rehabilitation
  - *Central Hunter Ironbark – Spotted Gum – Grey Box Forest in the NSW North Coast and Sydney Basin Bioregion EEC* (TSC Act)
  - 1.17 ha *Central Hunter Valley Eucalypt Forest and Woodland CEEC* (EPBC Act)
- HU869 Grey Box - Slaty Box shrub - grass woodland on sandstone slopes of the upper Hunter and Sydney Basin – Moderate to Good Condition
  - *Hunter Valley Footslopes Slaty Gum Woodland in the Sydney Basin Bioregion* (TSC Act)
  - 1.13 ha *Central Hunter Valley Eucalypt Forest and Woodland CEEC* (EPBC Act)
- HU905 – Narrow-leaved Ironbark – Grey Box Grassy Woodland of the Central and Upper Hunter – Moderate to Good Condition – Derived Native Grassland
  - 10.49 ha *Central Hunter Valley Eucalypt Forest and Woodland CEEC* (EPBC Act)
- HU905 – Narrow-leaved Ironbark – Grey Box Grassy Woodland of the Central and Upper Hunter – Moderate to Good Condition

- Central Hunter Grey Box – Ironbark Woodland in the NSW North Coast and Sydney Basin Bioregions (TSC Act)
- 143.46 ha *Central Hunter Valley Eucalypt Forest and Woodland CEEC* (EPBC Act)

- HU905 – Narrow-leaved Ironbark – Grey Box Grassy Woodland of the Central and Upper Hunter – Moderate to Good Condition – Regeneration
  - *Central Hunter Grey Box – Ironbark Woodland in the NSW North Coast and Sydney Basin Bioregions EEC* (TSC Act)
  - 22.79 ha *Central Hunter Valley Eucalypt Forest and Woodland CEEC* (EPBC Act)

- HU905 – Narrow-leaved Ironbark – Grey Box Grassy Woodland of the Central and Upper Hunter – Moderate to Good Condition – Thinned Canopy
  - *Central Hunter Grey Box – Ironbark Woodland in the NSW North Coast and Sydney Basin Bioregions EEC* (TSC Act)
  - 0.08 ha *Central Hunter Valley Eucalypt Forest and Woodland CEEC* (EPBC Act)

- HU906 Bull Oak grassy woodland of the central Hunter Valley – Moderate to Good Condition
  - 3.1 ha *Central Hunter Grey Box – Ironbark Woodland in the NSW North Coast and Sydney Basin Bioregions EEC* (TSC Act)
  - 10.19 ha *Central Hunter Valley Eucalypt Forest and Woodland CEEC* (EPBC Act).

State and Commonwealth listed TECs are shown in **Figures 3.3** and **3.4** respectively. Analysis of consistency with the scientific determinations for each TEC was undertaken, with consideration of the advice provided by the NSW Scientific Committee and/or the Commonwealth Threatened Species Scientific Committee guidelines for interpreting listings for species, populations and ecological communities under the TSC Act and EPBC Act respectively. Detailed analysis of the vegetation zones with respect to the NSW Scientific Committee and/or the Commonwealth Threatened Species Scientific Committee determinations is provided in below in **Sections 3.2.3.1** to **3.2.3.7**.

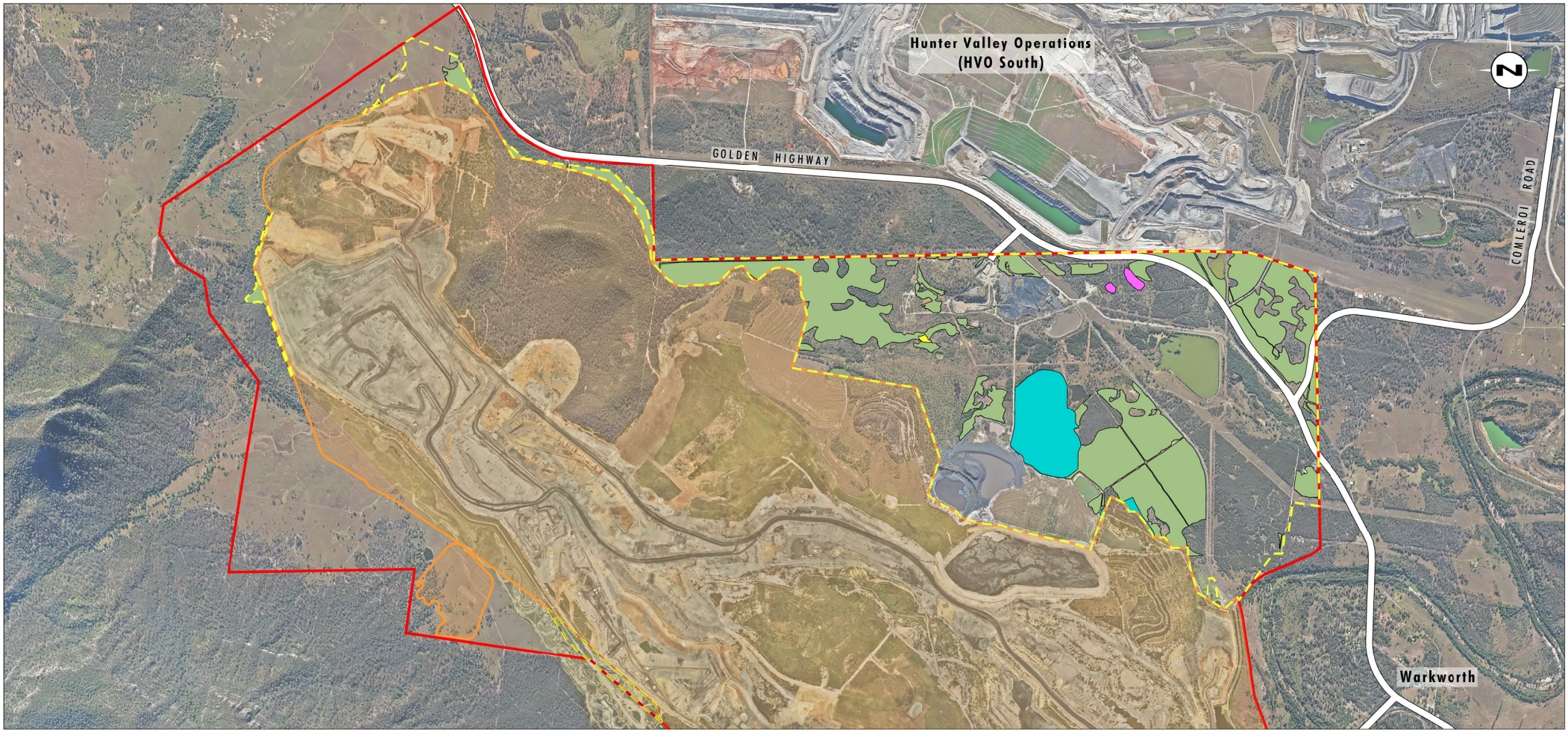

Image Source: AAM (2012), United (2016)
Data Source: Glencore (2014)

0 0.5 1.0 2.0km
1:40 000

Legend

- Development Site
- Development Footprint
- Approved Wambo Surface Development Area
- Central Hunter Grey Box-Ironbark Woodland in the New South Wales North Coast and Sydney Basin Bioregions (EEC)
- Central Hunter Ironbark-Spotted Gum-Grey Box Forest in the New South Wales North Coast and Sydney Basin Bioregions (EEC)
- Hunter Lowland Redgum Forest in the Sydney Basin and New South Wales North Coast Bioregions (EEC)
- Hunter Valley Footslopes Slaty Gum Woodland in the Sydney Basin Bioregion (VEC)

FIGURE 3.3

TSC Act Listed Threatened Ecological Communities

File Name (A4): R01/3890_033.dgn
20170405 15.53

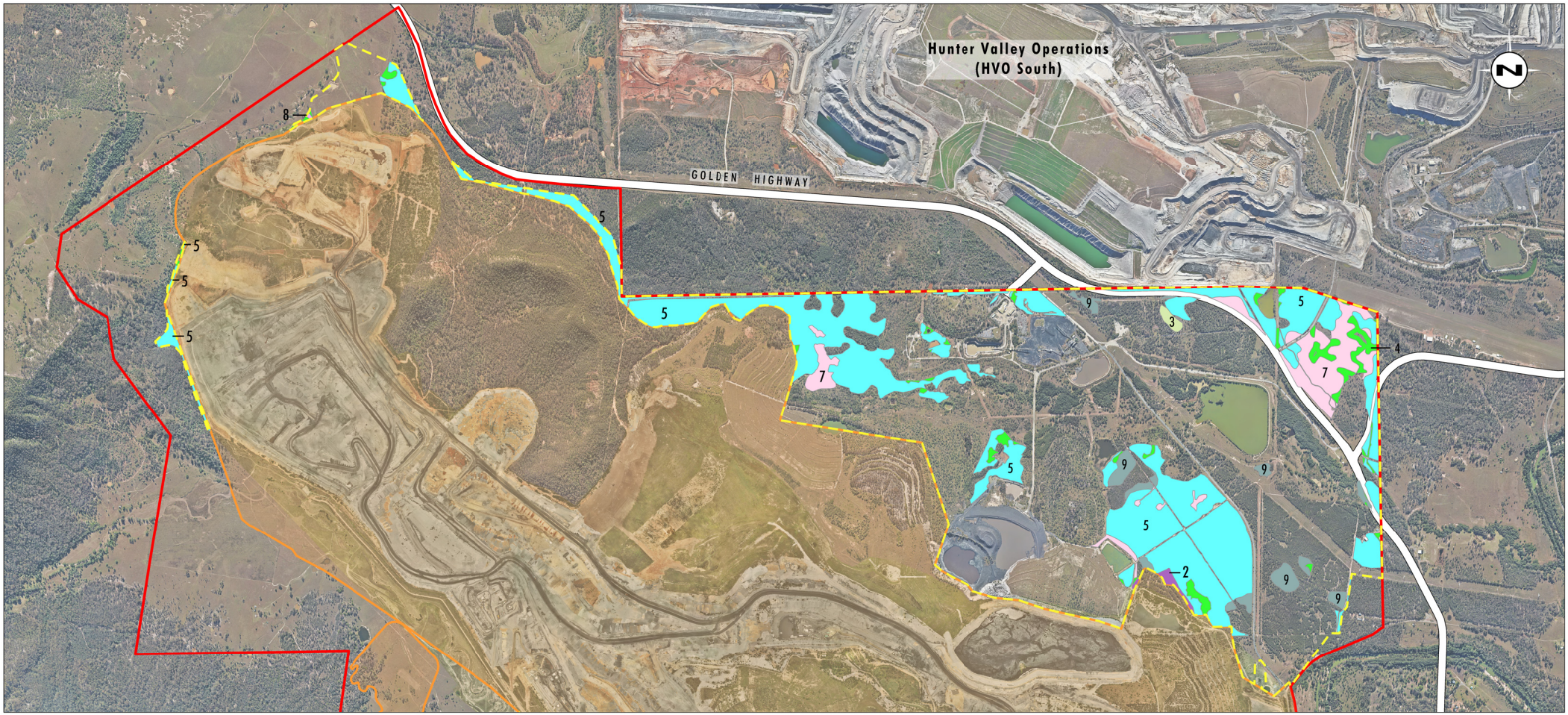

Image Source: AAM (2012), United (2016)
Data Source: Glencore (2014)

0 0.5 1.0 2.0km
1:35 000

Legend

- Development Site
- Development Footprint
- Approved Wambo Surface Development Area
- 2 - HU816 - Spotted Gum - Narrow-leaved Ironbark Shrub - Grass Open Forest on Slopes of the Upper Hunter and Sydney Basin - Moderate to Good Condition - Plantation/Rehabilitation
- 3 - HU869 - Grey Box - Slaty Box Shrub - Grass Woodland on Sandstone Slopes of the Upper Hunter and Sydney Basin - Moderate to Good Condition
- 4 - HU905 - Narrow-leaved Ironbark - Grey Box grassy Woodland of the Central and Upper Hunter - Derived Native Grassland
- 5 - HU905 - Moderate to Good Condition
- 7 - HU905 - Moderate to Good Condition - Regeneration
- 8 - HU905 - Moderate to Good Condition - Thinned Canopy
- 9 - HU906 - Bull Oak Grassy Woodland of the Central Hunter Valley - Moderate to Good Condition

FIGURE 3.4

Central Hunter Valley Eucalypt Forest and Woodland CEEC under the EPBC Act

File Name (A4): R01/3890_020.dgn
20170405 15.57

3.2.3.1 Central Hunter Valley Eucalypt Forest and Woodland CEEC

The *Central Hunter Valley Eucalypt Forest and Woodland CEEC* was listed under the EPBC Act during May 2015. Several vegetation types that occur in the Development Site conform to the CEEC and targeted field surveys were undertaken to determine the potential extent of the CEEC within the Development Site.

A total of approximately 189.48 hectares of *Central Hunter Valley Eucalypt Forest and Woodland CEEC* was identified within the Development Footprint (refer to **Figure 3.4**). Components of the following PCTs present in the Development Site conform to the CEEC:

- Zone 2: HU816 Spotted Gum - Narrow-leaved Ironbark Shrub - Grass Open Forest of the Central and Lower Hunter (1.17 hectares) – note that the area of this vegetation zone excluded from the *Central Hunter Valley Eucalypt Forest and Woodland CEEC* was based on a combination of the understorey having a high proportion of exotic species (greater than 50 per cent perennial exotic understorey), in particular *Acacia saligna*, as well as areas where the introduced sugar gum (*Eucalyptus cladocalyx*) was present. As a result the necessary CEEC condition thresholds were not met in these areas.

- Zone 3: HU869 Grey Box - Slaty Box Shrub - Grass Woodland on Sandstone Slopes of the Upper Hunter and Sydney Basin – (1.13 hectares) – note that the area of this vegetation zone excluded from the *Central Hunter Valley Eucalypt Forest and Woodland CEEC* was based on the patch size being less than the minimum 0.5 hectares and because it was surrounded by dense Bull Oak Forest. As a result the necessary CEEC condition thresholds were not met in these areas.

- Zones 4, 5, 7 and 8: HU905 Narrow-leaved Ironbark – Grey Box Grassy Woodland of the Central and Upper Hunter (176.98 hectares) – note that the areas of vegetation zones 5 – Moderate to Good Condition and Zone 7 – Moderate to Good Condition - Regeneration excluded from the *Central Hunter Valley Eucalypt Forest and Woodland CEEC* were based on a combination of the patch size being less than the minimum 0.5 hectares or the canopy not dominated by one or more of the four characteristic eucalypt species. Zone 4 –Derived Native Grassland areas were excluded where they were greater than 30 metres from a patch of woodland conforming to the *Central Hunter Valley Eucalypt Forest and Woodland CEEC*. Zone 6: HU905 Narrow-leaved Ironbark – Grey Box Grassy Woodland of the Central and Upper Hunter – Moderate to Good Condition – Cooba Open Shrubland was excluded from meeting the *Central Hunter Valley Eucalypt Forest and Woodland CEEC* based on the fact that it does not contain any of the four characteristic eucalypt species. In the context of the dominant canopy species, cooba (*Acacia salicina*), this species is described as being a shrub or tree 3-10 metres high according to Harden (2002). Within this vegetation zone the canopy ranges from 5 to 10 metres and cooba (*Acacia salicina*) is generally a single stemmed plant, meaning that this vegetation zone is classified as a woodland according to Walker and Hopkins (1990). In addition it does not form a naturally-occurring vegetation community according to all other regional mapping and classification work in the Hunter Valley. Based on this, and the fact that it is not a shrubland (rather it is a woodland as it is dominated by low trees, not shrubs), whether derived or not, it does not warrant inclusion in the CEEC delineation for this Project.

- Zone 9: HU906 Bull Oak Grassy Woodland of the Central Hunter Valley (10.19 hectares) – note that the area of this vegetation zone excluded from the *Central Hunter Valley Eucalypt Forest and Woodland CEEC* was based on bulloak (*Allocasuarina luehmannii*) dominating the canopy, in which there were fewer than three characteristic eucalypt species present per hectare (see below).

As per the key diagnostic characteristics and condition thresholds outlined in the Approved Conservation Advice (TSSC 2015) areas of vegetation were excluded from the Central Hunter Valley CEEC in the Development Site when:

- patches were less than the minimum 0.5 hectare (woodland component) condition threshold
- the key diagnostic characteristic for the canopy was not met, in which the canopy was not dominated by one or more of the four characteristic species
- bulloak (*Allocasuarina luehmannii*) dominated the canopy, where less than 3 characteristic eucalypt species occurred per hectare (on average)
- the perennial understorey vegetative cover was less than 50 per cent
- it did not meet the 'gap and indent' rules that were provided by OEH as further clarification on interpretation of the CEEC.

The majority of the Central Hunter Valley CEEC in the Development Site was represented by the Narrow-leaved Ironbark – Grey Box Grassy Woodland of the Central and Upper Hunter. The woodland form of this community has a canopy dominated by grey box (*Eucalyptus moluccana*), narrow-leaved ironbark (*Eucalyptus crebra*) and bulloak (*Allocasuarina luehmannii*). In addition, a regenerating form of this community was identified in the north-eastern portion of the Development Site which was dominated by young grey box, narrow-leaved ironbark and bulloak.

A small amount of Grey Box - Slaty Box Shrub - Grass Woodland on Sandstone Slopes of the Upper Hunter and Sydney Basin was included in the Central Hunter Valley CEEC, however this area of woodland was dominated solely by slaty box (*Eucalyptus dawsonii*). A small patch of the Planted/Rehabilitated Spotted Gum - Narrow-leaved Ironbark Shrub - Grass Open Forest of the Central and Lower Hunter which was dominated by Spotted Gum (*Corymbia maculata*) was found to conform to the Central Hunter Valley CEEC in the southern portion of the Development Site.

Umwelt has undertaken an intensive program of review of the CEEC based on a series of communications, via teleconference and email, with Department of the Environment and Energy (DoEE) staff from the assessment team and the Ecological Communities section. Revisions described in the paragraph below follow the advice provided by the Department.

The vast majority of the Bull Oak Grassy Woodland was excluded from the CEEC listing due to the dominance of bulloak (*Allocasuarina luehmannii*). However several small patches in the Development Site were found to contain at least 3 characteristic eucalypts (any combination of *Eucalyptus crebra*, *E*. *moluccana*, *E. dawsonii* or *Corymbia maculata*) per hectare and therefore satisfied the key diagnostic characteristic for canopy species dominance.

Derived native grasslands were included in the CEEC based on the 'gap and indent' rules that were provided by DoEE as further clarification on interpretation of the Conservation Advice for the *Central Hunter Valley Eucalypt Forest and Woodland CEEC.* This interpretation has been applied rather than a rigid 30 metre buffer within woodland/forest edges. The gap component of this interpretation means that where there is an area of grassland within a patch of woodland/forest, then the 30 metre strip of grassland within the woodland/forest conforms to the CEEC. The indent component requires that there are no sharp angles within the boundary of the CEEC, thus the boundary is to be smoothed so that no angles are greater than 150 degrees.

3.2.3.2 Hunter Floodplain Red Gum Woodland in the NSW North Coast and Sydney Basin Bioregions EEC

Zone 1 - HU812 – Forest Red Gum Grassy Open Forest on Floodplains of the Lower Hunter in Moderate to Good Condition mapped in the Development Footprint was compared to the Final Determination of *Hunter Floodplain Red Gum Woodland in the NSW North Coast and Sydney Basin Bioregions* EEC (TSC Act) (NSW Scientific Committee 2011a) and corresponds with the EEC with regard to the following attributes:

- Zone 1 occurs on a gentle slope (approximately 1 degree) arising from an ephemeral drainage flat along Redbank Creek within the Hunter Valley floor in the Sydney Basin Bioregion
- Zone 1 is likely to be on an associated floodplain rise or a small floodplain on alluvium which is a tributary to the Hunter River
- Zone 1 occurs in the Singleton Local Government Area (LGA) where it has previously been recorded
- Zone 1 supports a reasonable proportion of species that are in the list of characteristic species for the EEC given the very small size of the vegetation zone
    - 11 out of 46 (24 per cent) native species recorded in this vegetation unit are characteristic species in the EEC listing, and
    - 11 out of 37 (30 per cent) species in the characteristic species list for the EEC were recorded in this vegetation zone.

Zone 1 was also compared to the Hunter Lowland Redgum Forest in the Sydney Basin and NSW North Coast Bioregions EEC, see **Section 3.2.3.3** below.

3.2.3.3 Hunter Lowland Redgum Forest in the Sydney Basin and NSW North Coast bioregions EEC

Zone 1 – HU812 – Forest Red Gum Grassy Open Forest on Floodplains of the Lower Hunter in Moderate to Good Condition was also compared to the Final Determination of *Hunter Lowland Redgum Forest in the Sydney Basin and NSW North Coast Bioregions EEC* (TSC Act) (NSW Scientific Committee 2011b). Whilst this vegetation zone shares a proportion of characteristic species with the EEC (25 per cent or 9 out of 36 species included in the Final Determination and 20 per cent or 9 out of the 46 native species recorded in this vegetation zone), it was determined, largely based on geomorphological factors, that Zone 1 had a greater similarity to the *Hunter Floodplain Red Gum Woodland in the NSW North Coast and Sydney Basin Bioregions* EEC (TSC Act), as previously discussed in **Section 3.2.3.2**.

3.2.3.4 Central Hunter Grey Box – Ironbark Woodland in the NSW North Coast and Sydney Basin Bioregions EEC

Four vegetation zones mapped within the Development Site are consistent with the Final Determination of *Central Hunter Grey Box – Ironbark Woodland in the NSW North Coast and Sydney Basin Bioregions* EEC (NSW Scientific Committee 2011c). The four zones are:

- Zone 5 – HU905 – Narrow-leaved Ironbark – Grey Box Grassy Woodland of the Central and Upper Hunter – Moderate to Good Condition
- Zone 7 – HU905 – Narrow-leaved Ironbark – Grey Box Grassy Woodland of the Central and Upper Hunter – Moderate to Good Condition – Regeneration

- Zone 8 – HU905 – Narrow-leaved Ironbark – Grey Box Grassy Woodland of the Central and Upper Hunter – Moderate to Good Condition – Thinned Canopy, and

- Zone 9 - HU906 Bull Oak grassy woodland of the central Hunter Valley – Moderate to Good Condition.

The following three vegetation zones comply with the Final Determination of the EEC (NSW Scientific Committee 2011c) with regard to the following attributes:

- occur predominantly on Permian sediments within the NSW Sydney Basin Bioregion

- occur in the Singleton Local Government Area (LGA) where the EEC has previously been recorded

- support a reasonable proportion of species that are in the list of characteristic species for the EEC:

    - Zone 5 – HU905 – Moderate to Good Condition:

        - 28 out of 121 (23 per cent) native species recorded in this unit are characteristic species in the EEC listing; and

        - 28 out of 38 (74 per cent) species in the characteristic species list for the EEC were recorded in this unit.

    - Zone 7 – HU905 – Moderate-Good Condition Regeneration:

        - 20 out of 65 (31 per cent) native species recorded in this unit are characteristic species in the EEC listing; and

        - 20 out of 38 (53 per cent) species in the characteristic species list for the EEC were recorded in this unit.

    - Zone 8 – HU905 – Moderate-Good Condition – Thinned Canopy:

        - 12 out of 29 (41 per cent) native species recorded in this unit are characteristic species in the EEC listing; and

        - 12 out of 38 (32 per cent) species in the characteristic species list for the EEC were recorded in this unit.

In addition, following a site inspection, OEH required that a small area of Zone 9 HU906 Bull Oak grassy woodland of the central Hunter Valley – Moderate to Good Condition (3.1 hectares) in the northern portion of the Development Site was identified as *Central Hunter Grey Box ‑ Ironbark Woodland in the NSW North Coast and Sydney Basin Bioregions EEC* listed under the TSC Act. The remainder of this vegetation zone is not consistent with the EEC *Central Hunter Grey Box – Ironbark Woodland in the NSW North Coast and Sydney Basin Bioregions*.

It should be noted that the derived native grassland form of this community does not form part of the EEC *Central Hunter Grey Box – Ironbark Woodland in the NSW North Coast and Sydney Basin Bioregions*.

3.2.3.5 Central Hunter Ironbark – Spotted Gum – Grey Box Forest in the NSW North Coast and Sydney Basin Bioregion EEC

Zone 2 – HU816 – Spotted Gum - Narrow-leaved Ironbark Shrub - Grass Open Forest of the Central and Lower Hunter – Moderate to Good Condition – Plantation/Rehabilitation mapped within the Development Site is consistent with the *Central Hunter Ironbark – Spotted Gum – Grey Box Forest in the NSW North Coast and Sydney Basin Bioregion* EEC (TSC Act). The vegetation zone mapped within the Development Site occurs on previously disturbed land and is the result of revegetation efforts.

This vegetation zone complies with the Final Determination of *Central Hunter Ironbark – Spotted Gum – Grey Box Forest in the NSW North Coast and Sydney Basin Bioregion EEC* (NSW Scientific Committee 2011d) with regard to the following species specific attributes:

- this EEC is characterised by a canopy dominated by four key eucalypt species, namely spotted gum (*Corymbia maculata*), broad-leaved ironbark (*Eucalyptus fibrosa*), grey gum (*Eucalyptus punctata*) and narrow-leaved ironbark (*Eucalyptus crebra*). The canopy layer of this community was dominated by spotted gum (*Corymbia maculata*) and hickory wattle (*Acacia implexa*), with some occurrences of sugar gum (*Eucalyptus cladocalyx*)

- this vegetation zone supports a reasonable proportion of species that are in the list of characteristic species for the EEC

    - 15 out of 44 (34 per cent) native species recorded in this unit are characteristic species in the EEC listing, and

    - 15 out of 44 (34 per cent) species in the characteristic species list for the EEC were recorded in this unit. However of the 15 species recorded from the characteristic species list, only one species was a mid-storey or shrub species, the remaining species being either a canopy or ground layer species.

- Natural recruitment of the canopy, midstorey and ground cover layers was occurring.

Zone 5 – HU905 – Narrow-leaved Ironbark – Grey Box Grassy Woodland of the Central and Upper Hunter – Moderate to Good Condition and Zone 7 – HU905 – Narrow-leaved Ironbark – Grey Box Grassy Woodland of the Central and Upper Hunter – Moderate/Good Condition – Regeneration were also compared with the Final Determination of the *Central Hunter Ironbark – Spotted Gum – Grey Box Forest in the NSW North Coast and Sydney Basin Bioregion* EEC (NSW Scientific Committee 2011d). These vegetation zones share a moderate proportion of characteristic species with this EEC, as detailed below:

- Zone 5 – HU905 – Moderate to Good Condition:

    - 45 per cent or 20 out of 44 species included in the Final Determination, and

    - 17 per cent or 20 out of 121 native species recorded within this vegetation zone.

- Zone 7 – HU905 – Moderate-Good Condition Regeneration:

    - 36 per cent or 16 out of 44 species included in the Final Determination, and

    - 25 per cent or 16 out of 65 native species recorded within this vegetation zone.

However it was determined that a higher proportion of *Central Hunter Grey Box – Ironbark Woodland in the NSW North Coast and Sydney Basin Bioregions* EEC characteristic species were present in Zone 5 and Zone 7 (74 and 53 per cent respectively), and therefore these vegetation zones were attributed to this EEC (refer to **Section 3.2.3.4**).

3.2.3.6 Hunter Valley Footslopes Slaty Gum Woodland in the Sydney Basin Bioregion VEC

Zone 3 – HU869 – Grey Box – Slaty Box Shrub – Grass Woodland on Sandstone Slopes of the Upper Hunter and Sydney Basin –Moderate to Good Condition is consistent with the VEC *Hunter Valley Footslopes Slaty Gum Woodland in the Sydney Basin Bioregion* (TSC Act). In summary this community corresponds with the final determination of *Hunter Valley Footslopes Slaty Gum Woodland in the Sydney Basin Bioregion* VEC (NSW Scientific Committee 2011e) with regard to the following attributes:

- the vegetation zone occurs within the NSW Sydney Basin Bioregion
- the vegetation zone occurs in the Singleton Local Government Area (LGA) where it has previously been recorded
- the vegetation zone occurs on Permian sediments at the lower slopes of the Development Site
- the vegetation zone supports a reasonable proportion of species that are in the list of characteristic species for the VEC:
    - 12 out of 41 (29 per cent) native species recorded in this unit are in the VEC listing, and
    - 12 out of 29 (41 per cent) species in the characteristic species list for the VEC were recorded in this unit.

3.2.3.7 Swamp Oak Floodplain Forest of the NSW North Coast Sydney Basin and South East Corner Bioregions EEC

Zone 10 - HU945 Swamp Oak – Weeping Grass Grassy Riparian Forest of the Hunter Valley in Moderate to Good Condition is not consistent with the EEC *Swamp Oak Floodplain Forest of the NSW North Coast Sydney Basin and South East Corner Bioregions* (TSC Act). This community does not comply with the Final Determination of *Swamp Oak Floodplain Forest of the NSW North Coast Sydney Basin and South East Corner Bioregions* EEC (NSW Scientific Committee 2011f) with regard to the following attributes:

- The EEC typically occurs below 20 metres (rarely above 10 metres) in elevation; in comparison vegetation zone 9 occurs between approximately 60 and 95 metres in elevation
- The vegetation zone supports a very low proportion of species that are in the list of characteristic species for the EEC:
    - 2 out of 60 (3 per cent) native species recorded in this unit are in the EEC listing, and
    - 2 out of 45 (4 per cent) species in the characteristic species list for the EEC were recorded in this unit.

3.3 Threatened Species within the Development Site

3.3.1 Ecosystem-credit Species

3.3.1.1 Predicted Species

Table 3.6 below outlines the predicted ecosystem-credit species predicted to occur by the BioBanking Calculator and whether they were recorded within the Development Footprint during the surveys undertaken for this assessment, Atlas of NSW Wildlife records or previous surveys (as shown on **Figure 3.5**).

Table 3.6 Predicted Ecosystem-credit Species

Species Name	TSC Act	EPBC Act	Threatened Species Offset Multiplier	Previously Recorded within the Development Footprint
barking owl *Ninox connivens*	V	-	3.0	No
black-chinned honeyeater *Melithreptus gularis* subsp. *gularis*	V	-	1.3	No
brown treecreeper *Climacteris picumnus* subsp. *victoriae*	V	-	2.0	No
bush stone curlew *Burhinus grallarius*	E	-	2.6	No
Corben's long-eared bat *Nyctophilus corbeni*	V	V	2.1	No
diamond firetail *Stagonopleura guttata*	V	-	1.3	Yes
eastern false pipistrelle *Falsistrellus tasmaniensis*	V	-	2.2	No
east coast freetail-bat *Mormopterus norfolkensis*	V	-	2.2	Yes
eastern grass owl *Tyto longimembris*	V	-	1.3	No
flame robin *Petroica phoenicea*	V	-	1.3	No
gang-gang cockatoo *Callocephalon fimbriatum*	V	-	2.0	No
glossy black-cockatoo *Calyptorhynchus lathami*	V	-	1.8	Yes

Species Name	TSC Act	EPBC Act	Threatened Species Offset Multiplier	Previously Recorded within the Development Footprint
greater broad-nosed bat *Scoteanax rueppellii*	V	-	2.2	Yes
grey-crowned babbler *Pomatostomus temporalis* subsp. *temporalis*	V	-	1.3	Yes
hooded robin *Melanodryas cucullata* subsp. *cucullata*	V	-	1.7	Yes
little eagle *Hieraaetus morphnoides*	V	-	1.4	No
little lorikeet *Glossopsitta pusilla*	V	-	1.8	No
masked owl *Tyto novaehollandiae*	V	-	3.0	No
painted honeyeater *Grantiella picta*	V	V	1.3	No
powerful owl Ninox strenua	V	-	3.0	No
scarlet robin *Petroica boodang*	V	-	1.3	No
speckled warbler *Chthonicola sagittata*	V	-	2.6	Yes
spotted harrier *Circus assimilis*	V	-	1.4	No
spotted-tailed quoll *Dasyurus maculatus*	V	E	2.6	Yes
square-tailed kite *Lophoictinia isura*	V	-	1.4	No
squirrel glider *Petaurus norfolcensis*	V	-	2.2	No
swift parrot *Lathamus discolor*	E	CE	1.3	No
turquoise parrot *Neophema pulchella*	V	-	1.8	No
varied sittella *Daphoenositta chrysoptera*	V	-	1.3	Yes

Species Name	TSC Act	EPBC Act	Threatened Species Offset Multiplier	Previously Recorded within the Development Footprint
yellow-bellied sheathtail-bat ***Saccolaimus flaviventris***	V	-	2.2	Yes

3.3.1.2 Survey Results

Six ecosystem-credit species were recorded in the Development Footprint during the surveys undertaken for this assessment (refer to **Figure 3.5**). These were:

- grey-crowned babbler (*Pomatostomus temporalis temporalis*)
- speckled warbler (*Chthonicola sagittata*)
- large-eared pied bat (*Chalinolobus dwyeri*) – foraging habitat only
- east coast freetail bat (*Mormopterus norfolkensis*) – foraging habitat only
- eastern bentwing-bat (*Miniopterus schreibersii oceanensis*) –foraging habitat only
- eastern cave bat (*Vespadelus troughtoni*) – foraging habitat only.

Other ecosystem-credit species records that have been previously recorded within the Development Footprint are outlined in **Table 3.6** and shown in **Figure 3.5**.

A full fauna species list from the surveys undertaken is included in **Appendix B**.

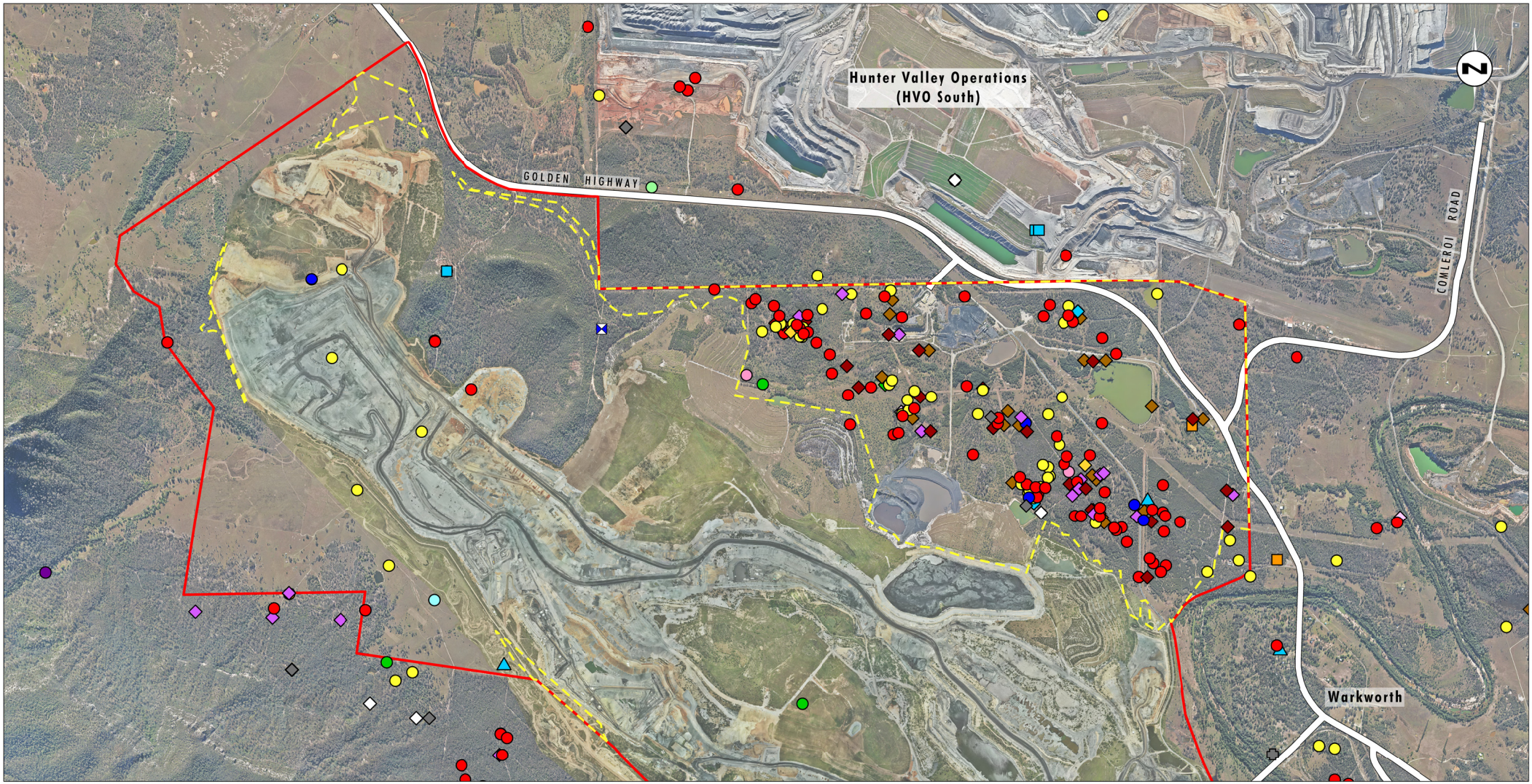

Image Source: AAM (2012), United (2016)
Data Source: Boundary - Glencore (2014), Records OEH (2017a), Umwelt (2009-2016)

0 0.5 1.0 2.0km
1:40 000

Legend

- Development Site
- Development Footprint
- Black Falcon
- Brown Treecreeper
- Diamond Firetail
- Dusky Woodswallow
- East-coast Freetail-bat
- Eastern Bentwing-bat
- Eastern Cave Bat
- Glossy Black-cockatoo
- Greater Broad-nosed Bat
- Grey-crowned Babbler
- Grey-headed Flying-fox
- Hooded Robin
- Large-eared Pied Bat
- Little Bentwing-bat
- Little Eagle
- Little Lorikeet
- New Holland Mouse
- Scarlet Robin
- Speckled Warbler
- Spotted-tailed Quoll
- Spotted Harrier
- Varied Sittella
- Yellow-bellied Sheathtail-bat

FIGURE 3.5

Fauna Ecosystem Credit Species

File Name (A4): R01/3890_017.dgn
20170405 16.00

3.3.2 Species-credit Species

3.3.2.1 Predicted Species-Credit Species

Table 3.7 below outlines the species-credit species predicted to occur by the BBCC and whether they are considered to occur in the Development Footprint.

Table 3.7 Predicted Species-credit Species

Species Name	Threatened Species Offset Multiplier	Impacted by the Project^	Justification for Impact
Denman pomaderris *Pomaderris reperta*	1.5	No	This species was not recorded within the Development Site despite extensive survey effort by Umwelt throughout the entire area across multiple surveys and years. All known records of this species occur with 5km of Denman approximately 30km to the northwest of the Development Site. There is no potential that this species would be impacted by the Project and no species credits have been generated for this species.
large-leafed monotaxis *Monotaxis macrophylla*	1.5	No	This species was not recorded within the Development Site despite extensive survey effort by Umwelt throughout the entire area across multiple surveys and years. The closest record occurs approximately 30km to the west of the Development Site in Wollemi National Park and generally grows on rocky ridges and hillsides. There is no potential that this species would be impacted by the Project and no species credits have been generated for this species.
leafless tongue orchid *Cryptostylis hunteriana*	4.0	No	This species was not recorded within the Development Site despite extensive survey effort by Umwelt throughout the entire area across multiple surveys and years. This is species is primarily coastal with the closest records occurring 50km to the southeast of the Development Site near the Sugarloaf State Conservation Area. There is no potential that this species would be impacted by the Project and no species credits have been generated for this species.
Illawarra greenhood *Pterostylis gibbosa*	1.3	No	This species was not recorded within the Development Site despite extensive survey effort by Umwelt throughout the entire area across multiple surveys and years. This is species is known from a small number of populations in the Hunter region in open forest or woodland, on flat or gently sloping land. The closest record occurs approximately 10km south of the Development Site near Milbrodale (OEH 2017a). It was not recorded during the targeted surveys and therefore it is unlikely that this species would be impacted by the Project and no species credits have been generated for this species.

Species Name	Threatened Species Offset Multiplier	Impacted by the Project^	Justification for Impact
Ozothamnus tesselatus	4.0	No	This species was not recorded within the Development Site despite extensive survey effort by Umwelt throughout the entire area across multiple surveys and years. This species is generally restricted to a few locations north of Rylstone, NSW and is primarily known from the Goulburn River National Park. There is no potential that this species would be impacted by the Project and no species credits have been generated for this species.
pine donkey orchid ***Diuris tricolor***	1.3	No	This species was not recorded within the Development Site despite extensive survey effort by Umwelt throughout the entire area across multiple surveys and years. The closest record of this species occurs approximately 20km northwest of the Development Site and is generally known to occur around Muswellbrook and Denman. There is no potential that this species would be impacted by the Project and no species credits have been generated for this species.
scant pomaderris ***Pomaderris queenslandica***	1.5	No	This species was not recorded within the Development Site despite extensive survey effort by Umwelt throughout the entire area across multiple surveys and years. It is acknowledged that this species was noted as being recorded as part of the Wambo UHSA in lands adjacent to the Development Site (Niche 2014), however subsequent surveys of this area (including *Pomaderris* samples from this area sent to Neville Walsh of the Royal Botanic Gardens Victoria for identification) has not confirmed these records (refer to **Appendix D** for further details). The closest confirmed record of this species occurs approximately 40km northwest of the Development Site and is generally known to occur around Denman and in the Goulburn River National Park. There is no potential that this species would be impacted by the Project and no species credits have been generated for this species.
Singleton mint bush ***Prostanthera cineolifera***	1.4	No	This species was not recorded within the Development Site despite extensive survey effort by Umwelt throughout the entire area across multiple surveys and years. The species is restricted to a few localities around Walcha, Scone, Cessnock and St Albans. The closest record of this species occurs approximately 25km to the southeast near Pokolbin State Forest and the Singleton Military Area. There is no potential that this species would be impacted by the Project and no species credits have been generated for this species.

Species Name	Threatened Species Offset Multiplier	Impacted by the Project^	Justification for Impact
slaty red gum *Eucalyptus glaucina*	1.4	No	This species has been recorded near the Development Site on land associated with the Wambo Coal Mine. While suitable habitat for the species occurs within the Development Footprint, this species was not recorded within this area despite extensive survey effort by Umwelt throughout the entire area across multiple surveys and years. There is no potential that this species would be impacted by the Project and no species credits have been generated for this species.
small snake orchid *Diuris pedunculata*	4.0	No	This species was not recorded within the Development Site despite extensive survey effort by Umwelt throughout the entire area across multiple surveys and years. The species is restricted to a few localities south of Canberra and north in the New England Tablelands. The closest record of this species occurs over 100km north near Nundle. There is no potential that this species would be impacted by the Project and no species credits have been generated for this species.
tall knotweed *Persicaria elatior*	1.3	No	This species was not recorded within the Development Site despite extensive survey effort by Umwelt throughout the entire area across multiple surveys and years. This species usually grows in damp habitats. The closest record of this species occurs approximately 35km south of the Development Site near a drainage line south of Wollombi. There is no potential that this species would be impacted by the Project and no species credits have been generated for this species.
Weeping Myall population in the Hunter catchment	7.7	No	This endangered population was recorded during Umwelt surveys of the wider Development Site. Revisions to the boundary of the Development Footprint avoided all impacts on this endangered population. There is no potential that this species would be impacted by the Project and no species credits have been generated for this species.
Wollemi mint-bush *Prostanthera cryptandroides* **subsp.** *cryptandroides*	1.5	No	This species was not recorded within the Development Site despite extensive survey effort by Umwelt throughout the entire area across multiple surveys and years. This species is known from habitats in Wollemi National Park between Lithgow and Denman. The closest record of the species occurs approximately 30km to the northwest near Denman. There is no potential that this species would be impacted by the Project and no species credits have been generated for this species.

Species Name	Threatened Species Offset Multiplier	Impacted by the Project^	Justification for Impact
brush-tailed phascogale ***Phascogale tapoatafa***	2.0	No	This species has not been recorded previously during the Umwelt monitoring surveys undertaken in the Development Site during 2008, 2009, 2010, 2011 and 2013 (Umwelt 2014a). Furthermore, this species has not been recorded during the surveys undertaken for the UHSA where remote cameras were used in combination with spotlighting and hair funnel surveys. One road kill record of the species occurs within 300 metres east of the Development Site along Jerry's Plains Road. Given the recent history of remote camera surveys in the project area and surrounds, and the occurrence of only a single 13 year old record within a 10 kilometre radius, it is considered unlikely that the brush-tailed phascogale occurs in the Development Footprint. It is unlikely that this species would be impacted by the Project and no species credits have been generated for this species.
eastern pygmy-possum ***Cercartetus nanus***	2.0	No	This species has been recorded in intact habitats in the adjacent Wollemi National Park and more recently near Rothbury to the southeast of the Development Site. The closest record occurs approximately 10km south of the Development Site in Wollemi National Park. While suitable habitat for the species occurs within the Development Footprint, this species was not recorded within this area despite extensive survey effort by Umwelt throughout the entire area across multiple surveys and years. There is no potential that this species would be impacted by the Project and no species credits have been generated for this species.
green and golden bell frog ***Litoria aurea***	2.6	No	This species was not recorded within the Development Site despite extensive survey effort by Umwelt throughout the entire area across multiple surveys and years. The Upper Hunter green and golden bell frog key population consists of one main diffuse population at, or in the vicinity of, the Ravensworth and Liddell area and bordering areas of the Singleton and Muswellbrook LGA. No records of the population in the Upper Hunter have been found since 2009 approximately 20km north of the Development Site. The water bodies within the Development Footprint provide potential habitat for the species but the absence of individuals and historical records of this species indicates that the Development Footprint is unlikely to provide habitat for the species. There is no potential that this species would be impacted by the Project and no species credits have been generated for this species.

Species Name	Threatened Species Offset Multiplier	Impacted by the Project^	Justification for Impact
koala *Phascolarctos cinereus*	2.6	No	The koala was not recorded within the Development Site during the targeted SAT or spotlighting surveys and few preferred feed trees were recorded within the project area. There are no known records of this species occurring within the Development Site. The closest record of the species occurs approximately 10km to the southwest of the Development Site in Wollemi National Park. Given the scattered nature of the eucalypt woodlands in the Development Footprint and lack of primary koala feed trees in the Hunter-Central Rivers CMA (DECC 2008), it is unlikely this species uses these habitats on a long-term basis. There is no potential that this species would be impacted by the Project and no species credits have been generated for this species.
pale-headed snake *Hoplocephalus bitorquatus*	3.3	No	This species was not recorded within the Development Site despite extensive survey effort by Umwelt throughout the entire area across multiple surveys and years. The closest record of this species occurs approximately 50km to the east of the Development Site. Ecological surveys of the United area since 1981 (Dames & Moore 1981; Envirosciences 1991; Ecoserve Ecological Consultants 2005, 2006, 2007a, 2007b; HLA 2001a, 2001b, 2002; Umwelt 2009a, 2009b, 2009c, 2010c, 2010d, 2011, 2012a, 2012b, 2012c, 2014) have failed to identify this species in and around the Development Site. There is no potential that this species would be impacted by the Project and no species credits have been generated for this species.

Species Name	Threatened Species Offset Multiplier	Impacted by the Project^	Justification for Impact
regent honeyeater *Anthochaera phrygia*	7.7	No	This species has not been recorded within the Development Site despite targeted winter bird surveys undertaken over six years (2010-2016). Previous records of the species in the locality include one record within 500 metres to the south of the Development Site in riparian vegetation associated with Wollombi Brook. This record is dated from 1991 with a location accuracy of 10,000 metres (OEH 2017a). Another record occurs approximately 2 kilometres to the south of the Development Site also along Wollombi Brook dated from 1987 with a location accuracy of 1,000 metres (OEH 2017a). A more recent record from 2002 occurs approximately 5 kilometres to the southeast of the Development Site adjacent to Wallaby Scrub Road and Sandy Hollow Creek in box-ironbark woodlands (OEH 2017a). No recent (within the last 5 years) records occur within 5km of the Development Site. While the Project will likely exacerbate habitat loss and fragmentation for the species in potential foraging habitat in the wider Hunter Valley, the species has not been recorded utilising the habitats of the Development Footprint. This is likely to be due to the low frequency of key feed trees (DoE 2016) and the small number of individuals remaining in the population utilising other higher quality habitats in NSW. It is unlikely that this species would be impacted by the Project and no species credits have been generated for this species.

^ As entered into the 'Threatened Species Survey Results' tab in the BBCC.

Two additional species-credit species were not predicted to occur in the Development Footprint in the BBCC but were recorded during the surveys. These species are outlined in **Table 3.8**.

Table 3.8 Species-credit Species Recorded within the Development Site

Species Name	Threatened Species Offset Multiplier	Impacted by the Project^	Justification
eastern osprey ***Pandion cristatus***	1.3	No	The single record of the eastern osprey occurs in the Development Site. This species was observed roosting in a tree during spotlighting surveys. The OEH Atlas of NSW Wildlife doesn't contain any other eastern osprey records within 10 kilometres of the Development Site. The nearest records on the OEH Atlas of NSW Wildlife are approximately 60 kilometres to the east of the Development Site. The species usually prefers coastal areas, especially the mouths of large rivers, lagoons and lakes and it feed on fish over clear, open water. Any individuals of this species recorded in the Hunter Valley are considered to be vagrants. Therefore, it is considered that the Development Site does not provide foraging habitat for this species.
southern myotis ***Myotis macropus***	7.7	Yes	Southern myotis has been recorded on three occasions within the Development Site. The OEH Atlas of NSW Wildlife contains a total of four records within 10 kilometres of the Development Site. This species roosts close to water in caves, bridges, culverts, hollow-bearing trees and other structures. A total of 7.3 hectares of potential breeding habitat, which occurs within a 200 metre buffer of Redbank Creek, has been identified for this species within the Development Footprint.

^ As entered into the 'Threatened Species Survey Results' tab in the BBCC.

3.3.2.2 Species Habitat Polygons

Species habitat polygons have been prepared for all the species recorded and assumed present at the site as per **Tables 3.7** and **3.8** above.

Southern myotis (*Myotis macropus*)

Any area of woodland or forest within 200 metres of a permanent water body and that contains tree hollows in the Development Site may provide breeding habitat for this species. All woodland and forest vegetation containing hollow bearing trees within 200 metres either side of the sections of Redbank Creek with permanent water, were mapped as potential breeding habitat for this species within the Development Footprint. A total of 7.3 hectares of potential breeding habitat, which occurs within the 200 metre creekline buffer, has been mapped for this species within the Development Site. Other sections of Redbank Creek were surveyed and none were identified as containing permanent (or near permanent) water bodies or lacked tree hollows within 200 metres either side of the creek.

The species polygon for southern myotis was prepared:

- using satellite imagery dated 2014
- using the unit of measurement identified for those species in the Threatened Species Profile Database (OEH 2017b)
- including the location of the species or areas likely occupied by the species
- containing the specific habitat feature associated with the species at the Development Footprint, and
- using GPS to confirm the location of the species polygon on the best available aerial image of the Development Footprint.

The species polygon for southern myotis is shown on **Figure 3.6**.

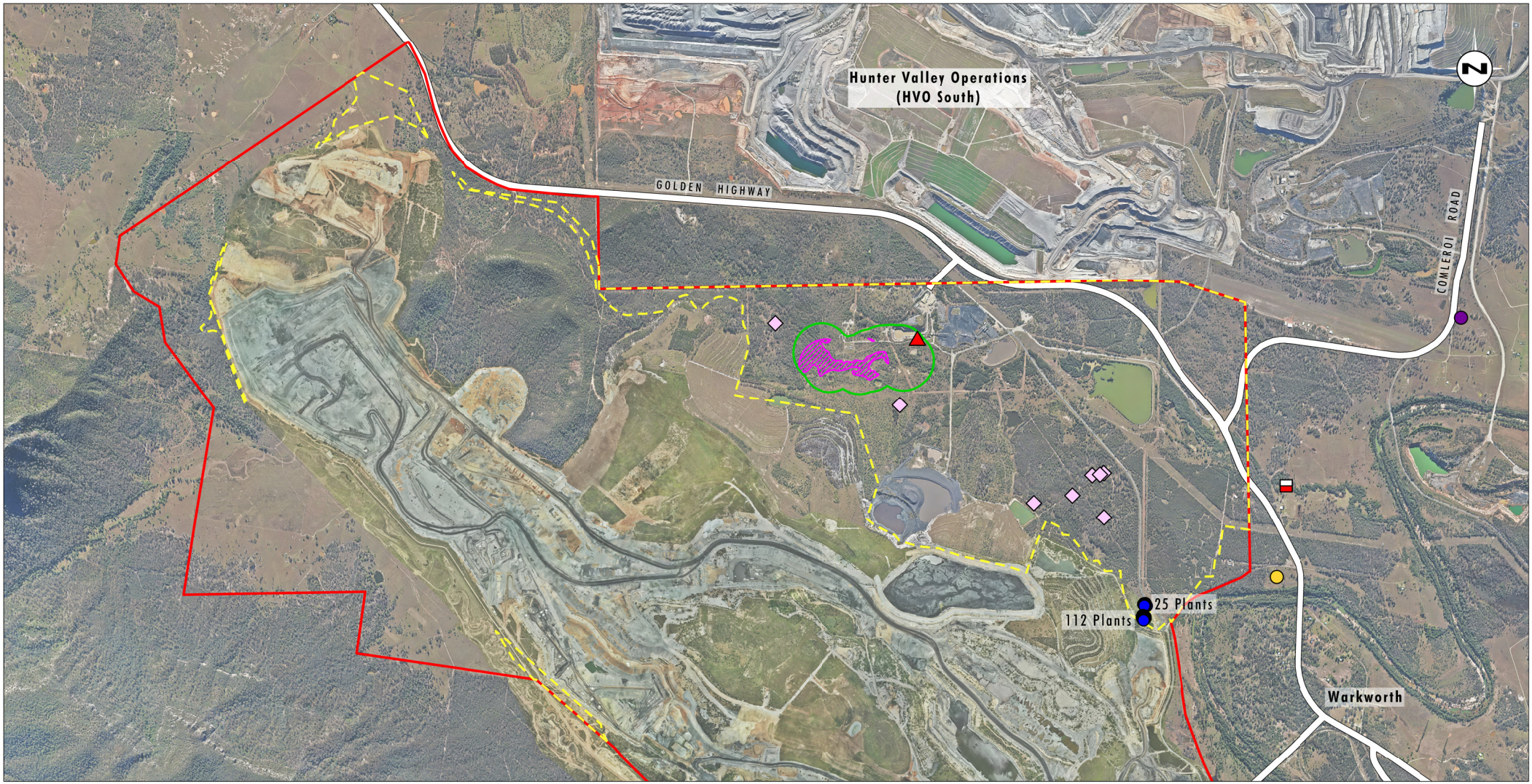

Image Source: AAM (2012), United (2016)
Data Source: Boundary - Glencore (2014), Records OEH (2017a), Umwelt (2009-2016)

0 0.5 1.0 2.0km
1:40 000

Legend

- Development Site
- Development Footprint
- Southern Myotis Potential Breeding Habitat
- Southern Myotis 200m Creekline Buffer
- *Acacia pendula* (not within the Development Footprint)
- Eastern Osprey
- Brush-tailed Phascogale
- Regent Honeyeater
- Southern Myotis
- *Eucalyptus camaldulensis*

FIGURE 3.6

Species Credit Flora and Fauna Species

File Name (A4): R01/3890_016.dgn
20170405 16.01

4 Avoidance and Minimisation of Impacts

4.1 Avoidance

4.1.1 Site Selection

United sought to avoid and minimise potential impacts on the ecological values of the Development Site throughout the Project planning process as discussed in further detail in **Section 4.1.2**. This included avoidance and minimisation of disturbance of key vegetation communities through designing the Project to maximise use of existing mining and transport facilities, and the avoidance of all areas of the Weeping Myall endangered population recorded by Umwelt in the Development Site.

4.1.2 Planning Phase

Avoidance measures can include relocation of the disturbance, alternate designs of the Project and specific construction techniques tailored to avoid impacts. A number of design changes were implemented during the early stages of designing the Project that ameliorated the impacts of the Project on biodiversity entities, including threatened species, endangered ecological communities, and/or their habitats. United has undertaken detailed studies which considered numerous alternative mine and infrastructure plans as discussed in further detail in Section 3.0 of the main text of the EIS.

A key alternative considered was to develop the United Open Cut as a standalone mining operation which would have resulted in approximately 148 hectares of further disturbance to biodiversity than the proposed Project as outlined in the EIS due to the need to develop stand-alone coal processing facilities, mine infrastructure (workshops etc) and transportation infrastructure (rail line, rail loop and train loading facility). This Option 1 Project (as detailed in Section 3.4.1 of the EIS) represented the largest disturbance footprint alterative. This included impacts to the north of the Development Footprint in areas containing *Central Hunter Valley Eucalypt Forest and Woodland CEEC*. Infrastructure associated with a proposed rail loop option would have impacted areas of potential *Warkworth Sands Woodland in the Sydney Basin Bioregion EEC*, and *Hunter Floodplain Red Gum Woodland in the NSW North Coast and Sydney Basin Bioregions EEC* occurring to the southeast of the Development Footprint. The revision of these designs reduced the overall impact of the Project on biodiversity.

The avoidance measures proposed for important vegetation communities and habitats are outlined in **Table 4.1** below.

Table 4.1 Targeted Avoidance Measures for Biodiversity Features

Biodiversity Feature	Targeted Avoidance Measures
Hunter Valley Weeping Myall Woodland of the Sydney Basin Bioregion EEC	Initial Development Footprint boundary included a 0.1 ha stand of Hunter Valley Weeping Myall Woodland of the Sydney Basin Bioregion (HU652 – Weeping Myall – Coobah – Scrub Wilga Shrubland of the Hunter Valley). The Development Footprint boundary was modified to avoid impacting on this 0.1 ha stand of the community. The stand will be managed for the recovery of the community and will be fenced to exclude grazing stock and unauthorised intrusions (with a 20 metre buffer between the stand and the fence, where practicable, considering the locations of existing infrastructure).

Biodiversity Feature	Targeted Avoidance Measures
Central Hunter Valley Eucalypt Forest And Woodland CEEC ***Warkworth Sands Woodland in the Sydney Basin Bioregion EEC*** ***Hunter Floodplain Red Gum Woodland in the NSW North Coast and Sydney Basin Bioregions EEC*** ***River Red Gum (Eucalyptus camaldulensis) population in the Hunter Catchment*** ***Habitat for a range of locally-occurring threatened fauna species***	Impacts for the Option 1 Project alternative (refer to Section 3.4.1 of the EIS) would have resulted in a predicted approximate 115 ha of further disturbance to the *Central Hunter Valley Eucalypt Forest and Woodland CEEC* and habitat to the north of the Development Footprint and south of the Golden Highway associated with a larger pit footprint. Furthermore, infrastructure associated with a proposed rail loop option would have impacted a small area of potential *Warkworth Sands Woodland in the Sydney Basin Bioregion EEC* occurring to the southeast of the Development Footprint adjacent to the existing 330kV transmission line easement. Option 1 also included impacts to Wollombi Brook required for a new rail line crossing, and therefore likely to impact a small area of *Hunter Floodplain Red Gum Woodland in the NSW North Coast and Sydney Basin Bioregions EEC* and the stands of river red gum (*Eucalyptus camaldulensis*) occurring along Wollombi Brook. The disturbance to these biodiversity features was avoided by the revision of the Project design. This has reduced the impacts of the Project on *Central Hunter Valley Eucalypt Forest and Woodland CEEC* and *Hunter Floodplain Red Gum Woodland in the NSW North Coast and Sydney Basin Bioregions EEC* and avoided completely any impacts on *Warkworth Sands Woodland in the Sydney Basin Bioregion EEC* and avoided potential clearing impacts on the River Red Gum (*Eucalyptus camaldulensis*) population in the Hunter Catchment.

4.1.3 Disturbance Boundary Revisions

Following the exhibition of the EIS in August 2016, revisions to the mine disturbance boundary were undertaken with the objective of further minimising the impacts of the Project on biodiversity. This refinement resulted in a reduction in the Development Footprint by approximately 37 hectares as shown on **Figure 4.1**. This reduction in the Development Footprint resulted in the following reductions in impacts of the Project:

- avoidance of impacts on 19.2 hectares of vegetation corresponding to the EPBC Act-listed *Central Hunter Valley Eucalypt Forest and Woodland CEEC*
- avoidance of impacts on 27.1 hectares of native woodland vegetation and fauna habitat
- avoidance of impacts on 7.9 hectares of native grassland vegetation.

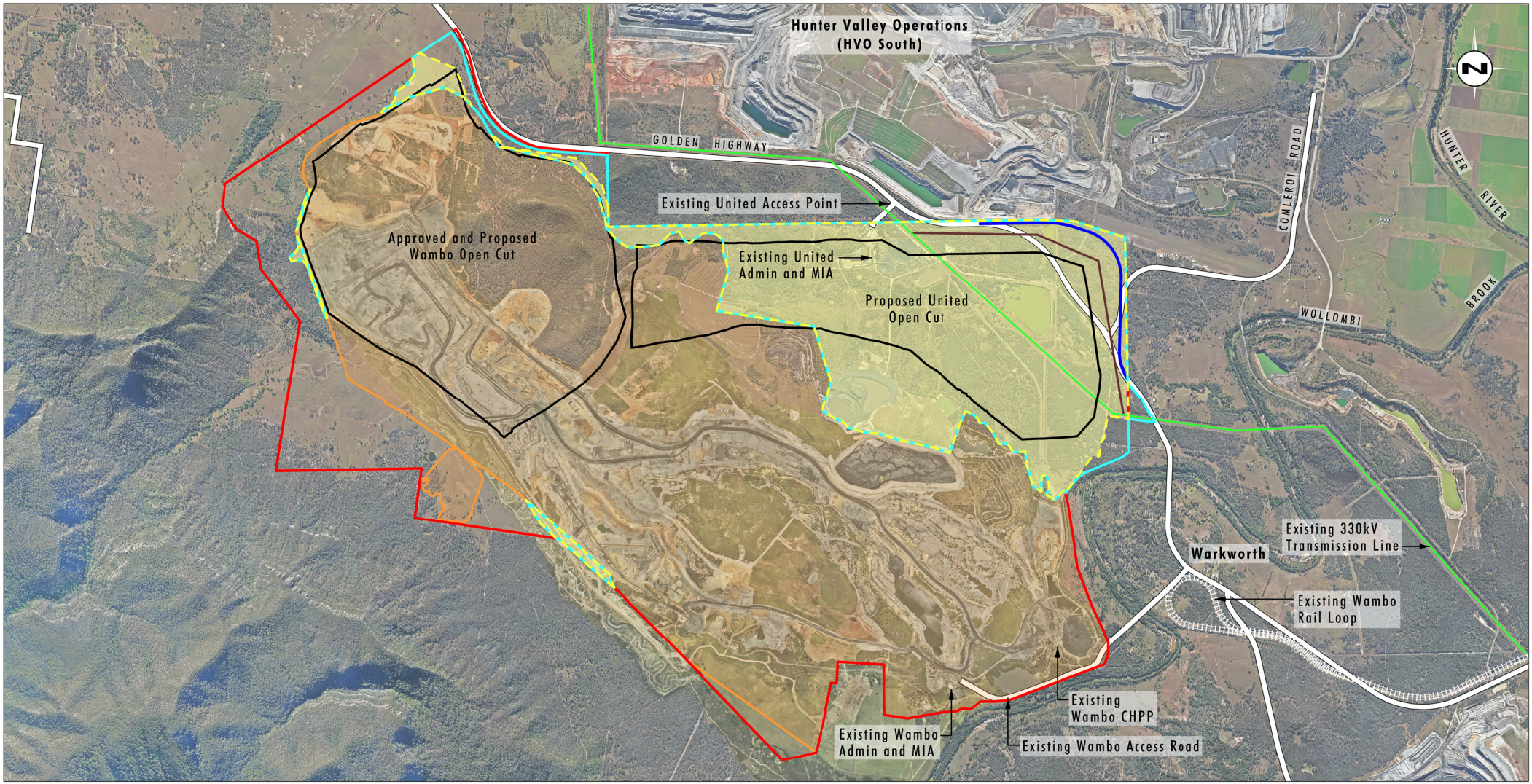

Image Source: United (2016)
Data Source: Glencore (2014)

0 1.0 2.0 2.5km
1:50 000

Legend

- Development Site
- Revised Development Footprint
- Development Footprint
- Approved Wambo Surface Development Area
- Proposed Conceptual Extraction Area
- Conceptual Golden Highway Realignment
- Existing 330kV Transmission Line
- Revised Conceptual Relocated 330kV Transmission Line

FIGURE 4.1

Revised Development Footprint

File Name (A4): R01/3890_021.dgn
20170323 15.18

4.2 Mitigation Measures

United has committed to the design and implementation of a comprehensive biodiversity mitigation strategy to mitigate the unavoidable impacts of the Project. During the preparation of the mitigation strategy, the UHSA Guidelines for the Mitigation of Coal Mining Impacts on Biodiversity (OEH 2015a) were consulted. Although the mitigation guidelines are not specifically relevant to an FBA assessment, they do provide useful guidance for Hunter Valley mining proponents on how to reduce significant local impacts on biodiversity while undertaking vegetation clearance, mining operations and related activities. The proposed mitigation measures for the Project are described in this section and are generally in accordance with those listed in the Mitigation Guidelines (OEH 2015a).

The following specific control measures are considered to be integral to the mitigation of impacts on the biodiversity features of the Development Site:

- landform establishment
- implementation of clearing procedures to minimise the impacts of the clearing process and maximise the recovery of any valuable biodiversity resources (e.g. seed collection, re-use of hollow logs and hollows where appropriate)
- feral animal and noxious weed control
- fencing and access control
- management of domestic stock
- bushfire management
- providing appropriate environmental management measures as part of the mining operations to minimise the potential for indirect impacts including:
    - water management systems that seek to minimise the potential for damage to flora and fauna and their habitats from erosion and unnatural flooding events
    - noise control systems to minimise noise impacts
    - dust control measures to minimise dust impacts
    - lighting controls to minimise night light impacts
    - blasting controls to minimise blast overpressure and vibration impacts.
- employee education and training.

Each of these control measures will contribute to the maintenance of habitat quality across the Development Site. Specific details on these measures and how they are consistent with the *Mitigation Guidelines* are outlined in the following sections.

Should the Project be approved, United will prepare an appropriate biodiversity management plan in accordance with any relevant Development Consent requirements. The project-specific biodiversity management will guide the implementation of the mitigation steps, which are addressed in the following sections. The outcomes of biodiversity monitoring (see below) will also be used to provide for the management plan to be reviewed and adapted in response to new information.

Monitoring is a tool that can be used to assess and inform the ongoing improvement of management actions. The effectiveness and long-term success of mitigation actions will be evaluated against key outcomes, which necessitate regular and appropriately targeted monitoring. This will be achieved by using formal monitoring programs and due diligence assessments that periodically examine measurable changes over time and provide information on impacts and the success or otherwise of mitigation actions.

The frequency and level of monitoring will be dependent on the environmental features to be assessed. The techniques proposed to be used will be documented in the biodiversity management plan, however it will be targeted, systematic and repeatable.

4.2.1 Landform Establishment

Changes to landform, geology and drainage regimes associated with mining have the potential to impact adjacent and nearby habitat areas. For example the creation of overburden emplacement areas typically results in changes in surface water and groundwater movement, availability and quality. The following mitigation controls will be undertaken to mitigate such potential impacts:

- appropriate drainage will be integrated in the design of rehabilitation areas to effectively manage drainage of the final landform without resulting in adverse impacts
- utilisation of natural landform design principles in the establishment of the final landform (as discussed in the EIS) to provide micro-relief in the landform and improved habitat outcomes
- identified areas of moderate to severe erosion will be remediated as soon as practicable.

4.2.2 Pre-clearance and Tree-felling

Pre-clearance surveys and tree-felling supervision recommendations are outlined in Section 5.10 of the Mitigation Guidelines (OEH 2015b). These procedures aim to identify significant biodiversity features within areas to be cleared and attempt to minimise the impact of clearing on these features.

A tree felling procedure will be implemented to minimise the potential for impacts on native fauna species (including threatened species) as a result of the clearing of hollow-bearing trees. The procedure will detail the necessary pre-clearing activities, requirements during clearing operations, and post-clearing requirements. The procedure will include the following:

- Pre-clearing surveys by a suitably experienced and experienced person prior to felling. This will include marking of hollow-bearing trees, as well as any other notable features such as fallen timber, hollow logs or boulders suitable for salvage; active nests, dreys or dens requiring consideration; and seed-bearing trees for salvage.
- Removal of non hollow-bearing trees/vegetation as close to the hollow-bearing tree felling date as practicable (in order to discourage fauna usage of the area). It is not necessary for the suitably qualified and experienced person to be present to supervise such works.
- Hollow-bearing tree felling procedures, including (but not limited to):
    - supervision of all hollow-bearing tree felling works by a suitably qualified and experienced person. If an ecological issue is encountered, the suitably qualified person is to advise on the most appropriate measures to ensure minimal impact on fauna species, particularly threatened species

- visual canopy inspection on the day of the felling of hollow-bearing trees to check for individual animals in the canopy
- shaking of hollow-bearing tree (with heavy machinery where safe to do so) to encourage resident fauna to abandon tree, prior to felling
- lowering of hollow-bearing trees as gently as possible (soft-felled) with machinery
- inspection of all hollows in felled trees by a suitably qualified and experienced person
- capture of any displaced/injured fauna by a suitably qualified and experienced person
- if a threatened species is identified in a habitat tree on the day of felling, the supervising person should advise the most appropriate method to minimise potential harm
- release of unharmed fauna into nearby secure habitats by a suitably experienced person
- injured fauna to be assessed and taken to wildlife carer, if necessary, by a suitably experienced person
- felled trees are to be rolled so that the number of hollows blocked against the ground are minimised
- all felled trees are to remain in place overnight to allow any unidentified fauna to escape
- salvage of suitable hollows for use as compensatory habitat, where practicable.

All personnel who will capture/handle/house and/or transport native fauna species (injured or uninjured) will be appropriately licensed under the relevant field survey and ethics authorities, currently this means licensing under the NSW *National Parks and Wildlife Act 1974* and the NSW Animal Ethics Committee.

The above pre-clearance and tree-felling procedure is generally consistent with the recommendations outlined in Section 5.10 of the UHSA Mitigation Guidelines (OEH 2015a).

4.2.3 Weed Control

Weed species could be inadvertently brought into the Development Site with imported materials, or could invade naturally through removal of native vegetation. The presence of weed species has the potential to be an impediment to revegetation and regeneration activities. In addition, the presence of weed species has the potential to decrease the value of vegetation for native species, particularly threatened species.

Existing weed management controls at United and Wambo will be incorporated into the Biodiversity Management Plan. Weed control will be undertaken in accordance with current mine practices and, for noxious weed species, with NSW control guidelines.

Regular weed inspections will be undertaken across the Development Site and appropriate weed control methods will be implemented.

4.2.4 Pest and Feral Animal Control

Introduced fauna species such as foxes, rabbits, pigs, dogs and feral cats could change in distribution and abundance in the Development Site and adjoining areas as future areas are cleared, mined and then rehabilitated. Clearing, thinning of vegetation and the creation of tracks through existing dense vegetation could assist the penetration of introduced fauna species such as pigs, cats and foxes, and allow them to establish in new areas. An increase in feral species within the Development Site has the potential to increase impacts on existing native species, particularly via predation and habitat destruction.

Pest and feral animal controls at United and Wambo will be incorporated into the Biodiversity Management Plan. Pest and feral animal control will be undertaken in accordance with current mine practices and in consideration of the UHSA mitigation guidelines (OEH 2015a).

Regular monitoring of revegetation areas will be undertaken to assess the level of impact by feral animals, particularly on vegetation establishment. Feral animal control works will be undertaken periodically to provide for the suppression of feral animals, and this will be undertaken in a manner that is sympathetic to ecological outcomes.

4.2.5 Fencing Control

Fencing may be used to demarcate vegetation where required. Any new fencing used within the Development Site adjacent to native vegetation areas will where possible remove the use of barbed wire especially in the top two strands and replace with plain wire. This type of fencing will minimise potential injury to, or death of, fauna species, particularly macropods and gliding or flying mammals, such as the grey-headed flying-fox (*Pteropus poliocephalus*) and threatened micro-bats. The use of as few wire strands as practical will be considered to reduce potential for fauna entanglement, particularly by macropods.

4.2.6 Domestic Stock

Domestic stock may be strategically grazed in parts of the Development Site to reduce weed species or to manage fuel loads for bushfire risk. The following mitigation measures will be undertaken to manage the impacts of grazing by domestic stock:

- Stock grazing will not be undertaken in areas of high biodiversity values
- Where livestock are being used to remove vegetation by crash grazing, the following principles will be considered:
    - Allow the stock to feed intensively in a defined area only for short periods
    - Undertake crash grazing between autumn and mid-spring – ideally before weed species set seed and when these species are more palatable and the nutrient content of the foliage is high
    - Manage the movement of livestock using fencing (temporary or permanent)
    - Monitor feed levels so that overgrazing does not occur.
- Where possible ground cover will be maintained towards 100 per cent
- The grazing pressure from other herbivores (e.g. kangaroos, wallabies, rabbits and hares) is to be reviewed in the context of the domestic stocking rate that can be utilised.

4.2.7 Bushfire Management

The vegetation that will be retained within the Development Site will require appropriate bushfire management to protect life and property, while supporting appropriate conditions for the significant ecological features identified in the Development Site. Appropriate bushfire management controls will be considered in the development of the Biodiversity Management Plan and where appropriate will include the application of fire research knowledge to generate ecological outcomes through the appropriate use of fire as an ecological management tool.

Bushfire management will consider:

- exclusion of planned bushfire from revegetation and regeneration areas to allow replanted and regenerating communities to mature to a stage where they are able to withstand bushfire and regenerate naturally following such an event
- consideration of the sensitivities of threatened species and threatened ecological communities to bushfire and appropriate bushfire planning and management in relation to known occurrences of these
- the use of ecologically appropriate fire regimes (be they related to burn frequency, duration or intensity), as these have the potential to impact negatively on significant ecological features
- asset protection
- appropriate incorporation of all relevant ecological requirements into bushfire management plans.

4.2.8 Fauna Habitat Enhancement and Re-instatement

In parallel with revegetation works in mine site rehabilitation areas (refer to **Section 6.4** for further details on mine site ecological rehabilitation), the Project will re-establish ground fauna habitat through the relocation of habitat features to targeted mine site rehabilitation areas, where practicable. This will contribute to the more rapid development of fauna species diversity in the medium to long term as vegetation establishment progresses. The following habitat enhancement and re-instatement mitigation measures will be considered in the detailed planning of rehabilitation of the site:

- dams could be constructed in the post-mining landform to facilitate the re-colonisation of woodland fauna communities. Dams provide a source of permanent water in the landscape and associated fauna species such as frogs and invertebrates will constitute suitable prey for many additional fauna species such as reptiles. Increasing the habitat complexity and range of micro-habitats occurring in the post-mining landscape will result in the increased utilisation of the rehabilitation by a much wider range of fauna species in the post-mining landform
- habitat enhancement of retained vegetation such as provision of nest boxes, salvaged hollows, fallen timber, hollow logs and boulders, as deemed necessary.

4.2.9 Employee Education and Training

The development of education packages and the facilitation of mine site awareness training can help to mitigate anthropogenic impacts on biodiversity. The ability of non-ecological personnel to identify key threatened species or key ecological threats can help to mitigate impacts on threatened species. Improved awareness and stewardship of mine site employees and contractors can potentially benefit all flora and fauna species and vegetation communities. The following mitigation actions will be undertaken to develop a greater understanding and awareness of biodiversity issues in non-ecological trained personnel:

- Inductions for staff, contractors and visitors will be undertaken to make them aware of the key ecological issues present in the Development Site and so that they know their role and responsibilities in the protection and/or minimisation of impacts to all native biodiversity.

Inductions will identify the location of sensitive flora and fauna and the policies being implemented to protect the biodiversity values of such areas.

4.2.10 Mitigation Measures Summary

Table 4.2 below provides a summary of the mitigation measures that will be implemented before, during and after construction to minimise the impacts of the Project.

Table 4.2 Mitigation Measures

Action	Outcome
Landform Establishment	• Appropriate drainage design within rehabilitation areas to avoid adverse impacts of erosion. • Provision of micro-relief in the rehabilitated landform to provide improved habitat outcomes
Pre-clearance surveys	• Reduction of impacts to hollow-dependant fauna species • Minimisation of impacts to fauna species • Identification of habitat resources for translocation or salvage
Tree-felling supervision	• Relocation of captured fauna individuals into nearby suitable secure habitat • Injured fauna individuals taken to a veterinary clinic or wildlife carer • Translocation or salvage of habitat resources
Weed control	• Minimisation of the spread of weeds within native vegetation (management of noxious weeds)
Pest and Feral Animal Control	• Minimise potential impacts to native fauna species from out-competition and/or preying of pest or feral animal species.
Domestic Stock	• Minimise potential impacts to native vegetation caused by increased cover of weed species or increased fuel loads causing elevated bushfire risk.
Bushfire Management	• Protect life and property, while supporting appropriate conditions for the existing ecological features.

Action	Outcome
Fauna Habitat Enhancement and Re-instatement	• Contribute to the more rapid development of fauna species diversity in medium to long term as vegetation establishment progresses.
Fencing Control	• Minimisation of impacts to native fauna species from the use of barbed-wire fences.
Employee education and training	• Communication to employees on their role and responsibilities as it relates to biodiversity

4.3 Direct Impacts Unable to be Avoided

The construction and operation of the Project will result in a range of direct impacts on biodiversity values within the Development Site. Direct impacts include the loss of native vegetation and fauna habitats as a result of clearance works and subsequent mining activity. The location and extent of direct (permanent) impacts is shown as the Development Site on **Figure 4.2.**

Table 4.3 below outlines these impacts as they were entered into the BBCC, which totals approximately 531 hectares of direct impacts to native vegetation communities. Direct impacts have been focused, where possible, outside of native vegetation communities through the planning of the Project, with approximately 147 hectares of cleared/non-native vegetation subject to direct impacts.

Avoidance and mitigation measures associated with minimising the impacts of these direct impacts are discussed in **Sections 4.1** and **4.2** above.

Table 4.3 Direct Impacts of the Project on Native Biodiversity Features

Ecological Feature	Area within the Development Footprint (ha)
Biometric Vegetation Type	
HU812 Forest Red Gum grassy open forest on floodplains of the lower Hunter [1] *Moderate to Good Condition*	0.29
HU816 Spotted Gum - Narrow-leaved Ironbark shrub - grass open forest of the central and lower Hunter [2] *Moderate to Good Condition – Plantation/Rehabilitation*	29.42
HU869 Grey Box - Slaty Box shrub - grass woodland on sandstone slopes of the upper Hunter and Sydney Basin [3] *Moderate to Good Condition*	1.56
HU905 Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter [4] *Moderate to Good Condition – Derived Native Grassland*	93.81

Ecological Feature	Area within the Development Footprint (ha)
HU905 Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter [5] *Moderate to Good Condition*	149.28
HU905 Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter *Moderate to Good Condition – Cooba Open Shrubland*	80.45
HU905 Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter [6] *Moderate to Good Condition – Regeneration*	26.55
HU905 Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter [7] *Moderate to Good Condition – Thinned Canopy*	0.08
HU906 Bull Oak grassy woodland of the central Hunter Valley [8] *Moderate to Good Condition*	117.67
HU945 Swamp Oak - Weeping Grass grassy riparian forest of the Hunter Valley *Moderate to Good*	31.61
Total	**530.73**
Species-credit Species Habitats	
Vegetation comprising breeding habitat for southern myotis (*Myotis macropus*)	7.30

1. Conforms to *Hunter Floodplain Red Gum Woodland in the NSW North Coast and Sydney Basin Bioregions* EEC (TSC Act)

2. Conforms to *Central Hunter Ironbark – Spotted Gum – Grey Box Forest in the NSW North Coast and Sydney Basin Bioregion* EEC (TSC Act) and 1.17 ha conforms to *Central Hunter Valley Eucalypt Forest and Woodland* CEEC (EPBC Act)

3. Conforms to *Hunter Valley Footslopes Slaty Gum Woodland in the Sydney Basin Bioregion* EEC (TSC Act) and 1.13 ha conforms to *Central Hunter Valley Eucalypt Forest and Woodland* CEEC (EPBC Act)

4. 10.49 ha conforms to *Central Hunter Valley Eucalypt Forest and Woodland* CEEC (EPBC Act)

5. Conforms to Central Hunter Grey Box – Ironbark Woodland in the NSW North Coast and Sydney Basin Bioregions EEC (TSC Act) and 143.62 ha conforms to *Central Hunter Valley Eucalypt Forest and Woodland* CEEC (EPBC Act)

6. Conforms to Central Hunter Grey Box – Ironbark Woodland in the NSW North Coast and Sydney Basin Bioregions EEC (TSC Act) and 22.79 ha conforms to *Central Hunter Valley Eucalypt Forest and Woodland* CEEC (EPBC Act)

7. Conforms to Central Hunter Grey Box – Ironbark Woodland in the NSW North Coast and Sydney Basin Bioregions EEC (TSC Act) and conforms to *Central Hunter Valley Eucalypt Forest and Woodland* CEEC (EPBC Act)

8. 3.1 ha conforms to Central Hunter Grey Box – Ironbark Woodland in the NSW North Coast and Sydney Basin Bioregions EEC (TSC Act) and 10.19 ha conforms to *Central Hunter Valley Eucalypt Forest and Woodland* CEEC (EPBC Act)

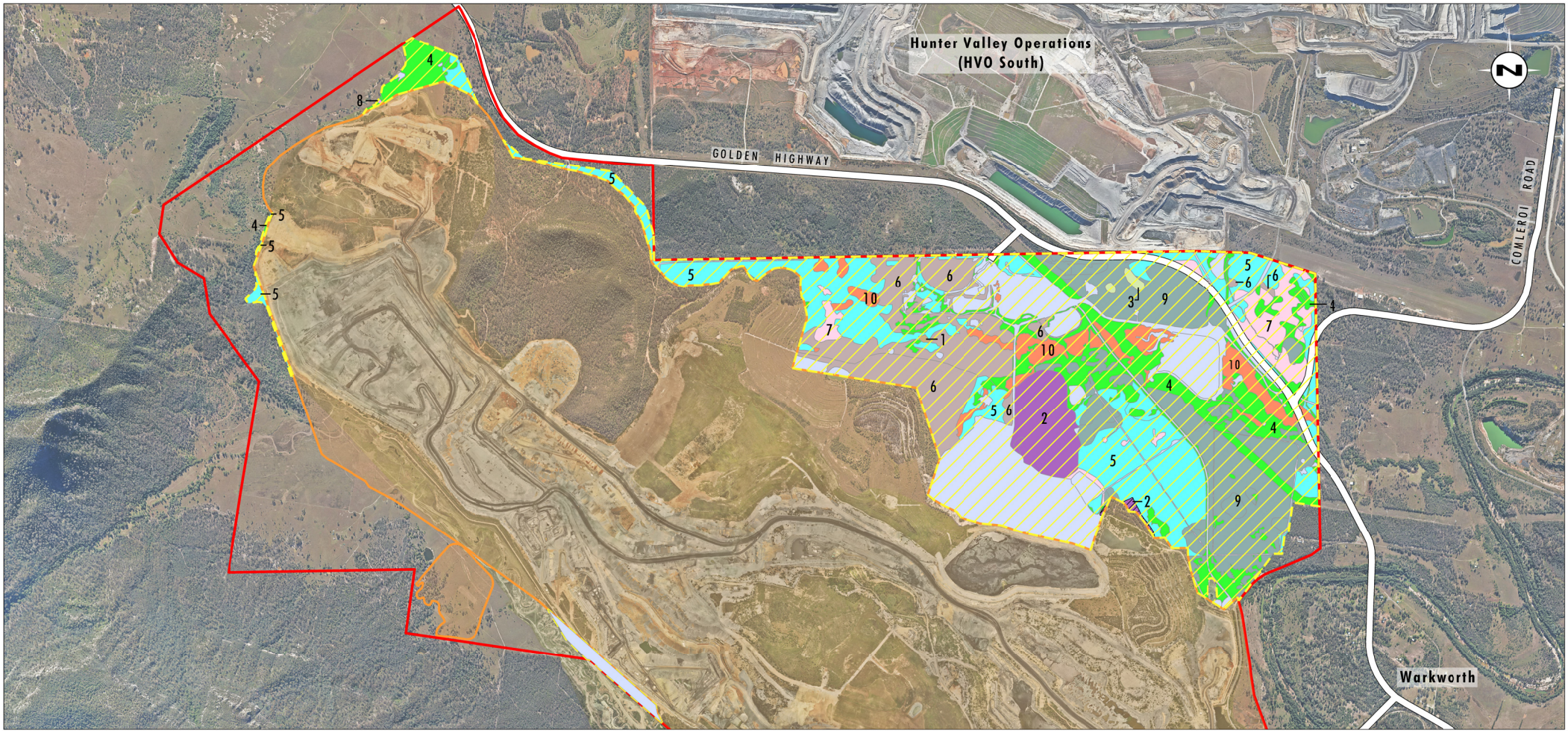

Image Source: AAM (2012), United (2016)
Data Source: Glencore (2014)

Legend

- Development Site
- Development Footprint
- Approved Wambo Surface Development Area
- 1 - HU812 - Forest Red Gum Grassy Open Forest on Floodplains of the Lower Hunter - Moderate to Good Condition
- 2 - HU816 - Spotted Gum - Narrow-leaved Ironbark Shrub - Grass Open Forest on Slopes of the Upper Hunter and Sydney Basin - Moderate to Good Condition - Plantation/Rehabilitation
- 3 - HU869 - Grey Box - Slaty Box Shrub - Grass Woodland on Sandstone Slopes of the Upper Hunter and Sydney Basin - Moderate to Good Condition
- 4 - HU905 - Narrow-leaved Ironbark - Grey Box grassy Woodland of the Central and Upper Hunter - Derived Native Grassland
- 5 - HU905 - Moderate to Good Condition
- 6 - HU905 - Moderate to Good Condition - Cooba Open Shrubland
- 7 - HU905 - Moderate to Good Condition - Regeneration
- 8 - HU905 - Moderate to Good Condition - Thinned Canopy
- 9 - HU906 - Bull Oak Grassy Woodland of the Central Hunter Valley
- - Moderate to Good Condition
- 10 - HU945 - Swamp Oak - Weeping Grass Grassy Riparian Forest of the Hunter Valley - Moderate to Good Condition
- Cleared Land
- Wambo Mine Rehabilitation

FIGURE 4.2

Final Development Footprint

File Name (A4): R01/3890_030.dgn
20170405 16.02

4.4 Assessment of Indirect Impacts on Biodiversity

The Project is not expected to result in any substantial indirect impacts on the biodiversity values of surrounding lands during the construction or operational phases of the Project. However, some minor indirect impacts associated with habitat connectivity, fugitive light emissions, dust, noise, surface water flow changes, groundwater changes, weeds and feral animals may occur during the construction and operational phases of the Project. This is further discussed in the sections below. Groundwater-dependent ecosystems (GDEs) were assessed in the EIS.

4.4.1 Indirect Impacts on Connectivity and Corridors

The removal of native vegetation from within the Development Footprint could affect the ability of some local fauna species to move throughout the landscape. A potential corridor of fauna movement (comprising fragmented remnant and woodland rehabilitation patches) exists between an area within the Development Footprint linking woodland and forest habitats to the north-west with those in the east and south-east. Removal of the vegetation in the additional disturbance area may reduce the dispersal, migration and movement ability of some fauna species within the local area.

In addition to the impacts on potential fauna corridors, the removal of native vegetation from the Development Footprint could result in a reduced ability for many fauna species to move throughout the landscape through a reduction in 'stepping stone' habitat areas. Isolated or fragmented areas of suitable habitat for species provide short to medium term refuges (or 'stepping stones' for species as they move from one area of habitat to another, travelling across unsuitable habitat areas between the 'stepping stones') for species as they disperse, migrate or move throughout the landscape. The loss of 'stepping stone' habitat areas for some species could result in an increased level of isolation of populations where species are unable or unwilling to travel across the increased distance between habitat areas.

To a large extent the potential loss of local and regional connectivity is already factored in to the credit calculation in that the Assessment Circle and associated Landscape Value Scores take into account the pre- and post-clearing percentage of native vegetation cover (excluding the proposed post-mine rehabilitation). It is unlikely that any further indirect impact through reduced connectivity and loss of corridors would be of any significant level.

4.4.2 Fugitive Light Emissions

Fugitive light emissions resulting from the construction and operation of the Project may result in adverse impacts on adjacent habitats and fauna species such as nocturnal fauna species, particularly birds and bats. Potential impacts may include:

- a reduction in the navigational signal ability for some nocturnal animals
- delaying bats from emerging from roost access points and shortening the amount of time available to them for foraging.

Appropriate lighting controls to minimise impacts will be implemented as part of the Project as necessary (providing that these actions do not compromise site safety issues). There will be no substantial change to fugitive light emissions given that the proposed mine operation is already is part of and adjacent to an operation with existing impacts.

Any additional impacts resulting from fugitive light emissions are not expected to be of any level of significance in relation to threatened species, populations and communities.

4.4.3 Noise Impacts

Construction and operational noise impacts have the potential to adversely impact native species. Potential impacts include:

- noise disturbing the roosting and foraging behaviour of fauna species
- noise reducing the occupancy of areas of suitable habitat.

Details of the noise controls that will be implemented as part of the Project are outlined in the EIS.

In regard to potential impacts on biodiversity, there will be no substantial change to noise impacts given that the proposed mine operation is part of, and adjacent to, an already existing operation with existing impacts.

Any additional impacts resulting from noise emissions are not expected to be of any level of significance in relation to threatened species, populations and communities.

4.4.4 Dust Impacts

Construction and operational dust impacts have the potential to adversely impact native species during ground disturbing works, including blasting. Potential impacts include dust covering vegetation thereby potentially reducing vegetation health and growth.

The design of the Project will include inherent measures to minimise the potential for adverse dust impacts. These include:

- progressive rehabilitation and stabilisation of disturbed land
- dust suppression on haul roads and other operational areas to reduce vehicle generated dust emissions
- a range of other dust control measures as discussed in Section 8.0 of the main text of the EIS.

In regard to potential impacts on biodiversity, there will be no substantial change to dust impacts given that the proposed mine is part of and adjacent to an already existing operation with existing impacts.

Any additional impacts resulting from dust are not expected to be of any level of significance in relation to threatened species, populations and communities.

4.4.5 Weed and Feral Animal Encroachment

Weed species could be inadvertently brought into the Development Footprint with imported materials, or could invade naturally through removal of native vegetation. The presence of weed species within the Development Footprint has the potential to decrease the value of extant vegetation to native species, particularly threatened species. Mitigation measures outlined in **Section 4.2** will be implemented to minimise the potential for weed encroachment into areas surrounding the Development Footprint.

Populations of feral fauna species such as foxes, rabbits, pigs, dogs and cats can increase and quickly populate new areas as a result of disturbance. Clearing, thinning of vegetation and the creation of tracks have the ability to assist the establishment and spread of feral fauna species. Mitigation measures outlined in **Section 4.2** will minimise the potential for feral animal spread and impacts into surrounding areas around the Development Footprint.

There will be no substantial change to impacts from weeds or feral animals, given that the proposed mine is part of, and adjacent to, an existing operation with existing impacts.

Any additional impacts resulting from weeds or feral animals are not expected to be of any level of significance in relation to threatened species, populations and communities.

5 Impact Summary

5.1 Impacts Not Requiring Further Assessment

Impacts not requiring further assessment under the FBA include areas of land without native vegetation. The Development Footprint contains approximately 147 hectares of cleared land/non-native vegetation that will be removed as a result of the Project that does not meet the definition of 'native vegetation' under the *Native Vegetation Act 2003*. This impact does not require further assessment under the FBA.

5.2 Impacts Not Requiring Offset

Impacts on native vegetation not requiring offsets under the FBA include native vegetation that has a site value score of less than 17 and are not identified as an endangered or critically endangered ecological community, and/or associated with threatened species habitat (as represented by ecosystem credits).

Impacts on species and populations not requiring offsets under the FBA include threatened species habitat associated with a PCT that has a site value score of less than 17 or species or populations that are not threatened and do not form part of a EEC or CEEC.

A range of non-threatened flora and fauna species were recorded within the Development Footprint during the surveys undertaken for this assessment. These species do not require offsets under the FBA.

As no PCTs within the Development Footprint have a site value score of less than 17 all will require offsetting as discussed in **Section 5.3**.

5.3 PCTs and Threatened Species Requiring Offset

A range of PCTs, ecosystem-credit species and species-credit species were found to require offsetting for the Project as discussed in the sections below.

5.3.1 Ecosystem Credits

Table 5.1 outlines the ecosystem-credit species requiring offset as a result of the Project through the use of ecosystem credits linked to vegetation zones. The highest threatened species offset multiplier determines the credit requirements for the vegetation zones these species are predicted to occur in.

Table 5.1 Ecosystem-credit species requiring offset as a result of the Project

Common Name	Species Name	Threatened Species Offset Multiplier
barking owl	*Ninox connivens*	3.0
masked owl	*Tyto novaehollandiae*	3.0
powerful owl	*Ninox strenua*	3.0
bush stone curlew	*Burhinus grallarius*	2.6
speckled warbler	*Chthonicola sagittata*	2.6

Common Name	Species Name	Threatened Species Offset Multiplier
spotted-tailed quoll	*Dasyurus maculatus*	2.6
eastern freetail-bat	*Mormopterus norfolkensis*	2.2
eastern false pipistrelle	*Falsistrellus tasmaniensis*	2.2
greater broad-nosed bat	*Scoteanax rueppellii*	2.2
squirrel glider	*Petaurus norfolcensis*	2.2
yellow-bellied sheathtail-bat	*Saccolaimus flaviventris*	2.2
Corben's long-eared bat	*Nyctophilus corbeni*	2.1
brown treecreeper	*Climacteris picumnus* subsp. *victoriae*	2.0
gang-gang cockatoo	*Callocephalon fimbriatum*	2.0
glossy black-cockatoo	*Calyptorhynchus lathami*	1.8
little lorikeet	*Glossopsitta pusilla*	1.8
turquoise parrot	*Neophema pulchella*	1.8
hooded robin	*Melanodryas cucullata* subsp. *cucullata*	1.7
little eagle	*Hieraaetus morphnoides*	1.4
spotted harrier	*Circus assimilis*	1.4
square-tailed kite	*Lophoictinia isura*	1.4
black-chinned honeyeater	*Melithreptus gularis* subsp. *gularis*	1.3
diamond firetail	*Stagonopleura guttata*	1.3
eastern grass owl	*Tyto longimembris*	1.3
flame robin	*Petroica phoenicea*	1.3
grey-crowned babbler	*Pomatostomus temporalis* subsp. *temporalis*	1.3
painted honeyeater	*Grantiella picta*	1.3
scarlet robin	*Petroica boodang*	1.3
swift parrot	*Lathamus discolor*	1.3
varied sittella	*Daphoenositta chrysoptera*	1.3

Table 5.2 outlines the PCTs to be impacted as a result of the Project and the ecosystem credits required to offset those impacts. The full Credit Calculator report is included in **Appendix C**.

Table 5.2 Plant Community Types Requiring Offset and the Total Ecosystem Credits Required

Vegetation Zone	Plant Community Type	Total Area to be Impacted (ha)	Highest Threatened Species or EEC Offset Multiplier	Total Ecosystem Credits Required
1	HU812 Forest Red Gum grassy open forest on floodplains of the lower Hunter *Moderate to Good Condition*	0.29	3.0	20
2	HU816 Spotted Gum - Narrow-leaved Ironbark shrub - grass open forest of the central and lower Hunter *Moderate to Good Condition – Plantation/Rehabilitation*	29.42	3.0	1483
3	HU869 Grey Box - Slaty Box shrub - grass woodland on sandstone slopes of the upper Hunter and Sydney Basin *Moderate to Good Condition*	1.56	3.0	108
4	HU905 Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter *Moderate to Good Condition – Derived Native Grassland*	93.81	3.0	2568
5	HU905 Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter *Moderate to Good Condition*	149.28	3.0	9567
6	HU905 Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter *Moderate to Good Condition – Cooba Open Shrubland*	80.45	3.0	2705
7	HU905 Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter *Moderate to Good Condition – Regeneration*	26.55	3.0	1187

Vegetation Zone	Plant Community Type	Total Area to be Impacted (ha)	Highest Threatened Species or EEC Offset Multiplier	Total Ecosystem Credits Required
8	HU905 Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter *Moderate to Good Condition – Thinned Canopy*	0.08	3.0	3
9	HU906 Bull Oak grassy woodland of the central Hunter Valley *Moderate to Good Condition*	117.67	3.0	6852
10	HU945 Swamp Oak - Weeping Grass grassy riparian forest of the Hunter Valley *Moderate to Good*	31.61	3.0	2,132
TOTAL		**530.73**	-	**26,625**

5.3.2 Species Credits

Table 5.3 below outlines the species-credit species to be impacted as a result of the Project and the species credits required to offset those impacts. A full Credit Calculator report is included in **Appendix C**.

Table 5.3 Species-credit Species Requiring Offset and the Species Credits Required

Common Name *Scientific Name*	Habitat to be Impacted (ha)	Threatened Species Offset Multiplier	Species Credits Required
southern myotis (breeding habitat) *Myotis macropus*	7.3	7.7	562
Total	-	-	**562**

5.4 Impacts on Biodiversity that Require Further Consideration

Under the FBA, certain impacts on biodiversity values may require further consideration by the consent authority. These are impacts that are considered to be complicated or severe and include:

- impacts on landscape features, being:
    - impacts that will reduce the width of vegetation in the riparian buffer zone bordering significant streams and rivers, important wetlands or estuarine areas (in accordance with Section 9.2.3 of the FBA), or
    - impacts that will prevent species movement along corridors that have been identified as providing significant biodiversity linkages across the state (in accordance with Section 9.2.3 of the FBA), and
- impacts on native vegetation that are likely to cause the extinction of an EEC/CEEC from an IBRA subregion or significantly reduce its viability (in accordance with Section 9.2.4 of the FBA), and
- impacts on critical habitat or on threatened species or populations that are likely to cause the extinction of a species or population from an IBRA subregion or significantly reduce its viability (in accordance with Section 9.2.5 of the FBA).

In accordance with Sections 9.2.3, 9.2.4 and 9.2.5 of the FBA (OEH 2014b), impacts on the following biodiversity values require further consideration in the BAR. This information is provided in **Sections 5.4.1**, **5.4.2** and **5.4.3** below.

- Riparian buffer of Redbank Creek
- *Central Hunter Valley Eucalypt Forest and Woodland CEEC* under the EPBC Act
- Spotted-tailed quoll (*Dasyurus maculatus maculatus*)
- Swift parrot (*Lathamus discolor*)
- Regent honeyeater (*Anthochaera phrygia*).

5.4.1 Impacts on Vegetation in a Riparian Buffer Zone that Require Further Consideration

As per Section 9.2.3.2 of the FBA (OEH 2014b), impacts on vegetation in a riparian buffer zone that require further consideration include impacts on areas of native vegetation within:

(a) 20 m either side of a 4th and 5th order stream

(b) 50 m either side of a 6th order stream or higher, or

(c) 50 m around an estuarine area

Table 5.4 below provides further information for Redbank Creek in accordance with Section 9.2.3.3 of the FBA (OEH 2014b).

Table 5.4 Impacts on Riparian Buffers that Require Further Consideration

Details Required	Redbank Creek
(a) the name and stream order of the riparian buffer being impacted	Redbank Creek is a fourth order watercourse and flows in an easterly direction through the Development Footprint before joining Wollombi Brook approximately 4 kilometres upstream of the confluence with Hunter River. Redbank Creek is an ephemeral watercourse with flows only occurring in the creek during storm events or after prolonged rainfall. The Golden Highway crosses Redbank Creek via a box culvert approximately 2 kilometres upstream of its confluence with Wollombi Brook.
(b) the total area of the riparian buffer that is impacted by the Major Project, the extent to which the width of the link will be reduced and over what length, and the size of gaps being created or expanded	In accordance with Section 9.2.3.2 of the FBA (OEH 2014b), impacts that require further consideration on a fourth order stream are those within 20 metres either side of the stream. The Project will impact 12.9 hectares of vegetation that occurs up to 20 metres either side of Redbank Creek in the Development Footprint. This impact will occur across a 3.5 km length of Redbank Creek until the eastern boundary of the Development Footprint.
(c) the PCT and condition of the vegetation in the riparian buffer	Redbank Creek is primarily dominated by HU945 Swamp Oak - Weeping Grass grassy riparian forest of the Hunter Valley. This vegetation is in moderate to good condition however it has been subject to previous disturbances and exotic species such as the introduced species galenia (*Galenia pubescens*), fireweed (*Senecio madagascariensis*), mother-of-millions (*Bryophyllum delagoense*) and narrow-leaved cotton bush (*Gomphocarpus fruticosus*), which occur in moderate densities.

Details Required	Redbank Creek
(d) any indirect impacts on wetlands or watercourses downstream of the Development Site	The Project will result in changes to the catchment areas for Redbank Creek compared to the catchment areas of the current approved final landform at United and Wambo operations. As outlined in the surface water assessment as part of the EIS, the reductions in catchment areas for Redbank Creek from the current approved final landform are considered to be small within the context of ephemeral streams. That is, the change in flows is less than the seasonal and annual variations in flow volumes comparing dry years to wet years. The Project is consequently considered likely to have limited impact on waterway stability and scour potential, ecosystems and downstream impacts. Due to the large catchment area and highly regulated nature of the Hunter River the assessment indicates that the Project will have no impact on flows in the Hunter River.
(e) the mitigation measures proposed to minimise the impact on the biodiversity values of the riparian or downstream area	Erosion and sediment control measures to be implemented as part of the Project will be described in the Project Erosion and Sediment Control Plan (ESCP). These measures will be undertaken in accordance with the Blue Book (Volumes 1 and 2) (DECC 2008). The Project ESCP will provide a framework for the management of erosion and sedimentation for the Project.

5.4.2 Impacts on Native Vegetation that Require Further Consideration

As per Section 9.2.4.1 of the FBA (OEH 2014b), impacts on native vegetation that require further consideration include impacts on:

(a) any CEEC, unless the CEEC is specifically excluded by the SEARs

(b) an EEC specifically nominated in the SEARS as an EEC that is likely to become extinct or have its viability significantly reduced in the IBRA subregion.

Table 5.5 below provides further information for the *Central Hunter Valley Eucalypt Forest and Woodland CEEC* under the EPBC Act in accordance with Section 9.2.4.2 of the FBA (OEH 2014b).

Table 5.5 Impacts on Native Vegetation that Require Further Consideration

Details Required	*Central Hunter Valley Eucalypt Forest and Woodland CEEC*
(a) the area and condition of the CEEC or EEC to be impacted directly and indirectly by the proposed development	189.48 hectares of the CEEC will be directly impacted by the Project in the Development Footprint. This EEC occurs throughout the Development Footprint primarily represented by HU905 Narrow-leaved Ironbark – Grey Box Grassy Woodland of the Central and Upper Hunter. This CEEC occurs in moderate condition across the site as well as small areas of regeneration, derived native grassland and planted rehabilitation. The CEEC generally contains a predominately native groundcover with occurrences of some exotic species likely due to existing disturbances in the Development Site (refer to Section 3.2.1). Indirect impacts to the CEEC include fragmentation of larger patches, edge effects and reduced viability of the community in the local area.
(b) the extent and overall condition of the CEEC or EEC within an area of 1000 ha and then 10,000 ha surrounding the proposed development footprint.	Based on the regional mapping outlined in the Hunter Valley Remnant Vegetation Project (Peake 2006), the likely area of the CEEC surrounding the Development Footprint, comprises approximately: • 420 hectares (42%) in 1000 ha buffer area and • 1,800 hectares (18%) in the 10,000 ha buffer area. It is noted that this regional mapping is over 10 years old and vegetation clearance and substantial regeneration has occurred following this. The remnant patches of this EEC/CEEC are generally fragmented occurrences in a largely agricultural and mining landscape. Furthermore, the Development Footprint occurs adjacent to the south western limits for the CEEC, with Triassic sandstone dominating the western portion of the 10,000 buffer area.
(c) an estimate of the extant area and overall condition of the CEEC or EEC remaining in the IBRA subregion after the impact of the proposed development has been taken into consideration	The CEEC is known to occur primarily in the Hunter IBRA subregion. The EPBC Act Conservation Advice (TSSC 2015) predicts that the current extent of the community (as at 2006) is approximately 37,000 hectares. It is noted however, that extensive clearing but also regeneration has occurred in the Hunter since 2006. The 189.48 hectares of disturbance of the CEEC in the Development Footprint represents approximately 0.5 per cent of the remaining extent of the CEEC.
(d) the development proposal's impact on: **i. abiotic factors critical to the long-term survival of the CEEC or EEC. For example, will the impact lead to a reduction of groundwater levels or substantial alteration of surface water patterns?**	No abiotic factors critical to the survival of the community are listed in the EPBC Act Conservation Advice (TSSC 2015). The CEEC typically occurs on soils derived from the Permian sedimentary bedrock found on the Hunter Valley floor. The CEEC is not a Groundwater Dependent Ecosystem (GDE). The Project would be unlikely to adversely modify or destroy abiotic factors necessary for the long-term survival of this CEEC in the locality.

Details Required	*Central Hunter Valley Eucalypt Forest and Woodland CEEC*
ii. characteristic and functionally important species through impacts such as, but not limited to, inappropriate fire/flooding regimes, removal of understorey species or harvesting of plants	The Project will result in the removal of areas of CEEC within the Development Footprint as described in the sections above. Where this disturbance will occur, the Project will remove characteristic and functionally important species to the CEEC. These include, but are not limited to, narrow-leaved ironbark (*Eucalyptus crebra*), grey box (*Eucalyptus moluccana*) and a range of important native groundcover species as per the characteristic species in the EPBC Act Conservation Advice (TSSC 2015). The Project would be unlikely to impact these characteristic and functionally important species for this CEEC outside the Development Footprint in the wider locality.
iii. the quality and integrity of an occurrence of the CEEC or EEC through threats and indirect impacts including, but not limited to, assisting invasive flora and fauna species to become established or causing regular mobilisation of fertilisers, herbicides or other chemicals or pollutants which may harm or inhibit growth of species in the CEEC or EEC.	Vegetation clearing and landscape fragmentation in association with mining is a key threat for the CEEC. Once the topsoil is stripped these areas cannot easily be recovered to a pre-mining state (TSSC 2015). In addition to the mine site, further clearing and modification occurs in order to provide service infrastructure for mining activities (TSSC 2015). Mining activities also have the potential to introduce new weeds and facilitate the spread of existing ones. Land clearing activities have resulted in the proliferation of exotic species; notably galenia (*Galenia pubescens*), Rhodes grass (*Chloris gayana*), African lovegrass (*Eragrostis curvula*) and bridal creeper (*Asparagus asparagoides*) (TSSC 2015). As outlined in **Section 4.2**, management measures will be put in place as part of the Project to minimise weeds. The Project is not expected to cause regular mobilisation of fertilisers, herbicides or other chemicals or pollutants into the surrounding extent of this CEEC.
(e) direct or indirect fragmentation and isolation of an important area of the CEEC or EEC.	An important area (as defined by the FBA (OEH 2014b)) comprises an area of a CEEC or EEC that is necessary for the entity's long-term persistence and recovery. This may include areas identified in recovery plans, and/or an area large in comparison to other stands of the CEEC or EEC or occurrences of the CEEC or EEC at the limit of the community's range. Areas critical to the survival of the community, as identified in the EPBC Act Conservation Advice (TSSC 2015), include areas that meet the minimum condition thresholds (i.e. all areas that conform to the CEEC). While the occurrence of the CEEC within the Development Footprint is unlikely to be necessary for the CEEC's long-term persistence and recovery, this area would be considered critical to the survival of the community as per the EPBC Act Conservation Advice (TSSC 2015). While the Project will result in an increase in the level of fragmentation of this EEC at the local scale, the level of increase is considered negligible given the already highly fragmented nature of this CEEC across the Hunter region. Furthermore, targeted mine rehabilitation and restoration of derived native grassland is proposed to restore the community and connectivity in the post-mining landscape.

Details Required	*Central Hunter Valley Eucalypt Forest and Woodland CEEC*
(f) the measures proposed to contribute to the recovery of the CEEC or EEC in the IBRA subregion.	As part of the Project, a Biodiversity Offset Strategy will be prepared in accordance with the NSW Biodiversity Offsets Policy for Major Projects (OEH 2014a). This will require the identification of suitable land-based or non-land based offsets as outlined in this Policy. In the case of land-based offsets, these may be located in the same or any adjoining IBRA subregion in which the development occurs. The establishment of a BioBank site, as per BBAM (2014c), will include specific management actions that must be carried out to maintain and improve these communities at the BioBank Site. Furthermore, targeted mine rehabilitation is proposed to restore up to 584 hectares of this community in the post-mining landscape to promote the recovery of the CEEC and improve connectivity to surrounding landscapes. The proposed offset strategy for the Project is discussed in **Section 7.0**. This includes in-perpetuity conservation through the establishment of proponent-managed BioBank sites and ecological mine rehabilitation.

5.4.3 Impacts on Threatened Species that Require Further Consideration

As per Section 9.2.5.1 of the FBA (OEH 2014b), impacts on threatened species that require further consideration include impacts on:

(a) any critically endangered species, unless the critically endangered species is specifically excluded in the SEARs

(b) a threatened species or population that is specifically nominated in the SEARS as a species or population that is likely to become extinct or have its viability significantly reduced in the IBRA subregion if it is impacted on by the development, or

(c) where the survey or expert report undertaken in Section 6.6 confirms that a threatened species is present on the proposed development site, and the threatened species has not previously been recorded in the IBRA subregion according to records in the NSW Wildlife Atlas.

Table 5.6 below provides further information for the swift parrot and regent honeyeater, which are listed as critically endangered under the EPBC Act, and the spotted-tailed quoll which were specifically nominated in the SEARs, in accordance with Section 9.2.5.2 of the FBA (OEH 2014b).

Table 5.6 Impacts on Threatened Species that Require Further Consideration

Details Required	Swift parrot *Lathamus discolor*	Regent honeyeater *Anthochaera phrygia*	Spotted-tailed quoll *Dasyurus maculatus maculatus*
(a) the size of the local population directly and indirectly impacted by the development	The swift parrot has not been recorded within the Development Site despite targeted winter bird surveys undertaken over six years (2010-2016) in accordance with the seasonal requirements for this species. The Project will remove approximately 29.7 hectares of vegetation that contains key tree species listed for the swift parrot as per the National Recovery Plan for the species (Saunders and Tzaros 2011). It should be noted that the majority of this habitat is relatively young (less than 25 years old) and associated with post-mining rehabilitation. It is expected that the total population size for the swift parrot is less than 2,000 individuals (Saunders and Tzaros 2011).). The closest records of the species occur approximately 3 kilometres from the Development Footprint recorded 15 years ago in 2002 (OEH 2017a). The species is more regularly and recently recorded from habitats in the Singleton Military Area approximately 15 km from the Development Site. No known populations of the swift parrot occur within the Development Site and it is considered that the species is not likely to be impacted as a result of the Project.	The regent honeyeater has not been recorded within the Development Site despite targeted winter bird surveys undertaken over six years (2010-2016). The Project will remove approximately 29.4 hectares of vegetation that contains key tree species listed for the regent honeyeater as per the National Recovery Plan for the species (DoE 2016a). It should be noted that this habitat is relatively young (less than 25 years old) and associated with post-mining rehabilitation. As at 2010, the total population size is estimated at 350–400 mature individuals (DoE 2016). Previous records of the species in the locality include one record within 500 metres to the south of the Development Site in riparian vegetation associated with Wollombi Brook. This record is dated from 1991 with a location accuracy of 10,000 metres (OEH 2017a). Another record occurs approximately 2 kilometres to the south of the Development Site also along Wollombi Brook dated from 1987 with a location accuracy of 1,000 metres (OEH 2017a). A more recent record from 2002 occurs approximately 5 kilometres to the southeast of the Development Site adjacent to Wallaby Scrub Road in box-ironbark woodlands (OEH 2017a). No	The spotted-tailed quoll has been recorded on a single occasion in the east of the Development Site. This record was made by way of baited (i.e. a food source to attract animals) remote camera in an area of swamp oak vegetation during 2013. This species has not been recorded prior to this event or since this point in time despite subsequent targeted survey. The Project will remove approximately 356.5 hectares of suitable woodland and forest habitat as per the National Recovery Plan (DELWP 2016). It is considered unlikely that the spotted-tailed quoll is breeding within the Development Site, however it is likely that the spotted-tailed quoll occasionally utilises the habitats available as part of a wider territory. The quality of the impacted habitat is considered moderate due to the young age of the vegetation and availability of movement habitat along Redbank Creek. It is considered that the species is not likely to be substantially impacted as a result of the Project.

Details Required	Swift parrot *Lathamus discolor*	Regent honeyeater *Anthochaera phrygia*	Spotted-tailed quoll *Dasyurus maculatus maculatus*
		recent (within the last 5 years) records occur within 5km of the Development Site. No known populations of the regent honeyeater occur within the Development Site and it is considered that the species is not likely to be impacted as a result of the Project.	
(b) the likely impact (including direct and indirect impacts) that the development will have on the habitat of the local population, including but not limited to: **i. an estimate of the change in habitat available to the local population as a result of the proposed development**	The swift parrot breeds in Tasmania and moves to mainland Australia for the non-breeding season (usually arriving between February and March). Most of the population winters in Victoria and NSW. While in NSW, the species occurs in areas of box-gum woodlands and areas of suitable winter-flowering foraging habitat. The Development Site contains potential foraging habitat for the species. The Project will remove approximately 29.7 hectares of majority low quality habitat which is less than 25 years old post-mine rehabilitated vegetation that contains key tree species listed for the swift parrot as per the National Recovery Plan for the species (Saunders and Tzaros 2011). No known populations of the swift parrot occur within the Development Site and no change in known habitat will occur as a result of the Project.	The Regent honeyeater primarily breeds in four known key breeding areas where the species is regularly recorded). The species is known to disperse to foraging habitats in the non-breeding season. The species occurs in areas of box-gum woodlands and areas of suitable foraging habitat. One key feed species (spotted gum (*Corymbia maculata*)) (DoE 2016) has been recorded in the Development Footprint in very low densities. The Project will remove approximately 29.4 hectares of low quality habitat which is less than 25 years old post-mine rehabilitated vegetation that contains key feed species. No known populations of the regent honeyeater occur within the Development Site and no change in known habitat will occur as a result of the Project.	The spotted-tailed quoll generally dens in rock shelters, small caves, hollow logs or tree hollows and utilises numerous dens within its home range. Females occupy home ranges up to about 750 hectares and males up to 3500 hectares and usually traverse their ranges along densely vegetated creeklines. All woodland and forest habitat in the Development Footprint would contain suitable habitat for the species. No dens or signs of breeding has been found in the Development Site, however the Project will likely remove 356.5 hectares of suitable foraging and movement/dispersal habitat for this species.

Details Required	Swift parrot *Lathamus discolor*	Regent honeyeater *Anthochaera phrygia*	Spotted-tailed quoll *Dasyurus maculatus maculatus*
ii. the proposed loss, modification, destruction or isolation of the available habitat used by the local population, and	The Project will remove a range of native vegetation communities within the Development Footprint including fragmented eucalypt woodlands. None of the habitats in the Development Footprint have been recorded as being used by the swift parrot. No known habitat for the swift parrot occurs within the Development Footprint, however the Project may result in the loss, modification, destruction or isolation of potential habitat for the species.	The Project will remove a range of native vegetation communities within the Development Footprint including fragmented eucalypt woodlands. None of the habitats in the Development Footprint have been recorded as being used by the regent honeyeater. No known habitat for the regent honeyeater occurs within the Development Footprint, however the Project may result in the loss, modification, destruction or isolation of potential habitat for the species.	The Project will remove woodland and forest vegetation communities within the Development Footprint. The spotted-tailed quoll has been recorded once in the Development Site in 2013. No breeding habitat for the spotted-tailed quoll occurs within the Development Footprint, however the Project may result in the loss, modification, destruction or isolation of suitable foraging habitat for the species.
iii. modification of habitat required for the maintenance of processes important to the species' life cycle (such as in the case of a plant – pollination, seed set, seed dispersal, germination), genetic diversity and long-term evolutionary development.	The swift parrot breeds exclusively in Tasmania and migrates to mainland Australia during the non-breeding season. There is no potential for breeding habitat to occur in the Development Site. No breeding or nesting habitat for swift parrot occurs within the Development Site and the Project will not result in the modification of habitat important to the species' life cycle.	The regent honeyeater mainly breeds in four key sites, being the Bundarra-Barraba, Capertee Valley and Hunter Valley districts in NSW, and the Chiltern area in north-east Victoria (DoE 2016). Locally, the species has been recorded breeding in forest habitats around Kurri Kurri, NSW. No breeding or nesting habitat for regent honeyeater has been recorded within or in the vicinity of the Development Site and the Project will not result in the modification of habitat important to the species' life cycle.	Habitat that is critical to the survival of the spotted-tailed quoll includes large patches of forest with adequate denning resources and relatively high densities of medium-sized mammalian prey (DELWP 2016). No breeding or denning habitat for the spotted-tailed quoll has been recorded within the Development Site and the Project will not result in the modification of habitat important to the species' life cycle.

Details Required	Swift parrot *Lathamus discolor*	Regent honeyeater *Anthochaera phrygia*	Spotted-tailed quoll *Dasyurus maculatus maculatus*
(c) the likely impact on the ecology of the local population. At a minimum, address the following: - **breeding** - **foraging** - **roosting, and** - **dispersal or movement pathways**	No breeding or nesting habitat for the swift parrot occurs within the Development Site. Roosting habitat may be available in the eucalypt woodlands within the Development Site and native woodland vegetation containing key feed trees may provide some winter foraging habitat for the species, although this has not been recorded. The Project is unlikely to affect dispersal or movement pathways for this highly mobile species. The Project is unlikely to affect the ecology and biology of any population of the swift parrot in the locality.	No breeding or nesting habitat for the regent honeyeater has been recorded within the Development Site. Roosting habitat may be available in the eucalypt woodlands within the Development Site and native woodland vegetation containing key feed trees may provide some foraging habitat for the species, although this has not been recorded. The Project is unlikely to affect dispersal or movement pathways for this highly mobile species. The Project is unlikely to affect the ecology and biology of any population of the regent honeyeater in the locality.	No breeding or denning habitat for the spotted-tailed quoll has been recorded within the Development Site. Foraging habitat may be available in the eucalypt woodlands within the Development Site with Redbank Creek providing suitable dispersal habitat into surrounding lands. Intact and contiguous habitat associated with the adjacent Wollemi National Park will be unaffected by the Project and therefore it is unlikely that dispersal or movement pathways into these habitats will be affected. The removal of Redbank Creek may result in some disruption to dispersal pathways to the north of the site. The Project is unlikely to affect the ecology and biology of any population of the spotted-tailed quoll in the wider locality.
(d) a description of the extent to which the local population will become fragmented or isolated as a result of the proposed development	The swift parrot has not been recorded within the Development Site. This species is highly dispersive and it is unlikely that the Project will create a significant change to the species dispersal capacity or create a significant barrier to the movement of the species.	The regent honeyeater has not been recorded within the Development Site. This species is highly dispersive and it is unlikely that the Project will create a significant change to the species dispersal capacity or create a significant barrier to the movement of the species.	The spotted-tailed quoll has been recorded on one occasion in the Development Site. This species is highly dispersive and occurs in a wide range of habitats and it is unlikely that the Project will create a significant change to the species' dispersal capacity. The removal of Redbank Creek and mine construction may create a barrier to

Details Required	Swift parrot *Lathamus discolor*	Regent honeyeater *Anthochaera phrygia*	Spotted-tailed quoll *Dasyurus maculatus maculatus*
			the movement of the species in the Development Site, however this is unlikely to be significant in a regional context for the species.
(e) the relationship of the local population to other population/populations of the species. This must include consideration of the interaction and importance of the local population to other population/populations for factors such as breeding, dispersal and genetic viability/diversity, and whether the local population is at the limit of the species' range	The swift parrot occurs as a single population in Australia. The species is known to occur regularly in the winter months in the Hunter Valley in the habitats of the Singleton Military Base, approximately 15km from the Development Site. The Development Site is not at the limit of extent of the species known range. It is unlikely that the Project will impede the ability of the swift parrot population to interact for dispersal and genetic viability or diversity.	Despite minor differences between regent honeyeaters in the areas inhabited by the species and the direction and extent of movements, the lack of discernible genetic differences suggest that the regent honeyeater occurs as a single, contiguous population. Seasonal movements outside breeding season in autumn and winter appear to be related to foraging resource availability (DoE 2016). The Development Site is not at the limit of extent of the species known range. It is unlikely that the Project will impede the ability of the regent honeyeater population to interact for dispersal and genetic viability or diversity.	No 'important populations', as defined by the National Recovery Plan (DELWP 2016), of the spotted-tailed quoll occurs in the Hunter-Central Rivers area. Any local population of the spotted-tailed quoll in the locality is likely to be dispersing from higher quality habitats of Wollemi National Park occurring to the west of the Development Site. It is unlikely that the Project will impede the ability of the spotted-tailed quoll population to interact for dispersal and genetic viability or diversity.
(f) the extent to which the proposed development will lead to an increase in threats and indirect impacts, including impacts from invasive flora and fauna, that may in turn lead to a decrease in the viability of the local population	Key threats for the swift parrot include habitat loss and alteration, climate change, collision mortality and psittacine beak and feather disease (PBFD). The Project will exacerbate habitat loss and alteration for the species in potential winter foraging habitat in the Hunter Valley. The species has not been recorded utilising the habitats of the Development Footprint. This is likely to be due to the low frequency of key feed trees in the	Key threats for the regent honeyeater include habitat loss and fragmentation, habitat degradation and the species' small population size. The Project will exacerbate habitat loss and fragmentation for the species in potential foraging habitat in the Hunter Valley. The species has not been recorded utilising the habitats of the Development Footprint. This is likely to be due to the low frequency of key feed trees and the	Key threats for the spotted-tailed quoll include habitat loss and modification, fragmentation, timber harvesting, poison baiting, competition and predation, road mortality and bushfire. The Project will exacerbate habitat loss and fragmentation for the species in potential foraging habitat in the Hunter Valley. The species has been recorded rarely utilising the

Details Required	Swift parrot *Lathamus discolor*	Regent honeyeater *Anthochaera phrygia*	Spotted-tailed quoll *Dasyurus maculatus maculatus*
	area. The Project will not result in an increase of threats related to collision mortality or PBFD.	small number of individuals remaining in the population utilising other higher quality habitats in NSW.	habitats of the Development Footprint. This is likely to be due to the existing fragmented habitats of the Development Site.
(g) the measure/s proposed to contribute to the recovery of the species in the IBRA subregion	As part of the Project, a Biodiversity Offset Strategy will be prepared in accordance with the NSW Biodiversity Offsets Policy for Major Projects (OEH 2014a). This will require the identification of suitable land-based or non-land based offsets as outlined in this Policy. As the swift parrot is an ecosystem-credit species, the offsets will be matched as per the offsetting rules for like-for-like PCTs that will contain suitable habitat for the species. Land-based offsets will be located in the same or any adjoining IBRA subregion in which the development occurs. The establishment of a BioBank site, as per BBAM (OEH 2014c), will include specific management actions that must be carried out to maintain and improve these communities at the BioBank Site. The proposed offset strategy for the proposal is discussed in **Section 7.0**. Further detail on the offset strategy's suitability for the swift parrot is included in **Section 8.0**.	As part of the Project, a Biodiversity Offset Strategy will be prepared in accordance with the NSW Biodiversity Offsets Policy for Major Projects (OEH 2014a). This will require the identification of suitable land-based or non-land based offsets as outlined in this Policy. While no species credits for the regent honeyeater are generated for this Project, the offsets will be matched as per the offsetting rules for like-for-like PCTs that will contain suitable habitat for the species. Land-based offsets will be located in the same or any adjoining IBRA subregion in which the development occurs. The establishment of a BioBank site, as per BBAM (OEH 2014c), will include specific management actions that must be carried out to maintain and improve these communities at the BioBank Site. The proposed offset strategy for the proposal is discussed in **Section 7.0**. Further detail on the offset strategy's suitability for the regent honeyeater is included in **Section 8.0**.	As part of the Project, a Biodiversity Offset Strategy will be prepared in accordance with the NSW Biodiversity Offsets Policy for Major Projects (OEH 2014a). This will require the identification of suitable land-based or non-land based offsets as outlined in this Policy. As the spotted-tailed quoll is an ecosystem-credit species, the offsets will be matched as per the offsetting rules for like-for-like PCTs that will contain suitable habitat for the species. Land-based offsets will be located in the same or any adjoining IBRA subregion in which the development occurs. The establishment of a BioBank site, as per BBAM (OEH 2014c), will include specific management actions that must be carried out to maintain and improve these communities at the BioBank Site. The proposed offset strategy for the proposal is discussed in **Section 7.0**. Further detail on the offset strategy's suitability for the spotted-tailed quoll is included in **Section 8.0**.

5.5 Seven Part Tests of Significance

Threatened species impact assessment is an integral part of environmental impact assessment. The objective of Section 5A of the EP&A Act, the *assessment of significance*, is to improve the standard of consideration afforded to threatened species, populations and ecological communities, and their habitats through the planning and assessment process, and to ensure that the consideration is transparent.

Although it is understood that the preparation of a BioBanking Assessment under the FBA was intended to supersede the requirement to prepare Seven Part Tests, the Department of Planning and Environment (DPE) has advised that the requirements of Section 5A of the EP&A Act are to be considered in the BAR. The preparation of a BAR under the FBA addresses the components of the Seven Part Tests by use of the BBCC. A summary of the requirements of the Seven Part Tests of Significance and where they are addressed in the FBA Assessment is outlined in **Table 5.7** below.

Table 5.7 Seven Part Tests of Significance and the FBA

Seven Part Test of Significance	Where Addressed in the FBA Process
a) in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction;	Threatened species (ecosystem-credit and species-credit) are predicted in the BBCC by the landscape features of the Development Footprint (native vegetation cover, IBRA regions, patch sizes, condition and plant community types) and assessed by the impact on these features. Impacts requiring further consideration (Section 9.2 of the FBA (OEH 2014b) identify impacts on critically endangered threatened species, impacts that may cause the extinction of a species in a IBRA subregion and impacts that significantly reduce the viability of a species.
b) in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction	Endangered populations are predicted in the BBCC by the landscape features of the Development Footprint (native vegetation cover, IBRA regions, patch sizes, condition and plant community types) and assessed by the impact on these features. Impacts requiring further consideration (Section 9.2 of the FBA (OEH 2014b)) identify impacts that may cause the extinction of an endangered population in an IBRA subregion and impacts that significantly reduce the viability of a population.
c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed; **i. is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction; and** **ii. is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction;**	Endangered ecological communities are predicted in the BBCC by the plant community types and biometric community types identified from the field surveys and entered into the BBCC. Impacts requiring further consideration (Section 9.2 of the FBA (OEH 2014b) are identified as impacts on any critically endangered or endangered ecological community that may cause the extinction of the EEC/CEEC in a IBRA subregion or significantly reduce the viability of an EEC/CEEC.

Seven Part Test of Significance	Where Addressed in the FBA Process
d) in relation to the habitat of a threatened species, population or ecological community; **i. the extent to which habitat is likely to be removed or modified as a result of the action proposed;** **ii. whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action; and** **iii. the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality;**	Habitat loss is assessed in the BBCC via the 'Site Values' tab and the loss in site value score entered for each vegetation zone. Fragmentation of habitat is addressed as part of the 'Landscape Value' score including consideration of features before and after the development including per cent native vegetation cover, connectivity value and vegetation condition. The per cent cleared scores for the dominant Mitchell Landscape is also calculated in the 'Landscape Value' score. Important habitat features are identified through determining geographic and habitat features relevant for particular species-credit species and the assessment of landscape features (such as riparian buffers, important wetlands and state or regionally significant biodiversity links). The extent of habitat loss is ultimately determined by the measure of ecosystem credits and species credits calculated in the BBCC.
e) whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly);	Critical habitat is addressed under impacts that require further consideration by the consent authority (refer to Section 9.2 of the FBA (OEH 2014b)).
f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan; and	Recovery plans are not directly addressed in the FBA. Recovery plans (including drafts) have been prepared for koala (*Phascolarctos cinereus*) (DECC 2008), the regent honeyeater (*Anthochaera phrygia* (DoE 2016a)) and the swift parrot (Saunders and Tzaros 2011). It is likely that the Project would be inconsistent with any recovery plans prepared for the threatened species and/or communities impacted by the Project as it relates to impacts on the CEEC and habitat for the species. However the Project will not impede the implementation of these recovery plans. If supplementary offsetting measures are used (as per Appendix B of the NSW Biodiversity Offset Policy for Major Projects) to offset species or communities impacted by projects, reference can be made to the key objectives and actions in the relevant recovery plans.

Seven Part Test of Significance	Where Addressed in the FBA Process
g) whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.	Key threatening processes are not directly assessed under the FBA. In this case, the Project is likely to contribute to the following key threatening processes through the clearing of vegetation: • Clearing of native vegetation (TSC Act and EPBC Acts) • Loss of hollow-bearing trees (TSC Act) • Removal of dead wood and dead trees (TSC Act). The Project may to contribute to the following key threatening processes through clearing of vegetation, edge effects and the operation of the Project: • Aggressive exclusion of birds by noisy miners (*Manorina melanocephala*) (TSC and EPBC Acts) • Competition and grazing by the feral European rabbit (*Oryctolagus cuniculus*) (TSC and EPBC Acts) • Predation by the European red fox (*Vulpes vulpes*) (TSC and EPBC Acts) • Invasion of native plant communities by exotic perennial grasses (TSC Act). While the Project is considered likely to contribute to the function of the above key threatening processes, the Project as a whole, or any component of the Project would not be classified as a key threatening process.

5.6 Environmental Values not Assessed under the FBA

As per Section 2.3 of the FBA (OEH 2014b), biodiversity values not considered under the FBA include marine mammals, wandering sea birds and biodiversity that are endemic to Lord Howe Island. None of these biodiversity values occur or have the potential to occur within the Development Footprint and as such have not been specifically assessed as part of this assessment.

In addition, the FBA does not assess the direct impacts of a Project that are not associated with clearing of vegetation. Examples of these impacts include, but are not limited to:

- bird and bat strike associated with wind farm developments
- vehicle strike
- subsidence and cliff falls associated with mining developments
- downstream impacts on hydrology and environmental flows on surface vegetation and groundwater dependent ecosystems
- impacts on karst ecosystems.

The Project will not involve impacts related to wind farms, substantial changes to vehicle strike risk, or on karst ecosystems. The Project will not lead to subsidence associated impacts as it is an open cut mine. Cliff falls are a risk associated with the high-wall within the mining activity, however, no natural cliff areas will be impacted by the Project. The potential impacts on groundwater dependent ecosystems and downstream impacts on hydrology and environmental flows on vegetation are outlined in the main text of the EIS (Umwelt 2016a) and in Section 8.0 of the SOC report (Umwelt 2016a). It was concluded that the Project would not result in significant downstream impacts on surface vegetation. The EIS also contained a detailed assessment of impacts on GDEs.

6 Biodiversity Credit Report

A full Biodiversity Credit Report is included in **Appendix C**. A summary of the key outcomes in provided in the following sections.

6.1 Credits Required to Offset the Project

Table 6.1 below provides a summary of the ecosystem and species credits that require offsetting as a result of this Project.

Table 6.1 Credits Required to Offset the Project

Name	Credits Required
Ecosystem Credits	
HU812 – Forest Red Gum Grassy Open Forest on Floodplains of the Lower Hunter	20
HU816 – Spotted Gum - Narrow-leaved Ironbark Shrub - Grass Open Forest Slopes of the Upper	1,483
HU869 – Grey Box - Slaty Box Shrub - Grass Woodland on Sandstone Slopes of the Upper Hunter and Sydney Basin	108
HU905 – Narrow-leaved Ironbark - Grey Box grassy Woodland of the Central and Upper Hunter	16,030
HU906 – Bull Oak Grassy Woodland of the Central Hunter Valley	6,852
HU945 – Swamp Oak - Weeping Grass Grassy Riparian Forest of the Hunter Valley	2,132
Total	**26,625**
Species Credits	
southern myotis (*Myotis macropus*)	562
Total	**562**

6.2 Staged Credit Requirement

Consistent with discussions with OEH and DPE, it is proposed to stage the retirement of credits in accordance with the progressive development of the Project. This staging will be consistent with the staging of the Mining Operations Plans (MOP) for the Project, as governed by the *Mining Act 1992*.

United propose to stage the retirement of ecosystem credits as clearing of the Development Footprint occurs. This is currently planned to align with the existing MOP process administered by NSW DRE (MOPs are nominally approved for stages covering up to 7 years of mining activity). However, the final staging will be confirmed based on the detailed planning for implementation of the Project and discussions with DPE. **Table 6.2** outlines the staged credit requirements for the Project based on 7 year MOP stages. The credit

requirements for each stage are based on extrapolation of the average number of ecosystem credits per hectare for each PCT impacted as part of the Project.

Table 6.2 Staged Credit Requirements

Biometric Vegetation Type	Credits to be Retired during Stage 1	Credits to be Retired during Stage 2	Credits to be Retired during Stage 3	Total
Ecosystem Credits				
Threatened Ecological Communities				
Central Hunter Valley Eucalypt Forest and Woodland CEEC^ (including components of HU816, HU869, HU905 and HU906)	8,083	2,407	754	11,244
Hunter Floodplain Red Gum Woodland EEC (HU812 – Forest Red Gum Grassy Open Forest on Floodplains of the Lower Hunter)	0	20	0	20
Central Hunter Ironbark – Spotted Gum – Grey Box Forest EEC (HU816 – Spotted Gum - Narrow-leaved Ironbark Shrub - Grass Open Forest Slopes of the Upper)	1,424	0	0	1,424
Central Hunter Grey Box – Ironbark Woodland EEC (including components of HU905 and HU906)	639	55	17	711
Hunter Valley Footslopes Slaty Gum Woodland VEC (HU869 – Grey Box - Slaty Box Shrub - Grass Woodland on Sandstone Slopes of the Upper Hunter and Sydney Basin)	29	0	0	29
Non-threatened Communities				
HU905 – Narrow-leaved Ironbark - Grey Box grassy Woodland of the Central and Upper Hunter	3,933	815	238	4,896
HU906 – Bull Oak Grassy Woodland of the Central Hunter Valley	5,640	0	439	6,079
HU945 – Swamp Oak - Weeping Grass Grassy Riparian Forest of the Hunter Valley	2,004	114	14	2,132

Biometric Vegetation Type	Credits to be Retired during Stage 1	Credits to be Retired during Stage 2	Credits to be Retired during Stage 3	Total
Total Ecosystem Credits	**21,752**	**3,411**	**1,462**	**26,625**
Species Credits				
southern myotis (*Myotis macropus*)	208	354	0	562
Total Species Credits	**208**	**354**	**0**	**562**

^Note: where the areas of *Central Hunter Valley Eucalypt Forest and Woodland CEEC* under the EPBC Act also conform to TSC Act listed TECs (e.g. *Central Hunter Grey Box – Ironbark Woodland EEC* under the TSC Act), credits have been included in the *Central Hunter Valley Eucalypt Forest and Woodland CEEC* component as this is the higher conservation priority.

7 Biodiversity Offset Strategy

United is committed to delivering a biodiversity offset strategy that appropriately compensates for the unavoidable loss of ecological values as a result of the Project. The following biodiversity offset strategy has been developed in accordance with the FBA with United currently undertaking further works to add to the existing offset strategy for the Project.

As discussed in **Section 4.0**, United has, where possible, altered the Project to avoid and minimise ecological impacts in the project planning stage, and a range of impact mitigation strategies have been included to mitigate the impact on ecological values prior to the consideration of offsetting requirements. The final biodiversity offset strategy to be delivered for the Project will meet the offset requirements for the Project identified in **Section 6.0** and will include some or all of the following offsetting options under the FBA:

- In-perpetuity conservation through the establishment of proponent-managed BioBank sites, achieved through the retirement of credits
- Securing required credits through the open credit market
- Ecological mine rehabilitation
- Contributing money to supplementary measures in accordance with relevant conservation or recovery actions and/or
- Payments to the Biodiversity Offsets Fund.

It is understood that the Biodiversity Offsets Fund that forms part of the FBA policy is not currently established. It is expected that a Fund will become available under the new Biodiversity Assessment Method (BAM) to be finalised in 2017. The use of the Biodiversity Offsets Fund, once established, may be used to satisfy part of the offsetting requirement for the Project.

Fulfilling offset requirements for Stage 1 of the Project under the NSW *Biodiversity Offset Policy for Major Projects* is currently proposed to be undertaken using a combination of the following offset strategies (refer to **Figure 7.1**):

- In-perpetuity conservation using the retirement of biodiversity credits through the establishment of the following BioBank Sites:
    - Wambo BioBank Site
    - Highfields BioBank Site
    - Mangrove BioBank Site
- Restoration of up to 878 hectares of native vegetation communities (including *Central Hunter Valley Eucalypt Forest and Woodland* CEEC) as part of ecological mine rehabilitation.

It is acknowledged that further offsets will be required to fully offset the impacts of Stage 1 and the impacts of Stages 2 and 3 of the Project as outlined in **Section 7.6.2** below. United is currently investigating a number of potential offset sites within the region of the Development Footprint that contain quality vegetation and habitats in accordance with the requirements under the FBA (OEH 2014b). Further information on these areas will be provided following their formal inclusion in the offset package.

The sections below outline the information on the currently proposed offset package components as required in Table 22 of the FBA (OEH 2014b). Details of each of the proposed BioBank sites, their biodiversity values and credits generated are provided in **Sections 7.1** to **7.3**. Ecological mine rehabilitation is discussed in **Section 7.4**. All proposed BioBank sites have been subject to full biometric surveys as required under the BBAM (OEH 2014c). Full details on survey effort and results for the proposed BioBank sites are included in **Appendix D.**

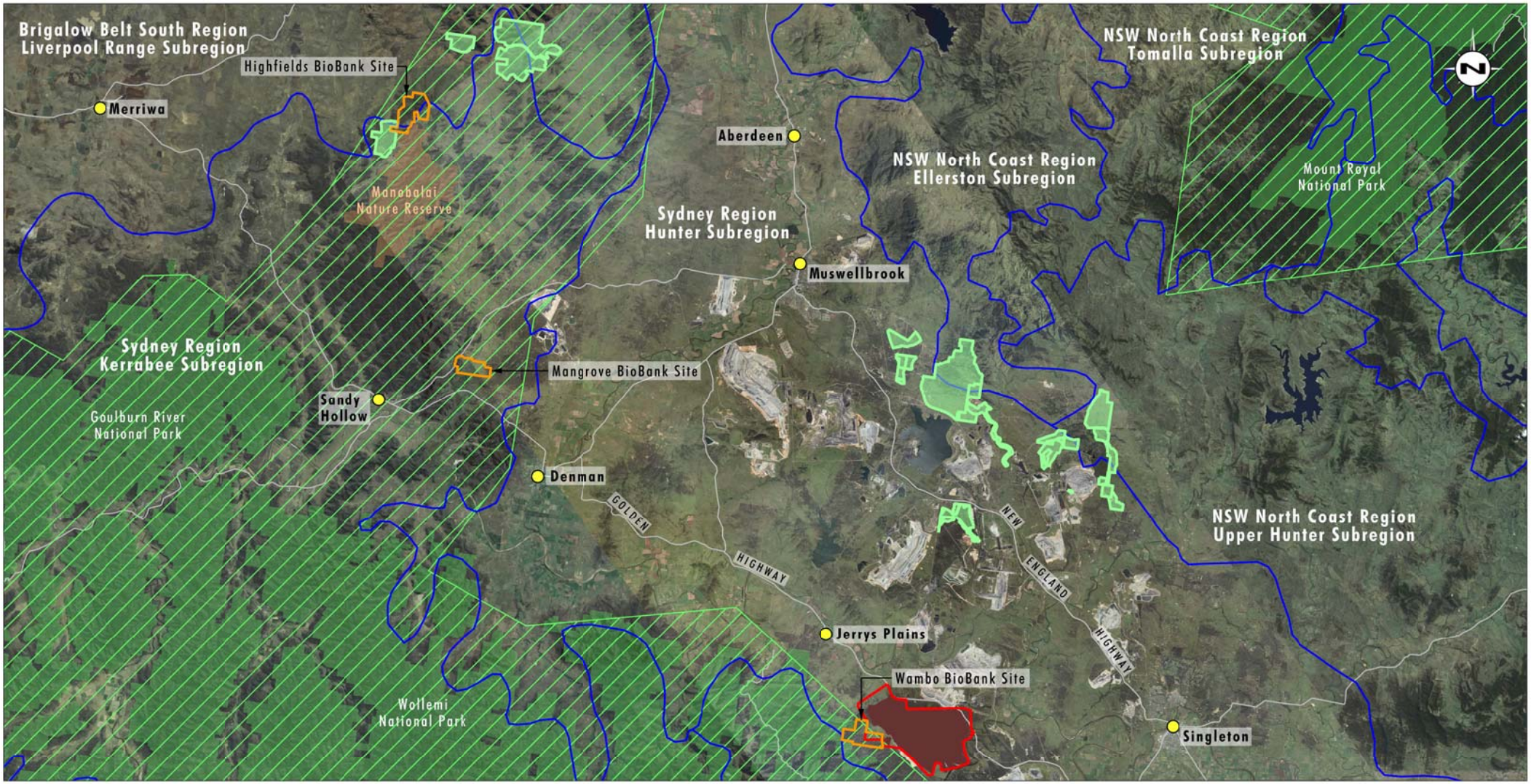

Image Source: Glencore (2008, 2013)
Data Source: Glencore (2016), Department of Lands (2013)

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1:400 000

Legend

- Development Site
- Biobank Sites
- Great Eastern Ranges Corridor Initiative
- Nature Reserve
- National Park
- IBRA V7 Region/Subregion
- Indicative Location of Mine Rehabilitation
- Other Glencore Offsets

FIGURE 7.1

Location Map - Biodiversity Offset Strategy

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20170522 10.47

7.1 Wambo BioBank Site

The proposed Wambo BioBank Site provides locational relevance to the Project, conserving an important area of intact valley floor vegetation and habitats in proximity to the Development Site and connecting to Wollemi National Park to the west. The proposed Wambo BioBank Site contains the following key biodiversity features relevant for the offsetting strategy for the Project:

- 149.6 hectares of *Central Hunter Valley Eucalypt Forest and Woodland CEEC* under the EPBC Act (and 47.9 hectares of grassland able to be restored to conform to the CEEC)
- 215.9 hectares of *Hunter Valley Footslopes Slaty Gum Woodland in the Sydney Basin Bioregion VEC* under the TSC Act
- 41.8 hectares of *Central Hunter Grey Box – Ironbark Woodland in the NSW North Coast and Sydney Basin Bioregions EEC* under the TSC Act
- Woodland and forest habitat suitable key threatened species such as spotted-tailed quoll (*Dasyurus maculatus*) and swift parrot (*Lathamus discolor*)
- Riparian habitat associated with a fifth order stream being North Wambo Creek, and
- Proximity to the impacts of the Project (immediately to the west of the Development Footprint).

7.1.1 Site Details

The proposed Wambo BioBank Site is a proposed offset that will be subject to a BioBank agreement and which is located immediately west of the Development Site. It comprises land owned by Wambo, located in the Jerrys Plains area, approximately 20 kilometres west of Singleton, NSW and adjacent to Wollemi National Park (refer to **Figure 7.1**).

Table 7.1 below provides general information on the proposed Wambo BioBank Site as required by Table 22 of the FBA (OEH 2014b).

Table 7.1 Wambo BioBank Site Details

Wambo BioBank Site	
IBRA Bioregion	Sydney Basin
IBRA Subregion	Hunter
Major Catchment Area	Hunter-Central Rivers
Rivers, Creeks, etc	North Wambo Creek (5th order)
Mitchell Landscape	Central Hunter Foothills
LGA	Singleton
Zoning	RU1 Primary Production
Size	338 hectares

Wambo BioBank Site	
Land Use History	The historical land use of the proposed Wambo BioBank Site has been agricultural, primarily cattle and sheep grazing, although currently the site is relatively unutilised. Parts of the proposed Wambo BioBank Site are currently subject to proposed underground longwall panels as part of the South Bates Extension Modification Project (yet to be approved) (refer to **Section 7.1.1.1**).
General Description	The proposed Wambo BioBank Site is 337.9 hectares in size, with approximately 20 per cent having been previously cleared for agricultural purposes (refer to **Figure 7.2**). The site is positioned on the lower slopes of the southern rim of the Hunter Valley at the base of steep slopes and sandstone escarpments to the southwest. The majority of the site contains Hunter Valley floor woodland vegetation, with small pockets of derived native grassland which have previously been cleared and areas of riparian vegetation along North Wambo Creek. The vegetation is reasonably young and as a result the hollow-bearing tree density is generally low. The woodland vegetation within the site occurs at the interface of land which has been predominantly cleared of trees and converted to grassland for grazing purposes.

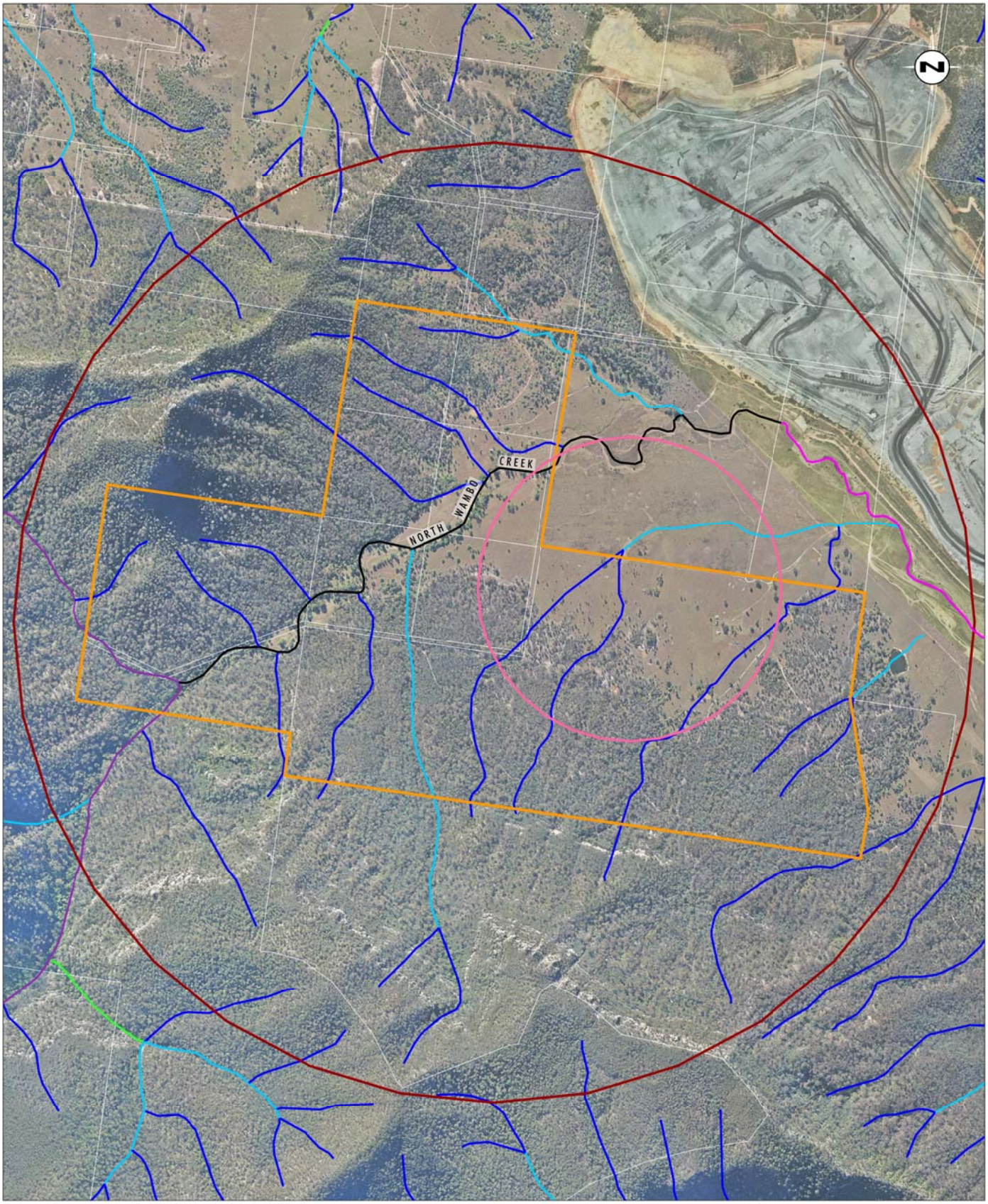

Image Source: AAM (2012), United (2016)
Data Source: LPI (2009)

0 0.25 0.5 1.0km
1:20 000

Legend

- Wambo BioBank Site
- 100ha Assessment Circle
- 1000ha Assessment Circle

Stream Order:

- 1st Order Stream
- 2nd Order Stream
- 3rd Order Stream
- 4th Order Stream
- 5th Order Stream or Greater
- Other Watercourse

FIGURE 7.2

Wambo BioBank Site

File Name (A4): R01/3890_023.dgn
20170519 14.56

7.1.1.1 South Bates Extension Modification

The South Bates Extension Modification proposes to extend longwall panel mining in the Wambo Coal Mine Whybrow Seam to the northwest of the previously approved South Bates Underground Mine. Parts of the proposed longwalls occur under the proposed Wambo BioBank Site. As discussed below the potential impacts of this mining activity (if approved) have been assessed (FloraSearch 2017) and were considered unlikely to result in a measurable impact on the quality of the native vegetation and habitats in the proposed BioBank site.

BioBank sites can be established in areas where mining leases exist and mining may occur. There is also precedent for establishment of biodiversity offset sites above underground mining area where the surface impacts and resultant impacts on biodiversity are low, such as at Glencore's Ulan Coal Mine. Given the high conservation value offered by the large area of CEEC at the Wambo BioBank site, the establishment of an offset site at this location is considered an appropriate outcome.

Further detailed assessment of the potential subsidence impacts associated with any future application to mine under this area will be undertaken as part of the approval process for that development application, however, a summary of the key findings of the assessments completed are provide below.

Potential impacts to native vegetation and habitats as a result of the longwall mining underneath the Wambo BioBanks Site may include subsidence of the land surface, which results in soil cracking, ponding of water, and bedrock cracking in streambeds leading to potential diversion of surface water flows to sub-surface fracture networks (FloraSearch 2017). Mine subsidence effects on the surface are expected to vary according to the depth of cover above the coal seam and surface features such as steep narrow ridge lines (FloraSearch 2017). Surface cracking of soils may potentially occur over the lower flat areas of the site, however would likely be less prevalent as depth of cover increases towards the southern escarpment to the west of the proposed Wambo BioBank Site (FloraSearch 2017).

Overall, the flora impact assessment (FloraSearch 2017) considered it unlikely for vegetation within areas of the proposed Wambo BioBank Site to be adversely affected by soil cracking due to mine subsidence. It was noted, however, that some woodland areas may be affected by ponding and minor effects to riparian vegetation along the upper reaches of North Wambo Creek. The assessment concluded that it is considered unlikely that these impacts will result in a measurable impact to the quality of the native vegetation and habitats in the proposed Wambo BioBank Site under a BioBanking scenario.

7.1.2 Survey Effort and Methods

Surveys of the proposed Wambo BioBank Site have included the following methodology:

- Detailed floristic and vegetation mapping surveys in November 2015 and February/March 2017 including 31 systematic plot-based surveys and collection of biometric data in accordance with BBAM 2014 (OEH 2014c).
- Targeted micro-bat echolocation surveys in November 2015 and February/March 2017 and potential breeding habitat mapping for southern myotis (*Myotis macropus*).
- Targeted winter bird surveys in July 2016, including bird surveys and call playback targeting the regent honeyeater and swift parrot.

Surveys of the proposed Wambo BioBank Site identified three BVTs and eight vegetation zones in accordance with the requirements under BBAM (OEH 2014c) (refer to **Figure 7.3**).

Full details on survey effort and results for the proposed Wambo BioBank Site are included in **Appendix D.**

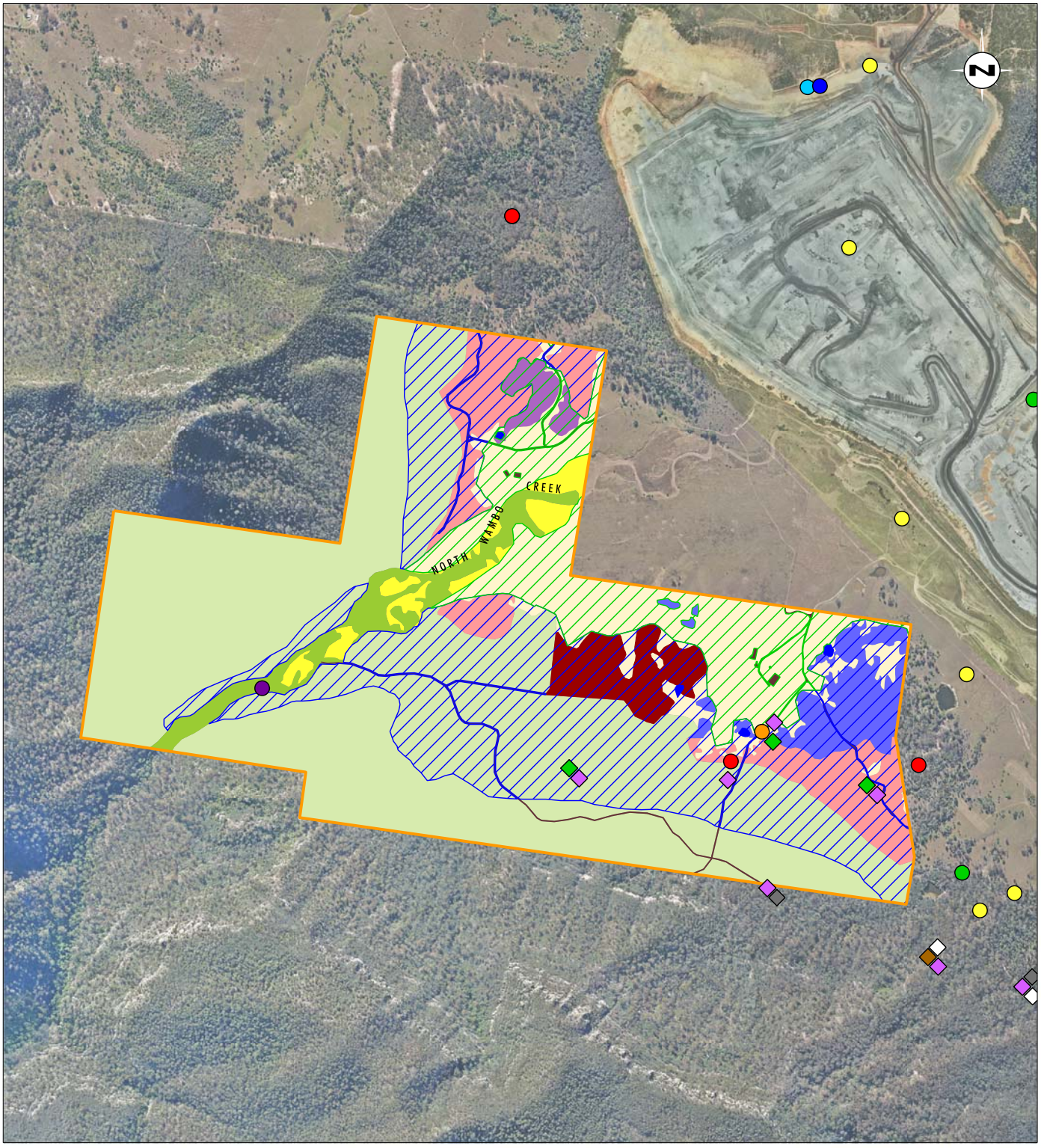

Image Source: AAM (2012), United (2016)
Data Source: LPI (2009)

0 0.25 0.5 1.0km
1:20 000

Legend

- Wambo BioBank Site
- 1 - HU618 - Slaty Box - Grey Gum Shrubby Woodland on Footslopes of the Upper Hunter Valley, Sydney Basin Bioregion - Moderate to Good Condition
- 2 - HU618 - Moderate to Good Condition - Regeneration
- 3 - HU712 River Oak Riparian Grassy Tall Woodland of the Western Hunter Valley (Brigalow Belt South) - Moderate to Good Condition
- 4 - HU712 - Moderate to Good Condition - Derived Native Grassland
- 5 - HU817 Narrow-leaved Ironbark - Bull Oak - Grey Box Shrub - Grass Open Forest of the Central and Lower - Moderate to Good Condition
- 6 - HU817 - Moderate to Good Condition - Cooba Woodland
- 7 - HU817 - Moderate to Good Condition - Derived Native Grassland
- 8 - HU817 - Moderate to Good Condition - Regeneration
- Cleared
- Waterbody
- Central Hunter Valley Eucalypt Forest and Woodland CEEC
- Areas able to be restored to Central Hunter Valley Eucalypt Forest and Woodland CEEC
- Dusky Woodswallow
- East-coast Freetail-bat
- Eastern Bentwing-bat
- Grey Crowned Babbler
- Hooded Robin
- Large-eared Pied Bat
- Little Bentwing-bat
- Little Eagle
- Little Lorikeet
- Speckled Warbler
- Varied Sittella
- Yellow-bellied Sheathtail-bat

FIGURE 7.3

Wambo BioBank Site Biodiversity Features

File Name (A4): R01/3890_032.dgn
20170519 15.16

7.1.3 Credits Generated

Table 7.2 below outlines the PCTs at the proposed Wambo BioBank Site and the ecosystem credits generated at this site.

Appendix E includes a full Biodiversity Credit Report for the proposed Wambo BioBank Site.

Table 7.2 PCTs and Credits Generated at the Wambo BioBank Site

Veg Zone	Plant Community Type *Condition Class*	Area (ha)	Credits Generated
1	HU618 - Slaty Box - Grey Gum Shrubby Woodland on Footslopes of the Upper Hunter Valley, Sydney Basin Bioregion[1, 2] *Moderate to Good*	204.7	3408
2	HU618 - Slaty Box - Grey Gum Shrubby Woodland on Footslopes of the Upper Hunter Valley, Sydney Basin Bioregion[1, 2] *Moderate to Good - Regeneration*	11.2	200
3	HU712 - River Oak Riparian Grassy Tall Woodland of the Western Hunter Valley (Brigalow Belt South) *Moderate to Good*	12.6	224
4	HU712 - River Oak Riparian Grassy Tall Woodland of the Western Hunter Valley (Brigalow Belt South) *Moderate to Good – Derived Native Grassland (DNG)*	7.3	115
5	HU817 - Narrow-leaved Ironbark - Bull Oak - Grey Box shrub - grass open forest of the central and lower Hunter[1, 3] *Moderate to Good*	28.5	429
6	HU817 - Narrow-leaved Ironbark - Bull Oak - Grey Box shrub - grass open forest of the central and lower Hunter *Moderate to Good – Cooba Woodland Variant*	4.0	60
7	HU817 - Narrow-leaved Ironbark - Bull Oak - Grey Box shrub - grass open forest of the central and lower Hunter[1] *Moderate to Good – DNG*	52.7	818
8	HU817 - Narrow-leaved Ironbark - Bull Oak - Grey Box shrub - grass open forest of the central and lower Hunter[1, 3] *Moderate to Good – Regeneration*	13.3	206
NA	Cleared land/waterbodies	3.6	-
Total		**337.9**	**5,460**

1 Conforms to (or partially conforms to) *Central Hunter Valley Eucalypt Forest and Woodland CEEC* under the EPBC Act (refer to **Appendix D** for details).

2 Conforms to *Hunter Valley Footslopes Slaty Gum Woodland in the Sydney Basin Bioregion VEC* under the TSC Act.

3 Conforms to *Central Hunter Grey Box – Ironbark Woodland in the NSW North Coast and Sydney Basin Bioregions EEC* under the TSC Act.

7.1.4 Improvement in Site Values

There are no pre-existing conservation obligations in relation to the proposed Wambo BioBank Site. This site has previously been, and could in the future be, developed for agricultural purposes under existing legislative arrangements. The economic viability of any farming on this area in the future (i.e. if not used for offsetting the impacts from the proposed Project) would almost certainly require an improvement in pasture quality which will significantly lower the ecological value of this land from that which presently exists.

The BBCC calculated the conservation management zones across the proposed Wambo BioBank Site using the predicted gain in site value scores based on standard management practices. These include:

- management of grazing for conservation
- weed control
- ecological fire management
- management of human disturbance
- retention of regrowth and remnant native vegetation
- replanting or supplementary planning where natural regeneration is not sufficient
- retention of dead timber
- erosion control
- retention of rocks.

Additional management actions are proposed to improve habitats and increase site attribute scores using the following methods:

- targeted supplementary planting of native canopy and midstorey species to improve the native species richness, native overstorey cover and overstorey regeneration
- targeted habitat augmentation including placement of logs and woody debris to improve the total length of fallen logs.

Table 7.3 below outlines the additional management actions and adjusted site value scores for the proposed Wambo BioBank Site.

Table 7.4 provides details of the additional management actions required to meet the requirements of Table 32 of BBAM (OEH 2014c).

Table 7.3 Site Value and Averted Loss Scores for Management Zones at the Wambo BioBank Site

Veg Zone	Plant Community Type *Condition Class*	Management Zone (in relation to LEP Zone)	Averted Loss	Site Value Score			Additional Management Actions to Increase Site Attribute Scores
				Current	Future	Gain	
1	HU618 - *Moderate to Good*	1_RU1	14.22	72.22	94.00	21.78	None applicable.
2	HU618 - *Moderate to Good – Regeneration*	2_RU1	9.33	58.89	90.44	31.55	Supplementary planting: • Native midstorey cover (1.0-2.5) Habitat augmentation: • Total length of fallen logs (1.0-2.0) Refer to **Table 7.4** for details.
3	HU712 - *Moderate to Good*	3_RU1	14.22	73.78	100.00	26.22	None applicable.
4	HU712 - *Moderate to Good DNG*	4_RU1	3.33	20.00	49.33	29.33	Supplementary planting and DNG restoration: • Native overstorey cover (1.0-2.0) • Native midstorey cover (0.0-1.5) • Overstorey regeneration (0.0-1.0) Habitat augmentation: • Total length of fallen logs (1.0-2.0) Refer to **Table 7.4** for details.
5	HU817 - *Moderate to Good*	5_RU1	13.02	61.46	78.12	16.66	None applicable.

Veg Zone	Plant Community Type *Condition Class*	Management Zone (in relation to LEP Zone)	Averted Loss	Site Value Score			Additional Management Actions to Increase Site Attribute Scores
				Current	Future	Gain	
6	HU817 - *Moderate to Good – Cooba Woodland Variant*	6_RU1	3.64	26.56	52.60	26.04	Supplementary planting: • Native midstorey cover (0.0-1.5) • Overstorey regeneration (0.0-1.0) Habitat augmentation: • Total length of fallen logs (0.0-0.5) Refer to **Table 7.4** for details.
7	HU817 - *Moderate to Good – DNG*	7_RU1	2.34	15.62	44.79	29.17	Supplementary planting and DNG restoration: • Native plant species richness (1.0-2.0) • Native overstorey cover (0.0-1.5) • Native midstorey cover (0.0-1.5) Habitat augmentation: • Total length of fallen logs (0.0-0.5) Refer to **Table 7.4** for details.
8	HU817 - *Moderate to Good – Regeneration*	8_RU1	7.98	53.47	76.91	23.44	None applicable.

Table 7.4 Additional Management Actions to Increase Site Attribute Scores at the Wambo BioBank Site

Site Attribute	Assessment Against Benchmark	Actions
Vegetation Zone 2 - HU618 - Slaty Box - Grey Gum Shrubby Woodland on Footslopes of the Upper Hunter Valley, Sydney Basin Bioregion ***Moderate to Good - Regeneration***		
Native midstorey cover (1.0-2.5)	Must achieve >50-75% or >100 - <125% of benchmark. Benchmark for HU618 = 10.00-60.00	Supplementary planting of midstorey species characteristic of surrounding areas of established HU618. Indicative species include: • currawang (*Acacia doratoxylon*) • narrow-leaved wattle (*Acacia linearifolia*) • cooba (*Acacia salicina*) • sticky hop-bush (*Dodonaea viscosa*) • native olive (*Notelaea microcarpa* var. *microcarpa*) • narrow-leaved geebung (*Persoonia linearis*).
Total length of fallen logs (1.0-2.0)	Placement of coarse woody debris is at least 10cm diameter and 0.5m long and will be in a range >25% and <50% of benchmark. Benchmark for HU618 = 66.00	Active placement of logs and placed in a configuration that reflects natural systems. This will include: • salvage of trees felled during construction works and emplacement within the vegetation zone as log piles (must be at least 10cm diameter and greater than 0.5m long). • salvage and placement of large rocks and boulders into piles as further potential habitat.

Site Attribute	Assessment Against Benchmark	Actions
Vegetation Zone 4 - HU712 - River Oak Riparian Grassy Tall Woodland of the Western Hunter Valley (Brigalow Belt South) ***Moderate to Good – DNG***		
Native overstorey cover (1.0-2.0)	Must achieve >25-50% or >100 - <175% of benchmark. Benchmark for HU712 = 10.00-50.00	Supplementary planting of canopy species characteristic of surrounding areas of established HU712. Indicative species include: • river oak (*Casuarina cunninghamiana* subsp. *cunninghamiana*) • forest red gum (*Eucalyptus tereticornis*) • rough-barked apple (*Angophora floribunda*).
Native midstorey cover (0.0-1.5)	Must achieve >25-50% or >100 - <175% of benchmark. Benchmark for HU712 = 10.00-50.00	Supplementary planting of midstorey species characteristic of surrounding areas of established HU712. Indicative species include: • river bottlebrush (*Callistemon sieberi*) • creeping saltbush (*Atriplex semibaccata*) • tree violet (*Melicytus dentatus*) • tantoon (*Leptospermum polygalifolium* subsp. *polygalifolium*).
Overstorey regeneration (0.0-1.0)	Must achieve >25-50% of the overstorey species for the PCT.	Characteristic overstorey species for HU712 includes: • river oak (*Casuarina cunninghamiana* subsp. *cunninghamiana*) • forest red gum (*Eucalyptus tereticornis*) • rough-barked apple (*Angophora floribunda*).
Total length of fallen logs (1.0-2.0)	Placement of coarse woody debris is at least 10cm diameter and 0.5m long and will be in a range >25% and <50% of benchmark. Benchmark for HU712 = 10.00	Active placement of logs and placed in a configuration that reflects natural systems. This will include: • salvage of trees felled during construction works and emplacement within the vegetation zone as log piles (must be at least 10cm diameter and greater than 0.5m long). • salvage and placement of large rocks and boulders into piles as further potential habitat.

Site Attribute	Assessment Against Benchmark	Actions
Vegetation Zone 6 - HU817 - Narrow-leaved Ironbark - Bull Oak - Grey Box shrub - grass open forest of the central and lower Hunter ***Moderate to Good – Cooba Woodland Variant***		
Native midstorey cover (0.0-1.5)	Must achieve >25-50% or >100 - <175% of benchmark. Benchmark for HU817 = 5.00-20.00	Supplementary planting of midstorey species characteristic of surrounding areas of established HU817. Indicative species include: • bulloak (*Allocasuarina luehmannii*) • blackthorn (*Bursaria spinosa*) • coffee bush (*Breynia oblongifolia*).
Overstorey regeneration (0.0-1.0)	Must achieve >25-50% of the overstorey species for the PCT.	Characteristic overstorey species for HU817 includes: • narrow-leaved ironbark (*Eucalyptus crebra*) • grey box (*Eucalyptus moluccana*) • bulloak (*Allocasuarina luehmannii*).
Total length of fallen logs (0.0-0.5)	Placement of coarse woody debris is at least 10cm diameter and 0.5m long and will be in a range >25% and <50% of benchmark. Benchmark for HU817 = 5.00	Active placement of logs and placed in a configuration that reflects natural systems. This will include: • salvage of trees felled during construction works and emplacement within the vegetation zone as log piles (must be at least 10cm diameter and greater than 0.5m long). • salvage and placement of large rocks and boulders into piles as further potential habitat.
Vegetation Zone 7 - HU817 - Narrow-leaved Ironbark - Bull Oak - Grey Box shrub - grass open forest of the central and lower Hunter ***Moderate to Good – DNG***		
Native plant species richness (1.0-2.0)	Must achieve between 50 – 100% of native species benchmark. Benchmark for HU817 = 41.00	Supplementary planting of species characteristic of surrounding areas of established HU817. Refer to below lists for overstorey and midstorey species.

Site Attribute	Assessment Against Benchmark	Actions
Native overstorey cover (0.0-1.5)	Must achieve >50-75% or >100 - <125% of benchmark. Benchmark for HU817 = 10.00-50.00	Supplementary planting of canopy species characteristic of surrounding areas of established HU817. Indicative species include: • narrow-leaved ironbark (*Eucalyptus crebra*) • grey box (*Eucalyptus moluccana*) • bulloak (*Allocasuarina luehmannii*).
Native midstorey cover (0.0-1.5)	Must achieve >25-50% or >100 - <175% of benchmark. Benchmark for HU817 = 5.00-20.00	Supplementary planting of midstorey species characteristic of surrounding areas of established HU817. Indicative species include: • bulloak (*Allocasuarina luehmannii*) • blackthorn (*Bursaria spinosa*) • coffee bush (*Breynia oblongifolia*).
Total length of fallen logs (0.0-0.5)	Placement of coarse woody debris is at least 10cm diameter and 0.5m long and will be in a range >25% and <50% of benchmark. Benchmark for HU817 = 5.00	Active placement of logs and placed in a configuration that reflects natural systems. This will include: • salvage of trees felled during construction works and emplacement within the vegetation zone as log piles (must be at least 10cm diameter and greater than 0.5m long). • salvage and placement of large rocks and boulders into piles as further potential habitat.

7.2 Highfields BioBank Site

The proposed Highfields BioBank Site occupies an important position in the landscape, particularly due to its proximity to Manobalai Nature Reserve and location within the corridor proposed as part of the Great Eastern Ranges Initiative. The proposed Highfields BioBank Site is also located in proximity to the Reedy Valley and Esparanga Offset Sites which were established for the approved Bulga Optimisation Project and Mount Owen Continued Operations Project in the Hunter Valley. The proposed Highfields BioBank Site contains the following key biodiversity features relevant for the offsetting strategy for the Project:

- 306 hectares of *White Box Yellow Box Blakely's Red Gum Grassy Woodland and Derived Native Grassland CEEC* under the EBPC Act and *White Box Yellow Box Blakely's Red Gum Woodland EEC* under the TSC Act
- woodland and forest habitat suitable key threatened species such as spotted-tailed quoll (*Dasyurus maculatus*), regent honeyeater (*Anthochaera phrygia*) and swift parrot (*Lathamus discolor*)
- riparian habitat associated with a third order stream being Dry Creek, and
- it is within the area targeted for conservation as part of the Great Eastern Ranges Initiative.

7.2.1 Site Details

The Highfields BioBank Site is a proposed offset that will be subject to a BioBank agreement and which is located approximately 60 km northwest of the Development Site. It comprises land owned by Glencore, located in the Manobalai area, approximately 30 kilometres northwest of Muswellbrook, NSW (refer to **Figure 7.1**).

Table 7.5 below provides general information on the proposed Highfields BioBank Site as required by Table 22 of the FBA (OEH 2014b).

Table 7.5 Highfields BioBank Site Details

Highfields BioBank Site	
IBRA Bioregion	Brigalow Belt South
IBRA Subregion	Liverpool Range
Major Catchment Area	Hunter-Central Rivers
Rivers, Creeks, etc	Dry Creek (3rd order)
Mitchell Landscape	Liverpool Range Valleys and Footslopes
LGA	Muswellbrook
Zoning	E3 Environmental Management RU1 Primary Production
Size	427 hectares

Highfields BioBank Site	
Land Use History	The historical land use of the Highfields BioBank Site has been agricultural, primarily cattle and sheep grazing. The property has been maintained as a landholding for this purpose since the late 1800s. Currently this property is maintained by Glencore and utilised for cattle grazing. Large portions of the property contain native vegetation cover.
General Description	The proposed Highfields BioBank Site is 427 hectares in size, with approximately 11 per cent having been previously cleared for agricultural purposes (refer to **Figure 7.4**). This cleared land occurs on the lower slopes and undulating land on the plateaus. The site has steep, rising hills with vegetative cover that ranges from open to dense woodland and containing ridgelines, outcrops and caves. The remainder of the BioBank Site is characterised by remnant woodland on the upper and lower slopes and drainage lines. The proposed Highfields BioBank Site contains an array of basalt, sandstone and conglomerate outcropping, primarily along the lower slopes and within the semi-regular ridgelines that line the elevated sections. These ridgelines, which form an escarpment in elevated areas, contain numerous caves. The gullies within the BioBank Site range from gradual to steep in slope and are generally dry with few aquatic or inundation dependent flora species present. There are a few small farm dams scattered on the lower slopes and upper plateaux of the BioBank Site, in areas cleared for livestock grazing. The alluvial flats and lower slopes trend from open grassland, to grassland with scattered trees to woodland areas, representing several different vegetation community types. The mid-slope areas tend to be dominated by forest and woodland, with woodland dominating above the ridgelines.

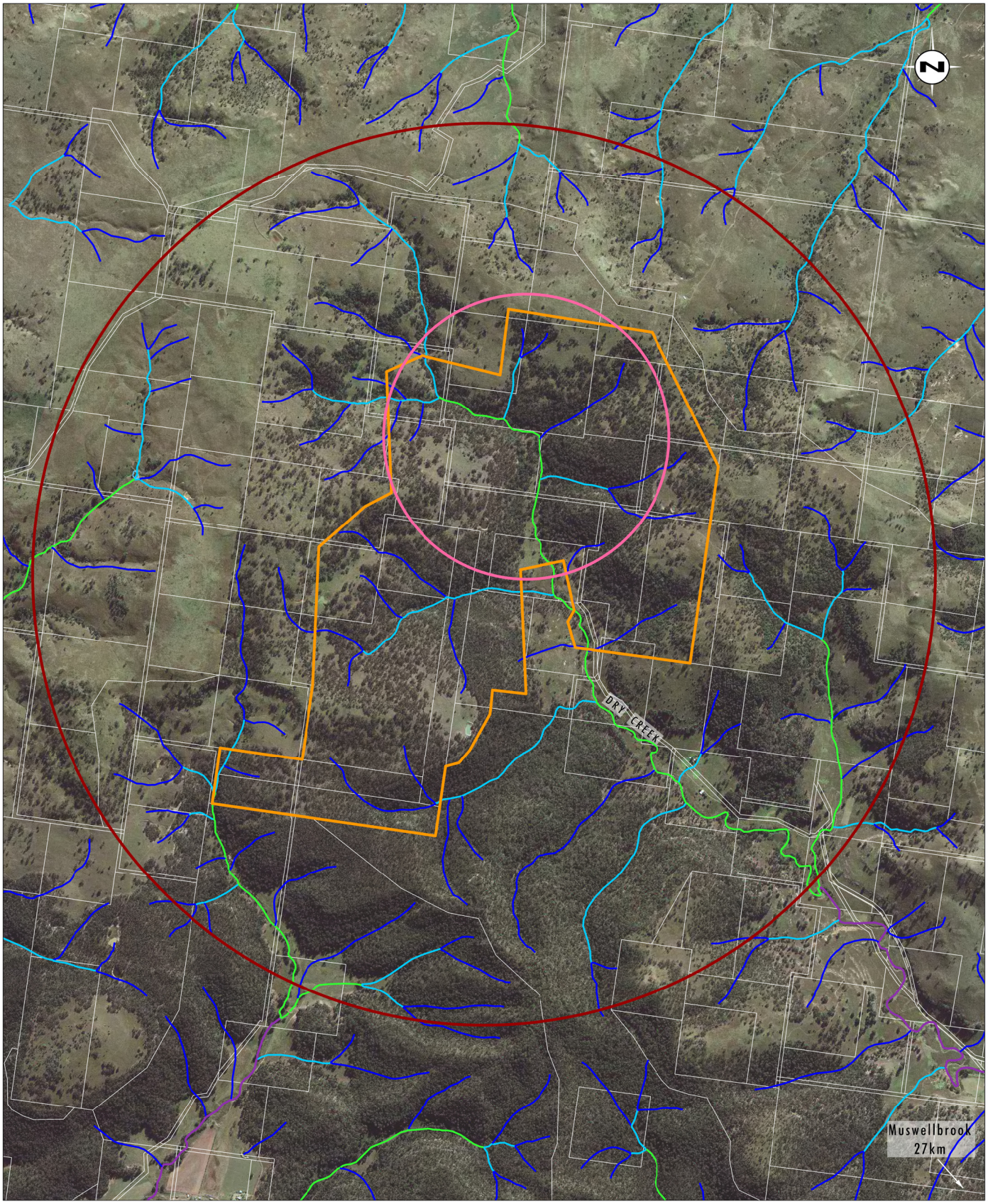

Image Source: Google Earth (2013)
Data Source: LPI NSW (2009)

0 0.5 1.0 1.5km
1:30 000

Legend

- Highfields BioBank Site
- 100ha Assessment Circle
- 1000ha Assessment Circle

Stream Order:

- 1st Order Stream
- 2nd Order Stream
- 3rd Order Stream
- 4th Order Stream

FIGURE 7.4

Highfields BioBank Site

7.2.2 Survey Effort and Methods

Surveys of the proposed Highfields BioBank Site included the following methodology:

- Detailed floristic and vegetation mapping surveys in May 2011, May 2013, November and December 2015 and November 2016 including 35 systematic plot-based survey and collection of biometric data in accordance with BBAM 2014 (OEH 2014c).
- Detailed fauna surveys in April 2011, April and May 2013, and October 2013, including hair funnel surveys, harp trapping, spotlighting, herpetological searches, bird surveys, call playback, micro-bat echolocation recording, remote camera surveys and habitat assessments.
- Targeted winter bird surveys in August 2011, July 2013 and August 2016 including bird surveys and call playback targeting the regent honeyeater (*Anthochaera phrygia*) and swift parrot (*Lathamus discolor*).

Surveys of the Highfields BioBank Site identified four BVTs and seven vegetation zones in accordance with the requirements under BBAM (OEH 2014c) and a range of threatened species (refer to **Figure 7.5**).

Full details on survey effort and results for the proposed Highfields BioBank Site are included in **Appendix D.**

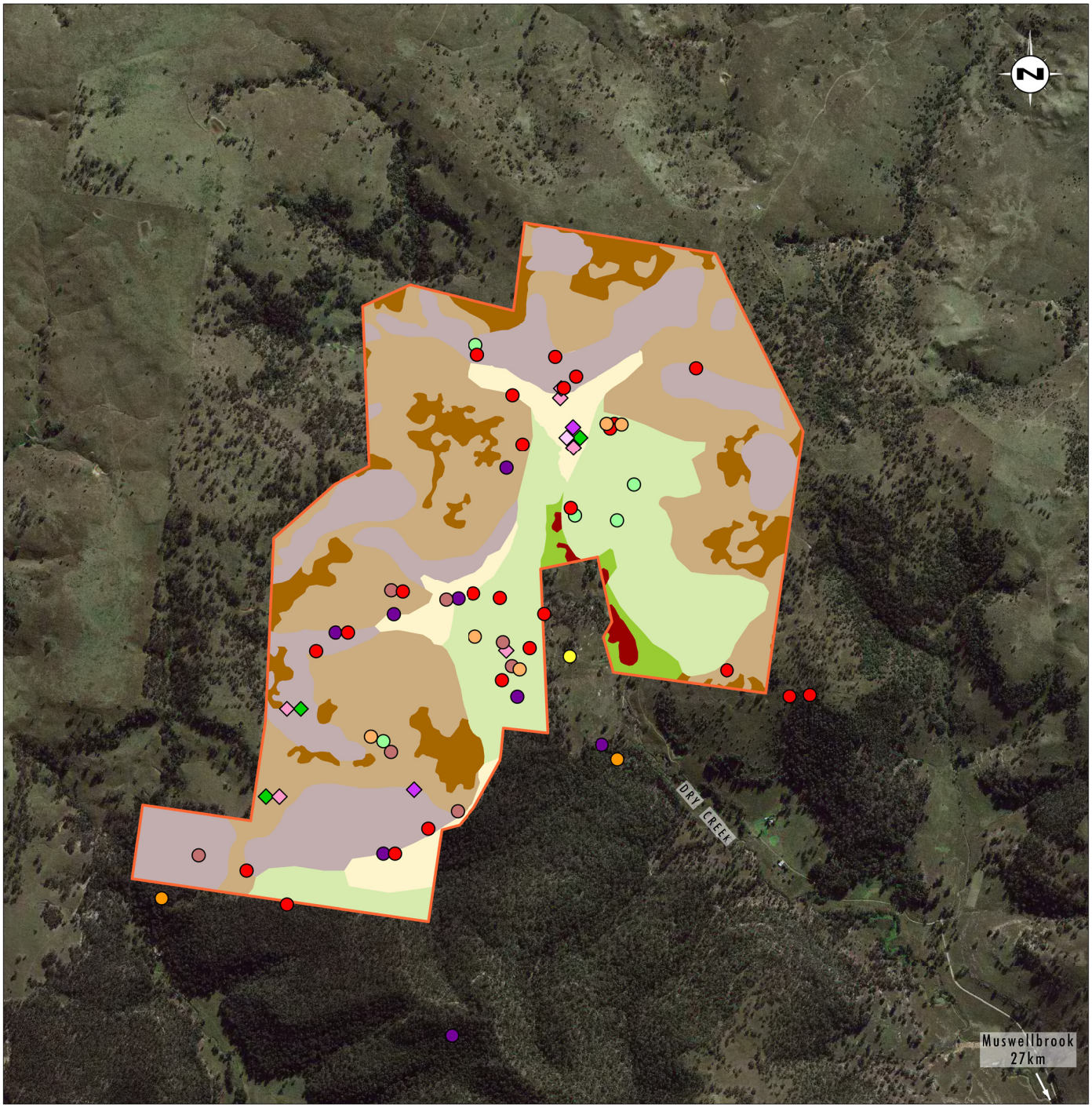

Image Source: Google Earth (2013)
Data Source: ATLAS (2016), Umwelt (2016), United (2015)

0 0.5 1.0 1.5km
1:25 000

Legend

- Highfields BioBank Site
- 1 - HU714 - Rough-Barked Apple - Red Gum - Yellow Box Woodland on alluvial clay to loam soils on valley flats in the northern NSW South Western Slopes Bioregion and Brigalow Belt South Bioregion - Moderate to Good Condition
- 2 - HU730 - White Box x Grey Box - Red Gum - Rough-barked Apple Grassy Woodland on rich soils on hills in the upper Hunter Valley - Moderate to Good Condition
- 3 - HU730 - Moderate to Good Condition - Shrubby Variant
- 4 - HU730 - Moderate to Good Condition - Derived Native Grassland
- 5 - HU821 - Blakely's Red Gum - Narrow-leaved Ironbark - Rough-barked Apple Shrubby Woodland of the upper Hunter - Moderate to Good Condition
- 6 - HU868 - Narrow-leaved Ironbark - Grey Gum Shrubby Open Forest on sandstone ranges of the upper Hunter Valley - Moderate to Good Condition
- 7 - HU868 - Low Condition - Derived Native Grassland

- *Cymbidium canaliculatum*
- Brown Treecreeper (eastern subspecies)
- Eastern Bentwing-bat
- Eastern Cave Bat
- Grey-crowned Babbler (eastern subspecies)
- Large-eared Pied Bat
- Little Lorikeet
- Scarlet Robin
- Southern Myotis
- Speckled Warbler
- Varied Sittella

FIGURE 7.5

Highfields BioBank Site Biodiversity Features

7.2.3 Credits Generated

Table 7.6 below outlines the PCTs at the proposed Highfields BioBank Site and the ecosystem credits generated at this site as required by Table 22 of the FBA (OEH 2014b).

Appendix E includes a full Biodiversity Credit Report for the proposed Highfields BioBank Site.

Table 7.6 PCTs and Credits Generated at the Highfields BioBank Site

Veg Zone	Plant Community Type *Condition Class*	Area (ha)	Credits Generated
1	HU714 - Rough-Barked Apple - red gum - Yellow Box woodland on alluvial clay to loam soils on valley flats in the northern NSW South Western Slopes Bioregion and Brigalow Belt South Bioregion[1,2] *Moderate to Good*	2.5	20
2	HU730 - White Box x Grey Box - red gum - Rough-barked Apple grassy woodland on rich soils on hills in the upper Hunter Valley[1,2] *Moderate to Good*	158.2	1884
3	HU730 - White Box x Grey Box - red gum - Rough-barked Apple grassy woodland on rich soils on hills in the upper Hunter Valley[1,2] *Moderate to Good – Shrubby Variant*	105.6	1209
4	HU730 - White Box x Grey Box - red gum - Rough-barked Apple grassy woodland on rich soils on hills in the upper Hunter Valley[1,2] *Moderate to Good – DNG*	39.7	499
5	HU821 - Blakely's Red Gum - Narrow-leaved Ironbark - Rough-barked Apple shrubby woodland of the upper Hunter *Moderate to Good*	24.9	534
6	HU868 - Narrow-leaved Ironbark - Grey Gum shrubby open forest on sandstone ranges of the upper Hunter Valley *Moderate to Good*	90.1	1058
7	HU868 - Narrow-leaved Ironbark - Grey Gum shrubby open forest on sandstone ranges of the upper Hunter Valley *Low*	6.5	87
Total		**427.5**	**5,291**

1 Conforms to *White Box Yellow Box Blakely's Red Gum Grassy Woodland and Derived Native Grassland CEEC* under the EPBC Act.

2 Conforms to *White Box Yellow Box Blakely's Red Gum Woodland EEC* under the TSC Act.

7.2.4 Improvement in Site Values

There are no pre-existing conservation obligations in relation to the proposed Highfields BioBank Site. This site is currently grazed and has previously been, and could in the future be, developed for agricultural purposes under existing legislative arrangements. The economic viability of any farming on this area in the future (i.e. if not used for offsetting the impacts from the Project) would almost certainly require an improvement in pasture quality which will significantly lower the ecological value of this land from that which presently exists.

The BBCC calculated the conservation management zones across the proposed Highfields BioBank Site using the predicted gain in site value scores based on standard management practices. These include:

- management of grazing for conservation
- weed control
- ecological fire management
- management of human disturbance
- retention of regrowth and remnant native vegetation
- replanting or supplementary planning where natural regeneration is not sufficient
- retention of dead timber
- erosion control
- retention of rocks.

Additional management actions are proposed to improve habitats and increase site attribute scores using the following methods:

- targeted supplementary planting of native canopy and midstorey species to improve the native overstorey cover, native midstorey cover and native ground cover (shrubs)
- targeted habitat augmentation including placement of logs and woody debris to improve the total length of fallen logs.

Table 7.7 below outlines the additional management actions and adjusted site value scores for the Highfields BioBank Site.

Table 7.8 provides details of the additional management actions required to meet the requirements of Table 32 of BBAM (OEH 2014c).

Table 7.7 Site Value and Averted Loss Scores for Management Zones at the Highfields BioBank Site

Veg Zone	Plant Community Type *Condition Class*	Management Zone (in relation to LEP Zone)	Averted Loss	Site Value Score			Additional Management Actions to Increase Site Attribute Scores
				Current	Future	Gain	
1	HU714 - *Moderate to Good*	1_RU1	10.41	65.62	66.67	1.05	None applicable
		1_E3	5.20				
2	HU730 - *Moderate to Good*	2_RU1	15.11	85.42	100.00	14.58	None applicable
		2_E3	7.56				
3	HU730 - *Moderate to Good – Shrubby Variant*	3_RU1	13.54	70.83	84.90	14.07	None applicable
		3_E3	6.77				
4	HU730 - *Moderate to Good – DNG*	4_RU1	3.38	26.04	50.00	23.96	Supplementary planting and DNG restoration: • Native overstorey cover (0.0-1.5) • Native midstorey cover (0.0-1.5) Refer to **Table 7.8** for details.
		4_E3	1.69				
5	HU821 - *Moderate to Good*	5_RU1	3.39	44.62	60.16	15.54	None applicable
		5_E3	1.70				
6	HU868 - *Moderate to Good*	6_RU1	12.00	75.33	92.00	16.67	None applicable
		6_E3	6.00				
7	HU868 – *Low*	7_RU1	4.00	28.67	61.33	32.66	Supplementary planting and DNG restoration:

Veg Zone	Plant Community Type *Condition Class*	Management Zone (in relation to LEP Zone)	Averted Loss	Site Value Score			Additional Management Actions to Increase Site Attribute Scores
				Current	Future	Gain	
		7_E3	2.00				• Native overstorey cover (0.0-1.5) • Native midstorey cover (0.0-1.5) Habitat augmentation: • Total length of fallen logs (1.0-2.0) Refer to **Table 7.7** for details.

RU1 = RU1 Primary Production land zoning under the *Muswellbrook Local Environmental Plan 2009*.

E3 = E3 Environmental Management land zoning under the *Muswellbrook Local Environmental Plan 2009*.

Table 7.8 Additional Management Actions to Increase Site Attribute Scores at the Highfields BioBank Site

Site Attribute	Assessment Against Benchmark	Actions
Vegetation Zone 4 - HU730 - White Box x Grey Box - red gum - Rough-barked Apple grassy woodland on rich soils on hills in the upper Hunter Valley ***Moderate to Good – DNG***		
Native overstorey cover (0.0-1.5)	Must achieve >25-50% or >100 - <175% of benchmark. Benchmark for HU868 = 15.00-40.00	Supplementary planting of canopy species characteristic of surrounding areas of established HU730. Indicative species include: • white box/grey box intergrades (*Eucalyptus albens – moluccana*) • grey box (*Eucalyptus moluccana*) • narrow-leaved ironbark (*Eucalyptus crebra*) • yellow box (*Eucalyptus melliodora*) • Blakely's red gum (*Eucalyptus blakelyi*).
Native midstorey cover (0.0-1.5)	Must achieve >25-50% or >100 - <175% of benchmark. Benchmark for HU868 = 5.00-20.00	Supplementary planting of midstorey species characteristic of surrounding areas of established HU730. Indicative species include: • velvet mock olive (*Notelaea microcarpa* var. *microcarpa*) • bulloak (*Allocasuarina luehmannii*) • shiny-leaved canthium (*Psydrax odoratum*) • cooba (*Acacia salicina*) • green wattle (*Acacia deanei* subsp. *deanei*).

Site Attribute	Assessment Against Benchmark	Actions
Vegetation Zone 7 - HU868 - Narrow-leaved Ironbark - Grey Gum shrubby open forest on sandstone ranges of the upper Hunter Valley ***Low Condition***		
Native overstorey cover (0.0-1.5)	Must achieve >25-50% or >100 - <175% of benchmark. Benchmark for HU868 = 20.00-50.00	Supplementary planting of canopy species characteristic of surrounding areas of established HU868. Indicative species include: • narrow-leaved ironbark (*Eucalyptus crebra*) • black cypress pine (*Callitris endlicheri*) • bulloak (*Allocasuarina luehmannii*).
Native midstorey cover (0.0-1.5)	Must achieve >25-50% or >100 - <175% of benchmark. Benchmark for HU868 = 10.00-60.00	Supplementary planting of midstorey species characteristic of surrounding areas of established HU868. Indicative species include: • narrow-leaved geebung (*Persoonia linearis*) • bulloak (*Allocasuarina luehmannii*) • currawang (*Acacia doratoxylon*) • velvet mock olive (*Notelaea microcarpa* var. *microcarpa*), • blunt beard-heath (*Leucopogon muticus*) • blackthorn (*Bursaria spinosa* subsp. *spinosa*) • coffee bush (*Breynia oblongifolia*).
Total length of fallen logs (1.0-2.0)	Placement of coarse woody debris is at least 10cm diameter and 0.5m long and will be in a range >25% and <50% of benchmark. Benchmark for HU868 = 66.00	Active placement of logs and placed in a configuration that reflects natural systems. This will include: • placement of log piles, where available, within the vegetation zone (must be at least 10cm diameter and greater than 0.5m long) • placement of large rocks and boulders into piles as further potential habitat.

7.3 Mangrove BioBank Site

The proposed Mangrove BioBank Site adjoins other offset sites that are protected as part of the offset for Glencore's Mangoola Mine. It will protect important lowland, river flat and creekline habitats, while also providing a link from the Mangoola offsets to vacant Crown land to the west, and ultimately to Manobalai Nature Reserve and Goulburn River National Park. The proposed Mangrove BioBank Site contains the following key biodiversity features relevant for the offsetting strategy for the Project:

- 20.0 hectares of *Central Hunter Grey Box – Ironbark Woodland in the NSW North Coast and Sydney Basin Bioregions EEC* under the TSC Act
- 15.2 hectares of *Hunter Floodplain Red Gum Woodland in the NSW North Coast and Sydney Basin Bioregions EEC* under the TSC Act and *White Box Yellow Box Blakely's Red Gum Grassy Woodland and Derived Native Grassland CEEC* under the EPBC Act.
- suitable breeding (hollow-bearing tree) habitat for southern myotis (*Myotis macropus*)
- woodland and forest habitat suitable key threatened species such as spotted-tailed quoll (*Dasyurus maculatus*), regent honeyeater (*Anthochaera phrygia*) and swift parrot (*Lathamus discolor*), and
- riparian habitat associated with a sixth order stream being Wybong Creek.

7.3.1 Site Details

The Mangrove BioBank Site is a proposed offset that will be subject to a BioBank agreement and which is located approximately 41 km northwest of the Development Site and approximately 18 km south of the Highfields BioBank Site. It occurs on land owned by Glencore, located in the Manobalai area, approximately 30 kilometres northwest of Muswellbrook, NSW (refer to **Figure 7.1**).

Table 7.9 below provides general information on the proposed Mangrove BioBank Site as required by Table 22 of the FBA (OEH 2014b).

Table 7.9 Mangrove BioBank Site Details

Mangrove BioBank Site	
IBRA Bioregion	Sydney Basin
IBRA Subregion	Kerrabee
Major Catchment Area	Hunter-Central Rivers
Rivers, Creeks, etc	Wybong Creek (6th order)
Mitchell Landscape	Upper Hunter Channels and Floodplain
LGA	Muswellbrook
Zoning	RU1 Primary Production E3 Environmental Management
Size	259 hectares

Mangrove BioBank Site	
Land Use History	The historical land use of the proposed Mangrove BioBank site has been agricultural, primarily cattle and sheep grazing and limited crop production. Currently this property is maintained by Glencore and utilised for cattle grazing. Sections of the property however contain retained native vegetation cover.
General Description	The proposed Mangrove BioBank Site is 259 hectares in size, with approximately 68 per cent having been cleared for agricultural purposes (refer to **Figure 7.6**). This cleared land occurs on the lower and mid slopes. Steep, rising hills range from open to moderately dense woodland and containing ridgelines, outcrops and caves. The remainder of the BioBank Site is characterised by remnant woodland on the slopes and along Wybong Creek. The site is dominated by generally cleared creek flats/floodplain, with some rock outcropping on the western end of the property, in particular. Small farm dams are scattered on the lower and mid slopes of the site, in areas cleared for livestock grazing. Wybong Creek runs through the lowest section of the BioBank Site and is a semi-permanent watercourse with a mix of sand-silt based pools and stony riffles. The creek has deeply incised banks, however the floodplains are gently sloping.

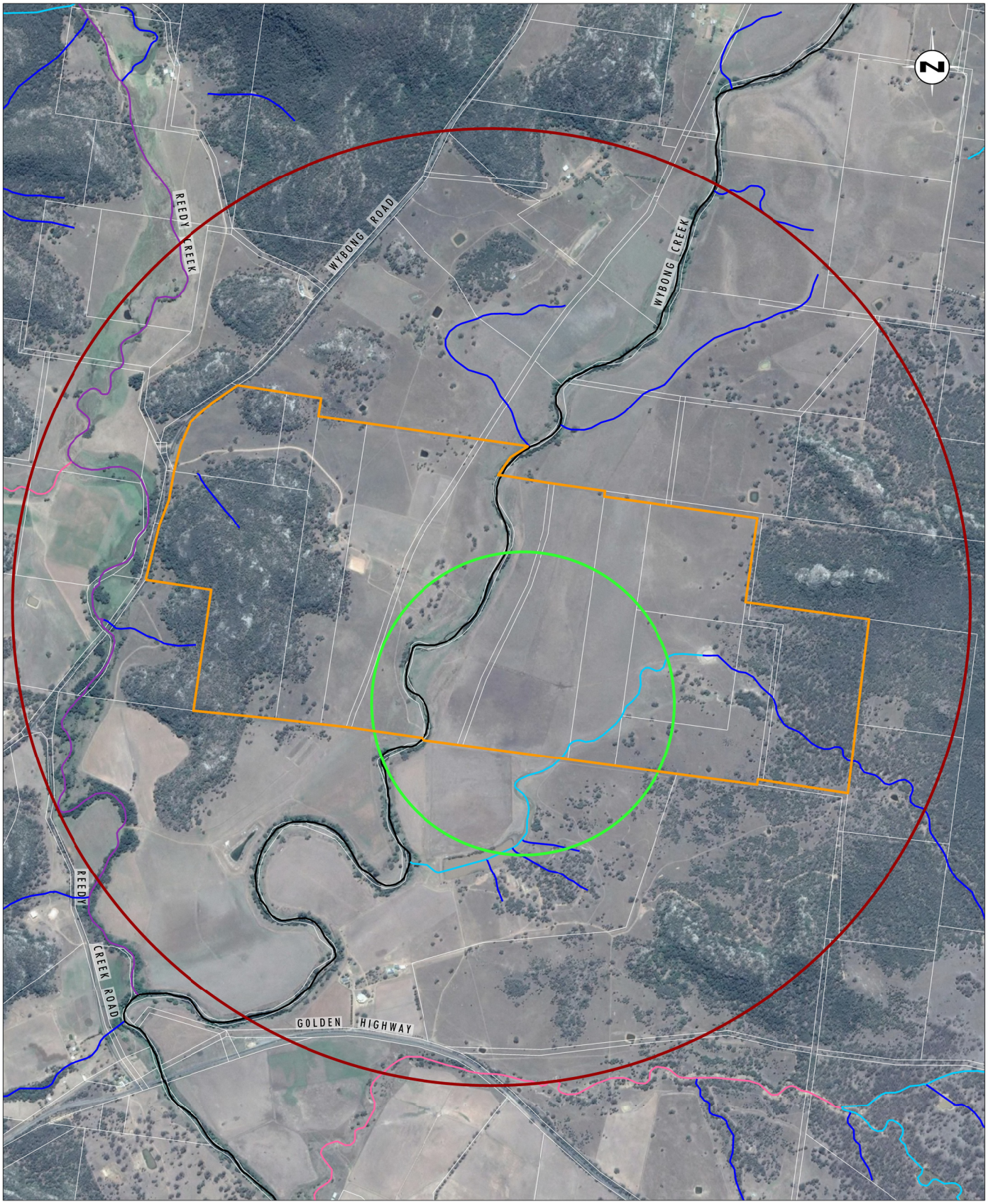

Image Source: Google Earth (Jan 2014)
Data Source: LPI NSW (2009)

0 0.25 0.5 1.0km
1:20 000

Legend

- Mangrove BioBank Site
- 200ha Assessment Circle
- 2000ha Assessment Circle
- 3rd Order Stream
- 4th Order Stream
- 5th Order Stream or Greater

Stream Order:

- 1st Order Stream
- 2nd Order Stream

FIGURE 7.6

Mangrove BioBank Site

File Name (A4): R01/3890_019.dgn
20170322 14.56

7.3.2 Survey Effort and Methods

Surveys of the proposed Mangrove BioBank Site included the following methodology:

- Detailed floristic and vegetation mapping surveys in April and May 2012, November 2015, and November 2016 including 30 systematic plot-based survey and collection of biometric data in accordance with BBAM 2014 (OEH 2014c).
- General fauna surveys in April and May 2012, including hair funnel surveys, spotlighting, herpetological searches, bird surveys, call playback, micro-bat echolocation recording and habitat assessments.
- Targeted searches in September and October 2015 for the terrestrial orchids painted diuris (*Diuris tricolor*) and *Prasophyllum petilum*.
- Targeted micro-bat echolocation surveys and breeding habitat mapping for southern myotis (*Myotis macropus*) in November 2015.
- Targeted winter bird surveys in August 2016, including bird surveys and call playback targeting the regent honeyeater and swift parrot.

Surveys of the proposed Mangrove BioBank Site identified four BVTs and eight vegetation zones in accordance with the requirements under BBAM 2014 (OEH 2014c) and a range of threatened species (refer to **Figure 7.7**).

Full details on survey effort and results for the proposed Mangrove BioBank Site are included in **Appendix D.**

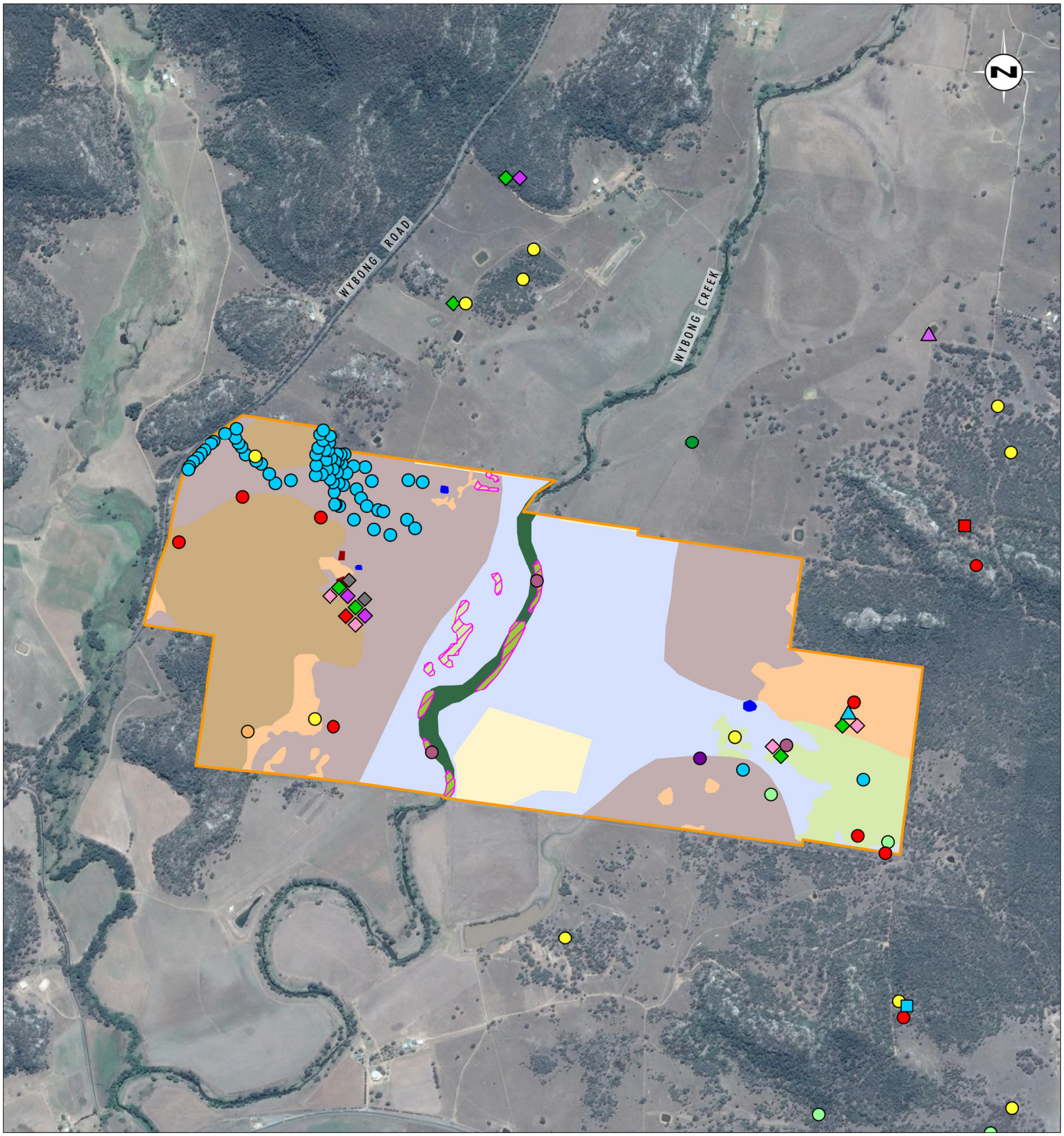

Image Source: Google Earth (2013)
Data Source: ATLAS (2016), Umwelt (2016), United (2015)

0 0.25 0.5 1.0km
1:20 000

Legend

- Mangrove BioBank Site
- 1 - HU599 - River Red Gum / River Oak Riparian Woodland Wetland in the Hunter Valley - Moderate to Good Condition
- 2 - HU599 - Moderate to Good Condition - Derived Native Grassland
- 3 - HU678 - Black Cypress Pine - Ironbark+/-Narrow-leaved Wattle Low Open Forest Mainly on Narrabeen Sandstone in the Upper Hunter Region of the Sydney Basin Bioregion - Moderate to Good Condition
- 4 - HU812 - Forest Red Gum Grassy Open Forest on Floodplains of the Lower Hunter - Moderate to Good Condition
- 5 - HU812 - Moderate to Good Condition - Derived Native Grassland
- 6 - HU905 - Narrow-leaved Ironbark - Grey Box Grassy Woodland of the central and upper Hunter - Moderate to Good Condition
- 7 - HU905 - Moderate to Good Condition - Derived Native Grassland
- 8 - HU812 - Moderate to Good_Poor Condition - Exotic Grassland
- Cleared Land
- Water Body
- Southern Myotis Potential Breeding Habitat

- *Acacia pendula*
- Brown Treecreeper (eastern subspecies)
- Diuris tricolor
- Eastern Bentwing-bat
- Eastern Cave Bat
- Eastern False Pipistrelle
- Glossy Black-cockatoo
- Grey-crowned Babbler (eastern subspecies)
- Koala
- Large-eared Pied Bat
- Little Lorikeet
- Southern Myotis
- Speckled Warbler
- Square-tailed Kite
- Squirrel Glider
- Varied Sittella
- Yellow-bellied Sheathtail-bat

FIGURE 7.7

Mangrove BioBank Site Biodiversity Features

File Name (A4): R01/3890_015.dgn
20160715 16.54

7.3.3 Credits Generated

Table 7.10 below outlines the PCTs at the proposed Mangrove BioBank Site and the ecosystem and species credits generated at this site as required by Table 22 of the FBA (OEH 2014b).

Appendix E includes a full Biodiversity Credit Report for the proposed Mangrove BioBank Site.

Table 7.10 PCTs and Credits Generated at the Mangrove BioBank Site

Veg Zone	Plant Community Type *Condition Class*	Area (ha)	Credits Generated
1	HU599 - River Red Gum / River Oak riparian woodland wetland in the Hunter Valley *Moderate to Good*	1.8	28
2	HU599 - River Red Gum / River Oak riparian woodland wetland in the Hunter Valley *Moderate to Good - DNG*	4.2	78
3	HU678 - Black Cypress Pine - ironbark +/- Narrow-leaved Wattle low open forest mainly on Narrabeen Sandstone in the Upper Hunter region of the Sydney Basin Bioregion *Moderate to Good*	44.9	783
4	HU812 - Forest Red Gum grassy open forest on floodplains of the lower Hunter[1,2] *Moderate to Good*	15.2	188
5	HU812 - Forest Red Gum grassy open forest on floodplains of the lower Hunter *Moderate to Good - DNG*	73.8	1080
6	HU905 - Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter[3] *Moderate to Good*	20.0	304
7	HU905 - Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter *Moderate to Good - DNG*	86.7	1428
8	HU812 - Forest Red Gum grassy open forest on floodplains of the lower Hunter *Moderate to Good - Poor*	11.9	181
Total Ecosystem Credits		**258.5**	**4,070**
-	southern myotis (*Myotis macropus*)	3.0	21
-	pine donkey orchid (*Diuris tricolor*)	1,114	7,909
Total Species Credits		**-**	**7,930**

1 Conforms to *White Box Yellow Box Blakely's Red Gum Grassy Woodland and Derived Native Grassland CEEC* under the EPBC Act.
2 Conforms to *Hunter Floodplain Red Gum Woodland in the NSW North Coast and Sydney Basin Bioregions EEC* under the TSC Act.
3 Conforms to *Central Hunter Grey Box – Ironbark Woodland in the NSW North Coast and Sydney Basin Bioregions EEC* under the TSC Act.

7.3.4 Improvement in Site Values

There are no pre-existing conservation obligations in relation to the proposed Mangrove BioBank Site. This site is currently grazed and has previously been, and could in the future be, developed for agricultural purposes under existing legislative arrangements. The economic viability of any farming on this area in the future (i.e. if not used for offsetting the impacts from the Project) would almost certainly require an improvement in pasture quality which will significantly lower the ecological value of this land from that which presently exists.

The BBCC calculated the conservation management zones across the proposed Mangrove BioBank Site using the predicted gain in site value scores based on standard management practices. These include:

- management of grazing for conservation
- weed control
- ecological fire management
- management of human disturbance
- retention of regrowth and remnant native vegetation
- replanting or supplementary planning where natural regeneration is not sufficient
- retention of dead timber
- erosion control
- retention of rocks.

Additional management actions are proposed to improve habitats and increase site attribute scores using the following methods:

- targeted supplementary planting of native canopy and midstorey species to improve the native species richness, native overstorey cover, native midstorey cover and overstorey regeneration
- targeted habitat augmentation including placement of logs and woody debris to improve the total length of fallen logs.

Table 7.11 below outlines the additional management actions and adjusted site value scores for the Mangrove BioBank Site.

Table 7.12 provides details of the additional management actions required to meet the requirements of Table 32 of BBAM 2014 (OEH 2014c).

Table 7.11 Site Value and Averted Loss Scores for Management Zones at the Mangrove BioBank Site

Veg Zone	Plant Community Type *Condition Class*	Management Zone (in relation to LEP Zone)	Averted Loss	Site Value Score			Additional Management Actions to Increase Site Attribute Scores
				Current	Future	Gain	
1	HU599 - *Moderate to Good*	1_RU1	5.00	26.00	47.89	21.89	Not applicable.
2	HU599 - *Moderate to Good - DNG*	2_RU1	5.00	24.00	57.33	33.33	Supplementary planting and DNG restoration: • Native plant species (1.0-2.0) • Native overstorey cover (0.0-1.5) • Native midstorey cover (0.0-1.5) Habitat augmentation: • Total length of fallen logs (0.0-0.5) Refer to **Table 7.12** for details.
3	HU678 - *Moderate to Good*	3_RU1	14.84	70.31	89.06	18.75	Not applicable.
4	HU812 - *Moderate to Good*	4_RU1	21.33	100.00	100.00	0.00	Not applicable.
		4_E3	10.66				
5	HU812 - *Moderate to Good - DNG*	5_RU1	5.00	47.33	64.67	17.34	Supplementary planting and DNG restoration: • Native overstorey cover (0.0-1.5) Habitat augmentation: • Total length of fallen logs (0.0-0.5) Refer to **Table 7.12** for details.
		5_E3	2.50				
6	HU905 - *Moderate to Good*	6_RU1	13.72	68.06	82.64	14.58	Not applicable.
		6_E3	14.58				

Veg Zone	Plant Community Type *Condition Class*	Management Zone (in relation to LEP Zone)	Averted Loss	Site Value Score			Additional Management Actions to Increase Site Attribute Scores
				Current	Future	Gain	
7	HU905 - *Moderate to Good - DNG*	7_RU1	3.12	25.52	52.08	26.56	Supplementary planting and DNG restoration: • Native overstorey cover (0.0-1.5) • Native midstorey cover (0.0-1.5) Habitat augmentation: • Total length of fallen logs (1.0-2.0) Refer to **Table 7.12** for details.
		7_E3	1.56				
8	HU812 - *Moderate to Good - Poor*	8_RU1	4.00	29.33	50.00	20.67	Supplementary planting and DNG restoration: • Native plant species (1.0-2.0) • Native overstorey cover (0.0-1.5) • Overstorey regeneration (0.0-1.0) Habitat augmentation: • Total length of fallen logs (0.0-0.5) Refer to **Table 7.12** for details.

RU1 = RU1 Primary Production land zoning under the *Muswellbrook Local Environmental Plan 2009*.

E3 = E3 Environmental Management land zoning under the *Muswellbrook Local Environmental Plan 2009*.

Table 7.12 Additional Management Actions to Increase Site Attribute Scores at the Mangrove BioBank Site

Site Attribute	Assessment Against Benchmark	Actions
Vegetation Zone 2 - HU599 - River Red Gum / River Oak riparian woodland wetland in the Hunter Valley ***Moderate to Good - DNG***		
Native plant species richness (1.0-2.0)	Must achieve between 50 – 100% of native species benchmark. Benchmark for HU599 = 38.00	Supplementary planting of species characteristic of surrounding areas of established HU599. Refer to below lists for canopy and midstorey species.
Native overstorey cover (0.0-1.5)	Must achieve >25-50% or >100 - <175% of benchmark. Benchmark for HU599 = 10.00-50.00	Supplementary planting of canopy species characteristic of surrounding areas of established HU599. Indicative species include: • river oak (*Casuarina cunninghamiana* subsp. *cunninghamiana*) • river red gum (*Eucalyptus camaldulensis*) • rough-barked apple (*Angophora floribunda*) • yellow box (*Eucalyptus melliodora*).
Native midstorey cover (0.0-1.5)	Must achieve >25-50% or >100 - <175% of benchmark. Benchmark for HU599 = 10.00-50.00	Supplementary planting of midstorey species characteristic of HU599.
Total length of fallen logs (0.0-0.5)	Placement of coarse woody debris is at least 10cm diameter and 0.5m long and will be in a range >25% and <50% of benchmark. Benchmark for HU599 = 10.00	Active placement of logs and placed in a configuration that reflects natural systems. This will include: • placement of log piles, where available, within the vegetation zone (must be at least 10cm diameter and greater than 0.5m long) • placement of large rocks and boulders into piles as further potential habitat.

Site Attribute	Assessment Against Benchmark	Actions
Vegetation Zone 5 - HU812 - Forest Red Gum grassy open forest on floodplains of the lower Hunter ***Moderate to Good – DNG***		
Native overstorey cover (0.0-1.5)	Must achieve >25-50% or >100 - <175% of benchmark. Benchmark for HU812 = 15.00-65.00	Supplementary planting of canopy species characteristic of surrounding areas of established HU812. Indicative species include: • forest red gum (*Eucalyptus tereticornis*) • Blakelys red gum (*Eucalyptus blakelyi*) • grey box (*Eucalyptus moluccana*) • narrow-leaved ironbark (*Eucalyptus crebra*).
Total length of fallen logs (0.0-0.5)	Placement of coarse woody debris is at least 10cm diameter and 0.5m long and will be in a range >25% and <50% of benchmark. Benchmark for HU812 = 10.00	Active placement of logs and placed in a configuration that reflects natural systems. This will include: • placement of log piles, where available, within the vegetation zone (must be at least 10cm diameter and greater than 0.5m long) • placement of large rocks and boulders into piles as further potential habitat.
Vegetation Zone 7 - HU905 - Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter ***Moderate to Good - DNG***		
Native overstorey cover (0.0-1.5)	Must achieve >25-50% or >100 - <175% of benchmark. Benchmark for HU905 = 15.00-40.00	Supplementary planting of canopy species characteristic of surrounding areas of established HU905. Indicative species include: • narrow-leaved ironbark (*Eucalyptus crebra*) • grey box (*Eucalyptus moluccana*) • black cypress pine (*Callitris endlicheri*).

Site Attribute	Assessment Against Benchmark	Actions
Native midstorey cover (0.0-1.5)	Must achieve >25-50% or >100 - <175% of benchmark. Benchmark for HU905 = 5.00-20.00	Supplementary planting of midstorey species characteristic of surrounding areas of established HU905. Indicative species include: • black she-oak (*Allocasuarina littoralis*) • velvet mock olive (*Notelaea microcarpa* var. *microcarpa*) • native olive (*Notelaea microcarpa*) • blunt beard-heath (*Leucopogon muticus*) • bead bush (*Spartothamnella juncea*).
Total length of fallen logs (1.0-2.0)	Placement of coarse woody debris is at least 10cm diameter and 0.5m long and will be in a range >25% and <50% of benchmark. Benchmark for HU905 = 5.00	Active placement of logs and placed in a configuration that reflects natural systems. This will include: • placement of log piles, where available, within the vegetation zone (must be at least 10cm diameter and greater than 0.5m long) • placement of large rocks and boulders into piles as further potential habitat.
Vegetation Zone 8 - HU812 - Forest Red Gum grassy open forest on floodplains of the lower Hunter ***Moderate to Good - Poor***		
Native plant species richness (1.0-2.0)	Must achieve between 50 – 100% of native species benchmark. Benchmark for HU812 = 15.00	Supplementary planting of species characteristic of surrounding areas of established HU599. Refer to below lists for canopy and midstorey species.
Native overstorey cover (0.0-1.5)	Must achieve >25-50% or >100 - <175% of benchmark. Benchmark for HU812 = 15.00-65.00	Supplementary planting of canopy species characteristic of surrounding areas of established HU905. Indicative species include: • forest red gum (*Eucalyptus tereticornis*) • Blakelys red gum (*Eucalyptus blakelyi*) • grey box (*Eucalyptus moluccana*) • narrow-leaved ironbark (*Eucalyptus crebra*).

Site Attribute	Assessment Against Benchmark	Actions
Overstorey regeneration (0.0-1.0)	Must achieve >25-50% of the overstorey species for the PCT.	Characteristic overstorey species for HU812 at the Mangrove BioBank Site includes: • forest red gum (*Eucalyptus tereticornis*) • Blakelys red gum (*Eucalyptus blakelyi*) • grey box (*Eucalyptus moluccana*) • narrow-leaved ironbark (*Eucalyptus crebra*).
Total length of fallen logs (0.0-0.5)	Placement of coarse woody debris is at least 10cm diameter and 0.5m long and will be in a range >25% and <50% of benchmark. Benchmark for HU812 = 5.00	Active placement of logs and placed in a configuration that reflects natural systems. This will include: • placement of log piles, where available, within the vegetation zone (must be at least 10cm diameter and greater than 0.5m long) • placement of large rocks and boulders into piles as further potential habitat.

7.4 Mine Rehabilitation

The NSW *Biodiversity Offset Policy for Major Projects* enables the use of ecological mine rehabilitation to contribute towards meeting the offset requirement of a mining project. While no theoretical limit exists for the amount that rehabilitation can contribute to the offset under the FBA (OEH 2014b), United acknowledges the importance of providing a varied offset strategy that includes a combination of offset components including land-based offsets and revegetation programs. As outlined in the EIS, taking into account the existing rehabilitation commitments for the Wambo open cut, there is approximately 878 hectares of ecological rehabilitation proposed as part of the Project that is suitable for use as part of the biodiversity offset strategy. As outlined below this area has been divided into two different PCTs, including the restoration of *Central Hunter Valley Eucalypt Forest and Woodland CEEC*.

7.4.1 Target PCTs for Mine Rehabilitation

Table 7.13 below outlines the target PCTs for mine rehabilitation, the natural distribution of the PCTs in relation to the Project, the proposed increase in site attribute scores, the area of rehabilitation and the ecosystem credits proposed to be generated using the Calculator for FBA Section 12.2: "Generating biodiversity credits for ecological rehabilitation of previously mined land" (OEH 2015). It should be noted that no species credits are currently proposed to be generated through mine rehabilitation.

The broad location of the mine rehabilitation is shown in **Figure 7.8**, with the exact areas of ecological rehabilitation that will form part of the offset strategy to be determined through the detailed rehabilitation planning.

Table 7.13 Target PCTs for Mine Rehabilitation

Natural Distribution in Relation to the Development Site	Proposed Increase in Site Attribute Condition Scores	Area Proposed for Rehabilitation (ha)	Ecosystem Credits Generated
PCT1691 (HU905) - Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter Conforming to *Central Hunter Valley Eucalypt Forest and Woodland CEEC*			
PCT1691 occurs naturally in the Hunter IBRA subregion. This PCT is equivalent to MU 10 - Central Hunter Box – Ironbark Woodland, as mapped by Peake (2006), which occurs across 14,800 hectares of the central Hunter Valley. The PCT is known to extend from the Singleton Military Base, west to Denman and Wybong, and north to Castle Rock and Muswellbrook.	• Native species richness: 1.0 • Over-storey cover: 1.0 • Mid-storey cover: 1.0 • Native ground cover (grasses): 1.0 • Native ground cover (shrubs): 1.0 • Native ground cover (other): 1.0 • Exotic plant cover: 1.0 • Number of trees with hollows: 0.5 • Over-storey regeneration: 0.5 • Total length of fallen logs: 0.5	584	2,814

Natural Distribution in Relation to the Development Site	Proposed Increase in Site Attribute Condition Scores	Area Proposed for Rehabilitation (ha)	Ecosystem Credits Generated
PCT1692 (HU906) - Bull Oak grassy woodland of the central Hunter Valley			
PCT1692 occurs naturally in the Hunter IBRA subregion. This PCT is equivalent to MU 32 - Central Hunter Bulloak Forest Regeneration, as mapped by Peake (2006), which occurs across 822 hectares of the central Hunter Valley. The PCT is known to occur from Belford and Singleton to the Denman and Wybong districts. It also extends around the rim of the Hunter Valley floor.	• Native species richness: 1.0 • Over-storey cover: 1.0 • Mid-storey cover: 1.0 • Native ground cover (grasses): 1.0 • Native ground cover (shrubs): 1.0 • Native ground cover (other): 1.0 • Exotic plant cover: 1.0 • Number of trees with hollows: 0.5 • Over-storey regeneration: 0.5 • Total length of fallen logs: 0.5	294	1,416
	Total	**878**	**4,230**

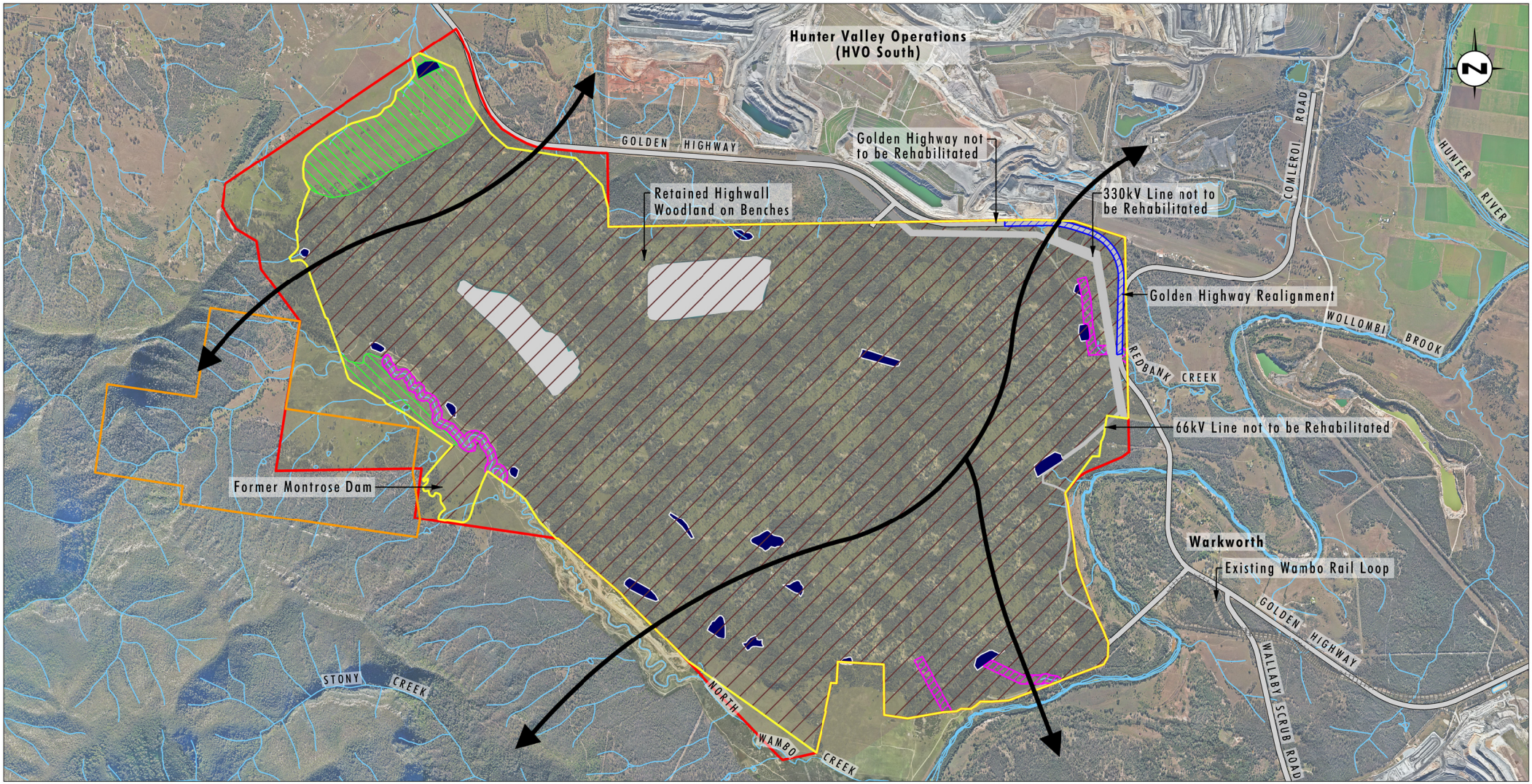

Image Source: AAM (2012), United (2015)
Base Data Source: Glencore (2015), LPI (2009)
Note: Contour Interval 10m

0 1.0 2.0 2.5km
1:50 000

Legend

- Development Site
- Wambo BioBank Site
- Conceptual Rehabilitation Boundary
- Habitat Corridors (existing and proposed vegetation)
- Riparian Vegetation
- Grassland (Agricultural)
- Indicative Area of Ecological Mine Rehabilitation

FIGURE 7.8

Conceptual Ecological Mine Rehabilitation

File Name (A4): R01/3890_022.dgn
20170405 13.46

7.4.2 Rehabilitation Objectives

United's rehabilitation objectives for the Development Site include the following:

- Provide for the safety of employees and the public during and following the closure of the mining operations.
- Provide a sustainable final landform and uses that can co-exist with surrounding land uses. This includes a commitment to the establishment of 'micro-relief' within the final landform for the Project to assist with long-term landform stability and to provide a more natural looking and functioning landform.
- Establish similar native vegetation communities to those that will be impacted by the Project.
- Establishment of ecological rehabilitation as part of the biodiversity offset for the Project.
- Develop native vegetation corridors linking surrounding remnant vegetation areas to the southwest of the Development Site to existing remnants in the north east and south east, and the proposed future native rehabilitation areas of Hunter Valley Operations mine and Mount Thorley Warkworth
- Inclusion of grassland areas for agricultural land use where appropriate.

In achieving these objectives, United will also aim to:

- Minimise the potential environmental impacts from closure activities.
- Comply with relevant regulatory requirements and attain regulatory consensus on the successful closure and rehabilitation of the site.
- Reduce the need for long term monitoring and maintenance by achieving effective rehabilitation.
- Regularly consult with the relevant stakeholders during the closure and rehabilitation planning and implementation process.

7.4.3 Preliminary Performance Indicators and Completion Criteria

Mine rehabilitation will be undertaken in accordance with an approved Mine Operations Plan (MOP) which will detail performance measures and criteria for specific areas that are to be rehabilitated during the term of the MOP. The MOP process provides benchmarks against which performance of the rehabilitation strategy can be measured through development of completion criteria and performance indicators. The preliminary completion criteria and performance indicators that have been developed for the ecological rehabilitation will be reviewed in accordance with the MOP review timeframe (nominally 7 years) to confirm that the rehabilitation areas are meeting or trending towards meeting the completion criteria. Subsequent reviews of the MOP will consider relevant updates to PCTs, benchmarks and assessment methodologies in relation to ongoing refinement of the final completion criteria.

As required in Section 12.2.1.5 of the FBA (OEH 2014b) **Table 7.14** below outlines the preliminary performance indicators and completion criteria for the rehabilitation of the PCTs proposed to be established in the Development Site to contribute to the offset strategy for the Project. While the values in **Table 7.14** have been guided by the Draft *Guidelines for the Ecological Rehabilitation of Recognisable and Self-sustaining Plant Communities Types* (OEH 2015b) and the Biodiversity Assessment Method (BAM) (OEH 2017d), these are preliminary and in consideration of the ongoing changes in legislation and policy, mine

rehabilitation indicators and criteria will be reviewed and modified as part of the MOP process and will consider the contemporary best practice guidance on ecological mine rehabilitation.

Table 7.14 Preliminary Performance Indicators and Completion Criteria by PCT

Attribute	Preliminary Performance Indicators (by Year 7)	Preliminary Completion Criteria (to generate credits for offset)
PCT1691 (HU905) - Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter Conforming to *Central Hunter Valley Eucalypt Forest and Woodland CEEC*		
Site Condition	Native species richness scores are trending towards benchmark for PCT1691 as determined through monitoring.	Rehabilitation contains >50% of the native plant species richness benchmark (i.e. >20 native species) for species characteristic to PCT1691. Native species richness benchmark for PCT1691 is 41 species.
	Overstorey cover scores are trending towards benchmark for PCT1691 as determined through monitoring.	Rehabilitation achieves between >25% and <200% of per cent native overstorey cover benchmark for species characteristic to PCT1691. Native overstorey cover benchmark for PCT1691 is 15-40%.
	Midstorey cover scores are trending towards benchmark for PCT1691 as determined through monitoring.	Rehabilitation achieves between >25% and <200% of per cent native midstorey cover benchmark for species characteristic to PCT1691. Native midstorey cover benchmark for PCT1691 is 5-20%.
	Native ground cover (grasses) scores are trending towards benchmark for PCT1691 as determined through monitoring.	Rehabilitation achieves between >25% and <200% of per cent native ground cover (grasses) benchmark for species characteristic to PCT1691. Native ground cover (grasses) benchmark for PCT1691 is 30-50%.
	Native ground cover (shrubs) scores are trending towards benchmark for PCT1691 as determined through monitoring.	Rehabilitation achieves between >25% and <200% of per cent native ground cover (shrubs) benchmark for species characteristic to PCT1691. Native ground cover (shrubs) benchmark for PCT1691 is 5-10%.
	Native ground cover (other) scores are trending towards benchmark for PCT1691 as determined through monitoring.	Rehabilitation achieves between >25% and <200% of per cent native ground cover (other) benchmark for species characteristic to PCT1691. Native ground cover (other) benchmark for PCT1691 is 20-40%.

Attribute	Preliminary Performance Indicators (by Year 7)	Preliminary Completion Criteria (to generate credits for offset)
	Exotic plant cover is trending towards less than 45% for total ground and midstorey cover as determined through monitoring.	Exotic plant cover is <45% for total ground and midstorey cover.
	Number of trees with hollows (i.e. natural hollows or stags salvaged from other areas and placed into rehabilitation) occur in the rehabilitation.	Rehabilitation contains hollows >25% of the number of hollow-bearing trees benchmark for PCT1691. Number of trees with hollows benchmark for PCT1691 is 30 trees per hectare. This is proposed to be achieved with the installation of artificial nest boxes.
	Targeted planting of canopy species is undertaken with natural reproduction processes (seeds, fruiting) taking place.	Rehabilitation contains at least 25% of dominant overstorey species naturally regenerating (i.e. not planted or seeded).
	Fallen timber and logs occur in the rehabilitation.	Rehabilitation contains >25% of the total length of fallen log benchmark for PCT1691. Total length of fallen log benchmark for PCT1691 is 50 metres per hectare.
Vegetation Composition	Targeted planting of flora species characteristic or diagnostic of PCT1691 is undertaken, including the following species: • narrow-leaved Ironbark (*Eucalyptus crebra*) • grey box (*Eucalyptus moluccana*) • kurrajong (*Brachychiton populneus*) • native olive (*Notelaea microcarpa*) • winter apple (*Eremophila debilis*) • purple wiregrass (*Aristida ramosa*) • barbed wire grass (*Cymbopogon refractus*) • tall chloris (*Chloris ventricosa*) • yellow burr-daisy (*Calotis lappulacea*) • kidney weed (*Dichondra repens*) • paddock lovegrass (*Eragrostis leptostachya*) • weeping grass (*Microlaena stipoides*) • slender bamboo grass (*Austrostipa verticillata*)	Rehabilitation contains at least 50% of the species characteristic or diagnostic of PCT1691 as outlined in the VIS (or equivalent) or in suitable local reference sites.

Attribute	Preliminary Performance Indicators (by Year 7)	Preliminary Completion Criteria (to generate credits for offset)
Vegetation Structure	Targeted planting of flora species characteristic of growth form groups for PCT1691 is undertaken. Growth form groups include: • Trees • Shrubs • Grasses • Forbs • Ferns and • Other species	Rehabilitation contains vegetation structure and vegetation growth forms covers within a suitable range of benchmark for PCT1691 (or equivalent). Benchmark data for PCT1691 (or equivalent) for structure condition is expected to be available following the release of the BAM (OEH 2017d). A measureable range of benchmark for rehabilitation will be confirmed following the release of this information.
Ecosystem Function	Targeted placement of functional features is undertaken including: • Leaf litter • Fallen timber and logs • Nest boxes or salvaged hollows	Rehabilitation contains leaf litter, course woody debris and hollows within a suitable range of benchmark for PCT1691 (or equivalent). Benchmark data for PCT1691 (or equivalent) for function condition is expected to be available following the release of the BAM (OEH 2017d). A measureable range of benchmark for rehabilitation will be confirmed following the release of this information.
	Targeted planting of characteristic canopy species is undertaken. Species include: • narrow-leaved Ironbark (*Eucalyptus crebra*) • grey box (*Eucalyptus moluccana*)	The following characteristic canopy species are regenerating across the rehabilitation (i.e. evidence of regeneration stems <5cm DBH): • narrow-leaved Ironbark (*Eucalyptus crebra*) • grey box (*Eucalyptus moluccana*)
	High threat weeds (OEH 2017d) do not comprise more than 20% cover of any stratum.	High threat weeds (OEH 2017d) do not comprise more than 10% cover of any stratum.
Conformance to *Central Hunter Valley Eucalypt Forest and Woodland CEEC* (as per the key diagnostic characteristics and condition thresholds outlined in the EPBC Act Conservation	Rehabilitation is identified to be within the Hunter River catchment.	*Central Hunter Valley Eucalypt Forest and Woodland CEEC* rehabilitation is identified to be within the Hunter River catchment.
	Rehabilitation is undertaken using material derived from the Permian-aged geological stratum.	*Central Hunter Valley Eucalypt Forest and Woodland CEEC* rehabilitation is restored on material derived from the Permian-aged geological stratum.
	Rehabilitation of this community is not undertaken on alluvial flats, Aeolian sands, Triassic-aged sediments or escarpments.	*Central Hunter Valley Eucalypt Forest and Woodland CEEC* rehabilitation does not occur on alluvial flats, Aeolian sands, Triassic-aged sediments or escarpments.

Attribute	Preliminary Performance Indicators (by Year 7)	Preliminary Completion Criteria (to generate credits for offset)
Advice (DoE 2015))	Rehabilitation is trending towards a woodland or forest community with a projected canopy cover of 10% or more or with a native tree density of 20 stems per hectare that are at least one metre in height.	*Central Hunter Valley Eucalypt Forest and Woodland CEEC* rehabilitation comprises a woodland or forest community with a projected canopy cover of 10% or more or with a native tree density of 20 stems per hectare that are at least one metre in height.
	Targeted planting of species characteristic of *Central Hunter Valley Eucalypt Forest and Woodland CEEC* is undertaken including one or more of the following: • narrow-leaved Ironbark (*Eucalyptus crebra*) • grey box (*Eucalyptus moluccana*) • spotted gum (*Corymbia maculata*) • slaty gum (*Eucalyptus dawsonii*)	*Central Hunter Valley Eucalypt Forest and Woodland CEEC* rehabilitation comprises at least one of the following canopy species: • narrow-leaved Ironbark (*Eucalyptus crebra*) • grey box (*Eucalyptus moluccana*) • spotted gum (*Corymbia maculata*) • slaty gum (*Eucalyptus dawsonii*)
	The following canopy species are not actively planted in the rehabilitation or removed if they appear: • forest oak (*Allocasuarina torulosa*) • white mahogany (*Eucalyptus acmenoides*) • broad-leaved ironbark (*Eucalyptus fibrosa*)	*Central Hunter Valley Eucalypt Forest and Woodland CEEC* rehabilitation patch contains no more than two trees per hectare of the following species: • forest oak (*Allocasuarina torulosa*) • white mahogany (*Eucalyptus acmenoides*) • broad-leaved ironbark (*Eucalyptus fibrosa*)

Attribute	Preliminary Performance Indicators (by Year 7)	Preliminary Completion Criteria (to generate credits for offset)
	Targeted planting of native understorey species in rehabilitation including native grasses, herbs and shrubs. Examples include: • native olive (*Notelaea microcarpa*) • gorse bitter pea (*Daviesa ulicifolia*) • poison rock fern (*Cheilanthes sieberi* subsp. *sieberi*) • winter apple (*Eremophila debilis*) • purple wiregrass (*Aristida ramosa*) • barbed wire grass (*Cymbopogon refractus*) • tall chloris (*Chloris ventricosa*) • yellow burr-daisy (*Calotis lappulacea*) • kidney weed (*Dichondra repens*) • paddock lovegrass (*Eragrostis leptostachya*) • weeping grass (*Microlaena stipoides*) • slender bamboo grass (*Austrostipa verticillata*)	*Central Hunter Valley Eucalypt Forest and Woodland CEEC* rehabilitation has greater or equal to 50% of perennial understorey vegetative cover including at least 12 native understorey species.
PCT1692 (HU906) - Bull Oak grassy woodland of the central Hunter Valley		
Site Condition	Native species richness scores are trending towards benchmark for PCT1692 as determined through monitoring.	Rehabilitation contains >50% of the native plant species richness benchmark (i.e. >20 native species) for species characteristic to PCT1692. Native species richness benchmark for PCT1692 is 41 species.
	Overstorey cover scores are trending towards benchmark for PCT1692 as determined through monitoring.	Rehabilitation achieves between >25% and <200% of per cent native overstorey cover benchmark for species characteristic to PCT1692. Native overstorey cover benchmark for PCT1692 is 15-40%.
	Midstorey cover scores are trending towards benchmark for PCT1692 as determined through monitoring.	Rehabilitation achieves between >25% and <200% of per cent native midstorey cover benchmark for species characteristic to PCT1692. Native midstorey cover benchmark for PCT1692 is 5-20%.

Attribute	Preliminary Performance Indicators (by Year 7)	Preliminary Completion Criteria (to generate credits for offset)
	Native ground cover (grasses) scores are trending towards benchmark for PCT1692 as determined through monitoring.	Rehabilitation achieves between >25% and <200% of per cent native ground cover (grasses) benchmark for species characteristic to PCT1692. Native ground cover (grasses) benchmark for PCT1692 is 30-50%.
	Native ground cover (shrubs) scores are trending towards benchmark for PCT1692 as determined through monitoring.	Rehabilitation achieves between >25% and <200% of per cent native ground cover (shrubs) benchmark for species characteristic to PCT1692. Native ground cover (shrubs) benchmark for PCT1692 is 5-10%.
	Native ground cover (other) scores are trending towards benchmark for PCT1692 as determined through monitoring.	Rehabilitation achieves between >25% and <200% of per cent native ground cover (other) benchmark for species characteristic to PCT1692. Native ground cover (other) benchmark for PCT1692 is 20-40%.
	Exotic plant cover is trending towards less than 45% for total ground and midstorey cover as determined through monitoring.	Exotic plant cover is <45% for total ground and midstorey cover.
	Number of trees with hollows (i.e. natural hollows or stags salvaged from other areas and placed into rehabilitation) occur in the rehabilitation.	Rehabilitation contains hollows >25% of the number of hollow-bearing trees benchmark for PCT1692. Number of trees with hollows benchmark for PCT1692 is 30 trees per hectare.
	Targeted planting of canopy species is undertaken with natural reproduction processes (seeds, fruiting) taking place.	Rehabilitation contains at least 25% of dominant overstorey species naturally regenerating (i.e. not planted or seeded).
	Fallen timber and logs occur in the rehabilitation.	Rehabilitation contains >25% of the total length of fallen log benchmark for PCT1692. Total length of fallen log benchmark for PCT1692 is 50 metres per hectare.

Attribute	Preliminary Performance Indicators (by Year 7)	Preliminary Completion Criteria (to generate credits for offset)
Vegetation Composition	Targeted planting of flora species characteristic or diagnostic of PCT1692 is undertaken, including the following species: • bulloak (*Allocasuarina luehmannii*) • barbed wired grass (Cymbopogon refractus) • couch (Cynodon dactylon) • threeawn speargrass (*Aristida vagans*) • paddock lovegrass (Eragrostis leptostachya) • weeping grass (Microlaena stipoides) • purple wiregrass (*Aristida ramosa*) • pitted bluegrass (*Bothriochloa decipiens*) • Brown's lovegrass (*Eragrostis brownii*)	Rehabilitation contains at least 50% of species characteristic or diagnostic of PCT1692 as outlined in the VIS or in suitable local reference sites.
Vegetation Structure	Targeted planting of flora species characteristic of growth form groups for PCT1692 is undertaken. Growth form groups include: • Trees • Shrubs • Grasses • Forbs • Ferns and • Other species	Rehabilitation contains vegetation structure and vegetation growth forms covers within a suitable range of benchmark for PCT1692 (or equivalent). Benchmark data for PCT1692 (or equivalent) for structure condition is expected to be available following the release of the BAM (OEH 2017d). A measureable range of benchmark for rehabilitation will be confirmed following the release of this information.
Ecosystem Function	Targeted placement of functional features is undertaken including: • Leaf litter • Fallen timber and logs • Nest boxes or salvaged hollows	Rehabilitation contains leaf litter, course woody debris and hollows within a suitable range of benchmark for PCT1692 (or equivalent). Benchmark data for PCT1692 (or equivalent) for function condition is expected to be available following the release of the BAM (OEH 2017d). A measureable range of benchmark for rehabilitation will be confirmed following the release of this information.

Attribute	Preliminary Performance Indicators (by Year 7)	Preliminary Completion Criteria (to generate credits for offset)
	Targeted planting of characteristic canopy species is undertaken. Species include: • bulloak (*Allocasuarina luehmannii*)	The following characteristic canopy species are regenerating across the rehabilitation (i.e. evidence of regeneration stems <5cm DBH): • bulloak (*Allocasuarina luehmannii*)
	High threat weeds (OEH 2017d) do not comprise more than 20% cover of any stratum.	High threat weeds (OEH 2017d) do not comprise more than 10% cover of any stratum.

7.4.4 Achievability of Ecological Mine Rehabilitation

Glencore is committed to the continual improvement of native ecosystem establishment in mine rehabilitation across all of its mine sites and believes that mine rehabilitation plays an important role in mitigating and offsetting impacts on biodiversity. Glencore has had considerable success in establishing high quality mine rehabilitation in the Hunter Valley.

Successful mine ecological rehabilitation has been undertaken at Glencore's Mt Owen mine site since the mid-1990s. Glencore's Mount Owen operation has worked closely with researchers from the University Of Newcastle since 1995 with the initial goal of the Mount Owen mine research program to re-establish sustainable nutrient acquisition and cycling using natural root-microbe associations. This project soon expanded to include research into the use of available bulk materials and amelioration techniques for mine rehabilitation when forest topsoil would eventually run out. The rehabilitation strategy at Mount Owen has also benefited from the results of research such as a doctorate project through the University of Queensland titled '*Enhancing Eucalypt Forest Re-establishment on Coal Mined Land at Mount Owen'*.

Glencore has also participated in several Australian Coal Association Research Program (ACARP) projects on mine site rehabilitation. In collaboration with the University of Newcastle, Glencore has supported a research program that will lead to the most effective methods to establish dry sclerophyll and other native forest communities on rehabilitated overburden emplacements. The report *Establishing Native Vegetation – Principles and Interim Guidelines for Spoil Placement Areas and Restoration Lands* (Nussbaumer *et al.* 2012) summarises the outcomes of the University of Newcastle research programs and provides guidance for the ongoing development of ecological rehabilitation on each of Glencore's Hunter Valley operations.

Recent vegetation composition and condition investigations by Umwelt have indicated that the mine rehabilitation at a number of Glencore's Hunter Valley mine sites are likely to contain areas of the *Central Hunter Valley Eucalypt Forest and Woodland CEEC*. Umwelt's review focussed on the key diagnostic features of the CEEC to determine whether these were met. All three Glencore sites assessed were rehabilitated some time ago under project approval conditions that did not require the re-establishment of the CEEC. At two of the three sites the ecological rehabilitation focussed on the re-establishment of a functioning, complex woodland ecosystem, while the third site was focussed on the development of a woody cover to control erosion and improve land stability. The outcomes of this assessment show that the re-establishment of the CEEC, within the parameters of its key diagnostic features, is possible and achievable even without careful planning and controls, and therefore a 'recognisable' community can be established. Glencore intends to undertake further investigations into whether or not these communities are or will become 'self-sustaining', with the early outcomes of investigations to date being promising. The lessons learnt from these successful rehabilitation areas (and other Glencore mine sites) will be built into the rehabilitation strategy for the Project to ensure Glencore achieves the overall objective of ecological rehabilitation, that is, the creation of recognisable and self-sustaining PCTs.

7.4.5 Long-term Security of Mine Rehabilitation

As required in the FBA (OEH 2014b) and the NSW *Biodiversity Offset Policy for Major Projects*, a security bond will be required in order to ensure that the cost of rehabilitation will be met by the proponent. The monetary amount is to be sufficient to cover the cost of undertaking the works to achieve self-sustaining and recognisable PCTs as outlined in **Table 7.14** above. Specific costs of the rehabilitation in relation to ecological gain will be detailed in the MOP.

Following the completion of the rehabilitation and achievement of the criteria set out in **Table 7.14**, the ongoing land use for the area of mine rehabilitation will be targeted for native vegetation conservation to provide ongoing protection and management of the area.

7.4.6 Monitoring Requirements

The monitoring program for the mine rehabilitation will be detailed in the MOP. Broadly, the monitoring program will include:

- ***Initial establishment inspections*** – within approximately three months of each rehabilitation campaign to provide early identification of potential issues to minimise harm to the establishing rehabilitation. Examples of these issues include: erosion that has occurred due to storm events, failure of drainage structures and a lack of germination or establishment of ground cover.

- ***Routine general inspections*** – to be undertaken at least annually until it can be demonstrated that completion criteria has been met. Parameters may include growing media conditions, the presence and extent of erosion, the stability of drainage and sediment control structures, runoff water quality, revegetation germination rates, plant health, species density and diversity, presence of colonising fauna (e.g. ants, foraging birds), control of unauthorized access, effectiveness of habitat augmentation features and presence and/or impact of feral animals and weeds.

- ***Ecosystem development monitoring*** - to evaluate the progress of rehabilitation towards achieving the rehabilitation completion criteria outlined in **Table 7.14**, including a focus on composition, function and structure. The monitoring program should also include non-mined areas for reference (analogue) sites.

7.5 Supplementary Measures

No supplementary measures are currently proposed.

7.6 Summary of Available Credits

Table 7.15 below provides a summary of the ecosystem and species credits available at each of the proposed BioBank sites and mine rehabilitation.

Table 7.15 Summary of Offset Package

PCT / Species	Area (ha)	Credits
Wambo BioBank Site		
HU618 - Slaty Box - Grey Gum Shrubby Woodland on Footslopes of the Upper Hunter Valley, Sydney Basin Bioregion	215.9	3,608

PCT / Species	Area (ha)	Credits
HU712 - River Oak Riparian Grassy Tall Woodland of the Western Hunter Valley (Brigalow Belt South)	19.9	339
HU817 - Narrow-leaved Ironbark - Bull Oak - Grey Box shrub - grass open forest of the central and lower Hunter	98.5	1,53
Total Ecosystem Credits	**334.3**	**5,460**
Highfields BioBank Site		
HU714 - Rough-Barked Apple - red gum - Yellow Box woodland on alluvial clay to loam soils on valley flats in the northern NSW South Western Slopes Bioregion and Brigalow Belt South Bioregion	2.5	20
HU730 - White Box x Grey Box - red gum - Rough-barked Apple grassy woodland on rich soils on hills in the upper Hunter Valley	303.5	3,592
HU821 - Blakely's Red Gum - Narrow-leaved Ironbark - Rough-barked Apple shrubby woodland of the upper Hunter	24.9	534
HU868 - Narrow-leaved Ironbark - Grey Gum shrubby open forest on sandstone ranges of the upper Hunter Valley	96.6	1,145
Total Ecosystem Credits	**427.5**	**5,291**
Mangrove BioBank Site		
HU599 - River Red Gum / River Oak riparian woodland wetland in the Hunter Valley	6.0	106
HU678 - Black Cypress Pine - ironbark +/- Narrow-leaved Wattle low open forest mainly on Narrabeen Sandstone in the Upper Hunter region of the Sydney Basin Bioregion	44.9	783
HU812 - Forest Red Gum grassy open forest on floodplains of the lower Hunter	100.9	1,449
HU905 - Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter	106.7	1,732
Total Ecosystem Credits	**258.5**	**4,070**
pine donkey orchid (*Diuris tricolor*)^	1,114 individuals	7,909
southern myotis (*Myotis macropus*)	3.0	21
Total Species Credits	**-**	**7,930**
Mine Rehabilitation		
HU905 - Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter (conforming to *Central Hunter Valley Eucalypt Forest and Woodland CEEC* under the EPBC Act)	584	2,814
HU906 – Bull Oak Grassy Woodland of the Central Hunter Valley	294	1,416

PCT / Species	Area (ha)	Credits
Total	**878**	**4,230**
	Grand Total Ecosystem Credits	**19,069**
	Grand Total Species Credits	**7,930**

^To be allocated to other Glencore projects.

7.6.1 Stage 1 Offset Allocation

United proposes to retire biodiversity credits progressively based on the staging of native vegetation disturbance in line with the progressive development of the mine as outlined in **Table 6.2**. United proposes to retire credits for the first stage within 12 months post the date of commencement of clearing of native vegetation as part of the Project. The area of progressive disturbance and associated credits retired will be reported in the Annual Review, along with an indication of when the next stage of disturbance requiring further credits will occur. Credit retirement will be undertaken in accordance with the *NSW Biodiversity Offsets for Major Projects*.

In accordance with the like-for-like intent of the *NSW Biodiversity Offsets for Major Projects* and acknowledging the importance of threatened ecological communities, United proposes an offsetting strategy that prioritises the highest levels of the biodiversity conservation hierarchy (i.e. critically endangered ecological communities, endangered ecological communities, vulnerable ecological communities and then non-threatened communities).

Table 7.16 below outlines how the proposed offset package satisfies Stage 1 of the Project.

Table 7.16 Stage 1 Offset Package to Meet Credit Requirement for Ecosystem and Species Credits

Offset Option	PCT	Credits Required/Available for Stage 1 (Years 1-7)	Per cent (%) of Credit Requirement for Stage 1
***Central Hunter Valley Eucalypt Forest and Woodland CEEC* under the EPBC Act** (including components of HU816, HU869, HU905 and HU906)		**8,083**	**-**
Wambo BioBank Site	HU618 - Slaty Box - Grey Gum Shrubby Woodland on Footslopes of the Upper Hunter Valley, Sydney Basin Bioregion[1] (conforming to *Central Hunter Valley Eucalypt Forest and Woodland CEEC*)	1,662	20%
	HU817 - Narrow-leaved Ironbark - Bull Oak - Grey Box shrub - grass open forest of the central and lower Hunter[1] (conforming to *Central Hunter Valley Eucalypt Forest and Woodland CEEC*)	1,513	19%

Offset Option	PCT	Credits Required/Available for Stage 1 (Years 1-7)	Per cent (%) of Credit Requirement for Stage 1
Ecological mine rehabilitation	HU905 – Narrow-leaved Ironbark - Grey Box grassy Woodland of the Central and Upper Hunter[1] (conforming to *Central Hunter Valley Eucalypt Forest and Woodland CEEC*)	2,814	35%
	TOTAL	**5,989**	**74%**
Central Hunter Ironbark – Spotted Gum – Grey Box Forest EEC (HU816 – Spotted Gum - Narrow-leaved Ironbark Shrub - Grass Open Forest Slopes of the Upper)		**1,424**	-
-	None available.	0	0%
	TOTAL	**0**	**0%**
Central Hunter Grey Box – Ironbark Woodland EEC (including components of HU905 and HU906)		**639**	-
Mangrove BioBank Site	HU905 - Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter[1] (conforming to *Central Hunter Grey Box – Ironbark Woodland EEC*)	639	100%
	TOTAL	**639**	**100%**
Hunter Valley Footslopes Slaty Gum Woodland VEC (HU869 – Grey Box - Slaty Box Shrub - Grass Woodland on Sandstone Slopes of the Upper Hunter and Sydney Basin)		**29**	-
Wambo BioBank Site	HU618 - Slaty Box - Grey Gum Shrubby Woodland on Footslopes of the Upper Hunter Valley, Sydney Basin Bioregion[1] (conforming to *Hunter Valley Footslopes Slaty Gum Woodland VEC*)	29	100%
	TOTAL	**29**	**100%**
HU905 – Narrow-leaved Ironbark - Grey Box grassy Woodland of the Central and Upper Hunter		**3,933**	-
Mangrove BioBank Site	HU905 - Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter[2]	1,093	28%
	TOTAL	**1,093**	**28%**

Offset Option	PCT	Credits Required/Available for Stage 1 (Years 1-7)	Per cent (%) of Credit Requirement for Stage 1
HU906 – Bull Oak Grassy Woodland of the Central Hunter Valley		**5,640**	**-**
Highfields BioBank Site	HU730 - White Box x Grey Box - red gum - Rough-barked Apple grassy woodland on rich soils on hills in the upper Hunter Valley[3] (conforming to *White Box Yellow Box Blakely's Red Gum Grassy Woodland EEC and Derived Native Grassland CEEC*)	3,592	64%
Highfields BioBank Site	HU714 - Rough-Barked Apple - red gum - Yellow Box woodland on alluvial clay to loam soils on valley flats in the northern NSW South Western Slopes Bioregion and Brigalow Belt South Bioregion[4] (conforming to *White Box Yellow Box Blakely's Red Gum Grassy Woodland EEC and Derived Native Grassland CEEC*)	20	0%
Ecological mine rehabilitation	HU906 – Bull Oak Grassy Woodland of the Central Hunter Valley[1]	1,416	25%
	TOTAL	**5,028**	**89%**
HU945 – Swamp Oak - Weeping Grass Grassy Riparian Forest of the Hunter Valley		**2,004**	**-**
Mangrove BioBank Site	HU599 - River Red Gum / River Oak riparian woodland wetland in the Hunter Valley[4]	106	5%
Mangrove BioBank Site	HU812 - Forest Red Gum grassy open forest on floodplains of the lower Hunter[4, 5]	1,449	72%
	TOTAL	**1,555**	**77%**
southern myotis (*Myotis macropus*)		**208**	**-**
Mangrove BioBank Site	southern myotis	21	10%
	OVERALL SPECIES CREDIT TOTAL	**21**	**10%**
	OVERALL ECOSYSTEM CREDIT REQUIREMENT	**21,752**	**100%**
	OVERALL ECOSYSTEM CREDIT ALLOCATION	**14,333**	**66%**

1 Like-for-like TEC.

2 Like-for-like rules: same PCT.

3 Like for like rules: same vegetation class, higher percent cleared.

4 Variation rules: same vegetation formation, higher percent cleared.

5 VIS database quotes 0% cleared for HU812 across the Hunter/Central Rivers CMA. This is likely due to an error/omission of data in the database. Known per cent cleared for HU812 is quoted as around 98% in Peake (2006) and over 90% in the NSW Scientific

Committee's Final Determination for Hunter Floodplain Red Gum Woodland in the NSW North Coast and Sydney Basin Bioregions EEC (NSWSC 2011).

It is acknowledged that further offsets will be required to offset the impacts of Stage 1 as shown in **Table 7.16** above. United is currently investigating a number of potential offset sites that contain quality vegetation and habitats in accordance with the requirements under the FBA (OEH 2014b). Full biometric surveys and the application of the BioBanking Credit Calculator in accordance with BBAM 2014 (OEH 2014c) will be required prior to reporting the credit allocation and the sites' suitability for offsetting the remaining requirements of Stage 1. Any other deficits will be met through the use of supplementary measures and/or the Biodiversity Offset Fund. Further information on these offsets will be provided following their formal inclusion in the offset package.

7.6.2 Stage 2 and 3 Offset Requirements

As outlined in **Table 6.2** and **Section 7.6.1** above, approximately 82 per cent of the overall credit requirement for the Project is required in Stage 1. It is proposed that the remaining credit requirements for Stages 2 and 3 are secured and retired within one year of the commencement of each of these stages. Where possible throughout the construction and operation of the Project, native vegetation areas will be avoided to minimise the loss of habitats and reduce the future offset credit requirement for the Project. No remaining credits from the currently proposed offset package (as described above) are suitable or available for offsetting in Stages 2 and 3.

United propose to utilise the options available under the NSW *Biodiversity Offset Policy for Major Projects* (or the present day equivalent policy in consultation with OEH) to satisfy the offset requirements for Stages 2 and 3. Broadly, these are expected to include:

- Land-based BioBank/Stewardship sites
- Securing required credits through the open credit market
- Contributing money to supplementary measures in accordance with relevant conservation or recovery actions and/or
- Payments to the available Offsets Fund.

Table 7.17 below outlines the remaining offset credit requirements and likely approximate offset hectares required should land based offsets be proposed (based on credit outcomes under BBAM 2014 (OEH 2014c)) based on the Stage 2 and 3 impacts for the Development Footprint.

Table 7.17 Stage 2 and 3 Remaining Offset Credit Requirements

Biometric Vegetation Type	Stage 2		Stage 3	
	Credits to be Retired	Estimated Area (ha) Offset Required	Credits to be Retired	Estimated Area (ha) Offset Required
Ecosystem Credits				
Central Hunter Valley Eucalypt Forest and Woodland CEEC (including components of HU816, HU869, HU905 and HU906)	2,407	218	754	69
Hunter Floodplain Red Gum Woodland EEC (HU812 – Forest Red Gum Grassy Open Forest on Floodplains of the Lower Hunter)	20	2	0	0
Central Hunter Grey Box – Ironbark Woodland EEC (including components of HU905 and HU906)	55	5	17	1.5

Biometric Vegetation Type	Stage 2		Stage 3	
	Credits to be Retired	Estimated Area (ha) Offset Required	Credits to be Retired	Estimated Area (ha) Offset Required
HU905 – Narrow-leaved Ironbark - Grey Box grassy Woodland of the Central and Upper Hunter	815	74	238	22
HU906 – Bull Oak Grassy Woodland of the Central Hunter Valley	0	0	439	40
HU945 – Swamp Oak - Weeping Grass Grassy Riparian Forest of the Hunter Valley	114	13	14	2
southern myotis	354	50	0	0
Total	**3,765**	**362**	**1,462**	**135**

9 Matters of National Environmental Significance

Under the Commonwealth EPBC Act, the approval of the Commonwealth Minister for the Environment and Energy is required for any action that may have a significant impact on matters of national environmental significance (MNES). These matters are:

- listed threatened species and communities
- migratory species protected under international agreements
- Ramsar wetlands of international importance
- the Commonwealth marine environment
- the Great Barrier Reef Marine Park
- World Heritage properties
- National Heritage places
- nuclear actions, and
- a water resource, in relation to coal seam gas development and large coal mining development.

Those aspects of the Project requiring approval under the EPBC Act were referred to DoEE in October 2015 to determine whether or not it was a controlled action, thereby requiring approval of the Commonwealth Minister for the Environment and Energy.

On 7 December 2015, the Project was determined to be a Controlled Action requiring approval under the EPBC Act. The assessment path for the Project is under the NSW Assessment Bilateral Agreement (2015) between the Commonwealth and NSW Governments and DoEE issued its assessment requirements through the SEARs on 15 December 2015. These requirements were addressed in Section 7.0 of the EIS.

The EPBC Referral identified 31 threatened species and communities with the potential to occur within 10 kilometres of the Development Footprint. Detailed Assessments of Significance were undertaken for all MNES with the potential to be impacted by the Project as part of the EPBC Referral. As per the detailed Assessments of Significance prepared for the EPBC Referral, *Central Hunter Valley Eucalypt Forest and Woodland critically endangered ecological community (CEEC)* was found to be significantly impacted as a result of the Project. Following the submission of the Referral, the following MNES were considered by DoEE to be potentially significantly impacted by the Project:

- *Central Hunter Valley Eucalypt Forest and Woodland CEEC*
- regent honeyeater (*Anthochaera phrygia*)
- swift parrot (*Lathamus discolor*)
- spotted-tailed quoll (*Dasyurus maculatus maculatus*)

No other MNES (relating to biodiversity) are likely to be significantly impacted as a result of the Project. Subsequent alterations to the Project boundaries since the preparation of the EPBC Referral have resulted in impact area reductions and no new impacts are applicable to other MNES.

Table 9.1 below provides a summary of the key impacts and offsets for the listed MNES above.

Table 9.1 Summary of Impact and Offset Areas for MNES

MNES	Impact Area (ha)	Proposed Offset Area (ha)
Central Hunter Valley Eucalypt Forest and Woodland CEEC	189.5	781.5 (including areas of mine rehabilitation)
regent honeyeater (*Anthochaera phrygia*)	29.4	348.4
swift parrot (*Lathamus discolor*)	29.7	426.8
spotted-tailed quoll (*Dasyurus maculatus maculatus*)	356.5	1,021.2

The following sections provide an assessment of the impacts of the Project on these MNES as well as the proposed mitigation and offsetting measures targeted for MNES as required by the SEARs.

9.1 Central Hunter Valley Eucalypt Forest and Woodland CEEC

9.1.1 Impact Assessment

Approximately 189.5 hectares of *Central Hunter Valley Eucalypt Forest and Woodland CEEC* will be impacted by the Project. Components of the following vegetation communities present in the Development Footprint partially conform to the CEEC:

- HU905 Narrow-leaved Ironbark – Grey Box Grassy Woodland of the Central and Upper Hunter (including some areas of derived native grasslands, regeneration and thinned canopy variants)
- HU816 Spotted Gum - Narrow-leaved Ironbark Shrub - Grass Open Forest of the Central and Lower Hunter
- HU869 Grey Box - Slaty Box Shrub - Grass Woodland on Sandstone Slopes of the Upper Hunter and Sydney Basin
- HU906 Bull Oak Grassy Woodland of the Central Hunter Valley.

Central Hunter Valley Eucalypt Forest and Woodland CEEC in the Development Footprint is further described in **Section 3.2.3.1** and illustrated in **Figure 3.4**.

An Assessment of Significance according to the *Significant Impact Guidelines 1.1 Environment Protection and Biodiversity Conservation Act 1999* (DoE 2013) was undertaken as part of the EPBC Referral and Statement of Consistency Report (Umwelt 2016b) to determine the significance of the impact on the CEEC. The assessment of significance identified that the loss of the community in the Development Footprint is likely to have a significant impact on the *Central Hunter Valley Eucalypt Forest and Woodland CEEC* as it will reduce the extent of the community, adversely impact some areas of critical habitat of the ecological community and interfere with the recovery of the ecological community. While the area of impact for the CEEC has been reduced by approximately 34 hectares since the completion of this assessment, the impacts on 189.5 hectares are still considered significant for this CEEC.

9.1.2 Avoidance and Mitigation

United has sought to avoid and minimise potential impacts on the ecological values of the Development Footprint throughout the Project planning and approval process. This has included a key focus on avoidance and minimisation of disturbance of *Central Hunter Valley Eucalypt Forest and Woodland CEEC* through designing the Project to maximise use of existing mining and transport facilities and revising impact boundaries.

A key alternative for the Project was to develop the United Open Cut as a standalone mining operation which would have resulted in approximately 148 hectares of further disturbance to vegetation communities than the proposed Project due to the need to develop stand-alone coal processing facilities, mine infrastructure (workshops, etc) and transportation infrastructure (rail line, rail loop and train loading facility). This Option 1 Project (as detailed in Section 3.4.1 of the EIS) represented the largest disturbance footprint alterative. This included impacts to the north of the Development Footprint in areas containing *Central Hunter Valley Eucalypt Forest and Woodland CEEC*.

Furthermore, following the exhibition of the EIS in August 2016, revisions to the mine disturbance boundary were undertaken to reduce the impacts by approximately 36 hectares of land including a reduction in impacts on approximately 19 hectares of *Central Hunter Valley Eucalypt Forest and Woodland CEEC*.

Mitigation measures for the Project are outlined in **Section 4.2**. Specifically for the *Central Hunter Valley Eucalypt Forest and Woodland CEEC*, the following mitigation measures are relevant:

- implementation of clearing procedures to minimise the impacts of the clearing process and maximise the recovery of any valuable biodiversity resources (e.g. seed collection, collection of logs and hollows)
- feral animal and noxious weed control
- fencing and access control
- management of domestic stock
- bushfire management.

9.1.3 Offsetting Outcomes

United is committed to delivering a biodiversity offset strategy that appropriately compensates for the removal of 189.5 hectares of *Central Hunter Valley Eucalypt Forest and Woodland CEEC* as a result of the Project. As outlined in **Section 7.0**, this will be undertaken in accordance with the FBA, the NSW *Biodiversity Offset Policy for Major Projects* and the EPBC Act Environmental Offsets Policy.

The proposed offset package seeks to balance the protection and improvement of existing high quality habitats along with providing suitable conservation gain by restoring grassland areas to conform to *Central Hunter Valley Eucalypt Forest and Woodland CEEC*, locating offsets in areas under threat of clearance and reinstating the CEEC in the post-mining landscape in the form of ecological mine rehabilitation.

The like-for-like offsets currently proposed for *Central Hunter Valley Eucalypt Forest and Woodland CEEC* include 781.5 hectares of the community as part of:

- 197.5 hectares at the proposed Wambo BioBank Site
- 584 hectares of mine rehabilitation

It is acknowledged that further offsets will be required to offset the *Central Hunter Valley Eucalypt Forest and Woodland CEEC* for Stages 2 and 3 of the Project as outlined in **Section 7.6.2**. United is currently investigating a number of potential offset sites within 5km of the Development Footprint that contain quality woodland areas and grasslands that can be regenerated to conform to the CEEC. Further information on these areas will be provided to the DoEE following their formal inclusion in the offset package. As outlined in **Table 7.17**, a further approximate 287 hectares of CEEC would be required to offset Stage 2 and 3 impacts under the FBA. This would complete the offsetting requirement for the CEEC and result in a total CEEC offset of approximately 1,068.5 hectares.

Table 9.2 below provides an assessment of the impact and offsetting outcomes for the proposed for the *Central Hunter Valley Eucalypt Forest and Woodland CEEC* with reference to the *EPBC Act Environmental Offsets Policy* (DSEWPC 2012).

Table 9.2 ***Central Hunter Valley Eucalypt Forest and Woodland CEEC*** **Impact and Offsetting Outcomes**

IMPACT	Development Footprint	
Impact Area	189.5 hectares of *Central Hunter Valley Eucalypt Forest and Woodland CEEC*	
Impact Quality	This EEC occurs throughout the Development Footprint and is primarily represented by HU905 Narrow-leaved Ironbark – Grey Box Grassy Woodland of the Central and Upper Hunter in moderate condition. Some areas across the site include areas of regeneration, derived native grassland and planted mine rehabilitation of lower quality. The CEEC generally contains a predominately native groundcover with occurrences of some exotic species likely due to existing disturbances in the Development Footprint (refer to **Section 3.2.1**).	
OFFSETS	**Wambo BioBank Site**	**Mine Rehabilitation**
Area of CEEC	The Wambo BioBank Site is 338 hectares in size. 149.3 hectares conform to the *Central Hunter Valley Eucalypt Forest and Woodland CEEC*. 48.2 hectares of grassland that would conform to CEEC following revegetation efforts also occur on the site. BVTs conforming to the CEEC include: • HU618 - Slaty Box - Grey Gum Shrubby Woodland on Footslopes of the Upper Hunter Valley, Sydney Basin Bioregion • HU817 Narrow-leaved Ironbark - Bull Oak - Grey Box Shrub - Grass Open Forest of the Central and Lower	It is proposed that 584 hectares of mine rehabilitation (i.e. sufficient area to satisfy 25% of the overall CEEC credit requirement under FBA) is restored in the post-mining landscape to conform to *Central Hunter Valley Eucalypt Forest and Woodland CEEC*. Target PCT for this comprises: • HU905 - Narrow-leaved Ironbark – Grey Box Grassy Woodland of the Central and Upper Hunter. This mine rehabilitation will be restored on material derived from the Permian-aged stratum.
Offset Location	The Wambo BioBank Site is located immediately to the west of the Development Site and adjacent to the Wollemi National Park (refer to **Figure 7.1**) and the Greater Blue Mountains World Heritage Area.	The proposed area of mine rehabilitation will be located across 584 hectares within the rehabilitated mining area of the Project (refer to **Figure 7.8**).

IMPACT	Development Footprint	
Offset Area Existing Quality	The majority of the Wambo BioBank Site contains Hunter Valley floor woodland vegetation, with small pockets of derived native grassland which have previously been cleared. The vegetation is reasonably young and the woodland vegetation within the site occurs at the interface of land which has been predominantly cleared of trees and converted to grassland for grazing purposes. The *Central Hunter Valley Eucalypt Forest and Woodland CEEC* occurring on the site occurs in moderate to good condition with minimal weed infestations and current disturbances.	The area to be restored using mine rehabilitation prior to the restoration of *Central Hunter Valley Eucalypt Forest and Woodland CEEC* will be primarily bare ground, devoid of any ecological value following the disturbances from open cut coal mining.
Conservation Gain and Improvement	The *Central Hunter Valley Eucalypt Forest and Woodland CEEC* within the Wambo BioBank Site is proposed to be managed in accordance with a BioBanking Agreement which includes standard management actions such as weed control, erosion control, managing grazing for conservation, managing human disturbance, the retention of regrowth and remnant vegetation and supplementary planting where natural regeneration is insufficient. The 48.2 hectares of grassland associated with HU618 and HU817 is proposed to be restored to the CEEC following revegetation efforts using characteristic canopy and midstorey species. This will result in a gain of 48.2 hectares of *Central Hunter Valley Eucalypt Forest and Woodland CEEC* on the Hunter Valley floor.	The proposed mine rehabilitation will restore up to 584 hectares of *Central Hunter Valley Eucalypt Forest and Woodland CEEC* within the post-mining landscape in the Hunter Valley. Following the removal of approximately 189 hectares, this represents a long-term gain of 395 hectares of the CEEC in the Hunter Valley. Following the establishment of mine rehabilitation restoring *Central Hunter Valley Eucalypt Forest and Woodland CEEC*, the ongoing land use for the area of mine rehabilitation will be targeted for native vegetation conservation to provide ongoing protection and management of the area.
Land Use and Tenure	The primary existing land use of the proposed Wambo BioBank Site is light grazing, however generally the site is unutilised. The proposed South Bates Extension Modification Project includes longwall panels directly under the proposed Wambo BioBank Site as discussed in **Section 7.1.1.1**. The proposed Wambo BioBank Site is currently wholly zoned RU1 Primary Production under the provisions of the Singleton *Local Environmental Plan 2013* (LEP).	The primary existing land use of the Development Site is mining. A small portion (30 hectares) of the mine-owned land is currently used for low intensity grazing. The Development Footprint is currently zoned RU1 Primary Production and SP2 Infrastructure under the provisions of the Singleton *Local Environmental Plan 2013* (LEP).

IMPACT	Development Footprint	
Averted Loss	The proposed Wambo BioBank Site is located adjacent to the boundaries of the United and Wambo open cut coal mines in an area of the Hunter Valley containing coal seams which could be extracted using open cut methods. Open cut coal mining could result in the total loss of the site. As the site is wholly zoned RU1 – Primary Production under the Singleton LEP 2013, extensive agriculture, forestry, and intensive plant agriculture are all permissible without consent in the RU1 zone. Certain native vegetation disturbance activities associated with routine agricultural activities can also be undertaken without any further approval requirements. While the proposed South Bates Extension Modification Project includes longwall panels directly under the proposed Wambo BioBank Site, the flora impact assessment (FloraSearch 2017) considered it unlikely for habitats within areas of the proposed Wambo BioBank Site to be adversely affected by soil cracking due to mine subsidence. Therefore these impacts are unlikely to substantially alter the *Central Hunter Valley Eucalypt Forest and Woodland CEEC* to the extent of reducing the condition of the CEEC on the site. The long-term conservation of the site under a BioBanking Agreement (or equivalent) represents a conservation gain by protecting this area from future surface disturbances related to open cut coal mining and agricultural practices.	Following the completion of open cut coal mining as part of the Project, the proponent will required to return the post-mining landscape to a suitable condition for safety and socio-economic (including agricultural) purposes. Restoration using standard mine rehabilitation techniques would not provide a high quality ecological outcome without the requirement to meet certain parameters The commitment to return 584 hectares of the post-mining landscape to *Central Hunter Valley Eucalypt Forest and Woodland CEEC* represents an averted loss based on the alternative of creating lower quality, standard mine rehabilitation that otherwise would not conform to the CEEC or achieve a higher standard for ecological outcomes.
Time Horizon	It is expected that the proposed Wambo BioBank Site would be secured in-perpetuity under a BioBanking Agreement (or equivalent) to provide long-term conservation and protection for the *Central Hunter Valley Eucalypt Forest and Woodland CEEC*.	Following the establishment of mine rehabilitation restoring *Central Hunter Valley Eucalypt Forest and Woodland CEEC*, the ongoing land use for the area of mine rehabilitation will be targeted for native vegetation conservation to provide ongoing protection and management of the area

9.1.4 Assessment of the Offset Strategy against the EPBC Act Environmental Offsets Policy (2012)

This section provides an assessment of the Biodiversity Offset Strategy for the *Central Hunter Valley Eucalypt Forest and Woodland CEEC* against the EPBC Act Environmental Offset Policy (DSEWPC 2012).

1. Suitable offsets must deliver an overall conservation outcome that improves or maintains the viability of the protected matter.

The Biodiversity Offset Strategy has been developed with the aim to maintain and improve biodiversity in the Hunter Valley with a focus on the *Central Hunter Valley Eucalypt Forest and Woodland CEEC*. With the inclusion of the Wambo BioBank Site and the proposed area of mine rehabilitation, it is likely that such an improvement will occur. The restoration of the *Central Hunter Valley Eucalypt Forest and Woodland CEEC* in existing grassland areas of the Wambo BioBank Site and in mine rehabilitation represents a gain of around 442.7 hectares, which will improve the viability of the CEEC in the Hunter Valley. 149.3 hectares of existing CEEC at the Wambo BioBank Site will be maintained and conserved in the long-term as an area of high quality habitats. This represents a total offset of 781.5 hectares of suitable potential habitat for the species in the Hunter Valley for an impact of 189.5 hectares at the Development Footprint.

Additionally, further offsets are currently being investigated to offset the *Central Hunter Valley Eucalypt Forest and Woodland CEEC* for Stages 2 and 3 of the Project that will add approximately 287 hectares of CEEC to the offset package.

2. Suitable offsets must be built around direct offsets but may include other compensatory measures.

The Biodiversity Offset Strategy is based on the use of direct land-based offsets and mine rehabilitation containing *Central Hunter Valley Eucalypt Forest and Woodland CEEC* that occur within the Hunter Region. The current Biodiversity Offset Strategy will result in the long-term conversation of 781.5 hectares of the *Central Hunter Valley Eucalypt Forest and Woodland CEEC*. Following the addition of offsets for Stages 2 and 3, this will increase to a total offset of approximately 1,068.5 hectares.

The Biodiversity Offset Strategy does not currently propose any other compensatory measures.

3. Suitable offsets must be in proportion to the level of statutory protection that applies to the protected matter.

The *Central Hunter Valley Eucalypt Forest and Woodland* is listed as a critically endangered ecological community under the EPBC Act. As discussed above, the Biodiversity Offset Strategy has focused on securing existing high quality areas of *Central Hunter Valley Eucalypt Forest and Woodland CEEC* and providing conservation gain through restoring previously cleared areas and mine spoil to the CEEC. The impacts on 189.5 hectares of *Central Hunter Valley Eucalypt Forest and Woodland CEEC* are proposed to be offset with 781.5 hectares of the CEEC at the BioBank sites and mine rehabilitation. Following the addition of offsets for Stages 2 and 3, this will increase to a total offset of approximately 1,068.5 hectares.

4. Suitable offsets must be of a size and scale proportionate to the residual impacts on the protected matter.

The impacts on 189.5 hectares of *Central Hunter Valley Eucalypt Forest and Woodland CEEC* at the Development Footprint are currently proposed to be offset with 781.5 hectares of the CEEC at the BioBank sites and mine rehabilitation. Following the addition of offsets for Stages 2 and 3, this will increase to a total offset of approximately 1,068.5 hectares. The Biodiversity Offset Strategy is commensurate with the

magnitude of impacts on *Central Hunter Valley Eucalypt Forest and Woodland CEEC* and delivers an outcome that is 'like for like' as well as proposing a gain of 442.7 hectares of the CEEC in the Hunter Region. The in-perpetuity protection of the BioBank sites is likely to result in a long-term higher quality outcome for the CEEC. It is envisaged that the Biodiversity Offset Strategy will deliver net biodiversity gains in the medium and long term.

5. Suitable offsets must effectively account for and manage the risks of the offset not succeeding.

The Biodiversity Offset Strategy is based on the use of direct land-based offsets that occur within the Hunter Region. The land-based offset sites have been determined to provide known areas of *Central Hunter Valley Eucalypt Forest and Woodland CEEC* affected by the Project, rather than potential areas. These areas are located within the Hunter Valley region and on Permian sediments required to support the CEEC.

The restoration of ecological mine rehabilitation will be responsive to any new ecological data that may arise through the ecological monitoring or research into improving mine rehabilitation relevant to the Hunter Valley and the *Central Hunter Valley Eucalypt Forest and Woodland CEEC*.

Furthermore, a positive feedback loop between monitoring and adaptive management of the land-based offset sites will be established as required under the BioBanking Agreement. Thresholds for key monitoring parameters will be proposed, together with trigger points or threshold exceedance levels to ensure that there are clear points at which a review of the monitoring and management approach is enacted. Completion criteria, outlined in **Table 7.14**, will also drive the requirement of mine rehabilitation conforming to the CEEC.

6. Suitable offsets must be additional to what is already required, determined by law or planning regulations, or agreed to under other schemes or programs.

The proposed offsets do not overlap with any other government funded protection or habitat restoration program. All offset sites are located on currently non-reserved land and will add a significant area to the conservation system.

7. Suitable offsets must be efficient, effective, timely, transparent, scientifically robust and reasonable.

The timing of the protection of the BioBank sites will be determined in line with the approval conditions for the Project. As outlined in **Section 6.2**, it is proposed that credits be retired according to the stages of the Project. Each of the proposed BioBank sites is on land wholly owned by Glencore or Wambo for the purposes of offsetting prior to the approval of the Project. The application of BioBanking Agreements for these sites provides for a transparent, consistent and scientifically robust method of monitoring and management in accordance with the *Threatened Species Conservation (Biodiversity Banking) Regulation 2008*.

The area of impact has been derived from detailed GIS mapping of Project boundaries and impact areas, and the ecological survey, mapping, impact assessments and design of the Biodiversity Offset Strategy have been completed by qualified ecologists with considerable experience in the region ensuring that the Strategy is scientifically robust, transparent and reasonable.

8. **Suitable offsets must have transparent governance arrangements including being able to be readily measured, monitored, audited and enforced.**

The *Central Hunter Valley Eucalypt Forest and Woodland CEEC* within the Wambo BioBank Site is proposed to be secured with a BioBanking Agreement (or equivalent) which provides in-perpetuity protection and funding for management and improvement of the biodiversity of the site.

A security bond will be required in order to ensure that the cost of mine rehabilitation will be met by the proponent. Following the completion of the rehabilitation, the ongoing land use for the area of mine rehabilitation will be targeted for native vegetation conservation to provide ongoing protection and management of the area.

9.2 Regent honeyeater (*Anthochaera phrygia*)

9.2.1 Impact Assessment

Regent honeyeater has not been recorded within the Development Footprint despite targeted winter bird surveys undertaken over six years (2010-2016). No breeding or nesting habitat for regent honeyeater has been recorded within the Development Footprint. Vegetation in the Development Footprint is known to contain one key tree species (as per the National Recovery Plan for the Regent Honeyeater (DoE 2016)), being spotted gum (*Corymbia maculata*) which occurs in low densities in the post-mining rehabilitation variant of HU816 Spotted Gum - Narrow-leaved Ironbark Shrub - Grass Open Forest of the Central and Lower Hunter. Box mistletoe (*Amyema miquelii*) also occurs in scattered locations across the Development Footprint. The Project will remove approximately 29.4 hectares of vegetation that contains key feed tree species for the regent honeyeater as defined by the National Recovery Plan.

Previous records of the species in the locality include one record mapped within 500 metres to the south of the Development Footprint in riparian vegetation associated with Wollombi Brook, however, this record is dated from 1991 with a location accuracy of 10,000 metres (OEH 2017a) and so the actual proximity to the site is unknown. Another record occurs approximately 2 kilometres to the south of the Development Footprint also along Wollombi Brook dated from 1987 with a location accuracy of 1,000 metres (OEH 2017a). A more recent record from 2002 occurs approximately 5 kilometres to the southeast of the Development Footprint adjacent to Wallaby Scrub Road and Sandy Hollow Creek in box-ironbark woodlands (OEH 2017a). No recent (within the last 15 years) records occur within 5km of the Development Footprint.

While the Project will remove a range of native vegetation communities within the Development Footprint including fragmented eucalypt woodlands, none of the habitats in the Development Footprint have been recorded as being used by regent honeyeater either historically or recently.

An Assessment of Significance according to the *Significant Impact Guidelines 1.1* (DoE 2013) was undertaken to determine the significance of the impact on the regent honeyeater as part of the EPBC Referral. The assessment of significance concluded that the Project was unlikely to have a significant impact on the regent honeyeater as it was unlikely to lead to a long term decrease in the population, fragment the population, disrupt the breeding cycle of the population, result in an invasive species harmful to the species, introduce a disease or interfere with the recovery of the species.

Following its assessment of the Referral, the DoEE concluded that the Project was likely to result in a significant impact on the species based on the information in the referral documentation (including impacts on 227 hectares of box-gum woodland potential habitat), the location of the action, species records and likely habitat present in the area. The species therefore required further assessment for the Project with this assessment satisfying that requirement.

Following the release of the *National Recovery Plan for the Regent Honeyeater* in April 2016, the area of impact was further refined to areas containing key tree foraging species as discussed in the paragraphs above (i.e. 29.4 hectares of potential foraging habitat).

9.2.2 Avoidance and Mitigation

United has sought to avoid and minimise potential impacts on the ecological values of the Development Footprint throughout the Project planning and approval process. This has included avoidance and minimisation of disturbance of habitat suitable for the regent honeyeater through designing the Project to maximise use of existing mining and transport facilities and revising impact boundaries.

A key alternative for the Project was to develop the United Open Cut as a standalone mining operation which would have resulted in approximately 148 hectares of further disturbance to native vegetation communities than the proposed Project due to the need to develop stand-alone coal processing facilities, mine infrastructure (workshops, etc) and transportation infrastructure (rail line, rail loop and train loading facility). This Option 1 Project (as detailed in Section 3.4.1 of the EIS) represented the largest disturbance footprint alterative.

Furthermore, following the exhibition of the EIS in August 2016, revisions to the mine disturbance boundary were undertaken to reduce the impacts to approximately 36 hectares of land including 26.9 hectares of native woodland.

Mitigation measures for the Project are outlined in **Section 4.2**. Specifically for the regent honeyeater, the following mitigation measures are relevant:

- implementation of clearing procedures (pre-clearance surveys and felling supervision) to minimise the impacts of the clearing process on locally-occurring fauna species
- feral animal and noxious weed control.

9.2.3 Offsetting Outcomes

United is committed to delivering a biodiversity offset strategy that appropriately compensates for the removal of 29.4 hectares of post-mining rehabilitation habitat containing key feed trees species for the regent honeyeater as a result of the Project. As outlined in **Section 7.0**, the offsetting for the Project will be undertaken in accordance with the FBA and the NSW *Biodiversity Offset Policy for Major Projects*.

The proposed offset package seeks to balance the protection and improvement of existing high quality habitats along with providing suitable conservation gain by restoring grassland areas to provide suitable woodland habitats for the species and locating offsets in areas under threat of clearance.

The like-for-like offsets currently proposed for regent honeyeater include a total of 348.4 hectares of suitable habitat as part of:

- 303.5 hectares at the Highfields BioBank Site
- 44.9 hectares at the Mangrove BioBank Site.

The suitable habitats at the Highfields and Mangrove BioBank Site have been identified through the presence of key foraging tree species for the regent honeyeater as outlined in the National Recovery Plan (DoE 2016) for the regent honeyeater where there are known or nearby (within 15km) records.

Table 9.3 below provides an assessment of the impact and offsetting outcomes for the proposed for the regent honeyeater with reference to the *EPBC Act Environmental Offsets Policy* (DSEWPC 2012).

Table 9.3 Regent Honeyeater Impact and Offsetting Outcomes

IMPACT	Development Footprint	
Impact Area	29.4 hectares of habitat containing key feed tree species as per the National Recovery Plan (DoE 2016).	
Impact Quality	This species has not been recorded within the Development Footprint despite targeted winter bird surveys undertaken over six years (2010-2016). No breeding or nesting habitat for regent honeyeater has been recorded within the Development Footprint. Vegetation in the Development Footprint is known to contain one key tree species (as per the National Recovery Plan for the Regent Honeyeater (DoE 2016)), being spotted gum (*Corymbia maculata*) which occurs in low densities in the planted HU816 Spotted Gum - Narrow-leaved Ironbark Shrub - Grass Open Forest of the Central and Lower Hunter. The quality of this habitat is considered low due to the young age of the post-mining rehabilitation which is characterised by a relatively open canopy supported by a shrubby understorey. The variable canopy is very sparse to sparse and between 5 to 11 metres in height.	
OFFSETS	**Highfields BioBank Site**	**Mangrove BioBank Site**
Area of Habitat	The Highfields BioBank Site is 427 hectares in size. 263.8 hectares of native woodland vegetation contains key feed tree species as outlined in the National Recovery Plan (DoE 2016) in the following vegetation zones: • HU730 - White Box x Grey Box - red gum - Rough-barked Apple grassy woodland on rich soils on hills in the upper Hunter Valley • HU730 - White Box x Grey Box - red gum - Rough-barked Apple grassy woodland on rich soils on hills in the upper Hunter Valley (shrubby variant) These zones include white/grey box intergrades (*Eucalyptus albens – moluccana*) and yellow box (*Eucalyptus melliodora*) as dominant or co-dominant canopy species. 39.7 hectares of derived native grassland associated with HU730 also occurs on the site, which will be regenerated to include canopy species characteristic of the woodland and shrub variants.	The Mangrove BioBank Site is 259 hectares in size. 44.9 hectares of native woodland vegetation contains feed tree species as outlined in the National Recovery Plan (DoE 2016) in the following vegetation zone: • HU678 - Black Cypress Pine - Ironbark+/-Narrow-leaved Wattle Low Open Forest Mainly on Narrabeen Sandstone in the Upper Hunter Region of the Sydney Basin Bioregion. This zone includes a a very sparse to sparse canopy dominated by broad-leaved ironbark (*Eucalyptus fibrosa*).

IMPACT	Development Footprint	
Offset Location	The Highfields BioBank Site is located approximately 60 km northwest of the Development Site. It is located in the Manobalai area, approximately 30 kilometres northwest of Muswellbrook, NSW (refer to **Figure 7.1**).	The Mangrove BioBank Site is located approximately 41 km northwest of the Development Site and approximately 18 km south of the Highfields BioBank Site. It occurs in the Manobalai area, approximately 30 kilometres northwest of Muswellbrook, NSW (refer to **Figure 7.1**).
Offset Area Existing Quality	The regent honeyeater has not been recorded within the Highfields BioBank Site. The closest record occurs approximately 5km to the southwest of the site near Manobalai Nature Reserve (OEH 2017a). Suitable habitat at the site is known to contain two key tree species (as per the National Recovery Plan for the Regent Honeyeater (DoE 2016)), being white/grey box intergrades (*Eucalyptus albens – moluccana*) and yellow box (*Eucalyptus melliodora*) in the HU730 - White Box x Grey Box - red gum - Rough-barked Apple grassy woodland on rich soils on hills in the upper Hunter Valley. The quality of this habitat is considered to be high for the regent honeyeater due to the moderate age of the vegetation which is characterised by a canopy between 6 to 20 metres in height and with moderate to high plant species diversity. Some disturbances from cattle grazing and weed species do occur in this habitat providing the opportunity for gain in habitat quality with appropriate management.	The regent honeyeater has not been recorded within the Mangrove BioBank Site. The closest record occurs approximately 15km to the southeast of the site near Jerrys Plains (OEH 2017a). Suitable habitat at the site is known to contain one feed tree species (as per the National Recovery Plan for the Regent Honeyeater (DoE 2016)), being broad-leaved ironbark (*Eucalyptus fibrosa*) in the HU678 - Black Cypress Pine - Ironbark+/-Narrow-leaved Wattle Low Open Forest Mainly on Narrabeen Sandstone in the Upper Hunter Region of the Sydney Basin Bioregion. The quality of this habitat is considered to be moderate for the regent honeyeater due to the moderate age of the vegetation which is characterised by a canopy between 15 to 20 metres in height and with an intact multi-species canopy, mid-storey and ground layer. Some disturbances from cattle grazing and weed species do occur in this habitat providing the opportunity for gain in habitat quality with appropriate management.

IMPACT	Development Footprint	
Conservation Gain and Improvement	The regent honeyeater habitat within the Highfields BioBank Site is proposed to be managed in accordance with a BioBanking Agreement which includes standard management actions such as weed control, erosion control, managing grazing for conservation, managing human disturbance, the retention of regrowth and remnant vegetation and supplementary planting where natural regeneration is insufficient. The 39.7 hectares of grassland associated with HU730 is proposed to be restored to the woodland formation following revegetation efforts using characteristic canopy and midstorey species, including white box and yellow box. This will result in a gain of 39.7 hectares of suitable regent honeyeater foraging habitat on the Hunter Valley floor.	The regent honeyeater habitat within the Mangrove BioBank Site is proposed to be managed in accordance with a BioBanking Agreement which includes standard management actions such as weed control, erosion control, managing grazing for conservation, managing human disturbance, the retention of regrowth and remnant vegetation and supplementary planting where natural regeneration is insufficient.
Land Use and Tenure	The historical land use of the Highfields BioBank Site has been agricultural, primarily cattle and sheep grazing. The property has been maintained as a landholding for this purpose since the late 1800s. Currently this property is maintained by Glencore and utilised for cattle grazing. The proposed Highfields BioBank Site is currently zoned RU1 Primary Production and E3 Environmental Management under the provisions of the Muswellbrook *Local Environmental Plan 2009* (LEP).	The historical land use of the Mangrove BioBank site has been agricultural, primarily cattle and sheep grazing and limited crop production. Currently this property is maintained by Glencore and utilised for cattle grazing. The proposed Mangrove BioBank Site is currently zoned RU1 Primary Production and E3 Environmental Management under the provisions of the Muswellbrook *Local Environmental Plan 2009* (LEP).

IMPACT	Development Footprint	
Averted Loss	The proposed Highfields BioBank Site is located on the northern boundary of the Manobalai Nature Reserve in an area of the dominated by agricultural activities in the Upper Hunter Valley. As the site is partially zoned RU1 – Primary Production under the Muswellbrook LEP 2009, extensive agriculture, forestry, and intensive plant agriculture are all permissible without consent in the RU1 zone. Certain native vegetation disturbance activities associated with routine agricultural activities can also be undertaken without any further approval requirements. The long-term conservation of the site under a BioBanking Agreement (or equivalent) represents a conservation gain by protecting this area from future surface disturbances related to agricultural practices.	The proposed Mangrove BioBank Site is located north of Denman and adjacent to Wybong Creek in an area of the dominated by agricultural activities in the Upper Hunter Valley. As the site is partially zoned RU1 – Primary Production under the Muswellbrook LEP 2009, extensive agriculture, forestry, and intensive plant agriculture are all permissible without consent in the RU1 zone. Certain native vegetation disturbance activities associated with routine agricultural activities can also be undertaken without any further approval requirements. The long-term conservation of the site under a BioBanking Agreement (or equivalent) represents a conservation gain by protecting this area from future surface disturbances related to agricultural practices.
Time Horizon	It is expected that the proposed Highfields BioBank Site would be secured in-perpetuity under a BioBanking Agreement (or equivalent) to provide long-term conservation and protection for threatened species habitats including for regent honeyeater.	It is expected that the proposed Mangrove BioBank Site would be secured in-perpetuity under a BioBanking Agreement (or equivalent) to provide long-term conservation and protection for threatened species habitats including for regent honeyeater.

9.2.4 Assessment of the Offset Strategy against the EPBC Act Environmental Offsets Policy (2012)

This section provides an assessment of the Biodiversity Offset Strategy for the regent honeyeater against the EPBC Act Environmental Offset Policy (DSEWPC 2012).

1. Suitable offsets must deliver an overall conservation outcome that improves or maintains the viability of the protected matter.

The Biodiversity Offset Strategy has been developed with the aim to maintain and improve biodiversity with a focus on habitats for threatened species in the Hunter Valley, including the regent honeyeater. With the inclusion of the Highfields and Mangrove BioBank Sites, it is likely that such an improvement will occur. The restoration White Box x Grey Box - red gum - Rough-barked Apple grassy woodland on rich soils on hills in the upper Hunter Valley in existing grassland areas of the Highfields BioBank Site represents a gain of around 39.7 hectares of vegetation dominated by key feed trees, which will improve the viability of the species in the Hunter Valley. 308.7 hectares of existing suitable foraging habitat at the BioBank Sites will be maintained and conserved in the long-term as an area of high quality habitats. This represents a total offset of 348.4 hectares of suitable potential habitat for the species in the Hunter Valley for an impact of 29.4 hectares at the Development Footprint.

2. Suitable offsets must be built around direct offsets but may include other compensatory measures.

The Biodiversity Offset Strategy is based on the use of direct land-based offsets containing suitable regent honeyeater foraging habitat that occurs within the Hunter Region. The Biodiversity Offset Strategy will result in the long-term conversation of 348.4 hectares of like-for-like offsets for the regent honeyeater. The Project will impact on 29.4 hectares of potential foraging habitat for the species in the form of low quality habitat which is relatively young post-mine rehabilitation.

The Biodiversity Offset Strategy does not propose any additional compensatory measures.

3. Suitable offsets must be in proportion to the level of statutory protection that applies to the protected matter.

Regent honeyeater is listed as critically endangered under the EPBC Act. As discussed above, the Biodiversity Offset Strategy has focused on securing existing high quality areas of regent honeyeater habitat and providing conservation gain in restoring previously cleared areas to woodland. The impacts on 29.4 hectares of potential foraging habitat for the species is proposed to be offset with 348.4 hectares of existing and to be restored habitat at the BioBank Sites.

4. Suitable offsets must be of a size and scale proportionate to the residual impacts on the protected matter.

The impacts on 29.4 hectares of potential foraging habitat (comprised of post-mine rehabilitation) for the regent honeyeater at the Development Footprint are proposed to be offset with 348.4 hectares existing and to be restored quality habitat at the BioBank Sites. The Biodiversity Offset Strategy is considered to be more than adequate to commensurate with the magnitude of impacts on regent honeyeater and delivers an outcome that is 'like for like' as well as proposing a gain in 39.7 hectares of habitat in the Hunter Region. The in-perpetuity protection of the BioBank Sites is likely to result in a long-term higher quality habitat outcome for the species. It is envisaged that the Biodiversity Offset Strategy will deliver net biodiversity gains in the medium and long term.

5. **Suitable offsets must effectively account for and manage the risks of the offset not succeeding.**

The Biodiversity Offset Strategy is based on the use of direct land-based offsets that occur within the Hunter Region. The land-based offset sites have been determined to provide suitable habitat for the regent honeyeater of higher quality than that affected by the Project. These areas are located within the Hunter Valley in areas near where the species has been previously recorded.

A positive feedback loop between monitoring and adaptive management of the land-based offset sites will be established as required under the BioBanking Agreement. Thresholds for key monitoring parameters will be proposed, together with trigger points or threshold exceedance levels to ensure that there are clear points at which a review of the monitoring and management approach is enacted.

6. **Suitable offsets must be additional to what is already required, determined by law or planning regulations, or agreed to under other schemes or programs.**

The proposed offsets do not overlap with any other government funded protection or habitat restoration program. All offset sites are located on currently non-reserved land and will add a significant area into the conservation system.

7. **Suitable offsets must be efficient, effective, timely, transparent, scientifically robust and reasonable.**

The timing of the protection of the BioBank Sites will be determined in line with the approval conditions for the Project. As outlined in **Section 6.2**, it is proposed that credits be retired according to the stages of the Project. Each of the proposed BioBank sites are on land wholly owned by Glencore and Wambo for the purposes of offsetting prior to the approval of the Project. The application of BioBanking Agreements for these sites provides for a transparent, consistent and scientifically robust method of monitoring and management in accordance with the *Threatened Species Conservation (Biodiversity Banking) Regulation 2008*. While no species credits are required for the Project for regent honeyeater, ecosystem credits that cover likely habitat for the species (such as for HU730) will be retired and managed under the BioBanking process.

The area of impact has been derived from detailed GIS mapping of Project boundaries and impact areas, and the ecological survey, mapping, impact assessments and design of the Biodiversity Offset Strategy have been completed by qualified ecologists with considerable experience in the region ensuring that the Strategy is scientifically robust, transparent and reasonable.

8. **Suitable offsets must have transparent governance arrangements including being able to be readily measured, monitored, audited and enforced.**

The suitable regent honeyeater habitat within the Highfields and Mangrove BioBank Sites is proposed to be secured with a BioBanking Agreement (or equivalent) which provides in-perpetuity protection and funding for management and improvement of the biodiversity of the site.

9.3 Swift parrot (*Lathamus discolor*)

9.3.1 Impact Assessment

Swift parrot has not been recorded within the Development Footprint despite targeted winter bird surveys undertaken over six years (2010-2016). Swift parrot breeds in Tasmania and moves to mainland Australia for the non-breeding season (usually arriving between February and March). Most of the population winters in Victoria and NSW. While in NSW, the species occurs in areas of box-gum woodlands and areas of suitable winter-flowering foraging habitat. The Development Footprint contains potential foraging habitat for the species. Vegetation in the Development Footprint is known to contain two key tree species (as per the National Recovery Plan for the Swift Parrot (Saunders and Tzaros 2011)), being spotted gum (*Corymbia maculata*) which occurs in low densities in the mine rehabilitation HU816 Spotted Gum - Narrow-leaved Ironbark Shrub - Grass Open Forest of the Central and Lower Hunter and forest red gum (*Eucalyptus tereticornis*) occurring HU812 Forest Red Gum Grassy Open Forest on Floodplains of the Lower Hunter. The Project will remove approximately 29.7 hectares of vegetation that contains key feed tree species for the swift parrot.

It is expected that the total population size for swift parrot is less than 2,000 individuals (TSSC 2016). The closest records of the species occur approximately 3 kilometres from the Development Footprint recorded 15 years ago in 2002 (OEH 2015). The species is more regularly and recently recorded from habitats in the Singleton Military Area approximately 15 km from the Development Footprint.

While the Project will remove a range of native vegetation communities within the Development Footprint including fragmented eucalypt woodlands, none of the habitats in the Development Footprint have been recorded as being used by swift parrot either historically or recently.

An Assessment of Significance according to the *Significant Impact Guidelines 1.1* (DoE 2013) was undertaken to determine the significance of the impact on the swift parrot as part of the EPBC Referral. The assessment of significance concluded that the Project was unlikely to have a significant impact on the swift parrot as it was unlikely to lead to a long term decrease in the population, fragment the population, disrupt the breeding cycle of the population, result in an invasive species harmful to the species, introduce a disease or interfere with the recovery of the species.

Following its assessment of the Referral, the DoEE concluded that the Project was likely to result in a significant impact on the species based on the information in the referral documentation (including impacts on 227 hectares of box-gum woodland potential habitat), the location of the action, species records and likely habitat present in the area. The species therefore required further assessment for the Project with this assessment satisfying that requirement. This area of impact was further refined using the National Recovery Plan for the Swift Parrot (Saunders and Tzaros 2011), to areas containing key tree foraging species as discussed in the paragraphs above (i.e. 29.7 hectares of potential foraging habitat).

9.3.2 Avoidance and Mitigation

United has sought to avoid and minimise potential impacts on the ecological values of the Development Footprint throughout the Project planning and approval process. This has included avoidance and minimisation of disturbance of habitat suitable for the swift parrot through designing the Project to maximise use of existing mining and transport facilities and revising impact boundaries.

A key alternative for the Project was to develop the United Open Cut as a standalone mining operation which would have resulted in approximately 148 hectares of further disturbance to native vegetation communities than the proposed Project due to the need to develop stand-alone coal processing facilities, mine infrastructure (workshops, etc) and transportation infrastructure (rail line, rail loop and train loading

facility). This Option 1 Project (as detailed in Section 3.4.1 of the EIS) represented the largest disturbance footprint alterative.

Furthermore, following the exhibition of the EIS in August 2016, revisions to the mine disturbance boundary were undertaken to reduce the impacts to approximately 36 hectares of land including 26.9 hectares of native woodland.

Mitigation measures for the Project are outlined in **Section 4.2**. Specifically for the swift parrot, the following mitigation measures are relevant:

- implementation of clearing procedures (pre-clearance surveys and felling supervision) to minimise the impacts of the clearing process on locally-occurring fauna species
- feral animal and noxious weed control.

9.3.3 Offsetting Outcomes

United is committed to delivering a biodiversity offset strategy that appropriately compensates for the removal of 29.7 hectares of majority post-mining rehabilitation habitat containing key feed trees species for the swift parrot as a result of the Project. As outlined in **Section 7.0**, this will be undertaken in accordance with the FBA and the NSW *Biodiversity Offset Policy for Major Projects*.

The proposed offset package seeks to balance the protection and improvement of existing high quality habitats along with providing suitable conservation gain by restoring grassland areas to provide suitable woodland habitats for the species and locating offsets in areas under threat of clearance.

The like-for-like offsets currently proposed for swift parrot include a total of 426.8 hectares of suitable habitat as part of:

- 19.9 hectares at the Wambo BioBank Site
- 306 hectares at the Highfields BioBank Site
- 100.9 hectares at the Mangrove BioBank Site.

The suitable habitats at the BioBank Sites have been identified through the presence of key foraging tree species for the swift parrot as outlined in the National Recovery Plan (Saunders and Tzaros 2011) where there are known or nearby (within 20km) records

Table 9.4 below provides an assessment of the impact and offsetting outcomes for the proposed for the swift parrot with reference to the *EPBC Act Environmental Offsets Policy* (DSEWPC 2012).

Table 9.4 Swift Parrot Impact and Offsetting Outcomes

IMPACT	Development Footprint		
Impact Area	29.7 hectares of habitat containing key feed tree species as per the National Recovery Plan (Saunders and Tzaros 2011).		
Impact Quality	This species has not been recorded within the Development Footprint despite targeted winter bird surveys undertaken over six years (2010-2016). No breeding or nesting habitat for swift parrot has been recorded within the Development Footprint. Vegetation in the Development Footprint is known to contain two key tree species (as per the National Recovery Plan for the Swift Parrot (Saunders and Tzaros 2011)), being spotted gum (*Corymbia maculata*) which occurs in low densities in the planted HU812 Spotted Gum - Narrow-leaved Ironbark Shrub - Grass Open Forest of the Central and Lower Hunter and forest red gum (*Eucalyptus tereticornis*) occurring HU812 Forest Red Gum Grassy Open Forest on Floodplains of the Lower Hunter. The quality of this habitat is considered low due to the post-mine rehabilitation vegetation which is characterised by a relatively open canopy supported by a shrubby understorey. The canopy in these communities are sparse and between 5 to 18 metres in height.		
OFFSETS	**Wambo BioBank Site**	**Highfields BioBank Site**	**Mangrove BioBank Site**
Area of Habitat	The Wambo BioBank Site is 338 hectares in size. 12.6 hectares of native woodland vegetation contains key feed tree species as outlined in the National Recovery Plan (Saunders and Tzaros 2011) in the following vegetation zones: • HU712 - River Oak Riparian Grassy Tall Woodland of the Western Hunter Valley (Brigalow Belt South) This zone includes forest red gum (*Eucalyptus tereticornis*) as a co-dominant canopy species. 7.3 hectares of derived native grassland associated with HU712 also occurs on the site, which will be regenerated to include canopy species characteristic of the woodland variant.	The Highfields BioBank Site is 427 hectares in size. 266.3 hectares of native woodland vegetation contains key feed tree species as outlined in the National Recovery Plan (Saunders and Tzaros 2011) in the following vegetation zones: • HU714 - Rough-Barked Apple - Red Gum - Yellow Box woodland on alluvial clay to loam soils on valley flats in the northern NSW South Western Slopes Bioregion and Brigalow Belt South Bioregion • HU730 - White Box x Grey Box - red gum - Rough-barked Apple grassy woodland on rich soils on hills in the upper Hunter Valley • HU730 - White Box x Grey Box - red gum - Rough-barked Apple grassy woodland on rich soils on hills in the upper Hunter	The Mangrove BioBank Site is 259 hectares in size. 15.2 hectares of native woodland vegetation contains feed tree species as outlined in the National Recovery Plan (Saunders and Tzaros 2011) in the following vegetation zone: • HU812 - Forest Red Gum Grassy Open Forest on Floodplains of the Lower Hunter This zone includes a very sparse to sparse canopy dominated by forest red gum (*Eucalyptus tereticornis*). 85.7 hectares of derived native grassland and cleared land associated with HU812 also occurs on the site, which will be regenerated to include canopy species characteristic of the woodland variant.

IMPACT	Development Footprint		
		Valley (shrubby variant) These zones include Blakely's / forest red gum intergrades (*Eucalyptus blakelyi - tereticornis*), white/grey box intergrades (*Eucalyptus albens – moluccana*) and yellow box (*Eucalyptus melliodora*) as dominant or co-dominant canopy species. 39.7 hectares of derived native grassland associated with HU730 also occurs on the site, which will be regenerated to include canopy species characteristic of the woodland and shrub variants.	
Offset Location	The Wambo BioBank Site is located immediately to the west of the Development Site and adjacent to the Wollemi National Park (refer to **Figure 7.1**) and the Greater Blue Mountains World Heritage Area.	The Highfields BioBank Site is located approximately 60 km northwest of the Development Site. It is located in the Manobalai area, approximately 30 kilometres northwest of Muswellbrook, NSW (refer to **Figure 7.1**).	The Mangrove BioBank Site is located approximately 41 km northwest of the Development Site and approximately 18 km south of the Highfields BioBank Site. It occurs in the Manobalai area, approximately 30 kilometres northwest of Muswellbrook, NSW (refer to **Figure 7.1**).
Offset Area Existing Quality	The swift parrot has not been recorded within the Wambo BioBank Site. The closest record occurs approximately 10km to the southeast of the site near Mount Thorley (OEH 2017a).The offset is adjacent to the Development Site. Suitable habitat at the site is known to contain one feed tree species (as per the National Recovery Plan for the Swift parrot (Saunders and Tzaros 2011)), being forest red gum in the HU712 - River Oak Riparian Grassy Tall Woodland of the Western Hunter Valley (Brigalow Belt South). The quality of this habitat is considered to be moderate for the swift parrot due to the age	The swift parrot has not been recorded within the Highfields BioBank Site. The closest record occurs approximately 20km to the northeast of the site near Scone (OEH 2017a). Suitable habitat at the site is known to contain three key tree species (as per the National Recovery Plan for the Swift parrot (Saunders and Tzaros 2011)), being Blakely's / forest red gum intergrades (*Eucalyptus blakelyi - tereticornis*), white/grey box intergrades (*Eucalyptus albens – moluccana*) and yellow box (*Eucalyptus melliodora*) in the HU714 and HU730 vegetation communities. The quality of this habitat is considered to be	The swift parrot has not been recorded within the Mangrove BioBank Site. The closest record occurs approximately 20km to the northeast of the site north of Lake Liddell (OEH 2017a). Suitable habitat at the site is known to contain one feed tree species (as per the National Recovery Plan for the Swift parrot (Saunders and Tzaros 2011)), being forest red gum (*Eucalyptus tereticornis*) in the HU812 - Forest Red Gum Grassy Open Forest on Floodplains of the Lower Hunter. The quality of this habitat is considered to be moderate for the swift parrot due to the moderate age of the vegetation which is

IMPACT	Development Footprint		
	of the vegetation which occurs along the edges of North Wambo Creek. Some disturbances from cattle grazing and weed species do occur in this habitat providing the opportunity for gain in habitat quality with appropriate management.	high for the swift parrot due to the moderate age of the vegetation which is characterised by a canopy between 6 to 20 metres in height and with moderate to high plant species diversity. Some disturbances from cattle grazing and weed species do occur in this habitat providing the opportunity for gain in habitat quality with appropriate management.	characterised by a canopy between 13 to 18 metres in height and with an intact multi-species canopy, mid-storey and ground layer. Some disturbances from cattle grazing and weed species do occur in this habitat providing the opportunity for gain in habitat quality with appropriate management.
Conservation Gain and Improvement	The swift parrot habitat within the Wambo BioBank Site is proposed to be managed in accordance with a BioBanking Agreement which includes standard management actions such as weed control, erosion control, managing grazing for conservation, managing human disturbance, the retention of regrowth and remnant vegetation and supplementary planting where natural regeneration is insufficient. The 7.3 hectares of grassland associated with HU730 is proposed to be restored to the woodland formation following revegetation efforts using characteristic canopy and midstorey species, including forest red gum. This will result in a gain of 7.3 hectares of suitable swift parrot foraging habitat on the Hunter Valley floor.	The swift parrot habitat within the Highfields BioBank Site is proposed to be managed in accordance with a BioBanking Agreement which includes standard management actions such as weed control, erosion control, managing grazing for conservation, managing human disturbance, the retention of regrowth and remnant vegetation and supplementary planting where natural regeneration is insufficient. The 39.7 hectares of grassland associated with HU730 is proposed to be restored to the woodland formation following revegetation efforts using characteristic canopy and midstorey species, including white box and yellow box. This will result in a gain of 39.7 hectares of suitable swift parrot foraging habitat on the Hunter Valley floor.	The swift parrot habitat within the Mangrove BioBank Site is proposed to be managed in accordance with a BioBanking Agreement which includes standard management actions such as weed control, erosion control, managing grazing for conservation, managing human disturbance, the retention of regrowth and remnant vegetation and supplementary planting where natural regeneration is insufficient. The 85.7 hectares of grassland and cleared land associated with HU812 is proposed to be restored to the woodland formation following revegetation efforts using characteristic canopy and midstorey species, including forest red gum. This will result in a gain of 85.7 hectares of suitable swift parrot foraging habitat on the Hunter Valley floor.
Land Use and Tenure	The primary existing land use of the proposed Wambo BioBank Site is light grazing, however generally the site is unutilised. The proposed Wambo BioBank Site is currently wholly zoned RU1 Primary	The historical land use of the Highfields BioBank Site has been agricultural, primarily cattle and sheep grazing. The property has been maintained as a landholding for this purpose since the late 1800s. Currently this property is maintained by Glencore and	The historical land use of the Mangrove BioBank site has been agricultural, primarily cattle and sheep grazing and limited crop production. Currently this property is maintained by Glencore and utilised for cattle grazing.

IMPACT	Development Footprint		
	Production under the provisions of the Singleton *Local Environmental Plan 2013* (LEP).	utilised for cattle grazing. The proposed Highfields BioBank Site is currently zoned RU1 Primary Production and E3 Environmental Management under the provisions of the Muswellbrook *Local Environmental Plan 2009* (LEP).	The proposed Mangrove BioBank Site is currently zoned RU1 Primary Production and E3 Environmental Management under the provisions of the Muswellbrook *Local Environmental Plan 2009* (LEP).
Averted Loss	The proposed Wambo BioBank Site is located adjacent to the boundaries of the United and Wambo mines in an area of the Hunter Valley containing coal seams which could be extracted using open cut methods. Open cut coal mining could result in the total loss of the site. As the site is wholly zoned RU1 – Primary Production under the Singleton LEP 2013, extensive agriculture, forestry, and intensive plant agriculture are all permissible without consent in the RU1 zone. Certain native vegetation disturbance activities associated with routine agricultural activities can also be undertaken without any further approval requirements. While the proposed South Bates Extension Modification Project includes longwall panels directly under the proposed Wambo BioBank Site, the flora impact assessment (FloraSearch 2017) considered it unlikely for habitats within areas of the proposed Wambo BioBank Site to be adversely affected by soil cracking due to mine subsidence. Therefore these impacts are unlikely to substantially alter the potential habitat for swift parrot on the site. The long-term conservation of the site under	The proposed Highfields BioBank Site is located on the northern boundary of the Manobalai Nature Reserve in an area of the dominated by agricultural activities in the Upper Hunter Valley. As the site is partially zoned RU1 – Primary Production under the Muswellbrook LEP 2009, extensive agriculture, forestry, and intensive plant agriculture are all permissible without consent in the RU1 zone. Certain native vegetation disturbance activities associated with routine agricultural activities can also be undertaken without any further approval requirements. The long-term conservation of the site under a BioBanking Agreement (or equivalent) represents a conservation gain by protecting this area from future surface disturbances related to agricultural practices.	The proposed Mangrove BioBank Site is located north of Denman and adjacent to Wybong Creek in an area of the dominated by agricultural activities in the Upper Hunter Valley. As the site is partially zoned RU1 – Primary Production under the Muswellbrook LEP 2009, extensive agriculture, forestry, and intensive plant agriculture are all permissible without consent in the RU1 zone. Certain native vegetation disturbance activities associated with routine agricultural activities can also be undertaken without any further approval requirements. The long-term conservation of the site under a BioBanking Agreement (or equivalent) represents a conservation gain by protecting this area from future surface disturbances related to agricultural practices.

IMPACT	Development Footprint		
	a BioBanking Agreement (or equivalent) represents a conservation gain by protecting this area from future surface disturbances related to open cut coal mining and agricultural practices.		
Time Horizon	It is expected that the proposed Wambo BioBank Site would be secured in-perpetuity under a BioBanking Agreement (or equivalent) to provide long-term conservation and protection for threatened species habitats including for swift parrot.	It is expected that the proposed Highfields BioBank Site would be secured in-perpetuity under a BioBanking Agreement (or equivalent) to provide long-term conservation and protection for threatened species habitats including for swift parrot.	It is expected that the proposed Mangrove BioBank Site would be secured in-perpetuity under a BioBanking Agreement (or equivalent) to provide long-term conservation and protection for threatened species habitats including for swift parrot.

9.3.4 Assessment of the Offset Strategy against the EPBC Act Environmental Offsets Policy (2012)

This section provides an assessment of the Biodiversity Offset Strategy for the swift parrot against the EPBC Act Environmental Offset Policy (DSEWPC 2012).

1. Suitable offsets must deliver an overall conservation outcome that improves or maintains the viability of the protected matter.

The Biodiversity Offset Strategy has been developed with the aim to maintain and improve biodiversity with a focus on habitats for threatened species in the Hunter Valley, including the swift parrot. With the inclusion of the Wambo Highfields and Mangrove BioBank Sites, it is likely that such an improvement will occur. The restoration of grasslands at the BioBank Sites represents a gain of around 132.7 hectares of vegetation dominated by key feed trees, which will improve the viability of the species in the Hunter Valley. 294.1 hectares of existing suitable foraging habitat at the BioBank Sites will be maintained and conserved in the long-term as an area of high quality habitats. This represents a total offset of 426.8 hectares of suitable potential habitat for the species in the Hunter Valley for an impact of 29.7 hectares at the Development Footprint.

2. Suitable offsets must be built around direct offsets but may include other compensatory measures.

The Biodiversity Offset Strategy is based on the use of direct land-based offsets containing suitable swift parrot foraging habitat that occurs within the Hunter Region. The Biodiversity Offset Strategy will result in the long-term conversation of 426.8 hectares of like-for-like offsets for the swift parrot. The Project will impact on 29.7 hectares of potential foraging habitat for the species in the form of majority low quality habitat which is relatively young post-mine rehabilitation.

The Biodiversity Offset Strategy does not propose any additional compensatory measures.

3. Suitable offsets must be in proportion to the level of statutory protection that applies to the protected matter.

Swift parrot is listed as critically endangered under the EPBC Act, however for the Project this species is assessed as having an 'endangered' listing status as per the SEARs. As discussed above, the Biodiversity Offset Strategy has focused on securing existing high quality areas of swift parrot habitat and providing conservation gain in restoring previously cleared areas to woodland. The impacts on 29.7 hectares of potential foraging habitat for the species is proposed to be offset with 426.8 hectares of existing and to be restored habitat at the BioBank Sites.

4. Suitable offsets must be of a size and scale proportionate to the residual impacts on the protected matter.

The impacts on 29.7 hectares of potential foraging habitat (comprised of post-mine rehabilitation) for the swift parrot at the Development Footprint are proposed to be offset with 426.8 hectares existing and to be restored quality habitat at the BioBank Sites. The Biodiversity Offset Strategy is considered to be more than adequate to commensurate with the magnitude of impacts on swift parrot and delivers an outcome that is 'like for like' as well as proposing a gain in 132.7 hectares of habitat in the Hunter Region. The in-perpetuity protection of the BioBank Sites is likely to result in a long-term higher quality habitat outcome for the species. It is envisaged that the Biodiversity Offset Strategy will deliver net biodiversity gains in the medium and long term.

5. Suitable offsets must effectively account for and manage the risks of the offset not succeeding.

The Biodiversity Offset Strategy is based on the use of direct land-based offsets that occur within the Hunter Region. The land-based offset sites have been determined to provide suitable habitat for the swift parrot of higher quality than that affected by the Project. These areas are located within the Hunter Valley in areas near where the species has been previously recorded.

A positive feedback loop between monitoring and adaptive management of the land-based offset sites will be established as required under the BioBanking Agreement. Thresholds for key monitoring parameters will be proposed, together with trigger points or threshold exceedance levels to ensure that there are clear points at which a review of the monitoring and management approach is enacted.

6. Suitable offsets must be additional to what is already required, determined by law or planning regulations, or agreed to under other schemes or programs.

The proposed offsets do not overlap with any other government funded protection or habitat restoration program. All offset sites are located on currently non-reserved land and will add a significant area into the conservation system.

7. Suitable offsets must be efficient, effective, timely, transparent, scientifically robust and reasonable.

The timing of the protection of the BioBank Sites will be determined in line with the approval conditions for the Project. As outlined in **Section 6.2**, it is proposed that credits be retired according to the stages of the Project. Each of the proposed BioBank sites are on land wholly owned by Glencore and Wambo for the purposes of offsetting prior to the approval of the Project. The application of BioBanking Agreements for these sites provides for a transparent, consistent and scientifically robust method of monitoring and management in accordance with the *Threatened Species Conservation (Biodiversity Banking) Regulation 2008*. While no species credits are required for the Project for swift parrot, ecosystem credits that cover likely habitat for the species (such as for HU730) will be retired and managed under the BioBanking process.

The area of impact has been derived from detailed GIS mapping of Project boundaries and impact areas, and the ecological survey, mapping, impact assessments and design of the Biodiversity Offset Strategy have been completed by qualified ecologists with considerable experience in the region ensuring that the Strategy is scientifically robust, transparent and reasonable.

8. Suitable offsets must have transparent governance arrangements including being able to be readily measured, monitored, audited and enforced.

The suitable swift parrot habitat within the Wambo, Highfields and Mangrove BioBank Sites is proposed to be secured with a BioBanking Agreement (or equivalent) which provides in-perpetuity protection and funding for management and improvement of the biodiversity of the site.

9.4 Spotted-tailed quoll (*Dasyurus maculatus maculatus*)

9.4.1 Impact Assessment

The spotted-tailed quoll has been recorded on a single occasion in the east of the Development Footprint. This record was made by way of baited (i.e. a food source to attract animals) remote camera in an area of swamp oak vegetation during 2013. This species has not been recorded prior to this event or since this point in time despite subsequent targeted survey. There are relatively few recent records of this species occurring from the floor of the Hunter Valley. It is considered unlikely that the spotted-tailed quoll is breeding within the Development Footprint, however, it is likely that the spotted-tailed quoll occasionally utilises the habitats available as part of a wider territory. Vegetation in the Development Footprint that would be suitable habitat for the species (as per the National Recovery Plan for the Spotted-tailed quoll (DoE 2016)), includes all forest and woodland habitat within the Development Footprint. The Project will remove approximately 356.5 hectares of suitable habitat for the spotted-tailed quoll.

An Assessment of Significance according to the *Significant Impact Guidelines 1.1* (DoE 2013) was undertaken to determine the significance of the impact on the spotted-tailed quoll as part of the EPBC Referral. The assessment of significance concluded that the Project was unlikely to have a significant impact on the spotted-tailed quoll as it was unlikely to lead to a long term decrease in the population, fragment the population, disrupt the breeding cycle of the population, result in an invasive species harmful to the species, introduce a disease or interfere with the recovery of the species.

Following its assessment of the Referral, the DoEE concluded that the Project was likely to result in a significant impact on the species based on the information in the referral documentation (including impacts on 462 hectares of likely woodland and grassland habitat), the location of the action, species records and likely habitat present in the area. It should be noted that following the release of the *National Recovery Plan for the Spotted-tailed Quoll* in May 2016, the area of impact was further refined as discussed in the paragraphs above (i.e. 356.5 hectares of potential woodland and forest habitat).

9.4.2 Avoidance and Mitigation

United has sought to avoid and minimise potential impacts on the ecological values of the Development Footprint throughout the Project planning and approval process. This has included avoidance and minimisation of disturbance of habitat suitable for the spotted-tailed quoll through designing the Project to maximise use of existing mining and transport facilities and revising impact boundaries.

A key alternative for the Project was to develop the United Open Cut as a standalone mining operation which would have resulted in approximately 148 hectares of further disturbance to native vegetation communities than the proposed Project due to the need to develop stand-alone coal processing facilities, mine infrastructure (workshops, etc) and transportation infrastructure (rail line, rail loop and train loading facility). This Option 1 Project (as detailed in Section 3.4.1 of the EIS) represented the largest disturbance footprint alterative.

Furthermore, following the exhibition of the EIS in August 2016, revisions to the mine disturbance boundary were undertaken to reduce the impacts to approximately 36 hectares of land including 26.9 hectares of native woodland.

Mitigation measures for the Project are outlined in **Section 4.2**. Specifically for the spotted-tailed quoll, the following mitigation measures are relevant:

- implementation of clearing procedures (pre-clearance surveys and felling supervision) to minimise the impacts of the clearing process on locally-occurring fauna species
- feral animal and noxious weed control.

9.4.3 Offsetting Outcomes

United is committed to delivering a biodiversity offset strategy that appropriately compensates for the removal of 356.5 hectares of suitable habitat for the spotted-tailed quoll as a result of the Project. As outlined in **Section 7.0**, this will be undertaken in accordance with the FBA and the NSW *Biodiversity Offset Policy for Major Projects*.

The proposed offset package seeks to balance the protection and improvement of existing high quality habitats along with providing suitable conservation gain by restoring grassland areas to provide suitable woodland habitats for the species and locating offsets in areas under threat of clearance.

The like-for-like offsets currently proposed for spotted-tailed quoll include a total of 1,021.2 hectares of suitable habitat as part of:

- 335.2 hectares at the Wambo BioBank Site
- 427.5 hectares at the Highfields BioBank Site
- 258.5 hectares at the Mangrove BioBank Site

The suitable habitats at the BioBank Sites have been identified through the presence of suitable woodland and forest habitat for the spotted-tailed quoll where there are known or nearby (within 5km) records.

Table 9.5 below provides an assessment of the impact and offsetting outcomes for the proposed for the spotted-tailed quoll with reference to the *EPBC Act Environmental Offsets Policy* (DSEWPC 2012).

Table 9.5 Spotted-tailed quoll Impact and Offsetting Outcomes

IMPACT	Development Footprint		
Impact Area	356.5 hectares of woodland and forest habitat as per the National Recovery Plan (DELWP 2016).		
Impact Quality	The spotted-tailed quoll has been recorded on a single occasion in the east of the Development Footprint. This record was made by way of baited (i.e. a food source to attract animals) remote camera in an area of swamp oak vegetation during 2013. This species has not been recorded prior to this event or since this point in time despite subsequent targeted survey. There are relatively few recent records of this species occurring from the floor of the Hunter Valley. It is considered unlikely that the spotted-tailed quoll is breeding within the Development Footprint, however it is likely that the spotted-tailed quoll occasionally utilises the habitats available as part of a wider territory. The quality of this habitat is considered moderate due to the young age of the vegetation and availability of movement habitat along Redbank Creek.		
OFFSETS	**Wambo BioBank Site**	**Highfields BioBank Site**	**Mangrove BioBank Site**
Area of Habitat	The Wambo BioBank Site is 338 hectares in size. 276 hectares of native woodland or forest vegetation occurs on the site that would provide suitable habitat for the species. North Wambo Creek contains riparian vegetation that would likely provide suitable movement habitat for the species. 59.2 hectares of derived native grassland also occurs on the site, which will be regenerated to woodland habitats.	The Highfields BioBank Site is 427 hectares in size. 381.3 hectares of native woodland or forest vegetation occurs on the site that would provide suitable habitat for the species. 46.2 hectares of derived native grassland also occurs on the site, which will be regenerated to woodland habitats.	The Mangrove BioBank Site is 259 hectares in size. 81.9 hectares of native woodland or forest vegetation occurs on the site that would provide suitable habitat for the species. Wybong Creek contains riparian vegetation that would likely provide suitable movement habitat for the species. 176.6 hectares of derived native grassland also occurs on the site, which will be regenerated to woodland habitats.
Offset Location	The Wambo BioBank Site is located immediately to the west of the Development Site and adjacent to the Wollemi National Park (refer to **Figure 7.1**) and the Greater Blue Mountains World Heritage Area.	The Highfields BioBank Site is located approximately 60 km northwest of the Development Site. It is located in the Manobalai area, approximately 30 kilometres northwest of Muswellbrook, NSW (refer to **Figure 7.1**).	The Mangrove BioBank Site is located approximately 41 km northwest of the Development Site and approximately 18 km south of the Highfields BioBank Site. It occurs in the Manobalai area, approximately 30 kilometres northwest of Muswellbrook, NSW (refer to **Figure 7.1**).

IMPACT	Development Footprint		
Offset Area Existing Quality	The spotted-tailed quoll has not been recorded within the Wambo BioBank Site. The closest record occurs approximately 2km to the west of the site in Wollemi National Park (OEH 2017a). The site contains woodland and riparian forest vegetation which is likely to provide suitable foraging and denning habitats for the species. The quality of this habitat is considered to be high for the spotted-tailed quoll due to the lack of substantial disturbances and the quality of intact vegetation to large contiguous habitat in Wollemi National Park. This would provide a suitably large area of habitat for the large home ranges occupied by individuals of the species.	The spotted-tailed quoll has not been recorded within the Highfields BioBank Site. The closest record occurs approximately 1km to the southwest of the site in the Esparanga Offset Site also owned by Glencore (Umwelt 2014). Another record also occurs approximately 5km to the south of the site along Dry Creek (OEH 2017a). The site contains woodland and forest vegetation which is likely to provide suitable foraging and denning habitats for the species. The quality of this habitat is considered to be high for the spotted-tailed quoll due to the lack of substantial disturbances and the quality of intact vegetation to large contiguous habitat in Manobalai Nature Reserve. This would provide a suitably large area of habitat for the large home ranges occupied by individuals of the species.	The spotted-tailed quoll has not been recorded within the Mangrove BioBank Site. The closest record occurs approximately 2km to the northeast of the site near the Mangoola Coal Mine (OEH 2017a). The site contains some areas of woodland and riparian forest vegetation associated with Wybong Creek which is likely to provide suitable foraging and denning habitats for the species. The quality of this habitat is considered to be moderate for the spotted-tailed quoll due to the likely movement habitat along Wybong Creek, however the site is currently dominated by derived native grasslands which would be considered low quality habitat.
Conservation Gain and Improvement	The spotted-tailed quoll habitat within the Wambo BioBank Site is proposed to be managed in accordance with a BioBanking Agreement which includes standard management actions such as weed control, erosion control, managing grazing for conservation, managing human disturbance, the retention of regrowth and remnant vegetation and supplementary planting where natural regeneration is insufficient. The 59.2 hectares of grassland is proposed to be restored to the woodland formation following revegetation efforts. This will result in	The spotted-tailed quoll habitat within the Highfields BioBank Site is proposed to be managed in accordance with a BioBanking Agreement which includes standard management actions such as weed control, erosion control, managing grazing for conservation, managing human disturbance, the retention of regrowth and remnant vegetation and supplementary planting where natural regeneration is insufficient. The 46.2 hectares of grassland is proposed to be restored to the woodland formation	The spotted-tailed quoll habitat within the Mangrove BioBank Site is proposed to be managed in accordance with a BioBanking Agreement which includes standard management actions such as weed control, erosion control, managing grazing for conservation, managing human disturbance, the retention of regrowth and remnant vegetation and supplementary planting where natural regeneration is insufficient. The 176.6 hectares of grassland is proposed to be restored to the woodland formation following revegetation efforts. This will result in

IMPACT	Development Footprint		
	a gain of 59.2 hectares of suitable spotted-tailed quoll habitat on the Hunter Valley floor.	following revegetation efforts. This will result in a gain of 46.2 hectares of suitable spotted-tailed quoll habitat on the Hunter Valley floor.	a gain of 176.6 hectares of suitable spotted-tailed quoll habitat on the Hunter Valley floor.
Land Use and Tenure	The primary existing land use of the proposed Wambo BioBank Site is light grazing, however generally the site is unutilised. The site is owned by Wambo. The proposed Wambo BioBank Site is currently wholly zoned RU1 Primary Production under the provisions of the Singleton *Local Environmental Plan 2013* (LEP).	The historical land use of the Highfields BioBank Site has been agricultural, primarily cattle and sheep grazing. The property has been maintained as a landholding for this purpose since the late 1800s. Currently this property is maintained by Glencore and utilised for cattle grazing. The proposed Highfields BioBank Site is currently zoned RU1 Primary Production and E3 Environmental Management under the provisions of the Muswellbrook *Local Environmental Plan 2009* (LEP).	The historical land use of the Mangrove BioBank site has been agricultural, primarily cattle and sheep grazing and limited crop production. Currently this property is maintained by Glencore and utilised for cattle grazing. The proposed Mangrove BioBank Site is currently zoned RU1 Primary Production and E3 Environmental Management under the provisions of the Muswellbrook *Local Environmental Plan 2009* (LEP).
Averted Loss	The proposed Wambo BioBank Site is located adjacent to the boundaries of the United and Wambo mines in an area of the Hunter Valley containing coal seams which could be extracted using open cut methods. Open cut coal mining could result in the total loss of the site. As the site is wholly zoned RU1 – Primary Production under the Singleton LEP 2013, extensive agriculture, forestry, and intensive plant agriculture are all permissible without consent in the RU1 zone. Certain native vegetation disturbance activities associated with routine agricultural activities can also be undertaken without any further approval requirements. While the proposed South Bates Extension Modification Project includes longwall panels	The proposed Highfields BioBank Site is located on the northern boundary of the Manobalai Nature Reserve in an area of the dominated by agricultural activities in the Upper Hunter Valley. As the site is partially zoned RU1 – Primary Production under the Muswellbrook LEP 2009, extensive agriculture, forestry, and intensive plant agriculture are all permissible without consent in the RU1 zone. Certain native vegetation disturbance activities associated with routine agricultural activities can also be undertaken without any further approval requirements. The long-term conservation of the site	The proposed Mangrove BioBank Site is located north of Denman and adjacent to Wybong Creek in an area of the dominated by agricultural activities in the Upper Hunter Valley. As the site is partially zoned RU1 – Primary Production under the Muswellbrook LEP 2009, extensive agriculture, forestry, and intensive plant agriculture are all permissible without consent in the RU1 zone. Certain native vegetation disturbance activities associated with routine agricultural activities can also be undertaken without any further approval requirements. The long-term conservation of the site under a BioBanking Agreement (or equivalent) represents a conservation gain by protecting

IMPACT	Development Footprint		
	directly under the proposed Wambo BioBank Site, the expected subsidence levels has been assessed as unlikely to substantially reduce the condition of the habitat on the site (MSEC 2017). The long-term conservation of the site under a BioBanking Agreement (or equivalent) represents a conservation gain by protecting this area from future surface disturbances related to open cut coal mining and agricultural practices.	under a BioBanking Agreement (or equivalent) represents a conservation gain by protecting this area from future surface disturbances related to agricultural practices.	this area from future surface disturbances related to agricultural practices.
Time Horizon	It is expected that the proposed Wambo BioBank Site would be secured in-perpetuity under a BioBanking Agreement (or equivalent) to provide long-term conservation and protection for threatened species habitats including for spotted-tailed quoll.	It is expected that the proposed Highfields BioBank Site would be secured in-perpetuity under a BioBanking Agreement (or equivalent) to provide long-term conservation and protection for threatened species habitats including for spotted-tailed quoll.	It is expected that the proposed Mangrove BioBank Site would be secured in-perpetuity under a BioBanking Agreement (or equivalent) to provide long-term conservation and protection for threatened species habitats including for spotted-tailed quoll.

9.4.4 Assessment of the Offset Strategy against the EPBC Act Environmental Offsets Policy (2012)

This section provides an assessment of the Biodiversity Offset Strategy for the spotted-tailed quoll proposed against the EPBC Act Environmental Offset Policy (DSEWPC 2012).

1. Suitable offsets must deliver an overall conservation outcome that improves or maintains the viability of the protected matter.

The Biodiversity Offset Strategy has been developed with the aim to maintain and improve biodiversity with a focus on habitats for threatened species in the Hunter Valley, including the spotted-tailed quoll. With the inclusion of the Wambo Highfields and Mangrove BioBank Sites, it is likely that such an improvement will occur. The restoration of grasslands at the BioBank Sites represents a gain of around 282 hectares of suitable foraging and denning habitat, which will improve the viability of the species in the Hunter Valley. 739.2 hectares of existing suitable foraging habitat at the BioBank Sites will be maintained and conserved in the long-term as an area of high quality habitats. This represents a total offset of 1,021.2 hectares of suitable habitat for the species in the Hunter Valley for an impact of 356.5 hectares at the Development Footprint.

2. Suitable offsets must be built around direct offsets but may include other compensatory measures.

The Biodiversity Offset Strategy is based on the use of direct land-based offsets containing suitable spotted-tailed quoll foraging and denning habitat that occurs within the Hunter Region. The Biodiversity Offset Strategy will result in the long-term conversation of 1,021.2 hectares of like-for-like offsets for the spotted-tailed quoll.

The Biodiversity Offset Strategy does not propose any additional compensatory measures.

3. Suitable offsets must be in proportion to the level of statutory protection that applies to the protected matter.

Spotted-tailed quoll is listed as endangered under the EPBC Act. As discussed above, the Biodiversity Offset Strategy has focused on securing existing high quality areas of spotted-tailed quoll habitat and providing conservation gain in restoring previously cleared areas to woodland. The impacts on 356.5 hectares of potential foraging habitat for the species is proposed to be offset with 1,021.2 hectares of existing and to be restored habitat at the BioBank Sites.

4. Suitable offsets must be of a size and scale proportionate to the residual impacts on the protected matter.

The impacts on 356.5 hectares of potential foraging habitat for the spotted-tailed quoll at the Development Footprint are proposed to be offset with 1,021.2 hectares existing and to be restored habitat at the BioBank Sites. The Biodiversity Offset Strategy is considered to be more than adequate to commensurate with the magnitude of impacts on spotted-tailed quoll and delivers an outcome that is 'like for like' as well as proposing a gain in 282 hectares of habitat in the Hunter Region. The in-perpetuity protection of the BioBank Sites is likely to result in a long-term higher quality habitat outcome for the species. It is envisaged that the Biodiversity Offset Strategy will deliver net biodiversity gains in the medium and long term.

5. Suitable offsets must effectively account for and manage the risks of the offset not succeeding.

The Biodiversity Offset Strategy is based on the use of direct land-based offsets that occur within the Hunter Region. The land-based offset sites have been determined to provide suitable habitat for the spotted-tailed quoll as affected by the Project. These areas are located within the Hunter Valley in areas near where the species has been previously recorded.

A positive feedback loop between monitoring and adaptive management of the land-based offset sites will be established as required under the BioBanking Agreement. Thresholds for key monitoring parameters will be proposed, together with trigger points or threshold exceedance levels to ensure that there are clear points at which a review of the monitoring and management approach is enacted.

6. Suitable offsets must be additional to what is already required, determined by law or planning regulations, or agreed to under other schemes or programs.

The proposed offsets do not overlap with any other government funded protection or habitat restoration program. All offset sites are located on currently non-reserved land and will add a significant area into the conservation system.

7. Suitable offsets must be efficient, effective, timely, transparent, scientifically robust and reasonable.

The timing of the protection of the BioBank Sites will be determined in line with the approval conditions for the Project. As outlined in **Section 6.2**, it is proposed that credits be retired according to the stages of the Project. Each of the proposed BioBank sites are on land wholly owned by Glencore and Wambo for the purposes of offsetting prior to the approval of the Project. The application of BioBanking Agreements for these sites provides for a transparent, consistent and scientifically robust method of monitoring and management in accordance with the *Threatened Species Conservation (Biodiversity Banking) Regulation 2008*. While no species credits are required for the Project for spotted-tailed quoll, ecosystem credits that cover likely habitat for the species will be retired and managed under the BioBanking process.

The area of impact has been derived from detailed GIS mapping of project boundaries and impact areas, and the ecological survey, mapping, impact assessments and design of the Biodiversity Offset Strategy have been completed by qualified ecologists with considerable experience in the region ensuring that the Strategy is scientifically robust, transparent and reasonable.

8. Suitable offsets must have transparent governance arrangements including being able to be readily measured, monitored, audited and enforced.

The suitable spotted-tailed quoll habitat within the Wambo, Highfields and Mangrove BioBank Sites is proposed to be secured with a BioBanking Agreement (or equivalent) which provides in-perpetuity protection and funding for management and improvement of the biodiversity of the site.

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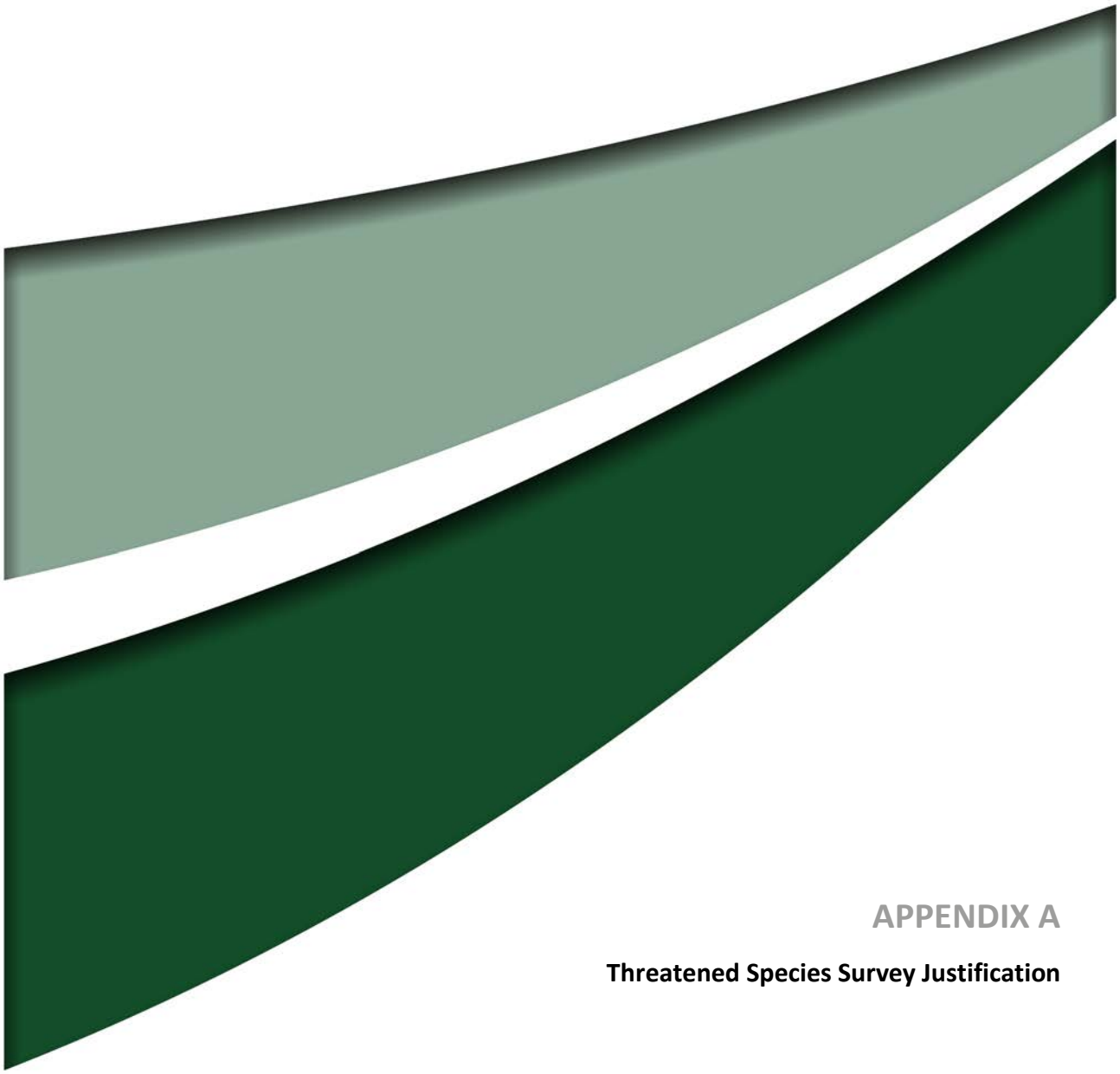


APPENDIX A

Threatened Species Survey Justification

Threatened Species Survey Justification

Table A1 below lists the flora and fauna species-credit species that were identified during database searches, a literature review and an assessment using the BioBanking Credit Calculator that are considered unlikely to occur. **Table A1** provides an individual description of why each of the species was excluded from further assessment within the Development Site as per Section 6.5.1.6 of the FBA (OEH 2014b).

1 BioBanking Credit Calculator
2 Commonwealth Protected Matters Search Tool (PMST)
CE Critically Endangered
E Endangered
V Vulnerable

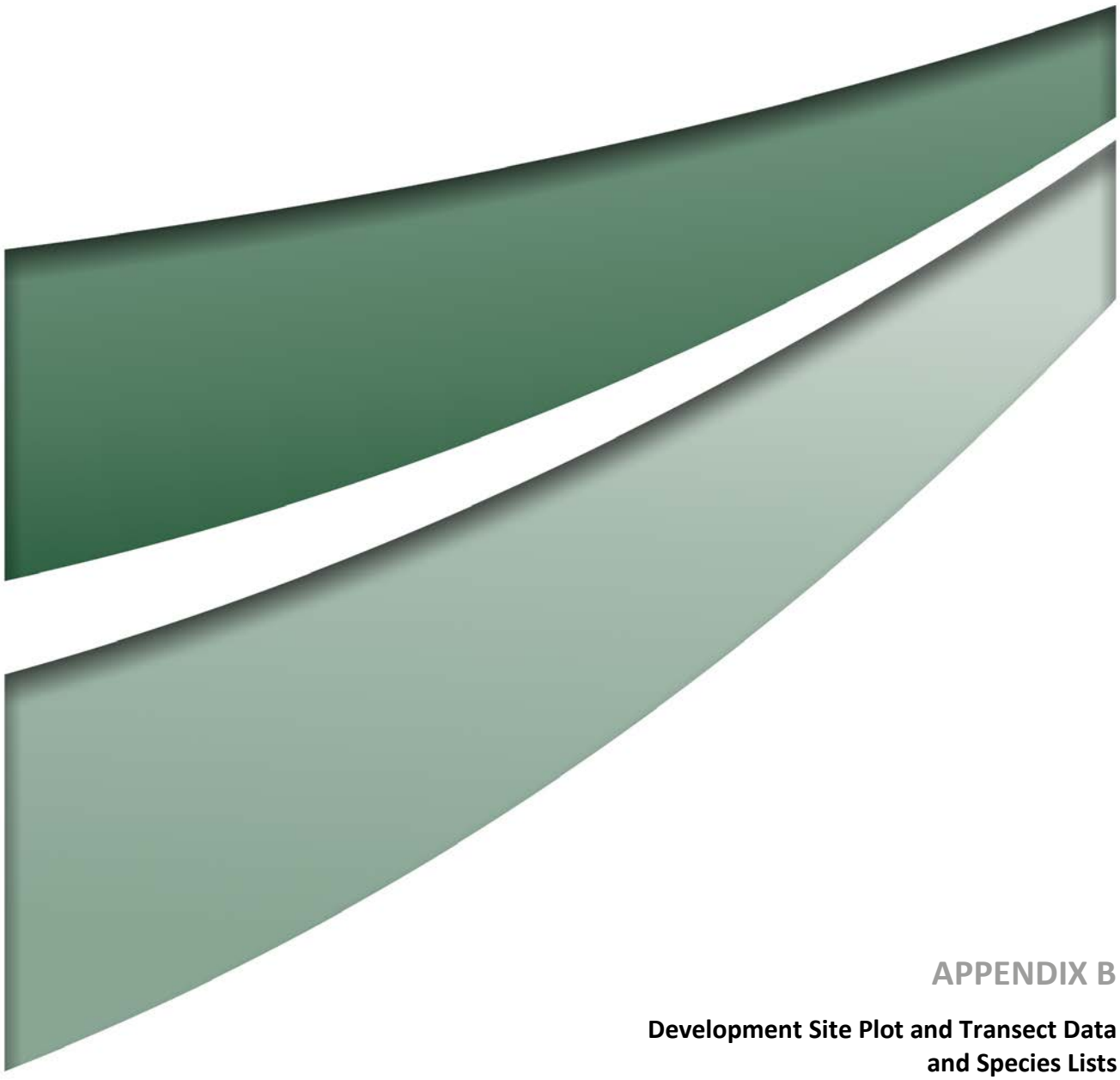
Table A1 – Threatened Species Survey Justification

Common Name *Scientific Name*	TSC Act	EPBC Act	Source	Reason Targeted Surveys and Further Assessment Were Not Required
Flora Species				
Allocasuarina glareicola	E	E	2	This species is not known to occur in the Hunter Valley. The closest record occurs over 100km south of the Development Site near Kurrajong (OEH 2017a) and therefore does not require further assessment.
Euphrasia arguta	CE	CE	2	This species is not known from the central Hunter Valley area. This species was rediscovered in 2008 in the Nundle area and has since been recorded in the Barrington Tops. The nearest of these records is over 90 kilometres to the north of the Development Site (OEH 2017a) and therefore does not require further assessment.
Olearia cordata	V	V	2	This species is known to occur in dry open sclerophyll forest and open shrubland on sandstone ridges. It is known to occur in Wollemi National Park with the closest record being approximately 10km to the southwest of the Development Site (OEH 2017a). However, the Development Site does not contain suitable sandstone habitat for the species and therefore does not require further assessment.
Omeo storksbill *Pelargonium* sp. (G.W. Carr 10345)	E	E	2	This species is not known to occur in the Hunter Valley. The closest record occurs over 250km south of the Development Site near Goulburn (OEH 2017a) and therefore does not require further assessment.

Common Name *Scientific Name*	TSC Act	EPBC Act	Source	Reason Targeted Surveys and Further Assessment Were Not Required
brown Pomaderris *Pomaderris brunnea*	E	V	2	This species is not known from the central Hunter Valley area. The nearest record is over 70km to the west of the Development Site (OEH 2017a) near Olinda and therefore does not require further assessment.
Austral toadflax *Thesium australe*	V	V	2	This species is not known from the central Hunter Valley area. A single old record (from 1959) occurs near Cassilis (OEH 2017a) over 100 km to the west of the Development Site. This species has also been recorded near Mangoola approximately 35 km to the north-west of the Development Site. This species does not require further assessment.
Wollemi pine *Wollemia nobilis*	E	E	2	This species is not known to occur in the Hunter Valley. The species was discovered in the remote canyons of Wollemi National Park and is not known to occur naturally anywhere else. This species does not require further assessment.
Homoranthus darwinioides	V	V	2	This species is not known to occur in the central Hunter Valley. It is found west of Muswellbrook between Merriwa and Bylong approximately 50km to the northwest of the Development Site (OEH 2017a) and therefore does not require further assessment.
Tarengo leek orchid *Prasophyllum petilum* (including *Prasophyllum* sp. *Wybong*)	E	E	2	*Prasophyllum*. sp. Wybong was considered to occur in the Upper Hunter Valley, the Central Tablelands and the New England Tablelands, however this species is now included with *P. petilum*. This species is known to occur around Muswellbrook and Manobalai approximately 40km to the northwest of the Development Site (OEH 2017a). This species does not require further assessment.
Fauna Species (Species-credit)				
booroolong frog *Litoria booroolongensis*	E	E	2	This species occurs predominantly along the western-flowing streams of the Great Dividing Range. This species is not known to occur in the Hunter Valley. The closet record of the species occurs approximately 50km to the north of the Development Site and was recorded in 1959 (OEH 2017a). This species does not require further assessment.

Common Name *Scientific Name*	TSC Act	EPBC Act	Source	Reason Targeted Surveys and Further Assessment Were Not Required
Littlejohns tree frog *Litoria littlejohni*	V	V	2	This species is known to occupy the plateaus and eastern slopes of the Great Dividing Range from Watagan State Forest south to Buchan in Victoria. The habitat requirements for this species are the upper reaches of permanent rocky streams with fringing vegetation or perched swamps. Such habitat does not exist within the Development Site and therefore does not require further assessment.
green-thighed frog *Litoria brevipalmata*	V	-	1	This species occurs in isolated locations, primarily along the coast and eastern ranges from Wollongong to Queensland. There are no known populations of this species in proximity to the Development Site with the nearest documented record from near Kurri Kurri, approximately 50km to the south east of the Development Site. This species does not require further assessment.
broad-headed snake *Hoplocephalus bungaroides*	E	V	2	Records of this species are typically confined within and south of the central coast of NSW. The closest record of this species occurs 50 km to the south of the Development Site in Yengo National Park (OEH 2017a). This species requires sandstone rocks on exposed cliff edges during spring, winter and autumn. This habitat does not occur in the Development Site. This species does not require further assessment.
pale-headed snake *Hoplocephalus bitorquatus*	V	-	1	This species is primarily known from habitats around the Piliga and north of Coffs Harbour. Records in the Hunter and Central Coast include scattered records near Gosford, Olney State Forest and a single record from 1994 in Paterson (OEH 2017a). Ecological surveys of the United mine area since 1981 have failed to identify this species. This species is unlikely to occur in the Development Site and does not require further assessment.
Australasian bittern *Botaurus poiciloptilus*	E	E	2	Records for this species are typically confined to more coastal regions where the species is found in swamps and water bodies with dense tall stands of reeds. There is no suitable habitat in the Development Site for this species and therefore does not require further assessment.
red goshawk *Erythrotriorchis radiatus*	CE	V	2	This species is very rare in NSW and is generally known from areas north of Coffs Harbour. Few sporadic historic records (over 30 years old) occur in the Hunter. This species is unlikely to occur in the Development Site and does not require further assessment.

Common Name *Scientific Name*	TSC Act	EPBC Act	Source	Reason Targeted Surveys and Further Assessment Were Not Required
common planigale *Planigale maculata*	V	-	1	This species has rarely been recorded in the Hunter Valley and all records occur north of Dungog and east of the Barrington Tops over 80km from the Development Site (OEH 2017a). This species is unlikely to occur in the Development Site and does not require further assessment.
Hastings River mouse *Pseudomys oralis*	E	E	2	This species has been recorded in Mt Royal National Park and further north within the Hunter Valley (OEH 2017a) approximately 40km from the Development Site. The species generally occurs at elevations between 300m and 1100m. The species is not known to occur in habitats that occur in the Development Site and therefore does not require further assessment.



APPENDIX B

Development Site Plot and Transect Data and Species Lists

Plot and Transect Data

The following plot and transect data was collected from surveys of the Development Footprint. It includes the ten site attributes that are recorded in each Biometric plot and transect as per Table 2 of the FBA (OEH 2014b). This data is assessed against benchmark data for PCTs and then entered into the BioBanking Credit Calculator (Major Project type) to assess the site value of each PCT in the Development Footprint.

The following abbreviations or symbols are used in the list:

NPS	native plant species
NOC	native overstorey cover
NMC	native midstorey cover
NGCG	native ground cover (grasses)
NGCS	native ground cover (shrubs)
NGCO	native ground cover (other)
EPC	exotic plant cover
NTH	number of trees with hollows
OR	overstorey regeneration, and
FL	total length of fallen logs.

Plot Name	NPS	NOS	NMS	NGCG	NGCS	NGCO	EPC	NTH	OR	FL	Easting	Northing	Zone
Zone 1: HU812 - Forest Red Gum grassy open forest on floodplains of the lower Hunter – Moderate to Good Condition													
Q78	48	14	8	98	0	24	22	0	1	42	311124	6396717	56
Zone 2: HU816 – Spotted Gum - Narrow-leaved Ironbark shrub - grass open forest of the central and lower Hunter - Moderate to Good Condition – Plantation/Rehabilitation													
Q3	16	8	21	66	4	24	30	0	1	0	312054	6396288	56
Q107	35	17	19	54	14	6	0	0	1	6	312465	6395571	56
P02	25	0	7	42	4	22	48	0	1	0	312031	6396109	56
P01	29	5	5.5	50	8	8	17	0	1	0	311802	6396173	56
Zone 3: HU869 – Grey Box - Slaty Box shrub - grass woodland on sandstone slopes of the upper Hunter and Sydney Basin - Moderate to Good Condition													
Q100	23	15.5	3	12	4	12	0	1	1	19	312599	6397152	56
Q101	36	12	19	38	14	22	2	2	1	27	312428	6397081	56
Zone 4: HU905 - Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter - Moderate to Good Condition – Derived Native Grassland													
Q69	20	0	0	86	0	28	36	0	1	0	312632	6396533	56
Q73	18	0	0	100	0	12	30	0	1	0	311841	6396515	56
Q79	31	0	0	92	0	36	22	0	1	0	313088	6396188	56
Q82	28	0	0	88	0	26	36	0	1	0	313472	6396053	56
Q85	22	0	0	90	0	44	18	0	1	0	312236	6396510	56
Q86	20	0	1.5	76	0	2	14	0	1	0	313833	6397005	56
RPU2	7	0	0	100	0	0	38	0	1	0	307701	639860	56
Zone 5: HU905 - Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter - Moderate to Good Condition													
Q4	47	10	23	52	12	22	2	5	1	90	310546	6397007	56

Q5	36	37	0	28	0	26	0	0	1	0	312293	6395783	56
Q7	32	25.5	3.5	40	4	24	0	0	1	12	312805	6395665	56
Q22	20	19	9.5	28	4	10	0	0	1	0	312595	6395847	56
Q23	23	22	0	8	2	8	0	0	1	8	312899	6395416	56
Q41	38	21.5	7.5	48	8	14	8	0	1	31	311426	6396145	56
Q88	33	9.2	0.8	40	8	8	0	1	1	15	313549	6397099	56
Q89	21	11	0.5	26	6	14	0	2	1	4	313340	6397290	56
Q108	29	26	17	12	4	22	0	3	1	9	312533	6395634	56
RPU3	33	12	4	44	10	10	0	0	1	85	308408	6398032	56
Zone 6: HU905 - Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter - Moderate to Good Condition – Cooba Open Shrubland													
Q20	15	0	13.5	86	2	18	8	0	0	0	310995	6397203	56
Q42	26	0	2.5	88	2	26	22	0	0	14	311663	6396257	56
Q74	46	0	5	82	0	38	16	0	0	0	311579	6396589	56
Q77	31	0	9	78	0	18	20	0	0	21	310565	6396691	56
Q84	34	0	20.5	88	0	44	30	0	0	0	310892	6397080	56
Q1	16	0	5.2	48	10	4	2	0	0	3	311240	6397102	56
Q2	37	0	5.5	82	0	24	14	0	0	0	311398	6396351	56
Q71	38	0	24	92	2	52	16	0	0	0	311240	6396407	56
Zone 7: HU905 - Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter - Moderate to Good Condition – Regeneration													
Q76	42	10.5	7.5	72	0	38	36	0	1	2	310438	6396743	56
Q70A	48	6	0	68	0	28	0	0	1	2	310406	6396970	56
P04	23	18	6.5	28	0	4	8	0	1	0	312877	6395670	56
P03	25	5.5	4.5	70	12	12	2	0	1	0	312731	6395579	56
Zone 8: HU905 - Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter - Moderate to Good Condition - Thinned Canopy													

RPU1	29	7.5	2	64	0	6	19	1	0	6.5	307185	6398478	56
Zone 9: HU906 - Bull Oak grassy woodland of the central Hunter Valley - Moderate to Good Condition													
Q18	17	18	0	16	0	22	0	0	1	0	313224	6395914	56
Q70	40	6.5	8.5	18	2	10	0	0	1	14	313331	6395414	56
Q75	32	17.5	0	8	0	12	0	1	1	0	312318	6396238	56
Q80	29	26	0	18	4	14	0	0	1	2	312969	6396173	56
Q81	32	22	11	6	0	8	0	0	1	2	313475	6395976	56
Q83	33	35.5	0	22	0	24	0	1	1	4	312895	6396921	56
Q87	31	5.8	1.1	36	2	6	0	0	1	5	313708	6396635	56
Q93	19	8	19	32	0	14	0	0	1	2	313087	6395860	56
Q105	28	15	23	60	8	16	4	0	1	5	312636	6396967	56
Q106	27	20	3	18	0	8	2	0	1	2	313456	6395764	56
Zone 10: HU945 - Swamp Oak - Weeping Grass grassy riparian forest of the Hunter Valley - Moderate to Good Condition													
Q21	17	16	0	70	4	12	4	0	0.5	117	311903	6396587	56
Q39	23	31	10	28	2	46	0	0	0.5	75	313351	6396577	56
Q40	23	18.5	10	86	2	68	2	7	0.5	19	312325	6396698	56
Q102	18	25	20	26	2	4	4	0	0.5	13	312440	6396721	56
Q103	16	31	14	30	0	8	6	0	0.5	0	313448	6396360	56

Flora Species List

The following list was developed from the systematic plot and transect surveys of the Development Footprint by Umwelt in 2009, 2013, 2014, 2015 and 2016 as outlined in **Section 2.2.3**. It includes all species of vascular plants observed during these surveys. It is acknowledged that the list is not comprehensive, as not all species are readily detected at any one time of the year. Many species flower only during restricted periods of the year, and some flower only once in several years. In the absence of flowering material, many of these species cannot be identified, or even detected.

Names of classes and families follow a modified Cronquist (1981) System.

Any species that could not be identified to the lowest taxonomic level are denoted in the following manner:

sp.	specimens that are identified to genus level only.

The following abbreviations or symbols are used in the list:

asterisk (*)	denotes species non-native species
subsp.	subspecies and
var.	variety.

All vascular plants recorded or collected were identified using keys and nomenclature in Harden (1992, 1993, 2000 and 2002) and Wheeler *et al.* (2002). Where known, changes to nomenclature and classification have been incorporated into the results, as derived from PlantNET (Botanic Gardens Trust 2017), the on-line plant name database maintained by the National Herbarium of New South Wales.

Common names used follow Harden (1992, 1993, 2000 and 2002) where available, and draw on other sources such as local names where these references do not provide a common name.

Family	*Scientific Name*	Common Name	Q1	Q2	Q3	Q4	Q5	Q7	Q18	Q20	Q21	Q22	Q23	Q39	Q40	Q41	Q42	Q69	Q70	Q71	Q72	Q73	Q74	Q75	Q76	Q77	Q78	Q79	Q80	Q81	Q82	Q83	Q84	Q85	Q86	Q87	Q88	Q89	Q93	Q100	Q101	Q102	Q103	Q104	Q105	Q106	Q107	Q108	RPU1	RPU2	RPU3	P01	P02	P03	P04
Coniferopsida (Conifers)																																																								
Cupressaceae	*Callitris endlicheri*	white cypress pine																																																			X		X	
Filicopsida (Ferns)																																																									
Adiantaceae	*Adiantum aethiopicum*	common maidenhair												X																																												
Adiantaceae	*Cheilanthes distans*	bristly cloak fern		X					X		X	X		X		X			X		X		X	X				X		X		X	X						X	X	X	X		X			X	X							
Adiantaceae	*Cheilanthes sieberi* subsp. *sieberi*	rock fern		X		X	X	X		X			X		X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X							X	X	X	X	X	X	X	X						
Marsileaceae	*Marsilea drummondii*	common nardoo																																																					X		
Pteridaceae	*Pellaea falcata*	Sickle fern																																																								X
Magnoliopsida – Liliidae (monocots)																																																									
Anthericaceae	*Arthropodium milleflorum*	pale vanilla-lily																																									X							X							
Anthericaceae	*Arthropodium* sp.																																		X		X																			
Anthericaceae	*Dichopogon* sp.	chocolate lily				X																																																					
Anthericaceae	*Laxmannia gracilis*	slender wire lily																												X		X														X											X
Anthericaceae	*Tricoryne elatior*	yellow autumn-lily																																											X											
Asparagaceae	**Asparagus asparagoides*	bridal creeper												X																																												
Commelinaceae	*Commelina cyanea*	native wandering Jew											X	X					X								X			X		X													X										X
Cyperaceae	*Carex appressa*	tall sedge																									X																									X	X		
Cyperaceae	*Carex inversa*	knob sedge																X		X		X																														X				
Cyperaceae	**Cyperus aggregatus*																													X																									
Cyperaceae	*Cyperus gracilis*	slender flat-sedge				X													X	X					X		X				X	X					X		X									X					
Cyperaceae	*Cyperus sphaeroideus*																																X																						
Cyperaceae	*Cyperus* sp.																						X																																	
Cyperaceae	*Eleocharis acuta*																X																																							
Cyperaceae	*Fimbristylis dichotoma*	common fringe-sedge		X			X			X								X	X		X	X	X	X	X	X	X	X		X	X	X	X	X							X			X		X								
Hypoxidaceae	*Hypoxis hygrometrica*	golden weather-grass																X				X	X		X								X																						
Hypoxidaceae	*Hypoxis pratensis*	golden weather-grass													X						X					X					X																									
Hypoxidaceae	*Hypoxis* sp.																		X																																					
Iridaceae	**Romulea rosea*																												X						X																				
Juncaceae	*Juncus* sp.	a rush															X																																							
Juncaceae	*Juncus subsecundus*	finger rush																				X																																		
Lomandraceae	*Lomandra confertifolia*	matrush																																		X	X	X	X																

Family	*Scientific Name*	Common Name	Q1	Q2	Q3	Q4	Q5	Q7	Q18	Q20	Q21	Q22	Q23	Q39	Q40	Q41	Q42	Q69	Q70	Q71	Q72	Q73	Q74	Q75	Q76	Q77	Q78	Q79	Q80	Q81	Q82	Q83	Q84	Q85	Q86	Q87	Q88	Q89	Q93	Q100	Q101	Q102	Q103	Q104	Q105	Q106	Q107	Q108	RPU1	RPU2	RPU3	P01	P02	P03	P04
Lomandraceae	*Lomandra confertifolia* subsp. *rubiginosa*	mat-rush																						X																																
Lomandraceae	*Lomandra filiformis*	wattle mat-rush										X											X						X		X								X	X		X		X	X		X			X	X			
Lomandraceae	*Lomandra filiformis* subsp. *filiformis*	wattle mat-rush											X						X		X								X																											
Lomandraceae	*Lomandra glauca*	pale mat-rush																						X								X									X			X											
Lomandraceae	*Lomandra longifolia*	spiny-headed mat-rush				X																													X		X																			
Lomandraceae	*Lomandra multiflora* subsp. *multiflora*	many-flowered mat-rush					X	X	X	X		X	X		X	X			X		X		X	X				X	X	X	X	X	X		X		X		X	X	X	X			X	X					X	X
Phormiaceae	*Dianella caerulea* var. *caerulea*	blue flax lily																						X																														X		X	
Phormiaceae	*Dianella caerulea* var. *cinerascens*	blue flax lily																																																			X			
Phormiaceae	*Dianella caerulea* var. *producta*	blue flax lily														X																																							
Phormiaceae	*Dianella longifolia* var. *longifolia*	blue flax lily																														X																							
Phormiaceae	*Dianella* sp.																																			X	X										X								
Poaceae	*Aristida jerichoensis* var. *jerichoensis*	Jericho wiregrass																	X																																					
Poaceae	*Aristida personata*																			X	X		X	X				X			X		X																						
Poaceae	*Aristida ramosa*	purple wiregrass	X	X	X		X		X	X		X	X					X								X							X					X	X	X		X	X	X	X	X	X		X	X	X	X
Poaceae	*Aristida* sp.	a wiregrass				X		X								X	X						X		X									X	X	X		X													X			
Poaceae	*Aristida vagans*	threeawn speargrass																				X						X	X	X			X							X															
Poaceae	*Austrostipa scabra*	speargrass		X	X	X	X																							X																				X	X				
Poaceae	*Austrostipa scabra* subsp. *falcata*	rough speargrass																		X	X											X																								
Poaceae	*Austrostipa scabra* subsp. *scabra*	rough speargrass											X			X	X						X																														X				
Poaceae	*Austrostipa* sp.	a speargrass																																			X	X	X														X		
Poaceae	*Austrostipa verticillata*	slender bamboo grass		X		X	X		X					X	X											X	X	X					X	X							X	X	X					X						
Poaceae	*Bothriochloa biloba*																																																			X			
Poaceae	*Bothriochloa decipiens*	red grass					X									X				X			X					X				X	X	X																	X				
Poaceae	*Bothriochloa macra*	red grass	X	X	X	X	X	X										X	X		X	X	X	X	X	X	X				X					X	X		X						X				X	X	X				
Poaceae	**Briza minor*	shivery grass																																	X																			X	
Poaceae	*Capillipedium spicigerum*	scented-top grass															X																																							
Poaceae	*Chloris divaricata* var. *divaricata*	slender chloris											X		X				X	X	X	X	X	X	X	X		X	X	X	X	X		X																						

Family	*Scientific Name*	Common Name	Q1	Q2	Q3	Q4	Q5	Q7	Q18	Q20	Q21	Q22	Q23	Q39	Q40	Q41	Q42	Q69	Q70	Q71	Q72	Q73	Q74	Q75	Q76	Q77	Q78	Q79	Q80	Q81	Q82	Q83	Q84	Q85	Q86	Q87	Q88	Q89	Q93	Q100	Q101	Q102	Q103	Q104	Q105	Q106	Q107	Q108	RPU1	RPU2	RPU3	P01	P02	P03	P04
Poaceae	**Chloris gayana*	Rhodes grass			X																				X									X																			
Poaceae	*Chloris truncata*	windmill grass			X																																X		X	X	X						X				X			X
Poaceae	*Chloris ventricosa*	tall chloris	X			X							X			X		X			X		X	X	X	X	X	X	X			X	X	X	X		X										X	X		X				
Poaceae	*Cymbopogon refractus*	barbed wire grass	X	X	X	X	X	X		X		X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X			X			X		X				X	X	X	X	
Poaceae	*Cynodon dactylon*	common couch		X													X			X	X		X				X	X			X			X					X					X					X	X		X	X	X	X
Poaceae	*Dichanthium sericeum*	Queensland bluegrass			X														X	X	X	X	X					X			X		X														X								
Poaceae	*Dichanthium sericeum* subsp. *sericeum*	Queensland bluegrass															X																																							
Poaceae	*Dichelachne micrantha*	shorthair plumegrass								X													X				X	X					X	X	X		X																		
Poaceae	*Digitaria brownii*	cotton panic grass																X				X	X				X						X																						
Poaceae	*Digitaria diffusa*	open summer-grass																				X				X		X		X																									
Poaceae	*Digitaria divaricatissima*	umbrella grass																																X																					
Poaceae	*Digitaria hystrichoides*	curly umbrella grass																																X																					
Poaceae	*Digitaria parviflora*	small-flowered finger grass													X																																									
Poaceae	*Echinopogon caespitosus*	Hedgehog grass																																																			X	X	X	
Poaceae	*Echinopogon ovatus*	forest hedgehog grass																																				X															X			X
Poaceae	*Elymus scaber* var. *scaber*	common wheatgrass											X																																								X			
Poaceae	*Enteropogon acicularis*																																																			X		X				
Poaceae	*Eragrostis alveiformis*																						X																																	
Poaceae	*Eragrostis benthamii*																															X																								
Poaceae	*Eragrostis curvula*																																																						X		X
Poaceae	*Eragrostis brownii*	Browns lovegrass																X								X			X																				X		X						
Poaceae	*Eragrostis elongata*	clustered lovegrass																				X												X																						
Poaceae	*Eragrostis leptostachya*	paddock lovegrass		X																			X			X					X			X													X								
Poaceae	*Eragrostis* sp.	a lovegrass								X								X									X	X							X	X	X																		
Poaceae	*Eriochloa pseudoacrotricha*	early spring grass		X												X				X	X	X					X				X																								
Poaceae	*Eulalia aurea*	silky browntop																									X							X																		X			
Poaceae	**Hyparrhenia hirta*	Coolatai grass																															X																						
Poaceae	**Megathrusus maximus*	guinea grass												X	X																																									
Poaceae	**Melinis repens*	red Natal grass																															X																						
Poaceae	*Microlaena stipoides* var. *stipoides*	weeping grass				X	X									X		X					X		X	X	X	X	X			X	X													X								
Poaceae	*Panicum effusum*	hairy panic					X												X	X	X	X	X		X		X	X						X		X										X	X							

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Poaceae	**Panicum miliaceum*	French millet																X																																					
Poaceae	*Panicum queenslandicum* var. *queenslandicum*	Yadbila grass																															X																						
Poaceae	*Panicum simile*	two-colour panic															X																																		X					
Poaceae	*Paspalidium distans*			X		X														X		X		X	X		X			X	X	X	X	X							X	X						X								
Poaceae	*Paspalidium gracile*	slender panic																			X																																					
Poaceae	*Paspalidium* sp.																																																			X					
Poaceae	**Paspalum dilatatum*	paspalum																		X		X	X			X		X			X		X	X																							
Poaceae	**Paspalum urvillei*	Vasey grass																																											X											
Poaceae	**Pennisetum clandestinum*	Kikuyu grass																																																		X					
Poaceae	*Rytidosperma bipartitum*	wallaby grass							X			X	X													X	X				X																												
Poaceae	*Rytidosperma caespitosum*	ringed wallaby grass														X	X																																										
Poaceae	*Rytidosperma fulvum*	wallaby grass				X		X																	X																	X	X															
Poaceae	*Rytidosperma monticola*	a wallaby grass																			X			X					X				X																										
Poaceae	*Rytidosperma racemosum* var. *racemosum*																																																			X		X					
Poaceae	*Rytidosperma* sp.	a wallaby grass								X																				X									X																			
Poaceae	*Rytidosperma tenuius*	a wallaby grass																																				X																				
Poaceae	**Setaria gracilis*	slender pigeon grass												X			X	X				X	X		X			X			X		X	X																									
Poaceae	*Sporobolus creber*	slender rats tail grass	X	X																X	X	X	X		X	X	X	X			X		X	X																X	X	X					
Poaceae	*Sporobolus* sp.																																																				X					
Poaceae	*Themeda australis*	kangaroo grass																					X																																				
Poaceae	**Urochloa panicoides*	urochloa grass																																																			X					
Magnoliopsida – Magnoliidae (dicots)																																																											
Acanthaceae	*Brunoniella australis*	blue trumpet				X	X	X	X		X	X	X	X		X			X		X		X		X	X	X		X	X	X	X		X			X	X	X		X	X	X	X	X	X			X			X	X
Acanthaceae	*Rostellularia adscendens*	pink tongues				X															X		X																																			
Aizoaceae	**Galenia pubescens*	galenia	X	X	X						X			X	X	X	X			X					X		X					X							X				X			X		X	X						
Amygdalaceae	**Prunus* sp.														X																																											
Anacardiaceae	**Schinus areira*	pepper tree																																																			X					
Apiaceae	**Cyclospermum leptophyllum*	slender celery			X																																																					
Apiaceae	*Daucus glochidiatus*	native carrot																															X																									
Apocynaceae	**Gomphocarpus fruticosus*	narrow-leaved cotton bush	X	X	X					X	X						X	X		X		X	X		X	X	X	X			X		X					X	X	X						X		X							

Family	*Scientific Name*	Common Name	Q1	Q2	Q3	Q4	Q5	Q7	Q18	Q20	Q21	Q22	Q23	Q39	Q40	Q41	Q42	Q69	Q70	Q71	Q72	Q73	Q74	Q75	Q76	Q77	Q78	Q79	Q80	Q81	Q82	Q83	Q84	Q85	Q86	Q87	Q88	Q89	Q93	Q100	Q101	Q102	Q103	Q104	Q105	Q106	Q107	Q108	RPU1	RPU2	RPU3	P01	P02	P03	P04
Apocynaceae	*Parsonsia eucalyptophylla*	gargaloo				X																																																	
Apocynaceae	*Parsonsia staminea*	Silk pod vine																																																		X			
Apocynaceae	**Tweedia coerulea*																											X			X																							
Asphodelaceae	**Aloe* sp.	aloe																																																	X						
Asteraceae	**Bidens pilosa*	cobblers pegs			X															X					X	X						X	X																			X	X		
Asteraceae	**Bidens subalternans*	greater beggars ticks													X																																					X						
Asteraceae	*Brachyscome multifida* var. *multifida*																		X																																							
Asteraceae	*Calocephalus citreus*	lemon beauty-heads																			X											X	X			X		X		X	X				X											
Asteraceae	*Calotis cuneata*	mountain burr-daisy						X																X																																		
Asteraceae	*Calotis cuneifolia*	purple burr-daisy		X					X	X	X	X	X	X	X	X	X		X	X	X		X		X		X	X	X	X		X	X								X	X		X	X	X	X	X			X					
Asteraceae	*Calotis lappulacea*	yellow burr-daisy		X	X		X			X						X	X			X	X				X										X		X	X														X	X	X	X
Asteraceae	**Carthamus lanatus*	saffron thistle	X		X					X																																															
Asteraceae	*Cassinia arcuata*	sifton bush																			X				X											X	X																				
Asteraceae	*Cassinia* sp.																																					X																		
Asteraceae	*Chrysocephalum apiculatum*	common everlasting		X			X	X					X			X		X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X				X	X	X	X		X	X	X	X				X				
Asteraceae	Cichorium intybus	chicory																																																			X	
Asteraceae	**Cirsium vulgare*	spear thistle											X	X			X														X																								
Asteraceae	**Conyza albida*	tall fleabane																													X																								
Asteraceae	**Conyza bonariensis*	flaxleaf fleabane																										X					X																								
Asteraceae	**Conyza* sp.	a fleabane			X											X	X																																							
Asteraceae	**Conyza sumatrensis*	tall fleabane								X	X			X	X																																										
Asteraceae	*Glossocardia bidens*	cobblers tack				X		X											X		X								X			X				X	X			X	X	X												
Asteraceae	**Hypochaeris microcephala* var. *albiflora*	white flatweed																				X					X				X		X																							
Asteraceae	**Hypochaeris radicata*	catsear																X										X						X																		X		X	
Asteraceae	*Lagenophora* sp.																		X																																					
Asteraceae	*Olearia elliptica* subsp. *elliptica*	sticky daisy bush					X			X			X																	X							X	X														X				
Asteraceae	**Schkuhria pinnata* var. *abrotanoides*	dwarf marigold																		X													X																			X	X				
Asteraceae	**Senecio madagascariensis*	fireweed		X	X			X			X	X	X	X	X	X	X	X	X		X	X	X		X	X	X	X		X	X	X	X	X	X	X	X	X			X	X		X			X	X					
Asteraceae	**Senecio* sp.	groundsel, fireweed																							X																															
Asteraceae	*Sigesbeckia orientalis*	Indian weed																							X																															
Asteraceae	*Solenogyne bellioides*	solengyne				X		X													X				X																															

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Asteraceae	*Soliva sp.																			X																												X	X					
Asteraceae	*Sonchus oleraceus	common sowthistle			X									X	X										X		X					X	X		X										X		X	X					
Asteraceae	*Tagetes minuta	stinking Roger																		X			X		X																								X	X					
Asteraceae	*Taraxacum officinale	dandelion																															X																					X	X
Asteraceae	Vernonia cinerea var. cinerea					X			X																																				X										
Asteraceae	Vittadinia cuneata	a fuzzweed		X		X																																							X										
Asteraceae	Vittadinia cuneata var. cuneata	a fuzzweed																			X																																			
Asteraceae	Vittadinia dissecta var. hirta	a fuzzweed																					X																																	
Asteraceae	Vittadinia muelleri	a fuzzweed									X										X																																		
Asteraceae	Vittadinia pustulata	a fuzzweed														X				X																																		
Asteraceae	Vittadinia sp.	a fuzzweed							X										X																				X															
Asteraceae	Vittadinia sulcata	a fuzzweed	X		X															X																																	X	X					X
Brassicaceae	*Lepidium africanum																																																			X					
Boraginaceae	*Heliotropium amplexicaule	blue heliotrope																		X																																				X	X	X	
Cactaceae	*Opuntia aurantiaca	tiger pear							X															X																X																
Cactaceae	*Opuntia humifusa	creeping pear						X					X			X			X										X	X	X								X	X									X	X					
Cactaceae	*Opuntia stricta var. stricta	common prickly pear		X		X	X					X	X						X		X					X	X	X										X		X	X			X										
Campanulaceae	Wahlenbergia communis	tufted bluebell																					X			X			X																								X		X	X
Campanulaceae	Wahlenbergia gracilis	sprawling bluebell																										X																												
Campanulaceae	Wahlenbergia luteola	bluebell		X																X					X																															
Campanulaceae	Wahlenbergia sp.	bluebell																	X					X																																
Caryophyllaceae	Paronychia brasiliana	Brazilian whitlow																																																			X					
Caryophyllaceae	*Petrorhagia nanteuilii	proliferous pink		X																																																					
Caryophyllaceae	*Stellaria media	common chickweed													X																																									
Casuarinaceae	Allocasuarina luehmannii	bulloak				X	X	X	X	X		X	X			X	X		X		X		X	X	X	X		X	X	X		X	X		X	X	X	X	X	X	X				X	X	X	X	X		X	X		X	X
Casuarinaceae	Casuarina glauca	swamp oak									X			X	X																																									
Celastraceae	Maytenus silvestris	narrow-leaved orangebark														X																																								
Chenopodiaceae	Atriplex semibaccata	creeping saltbush																		X											X																							X			
Chenopodiaceae	Atriplex spinibractea	spiny-fruit saltbush																									X																												
Chenopodiaceae	Einadia hastata	berry saltbush		X		X	X	X			X			X	X				X																																						
Chenopodiaceae	Einadia nutans	climbing saltbush						X																																																

Family	*Scientific Name*	Common Name	Q1	Q2	Q3	Q4	Q5	Q7	Q18	Q20	Q21	Q22	Q23	Q39	Q40	Q41	Q42	Q69	Q70	Q71	Q72	Q73	Q74	Q75	Q76	Q77	Q78	Q79	Q80	Q81	Q82	Q83	Q84	Q85	Q86	Q87	Q88	Q89	Q93	Q100	Q101	Q102	Q103	Q104	Q105	Q106	Q107	Q108	RPU1	RPU2	RPU3	P01	P02	P03	P04
Chenopodiaceae	*Einadia nutans* subsp. *linifolia*	climbing saltbush		X											X											X			X																	X								
Chenopodiaceae	*Einadia nutans* subsp. *nutans*	climbing saltbush					X						X				X		X					X							X							X					X		X								
Chenopodiaceae	*Einadia polygonoides*	knotweed goosefoot																		X	X								X		X																									
Chenopodiaceae	*Einadia trigonos*	fishweed																		X																																				
Chenopodiaceae	*Einadia trigonos* subsp. *stellulata*																										X																													
Chenopodiaceae	*Enchylaena tomentosa*	ruby saltbush	X	X	X		X	X			X		X	X	X	X	X		X	X			X	X			X		X	X	X	X				X		X	X	X	X				X	X	X	X	X					
Chenopodiaceae	*Maireana microphylla*	small-leaf bluebush		X		X	X				X				X					X						X				X				X			X							X					X	X				
Chenopodiaceae	*Maireana* sp.	cotton bush, bluebush, fissure-weed																																		X	X																	
Chenopodiaceae	*Sclerolaena muricata*	Black rolypoly																																																	X					
Clusiaceae	*Hypericum gramineum*	small St Johns wort																X								X						X															X				X			
Convolvulaceae	*Convolvulus erubescens*	pink bindweed	X			X														X							X								X								X											
Convolvulaceae	*Cuscuta campestris*	Golden Dodder																																																			X		
Convolvulaceae	*Dichondra repens*	kidney weed	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X		X	X	X	X	X	X	X	X	X	X	X	X		X	X			X	X	X	X	X	X	X	X	X	X			X		X		
Convolvulaceae	*Evolvulus alsinoides*	bindweed		X																																																		
Crassulaceae	**Bryophyllum delagoense*	mother of millions												X																																X									
Crassulaceae	Crassula siebriana	Australian stone crop																																																		X		
Dillanaceae	*Hibbertia sp.*																																																		X	X	X	
Euphorbiaceae	*Chamaesyce drummondii*	caustic weed	X	X			X	X													X								X									X													X			
Euphorbiaceae	*Chamaesyce* sp.																																																			X			
Fabaceae (Faboideae)	*Cullen tenax*	emu-foot						X																																															
Fabaceae (Faboideae)	*Daviesia genistifolia*	broom bitter pea										X				X																																							
Fabaceae (Faboideae)	*Daviesia leptophylla*												X																																									
Fabaceae (Faboideae)	*Daviesia ulicifolia*	gorse bitter pea					X												X					X				X	X	X		X									X	X				X		X						
Fabaceae (Faboideae)	*Daviesia ulicifolia* subsp. *stenophylla*	gorse bitter pea																																	X	X																		
Fabaceae (Faboideae)	*Daviesia ulicifolia* subsp. *ulicifolia*	gorse bitter pea																																			X																		
Fabaceae (Faboideae)	*Desmodium brachypodum*	large tick-trefoil				X																																						X									X	
Fabaceae (Faboideae)	*Desmodium gunnii*	slender tick-trefoil				X																					X																	X				X			X			
Fabaceae (Faboideae)	*Desmodium rhytidophyllum*															X																																							
Fabaceae (Faboideae)	*Desmodium varians*	slender tick-trefoil																	X						X				X	X		X													X		X				X				
Fabaceae (Faboideae)	*Glycine clandestina*	twining glycine	X	X				X	X						X	X											X									X								X			X							

Family	*Scientific Name*	Common Name	Q1	Q2	Q3	Q4	Q5	Q7	Q18	Q20	Q21	Q22	Q23	Q39	Q40	Q41	Q42	Q69	Q70	Q71	Q72	Q73	Q74	Q75	Q76	Q77	Q78	Q79	Q80	Q81	Q82	Q83	Q84	Q85	Q86	Q87	Q88	Q89	Q93	Q100	Q101	Q102	Q103	Q104	Q105	Q106	Q107	Q108	RPU1	RPU2	RPU3	P01	P02	P03	P04
Fabaceae (Faboideae)	*Glycine tabacina*	variable glycine		X		X	X	X			X			X	X	X	X	X	X	X	X		X	X	X	X	X		X	X	X	X	X		X	X			X	X	X	X	X									
Fabaceae (Faboideae)	*Glycine pacifica*																											X																											
Fabaceae (Faboideae)	*Hardenbergia violacea*	false sarsaparilla																																												X				X					
Fabaceae (Faboideae)	**Medicago* sp.	a medic	X																																													X	X					
Fabaceae (Faboideae)	Swainsona sp.																																																			X		
Fabaceae (Faboideae)	*Templetonia stenophylla*	leafy templetonia																																		X																			
Fabaceae (Faboideae)	**Trifolium augustifolium*																																																		X			
Fabaceae (Faboideae)	*Trifolium arvense																																																				X
Fabaceae (Faboideae)	**Trifolium campestre*	hop clover															X																																						
Fabaceae (Faboideae)	**Trifolium repens*	White clover																																																		X			
Fabaceae (Faboideae)	*Zornia dyctiocarpa* var. *dyctiocarpa*	zornia										X									X		X			X		X	X																										
Fabaceae (Mimosoideae)	*Acacia amblygona*	fan wattle		X		X	X	X				X				X			X	X				X					X	X		X	X				X	X			X			X	X	X	X			X	X	X	
Fabaceae (Mimosoideae)	*Acacia decora*	western golden wattle															X																																					X		
Fabaceae (Mimosoideae)	*Acacia decurrens*	black wattle			X																																														X			X		
Fabaceae (Mimosoideae)	*Acacia falcata*							X				X																																								X	X		
Fabaceae (Mimosoideae)	*Acacia implexa*	hickory wattle	X	X		X	X									X	X				X				X	X							X									X			X			X							
Fabaceae (Mimosoideae)	*Acacia linearifolia*	narrow-leaved wattle														X																																							
Fabaceae (Mimosoideae)	*Acacia salicina*	cooba	X	X	X	X				X					X	X	X		X	X	X		X		X	X	X						X									X			X			X		X		X		
Fabaceae (Mimosoideae)	**Acacia saligna*	golden wreath wattle		X	X																														X	X	X	X						X		X						
Fabaceae (Mimosoideae)	*Acacia* sp.	wattle														X																																				X	X	X	
Fabaceae (Mimosoideae)	*Neptunia gracilis*	Native sensitive plant																																																	1			
Geraniaceae	*Geranium solanderi* var. *solanderi*																X																																					X
Geraniaceae	*Geranium* sp.																										X			X																							
Goodeniaceae	*Goodenia hederacea*	ivy goodenia																						X					X																									
Goodeniaceae	*Goodenia rotundifolia*														X																																	X						
Goodeniaceae	*Goodenia* sp.																						X													X																	
Haloragaceae	*Gonocarpus tetragynus*																																																				X	X

Family	*Scientific Name*	Common Name	Q1	Q2	Q3	Q4	Q5	Q7	Q18	Q20	Q21	Q22	Q23	Q39	Q40	Q41	Q42	Q69	Q70	Q71	Q72	Q73	Q74	Q75	Q76	Q77	Q78	Q79	Q80	Q81	Q82	Q83	Q84	Q85	Q86	Q87	Q88	Q89	Q93	Q100	Q101	Q102	Q103	Q104	Q105	Q106	Q107	Q108	RPU1	RPU2	RPU3	P01	P02	P03	P04
Lamiaceae	*Ajuga australis*	austral bugle							X																																													
Lamiaceae	*Mentha satureioides*	native pennyroyal		X														X			X		X		X	X	X					X	X	X	X																		
Lamiaceae	*Spartothamnella juncea*	bead bush		X		X					X			X	X										X	X	X									X					X		X												
Linaceae	*Linum marginale*	native flax	X																		X		X					X							X																			
Linaceae	**Linum trigynum*	French flax	X							X																									X	X			X															
Lobeliaceae	*Pratia purpurascens*	whiteroot												X																																								
Loranthaceae	*Amyema cambagei*	needle-leaf mistletoe									X				X																																								
Loranthaceae	*Amyema miquelii*	box mistletoe					X																														X				X			X										
Loranthaceae	*Lysiana exocarpi* subsp. *tenuis*																													X												X	X	X										
Malaceae	**Malus* sp.	apple																													X																							
Malvaceae	*Abutilon oxycarpum*	straggly lantern-bush																																										X										
Malvaceae	*Hibiscus sturtii* var. *sturtii*	hill hibiscus														X																																						
Malvaceae	*Malva sp.*																																																		X		X	
Malvaceae	**Modiola caroliniana*	red-flowered mallow			X																												X																	X				
Malvaceae	*Sida corrugata*	corrugated sida		X		X		X			X	X	X	X	X					X	X				X		X		X	X							X			X	X	X			X		X		X	X				
Malvaceae	*Sida cunninghamii*	ridge sida																							X																														
Malvaceae	**Sida rhombifolia*	Paddys lucerne		X	X	X				X	X			X	X	X	X				X	X		X		X	X	X						X		X	X					X		X				X	X		X	X	X	
Malvaceae	*Sida* sp.																																																	X				
Malvaceae	*Sida subspicata*			X															X	X			X		X																			X									
Moracaea	*Ficus rubiginosa*	Rusty fg																																																				
Myoporaceae	*Eremophila debilis*	amulla	X	X	X	X	X	X	X		X		X	X	X	X			X	X	X		X	X	X		X				X	X			X	X	X	X	X		X	X	X	X		X		X	X				
Myoporaceae	*Myoporum montanum*	western boobialla																																		X	X										X						
Myrsinaceae	**Anagallis arvensis*	scarlet pimpernel	X		X					X				X	X	X	X						X	X	X	X	X	X			X	X	X	X	X			X								X			X	X	X	
Myrtaceae	*Corymbia maculata*	spotted gum																																														X						
Myrtaceae	*Eucalyptus blakeyi*	Blakely's red gum																																																		X			
Myrtaceae	**Eucalyptus cladocalyx*	sugar gum	X		X																																																	
Myrtaceae	*Eucalyptus crebra*	narrow-leaved ironbark				X	X	X				X				X			X		X			X	X														X	X									X	X				X
Myrtaceae	*Eucalyptus dawsonii*	slaty box																																																X	X				
Myrtaceae	*Eucalyptus moluccana*	grey box				X	X	X				X	X								X				X																											X		X			
Myrtaceae	*Eucalyptus punctata*	Grey gum																																																				X	X	
Myrtaceae	*Eucalyptus tereticornis*	forest red gum																									X																													
Myrtaceae	*Eucalyptus sparsifolia*	Brown stringy																																																		X			X

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Myrtaceae	*Melaleuca decora*											X							X											X																									
Oleaceae	*Notelaea microcarpa*	native olive				X	X	X																						X								X			X		X			X								
Oleaceae	*Notelaea microcarpa* var. *microcarpa*	native olive							X	X	X		X	X		X	X		X					X	X	X	X								X	X	X	X																			
Oleaceae	**Olea europaea* subsp. *cuspidata*	African olive	X	X							X												X				X														X		X															
Oxalidaceae	**Oxalis corniculata*	creeping oxalis																				X												X																							
Oxalidaceae	**Oxalis chnoodes*																																																						X	X
Oxalidaceae	*Oxalis exilis*																	X		X																																				
Oxalidaceae	*Oxalis perennans*		X	X										X		X	X				X					X					X																		X							
Oxalidaceae	*Oxalis radicosa*																											X																											
Oxalidaceae	*Oxalis* sp.				X	X																	X		X		X																	X	X									X	Xsain
Phyllanthaceae	*Breynia oblongifolia*	coffee bush																									X																		X										
Phyllanthaceae	*Phyllanthus hirtellus*	thyme spurge																																				X																		
Phyllanthaceae	*Phyllanthus virgatus*	wiry spurge				X			X									X	X	X	X		X	X	X		X		X		X		X	X						X	X		X	X	X	X	X							
Pittosporaceae	*Bursaria spinosa*	native blackthorn				X	X	X																							X							X							X	X	X							
Plantaginaceae	*Plantago debilis*	shade plantain			X	X				X				X		X				X	X				X		X				X													X						X					
Plantaginaceae	**Plantago lanceolata*	lambs tongues	X	X	X			X									X	X		X			X		X		X			X		X	X	X	X	X					X							X	X					
Plantaginaceae	**Plantago myosuros*																																		X																				
Plantaginaceae	*Veronica plebeia*	trailing speedwell														X											X																	X												
Polygonaceae	*Rumex brownii*	swamp dock																X																																						
Polygonaceae	*Rumex* sp.	dock															X		X																																					
Ranunculaceae	*Clematis glycinoides*	headache vine																																											X								X		
Ranunculaceae	*Clematis glycinoides* var. *glycinoides*													X																																									
Rubiaceae	*Asperula conferta*	common woodruff		X		X	X	X											X		X		X	X		X	X	X	X				X		X	X	X		X		X				X		X				X		X	X
Rubiaceae	**Galium divaricatum*	slender bedstraw																							X						X																								
Rubiaceae	**Galium murale*	small bedstraw													X																																									
Rubiaceae	*Galium* sp.															X	X																																					X	X		
Rubiaceae	*Opercularia diphylla*	stinkweed																						X						X																										
Rubiaceae	*Pomax umbellata*	pomax										X																																										X			
Rubiaceae	*Psydrax odorata*	shiny-leaved canthium				X								X		X																						X				X								X		X	X	X		
Rubiaceae	**Richardia stellaris*								X									X	X		X				X			X					X													X					X					
Rutaceae	*Geijera salicifolia*	brush wilga				X																					X																	X					X		X				
Santalaceae	*Choretrum candollei*	white sour bush																																																			X	X		

Family	Scientific Name	Common Name	Q1	Q2	Q3	Q4	Q5	Q7	Q18	Q20	Q21	Q22	Q23	Q39	Q40	Q41	Q42	Q69	Q70	Q71	Q72	Q73	Q74	Q75	Q76	Q77	Q78	Q79	Q80	Q81	Q82	Q83	Q84	Q85	Q86	Q87	Q88	Q89	Q93	Q100	Q101	Q102	Q103	Q104	Q105	Q106	Q107	Q108	RPU1	RPU2	RPU3	P01	P02	P03	P04
Santalaceae	*Exocarpos cupressiformis*	cherry ballart																																							X																
Sapindaceae	*Dodonaea* sp.	a hopbush																																				X																
Sapindaceae	*Dodonaea triquetra*	large-leaf hop-bush																																																			X								
Sapindaceae	*Dodonaea viscosa*	sticky hop-bush					X	X																													X																				
Sapindaceae	*Dodonaea viscosa* subsp. *cuneata*	wedge-leaf hop-bush										X					X																																												
Solanaceae	**Lycium ferocissimum*	African boxthorn																																										X								X								
Solanaceae	*Solanum brownii*	violet nightshade				X														X					X	X	X																												X		X			X	
Solanaceae	*Solanum cinereum*	Narrawa burr					X																																															X								
Solanaceae	**Solanum nigrum*	black-berry nightshade					X							X	X										X		X					X												X	X			X	X								
Solanaceae	*Solanum papaverifolium*																										X																																	
Solanaceae	*Solanum prinophyllum*	forest nightshade												X	X																								X						X	X															
Solanaceae	*Solanum pungetium*	eastern nightshade									X																																																				
Solanaceae	*Solanum* sp.																																								X																				
Stackhousiaceae	*Stackhousia muricata*	stackhousia							X																				X																																	
Stackhousiaceae	*Stackhousia viminea*	slender stackhousia				X	X	X										X	X		X		X	X				X			X			X	X				X	X	X			X	X		X											
Sterculiaceae	*Brachychiton populneus* subsp. *populneus*	kurrajong			X	X								X																												X		X												X				
Thymelaeaceae	*Pimelea latifolia* subsp. *elliptifolia*							X																																																						
Verbenaceae	**Verbena bonariensis*	purpletop																			X																																										
Verbenaceae	**Verbena rigida*	veined verbena	X	X	X	X				X							X	X				X	X		X	X	X	X			X		X	X										X																

Fauna Species List

The following fauna list was developed from surveys in and around the Development Footprint and threatened species records from the Atlas of NSW Wildlife (OEH 2017a).

The following abbreviations or symbols are used in the list:

asterisk (*)	Denotes species not indigenous to the Development Footprint
subsp.	Subspecies
M	Listed migratory species under the EPBC Act
V	Vulnerable under the TSC and/or EPBC Acts

Birds recorded were identified using descriptions in Pizzey and Knight (2012) and the scientific and common name nomenclature of Birdlife Australia (Birdlife International 2015). Reptiles recorded were identified using keys and descriptions in Cogger (2014) and Wilson & Swan (2008) and the scientific and common name nomenclature of Cogger (2014).

Amphibians recorded were identified using keys and descriptions in Cogger (2014), Robinson (1998), Anstis (2013) and Barker *et al*. (1995) and the scientific and common name nomenclature of Cogger (2014). Mammals recorded were identified using keys and descriptions in Van Dyck and Strahan (2008), and Menkhorst and Knight (2010) and the scientific and common name nomenclature of Van Dyck and Strahan (2008).

Scientific Name	Common Name	TSC Act	EPBC Act
AMPHIBIA			
Myobatrachidae			
Crinia signifera	common eastern froglet	-	-
Limnodynastes tasmaniensis	spotted marsh frog	-	-
Platyplectrum ornutum	ornate burrowing frog	-	-
Uperoleia laevigata	smooth toadlet	-	-
Uperoleia rugosa	wrinkled toadlet	-	-
Uperoleia sp.		-	-
Hylidae			
Litoria fallax	dwarf tree frog	-	-
Litoria latopalmata	broad-palmed frog	-	-
Litoria peronii	Peron’s tree frog	-	-
Litoria verreauxii	Verreaux's tree frog	-	-
REPTILES			
Cheloniidae			
Chelodina longicollis	eastern long-necked turtle	-	-
Gekkonidae			
Diplodactylus vittatus	stone gecko	-	-

Scientific Name	Common Name	TSC Act	EPBC Act
Underwoodisaurus milii	thick-tailed gecko	-	-
Varanidae			
Varanus varius	lace monitor	-	-
Elapidae			
Pseudechis porphyriacus	red-bellied black snake	-	-
Agamidae			
Amphibolurus muricatus	jacky lizard	-	-
Amphibolurus nobbi	nobbi	-	-
Pogona barbata	eastern bearded dragon	-	-
Scincidae			
Tiliqua scincoides	eastern blue-tongue lizard	-	-
Carlia tetradactyla	southern rainbow skink	-	-
Ctenotus robustus		-	-
Lampropholis delicata	grass skink	-	-
Lipholis modesta		-	-
Egernia sp.		-	-
Egernia striolata	tree skink	-	-
Typhlopidae			
Ramphotyphlops wiedii	blind or worm snake	-	-
AVES			
Anatidae			
Anas superciliosa	Pacific black duck	-	-
Biziura lobata	musk duck	-	-
Podicipedidae			
Tachybaptus novaehollandiae	Australasian grebe	-	-
Poliocephalus poliocephalus	hoary-headed grebe	-	-
Anhingidae			
Anhinga novaehollandiae	Australasian darter	-	-
Ardeidae			
Egretta novaehollandiae	white-faced heron	-	-
Phasianidae			
Coturnix ypsilophora	brown quail	-	-
Accipitridae			
Elanus axillaris	black-shouldered kite	-	-
Aquila audax	wedge-tailed eagle	-	-
Pandion cristatus	eastern osprey	V	M

Scientific Name	Common Name	TSC Act	EPBC Act
Falconidae			
Falco berigora	brown falcon	-	-
Falco cenchroides	nankeen kestrel	-	-
Falco longipennis	Australian hobby	-	-
Rallidae			
Fulica atra	Eurasian coot	-	-
Porphyrio porphyrio	purple swamphen	-	-
Gallinula tenebrosa	dusky moorhen	-	-
Recurvirostridae			
Himantopus himantopus	black-winged stilt	-	-
Turnicidae			
Turnix varius	painted button-quail	-	-
Podicipedidae			
Tachybaptus novaehollandiae	Australasian grebe	-	-
Rallidae			
Fulica atra	Eurasian coot	-	-
Anatidae			
Aythya australis	hardhead	-	-
Chenonetta jubata	Australian wood duck	-	-
Cygnus atratus	black swan	-	-
Threskiornithidae			
Platalea flavipes	yellow-billed spoonbill	-	-
Phalacrocoracidae			
Phalacrocorax varius	pied cormorant	-	-
Charadriidae			
Elseyornis melanops	black-fronted dotterel	-	-
Vanellus miles	masked lapwing	-	-
Strigidae			
Ninox novaeseelandiae	southern boobook	-	-
Columbidae			
Phaps chalcoptera	common bronzewing	-	-
Ocyphaps lophotes	crested pigeon	-	-
Geopelia humeralis	bar-shouldered dove	-	-
Podargidae			
Podargus strigoides	tawny frogmouth	-	-
Eurostopodidae			

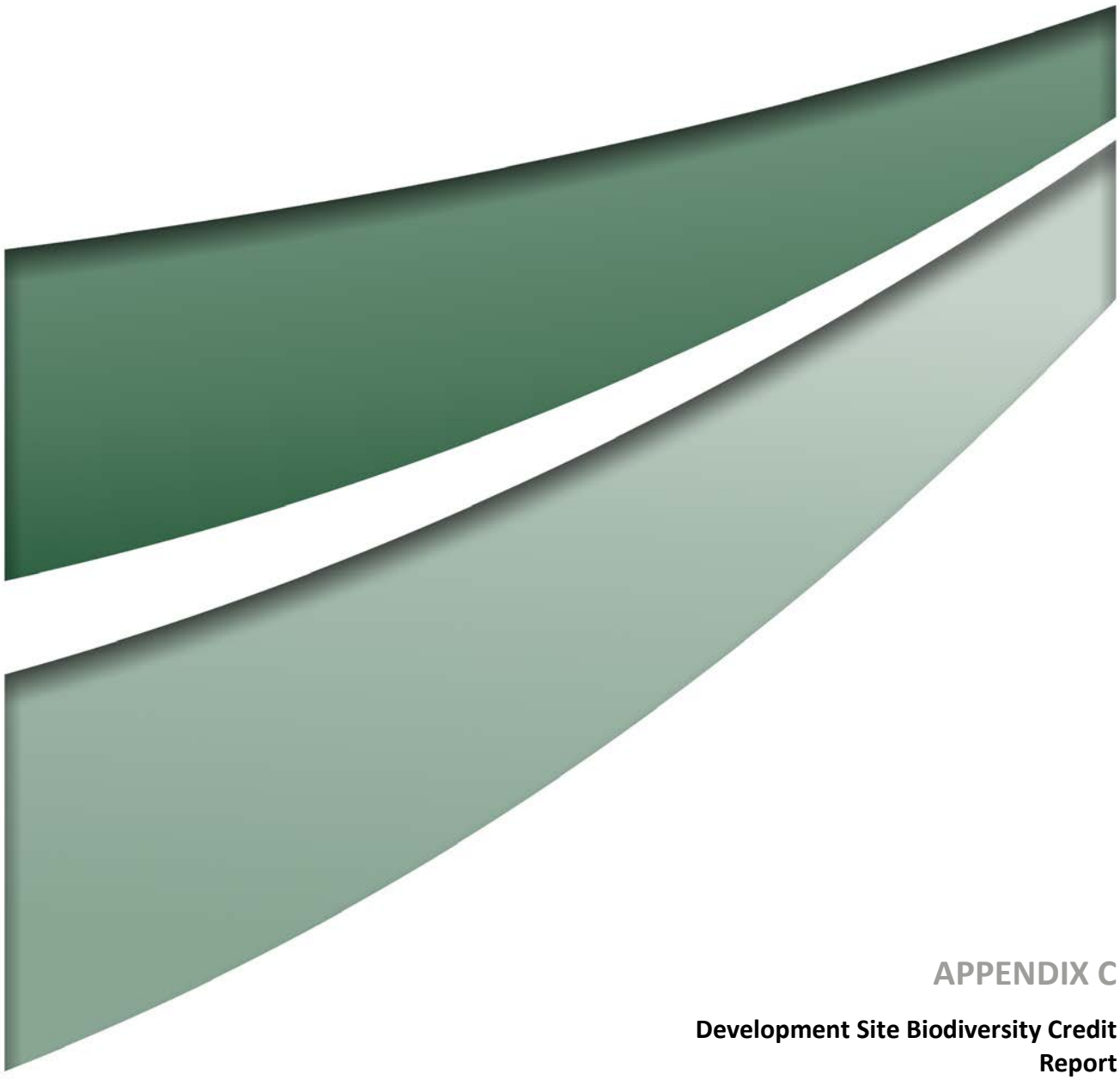
Scientific Name	Common Name	TSC Act	EPBC Act
Eurostopodus mystacalis	white-throated nightjar	-	-
Apodidae			
Hirundapus caudacutus	white-throated needletail	-	-
Cacatuidae			
Cacatua roseicapilla	galah	-	-
Cacatua galerita	sulphur-crested cockatoo	-	-
Calyptorhynchus lathami	glossy black-cockatoo	V	-
Psittacidae			
Alisterus scapularis	Australian king-parrot	-	-
Glossopsitta concinna	musk lorikeet	-	-
Platycercus eximius	eastern rosella	-	-
Cuculidae			
Chrysococcyx lucidus	shining bronze-cuckoo	-	-
Cacomantis flabelliformis	fan-tailed cuckoo	-	-
Eudynamis orientalis	eastern koel	-	-
Scythrops novaehollandiae	channel-billed cuckoo	-	-
Halcyonidae			
Dacelo novaeguineae	laughing kookaburra	-	-
Meropidae			
Merops ornatus	rainbow bee-eater	-	-
Coraciidae			
Eurystomus orientalis	dollarbird	-	-
Climacteridae			
Corombates leucophaeus	white-throated treecreeper	-	-
Maluridae			
Malurus cyaneus	superb fairy-wren	-	-
Acrocephalidae			
Acrocephalus australis	Australian reed-warbler	-	-
Pardalotidae			
Pardalotus punctatus	spotted pardalote	-	-
Pardalotus striatus	striated pardalote	-	-
Acanthizidae			
Chthonicola sagittata	speckled warbler	V	-
Smicrornis brevirostris	weebill	-	-
Gerygone olivacea	white-throated gerygone	-	-
Acanthiza pusilla	brown thornbill	-	-

Scientific Name	Common Name	TSC Act	EPBC Act
Acanthiza chrysorrhoa	yellow-rumped thornbill	-	-
Acanthiza nana	yellow thornbill	-	-
Acanthiza lineata	striated thornbill	-	-
Acanthiza reguloides	buff-rumped thornbill	-	-
Meliphagidae			
Anthochaera carunculata	red wattlebird	-	-
Anthochaera chrysoptera	little wattlebird	-	-
Acanthagenys rufogularis	spiny-cheeked honeyeater	-	-
Plectorhyncha lanceolata	striped honeyeater	-	-
Philemon corniculatus	noisy friarbird	-	-
Manorina melanocephala	noisy miner	-	-
Lichenostomus chrysops	yellow-faced honeyeater	-	-
Lichenostomus penicillatus	white-plumed honeyeater	-	-
Melithreptus brevirostris	brown-headed honeyeater	-	-
Melithreptus lunatus	white-naped honeyeater	-	-
Pomatostomidae			
Pomatostomus temporalis temporalis	grey-crowned babbler	V	-
Neosittidae			
Daphoenositta chrysoptera	varied sittella	V	-
Pachycephalidae			
Pachycephala pectoralis	golden whistler	-	-
Pachycephala rufiventris	rufous whistler	-	-
Colluricincla harmonica	grey shrike-thrush	-	-
Oriolidae			
Oriolus sagittatus	olive-backed oriole	-	-
Monarchidae			
Grallina cyanoleuca	magpie-lark	-	-
Megaluridae			
Cincloramphus mathewsi	brown songlark	-	-
Rhipiduridae			
Rhipidura albiscapa	grey fantail	-	-
Rhipidura leucophrys	willie wagtail	-	-
Campephagidae			
Coracina novaehollandiae	black-faced cuckoo-shrike	-	-
Lalage sueurii	white-winged triller	-	-
Artamidae			

Scientific Name	Common Name	TSC Act	EPBC Act
Artamus cyanopterus	dusky woodswallow	V	-
Cracticus torquatus	grey butcherbird	-	-
Cracticus nigrogularis	pied butcherbird	-	-
Gymnorhina tibicen	Australian magpie	-	-
Strepera graculina	pied currawong	-	-
Corvidae			
Corvus coronoides	Australian raven	-	-
Corcoracidae			
Corcorax melanorhamphos	white-winged chough	-	-
Petroicidae			
Microeca leucophaea	jacky winter	-	-
Petroica boodang	scarlet robin	V	-
Petroica goodenovii	red-capped robin	-	-
Eopsaltria australis	eastern yellow robin	-	-
Estrildidae			
Taeniopygia bichenovii	double-barred finch	-	-
Neochmia temporalis	red-browed finch	-	-
Stagonopleura guttata	diamond firetail	V	-
Dicaeidae			
Dicaeum hirundinaceum	mistletoebird	-	-
Hirundinidae			
Hirundo nigricans	tree martin	-	-
Hirundo neoxena	welcome swallow	-	-
Zosteropidae			
Zosterops lateralis	silvereye	-	-
Pelecanidae			
Pelecanus conspicillatus	Australian pelican	-	-
MAMMALS			
Ornithorhynchidae			
Tachyglossus aculeatus	short-beaked echidna	-	-
Dasyuridae			
Dasyurus maculatus	spotted-tailed quoll	V	E
Vombatidae			
Vombatus ursinus	common wombat	-	-
Phalangeridae			
Trichosurus vulpecula	common brushtail possum	-	-

Scientific Name	Common Name	TSC Act	EPBC Act
Petauridae			
Petaurus breviceps	sugar glider	-	-
Macropodidae			
Macropus giganteus	eastern grey kangaroo	-	-
Macropus rufogriseus	red-necked wallaby	-	-
Wallabia bicolor	swamp wallaby	-	-
Pteropodidae			
Pteropus policephalus	grey –headed flying fox	V	V
Emballonuridae			
Saccolaimus flaviventris	yellow-bellied sheathtail-bat	V	-
Rhinolophidae			
Rhinolophus megaphyllus	eastern horseshoe-bat	-	-
Molossidae			
Mormopterus planiceps	southern free-tail bat	-	-
Mormopterus norfolkensis	east-coast free-tailed bat	V	-
Mormopterus ridei		-	-
Mormopterus sp.2	freetail bat	-	-
Mormopterus sp.4	southern freetail bat	-	-
Austronomus australis	white-striped freetail-bat	-	-
Vespertilionidae			
Miniopterus australis	little bentwing-bat	V	-
Miniopterus schreibersii oceanensis	eastern bentwing-bat	V	-
Nyctophilus sp.	unidentified long-eared bat	-	-
Myotis macropus	southern myotis	V	-
Chalinolobus dwyeri	large-eared pied bat	V	V
Chalinolobus gouldii	Gould's wattled bat	-	-
Chalinolobus morio	chocolate wattled bat	-	-
Scoteanax rueppellii	greater broad-nosed bat	V	-
Scotorepens balstoni	inland broad-nosed bat	-	-
Vespadelus regulus	southern forest bat	-	-
Vespadelus troughtoni	eastern cave bat	V	-
Vespadelus vulturnus	little forest bat	-	-
Muridae			
*Mus musculus**	house mouse	-	-
*Rattus rattus**	black rat	-	-
Canidae			

Scientific Name	Common Name	TSC Act	EPBC Act
*Canis lupus familiaris**	dog	-	-
*Vulpes vulpes**	fox	-	-
Leporidae			
*Oryctolagus cuniculus**	rabbit	-	-
*Lepus capensis**	brown hare	-	-
Felidae			
*Felis cattus**	cat	-	-



APPENDIX C

Development Site Biodiversity Credit Report

Biodiversity credit report

This report identifies the number and type of biodiversity credits required for a major project.

Date of report: 17/03/2017 Time: 11:19:16AM Calculator version: v4.0

Major Project details

Proposal ID:	177/2017/4190MP
Proposal name:	United Wambo Open Cut Coal Mine Project_Revised Disturbance Area
Proposal address:	134 Jerrys Plains Road Warkworth NSW 2330
Proponent name:	United Collieries Pty Ltd
Proponent address:	134 Jerrys Plains Road NSW 2330
Proponent phone:	0402 111 222
Assessor name:	Kate Connolly
Assessor address:	75 York St Teralba NSW 2284
Assessor phone:	02 4950 5322
Assessor accreditation:	177

Summary of ecosystem credits required

Plant Community type	Area (ha)	Credits created
Bull Oak grassy woodland of the central Hunter Valley	117.67	6,852.22
Forest Red Gum grassy open forest on floodplains of the lower Hunter	0.29	20.00
Grey Box - Slaty Box shrub - grass woodland on sandstone slopes of the upper Hunter and Sydney Basin	1.56	108.00
Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter	350.17	16,029.94
Spotted Gum - Narrow-leaved Ironbark shrub - grass open forest of the central and lower Hunter	29.42	1,483.28
Swamp Oak - Weeping Grass grassy riparian forest of the Hunter Valley	31.61	2,132.00
Total	530.72	26,625

Credit profiles

1. Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter, (HU905)

Number of ecosystem credits created	16,030
IBRA sub-region	Hunter

Offset options - Plant Community types	Offset options - IBRA sub-regions
Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter, (HU905) Weeping Myall - Coobah - Scrub Wilga shrubland of the Hunter Valley, (HU652)	Hunter and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

2. Bull Oak grassy woodland of the central Hunter Valley, (HU906)

Number of ecosystem credits created	6,852
IBRA sub-region	Hunter

Offset options - Plant Community types	Offset options - IBRA sub-regions
Bull Oak grassy woodland of the central Hunter Valley, (HU906) Weeping Myall - Coobah - Scrub Wilga shrubland of the Hunter Valley, (HU652) White Box x Grey Box - red gum - Rough-barked Apple grassy woodland on rich soils on hills in the upper Hunter Valley, (HU730) Grey Gum - Forest Red Gum - Yellow Box grassy tall open forest on mid-slopes of the Hunter Valley - North Coast escarpment, (HU691) Narrow-leaved Ironbark +/- Grey Box grassy woodland of the upper Hunter Valley, mainly Sydney Basin Bioregion, (HU701) Narrow-leaved Ironbark - Bull Oak - Grey Box shrub - grass open forest of the central and lower Hunter, (HU817) Narrow-leaved Ironbark - Grey Box - Spotted Gum shrub - grass woodland of the central and lower Hunter, (HU818) Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter, (HU905) Blakely's Red Gum - Rough-barked Apple shrubby woodland of central and upper Hunter, (HU910)	Hunter and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

3. Spotted Gum - Narrow-leaved Ironbark shrub - grass open forest of the central and lower Hunter, (HU816)

Number of ecosystem credits created	1,483
IBRA sub-region	Hunter

Offset options - Plant Community types	Offset options - IBRA sub-regions
Spotted Gum - Narrow-leaved Ironbark shrub - grass open forest of the central and lower Hunter, (HU816) Melaleuca decora low forest of the central Hunter Valley, Sydney Basin Bioregion, (HU564) Slaty Red Gum grassy woodland on hinterland foothills of the southern North Coast, (HU619) Grey Ironbark - Broad-leaved Mahogany - Forest Red Gum shrubby open forest on Coastal Lowlands of the Central Coast, (HU802) Spotted Gum - Broad-leaved Mahogany - Grey Gum grass - shrub open forest on Coastal Lowlands of the Central Coast, (HU803) Spotted Gum - Broad-leaved Mahogany - Red Ironbark shrubby open forest, (HU804) Spotted Gum - Red Ironbark - Grey Gum shrub - grass open forest of the Lower Hunter, (HU806) Red Ironbark - Spotted Gum - Prickly-leaved Paperbark shrubby open forest of the Lower Hunter, (HU807) Spotted Gum - Red Ironbark - Narrow-leaved Ironbark - Grey Box shrub-grass open forest of the lower Hunter, (HU814) Spotted Gum - Narrow-leaved Ironbark-Red Ironbark shrub - grass open forest of the central and lower Hunter, (HU815) Grey Box - Grey Gum - Rough-barked Apple - Blakely's Red Gum grassy open forest of the central Hunter, (HU822)	Hunter and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

4. Grey Box - Slaty Box shrub - grass woodland on sandstone slopes of the upper Hunter and Sydney Basin, (HU869)

Number of ecosystem credits created	108
IBRA sub-region	Hunter

Offset options - Plant Community types	Offset options - IBRA sub-regions
Grey Box - Slaty Box shrub - grass woodland on sandstone slopes of the upper Hunter and Sydney Basin, (HU869) Slaty Box - Grey Gum shrubby woodland on footslopes of the upper Hunter Valley, Sydney Basin Bioregion, (HU618) Dapper Mugga Ironbark - Western Grey Box - Blakely's Red Gum - Black Cypress Pine grass shrub hill woodland (southern Brigalow Belt South Bioregion), (HU698) Red Ironbark - Black Cypress Pine - stringybark +/- Narrow-leaved Wattle shrubby open forest on sandstone in the Gulgong - Mendooran region, southern Brigalow Belt South Bioregion, (HU707) Narrow-leaved Ironbark- Black Cypress Pine - stringybark +/- Grey Gum +/ - Narrow-leaved Wattle shrubby open forest on sandstone hills in the southern Brigalow Belt South Bioregion and Sydney Basin Bio, (HU702) Narrow-leaved Ironbark - box - Mock Olive shrubby open forest mainly on basalt slopes over sandstone in the upper Hunter Valley, Brigalow Belt South Bioregion and Sydney Basin Bioregion, (HU700) White Box - Black Cypress Pine shrubby woodland of the Western Slopes, (HU824) Narrow-leaved Ironbark - Grey Gum shrubby open forest on sandstone ranges of the upper Hunter Valley, (HU868) Narrow-leaved Ironbark - Black Pine - Sifton Bush heathy open forest on sandstone ranges of the upper Hunter and Sydney Basin, (HU875) Narrow-leaved Stringybark - Ironbark heathy open forest on sandstone ranges of the upper Hunter, (HU882) Broom Bush - Allocasuarina gymnanthera heathy woodland on sandstone outcrops of the Sydney Basin, (HU923)	Hunter and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

5. Forest Red Gum grassy open forest on floodplains of the lower Hunter, (HU812)

Number of ecosystem credits created	20
IBRA sub-region	Hunter

Offset options - Plant Community types	Offset options - IBRA sub-regions
Forest Red Gum grassy open forest on floodplains of the lower Hunter, (HU812) Coastal floodplain sedgelands, rushlands, and forblands of the North Coast, (HU532) Swamp Oak swamp forest fringing estuaries, Sydney Basin Bioregion and South East Corner Bioregion, (HU635) Parramatta red gum - Fern-leaved banksia - Melaleuca sieberi swamp woodland of the Tomaree Peninsula, (HU865) Prickly-leaved Paperbark - Flax-leaved Paperbark swamp forest on poorly drained soils of the Central Coast, (HU929) Cabbage Gum - Forest Red Gum - Flax-leaved Paperbark Floodplain Forest of the Central Coast, (HU934) Swamp Oak - Sea Rush - Baumea juncea swamp forest on coastal lowlands of the Central Coast and Lower North Coast, (HU941) Swamp Oak - Prickly Paperbark - Tall Sedge swamp forest on coastal lowlands of the Central Coast and Lower North Coast, (HU942) Grey Gum - Red Gum - Paperbark shrubby open forest on coastal lowlands of the Northern Sydney Basin and Lower North Coast, (HU963)	Hunter and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

6. Swamp Oak - Weeping Grass grassy riparian forest of the Hunter Valley, (HU945)

Number of ecosystem credits created	2,132
IBRA sub-region	Hunter

Offset options - Plant Community types	Offset options - IBRA sub-regions
Swamp Oak - Weeping Grass grassy riparian forest of the Hunter Valley, (HU945) Swamp Mahogany swamp forest on coastal lowlands of the NSW North Coast Bioregion and northern Sydney Basin Bioregion, (HU633) Prickly-leaved Paperbark forest on coastal lowlands of the Central Coast and Lower North Coast, (HU930) Broad-leaved Paperbark - Swamp Mahogany - Swamp Oak - Saw Sedge swamp forest of the Central Coast and Lower North Coast, (HU931) Swamp Mahogany - Flax-leaved Paperbark swamp forest on coastal lowlands of the Central Coast, (HU932) Paperbarks - Woollybutt swamp forest on coastal lowlands of the Central Coast, (HU933) Melaleuca biconvexa - Swamp Mahogany - Cabbage Palm swamp forest of the Central Coast, (HU937) Swamp paperbark - Baumea juncea swamp shrubland on coastal lowlands of the Central Coast and Lower North Coast, (HU944)	Hunter and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

Summary of species credits required

Common name	Scientific name	Extent of impact Ha or individuals	Number of species credits created
Southern Myotis	Myotis macropus	7.30	562

APPENDIX D

BioBank Site Survey Methods and Results

Wambo BioBank Site

Background

The Wambo BioBank Site is located immediately west of the Development Site. It comprises land owned by Wambo, located in the Jerrys Plains area, approximately 20 kilometres west of Singleton, NSW and adjacent to Wollemi National Park. Wambo BioBank Site is located within the Sydney Basin IBRA bioregion and the Hunter IBRA subregion. The Wambo BioBank Site covers approximately 338 hectares.

Survey Methods

A total of 31 systematic plots/transect surveys were conducted across the Wambo BioBank Site during the surveys undertaken for this assessment. Furthermore, rapid vegetation assessments were undertaken in each of these survey periods.

Reference was made to the VIS Classification Database to identify Plant Community Types (PCTs), as well as reviews of other regional and local vegetation mapping and reporting when designing the field survey. The Wambo BioBank Site PCTs were further stratified into Vegetation Zones (condition states) following the initial field survey of the site to determine the appropriate number of transect/plots required in accordance with the BBAM (OEH 2014b) as outlined in **Table D1** and shown on **Figure D1**.

Table D1 Adequacy of Vegetation Survey in the Wambo BioBank Site

Veg Zone	PCT ID (BVT IDs) and PCT Name *Condition Class*	Area in the Wambo BioBank Site (ha)	Number of Biometric Plots/Transects	
			Required (BBAM 2014)	Undertaken During Survey
1	HU618 - Slaty Box - Grey Gum Shrubby Woodland on Footslopes of the Upper Hunter Valley, Sydney Basin Bioregion *Moderate to Good*	204.7	6	6
2	HU618 - Slaty Box - Grey Gum Shrubby Woodland on Footslopes of the Upper Hunter Valley, Sydney Basin Bioregion *Moderate to Good - Regeneration*	11.2	3	3
3	HU712 - River Oak Riparian Grassy Tall Woodland of the Western Hunter Valley (Brigalow Belt South) *Moderate to Good*	12.6	3	4
4	HU712 - River Oak Riparian Grassy Tall Woodland of the Western Hunter Valley (Brigalow Belt South) *Moderate to Good – Derived Native Grassland (DNG)*	7.3	3	3

Veg Zone	PCT ID (BVT IDs) and PCT Name *Condition Class*	Area in the Wambo BioBank Site (ha)	Number of Biometric Plots/Transects	
			Required (BBAM 2014)	Undertaken During Survey
5	HU817 - Narrow-leaved Ironbark - Bull Oak - Grey Box shrub - grass open forest of the central and lower Hunter *Moderate to Good*	28.5	4	4
6	HU817 - Narrow-leaved Ironbark - Bull Oak - Grey Box shrub - grass open forest of the central and lower Hunter *Moderate to Good – Cooba Woodland Variant*	4.0	2	2
7	HU817 - Narrow-leaved Ironbark - Bull Oak - Grey Box shrub - grass open forest of the central and lower Hunter *Moderate to Good – DNG*	52.7	5	5
8	HU817 - Narrow-leaved Ironbark - Bull Oak - Grey Box shrub - grass open forest of the central and lower Hunter *Moderate to Good – Regeneration*	13.3	3	4
Total		**338** **(337.9)**	**29**	**31**

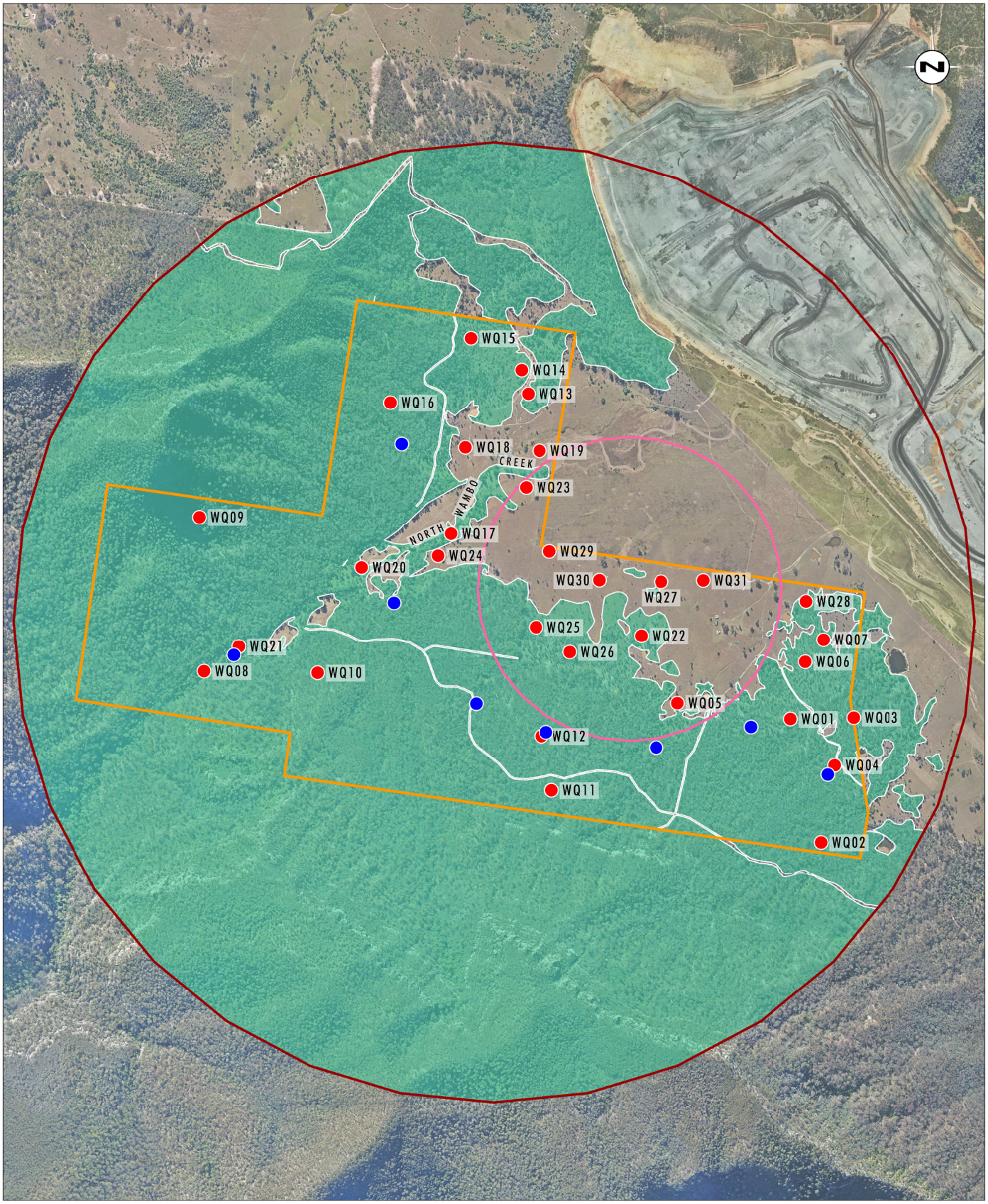


Image Source: AAM (2012), United (2016)
Data Source: LPI (2009)

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Legend

- Wambo Biobank Site Boundary
- 100ha Assessment Circle
- 1000ha Assessment Circle
- Native Vegetation
- Plot and Transect Locations
- Winter Birds 2016

FIGURE D1

Wambo BioBank Site Survey Methods

File Name (A4): R01/3890_027.dgn
20170519 15.28

Plot/Transect Data Collected

At each plot/transect data was recorded according to Section 5 of the BBAM (OEH 2014c). This involved setting out 20 x 50 metre and 20 x 20 metre plots and a 50 metre transect. The location of each quadrat was recorded using a hand-held GPS with accuracy of ± 5 metres. The Map Grid of Australia (MGA) coordinate system was used.

At each plot/transect, roughly 45 to 60 minutes was spent searching for all vascular flora species present within the 20 x 20 metre plot. Searches of each 20 x 20 metre plot were generally undertaken through parallel transects from one side of the plot to another. Most effort was spent on examining the groundcover, which usually supported well over half of the species present, however the composition of the shrub, mid-storey, canopy and emergent layers were also thoroughly examined. Effort was made to search the tree canopy and tree trunks for mistletoes, vines and epiphytes.

For each flora species recorded in the plot, the following data was collected in accordance with Table 1 of the BBAM (OEH 2014c):

- stratum/layer in which the species occurs
- growth form
- scientific name and common name
- cover
- abundance.

At each standard flora plot, 10 points along a 50 metre transect were assessed for:

- percentage native overstorey cover
- percentage native mid-storey cover.

In addition, 50 points along a 50 metre transect were assessed for:

- percentage native groundcover (grass)
- percentage native groundcover (shrubs)
- percentage native ground cover (other)
- percentage exotic plant cover.

Additional details were also recorded in each quadrat, including soil texture, drainage and depth; site disturbances; physiography (position in the landscape); and vegetation structure (strata percentage covers, heights and dominant species). Photographic records were also taken at each site.

A preliminary list of threatened flora species with potential to occur in the Wambo BioBank Site was generated during the literature review, completion of database searches and the TSPD. Searches of the TSPD were undertaken by the Hunter IBRA subregion and Hunter/Central Rivers CMA region. Searches for these species were undertaken in suitable habitat along numerous walking meandering transects and within the plot/transect surveys. These generally involved walking suitable habitat areas and searching for the targeted species within the Wambo BioBank Site.

Table D2 Species-credit Flora Species Targeted During Survey

Common Name *Scientific Name*	TSC Status	EPBC Status	Required Survey Period^	Survey Technique, Timing and Location
Cotoneaster pomaderris *Pomaderris cotoneaster*	E	E	All year	Opportunistic observations during plot and transect surveys.

^ Months that surveys are required according to the Threatened Species Profile Database for the Hunter/Central Rivers CMA.

A preliminary list of species-credit fauna species with potential to occur in the Wambo BioBank Site was generated during the literature review, completion of database searches and review of the TSPD. Searches of the TSPD were undertaken by the Liverpool Range IBRA subregion and Hunter/Central Rivers CMA region. Targeted surveys were undertaken for the species listed in **Table D3.**

Table D3 Species-credit Fauna Species Targeted During Survey

Common Name *Scientific Name*	TSC Status	EPBC Status	Required Survey Period^	Survey Technique, Timing and Location
regent honeyeater *Anthochaera phrygia*	CE	CE	All year	Winter bird surveys targeting this species were undertaken by two ecologists during July 2016.
southern myotis *Myotis macropus*	V	-		Targeted Anabat surveys in November 2015 and habitat searches in February 2017.

^ Months that surveys are required according to the Threatened Species Profile Database for the Hunter/Central Rivers CMA (March 2017).

Targeted Winter Bird Surveys

Targeted winter bird surveys were undertaken across the Wambo BioBank Site in July 2016. Winter bird surveys targeting the regent honeyeater (*Anthochaera phrygia*) and swift parrot (*Lathamus discolor*) comprised a total of 8 person hours of survey (refer to **Table D4**). Surveys comprised a combination of predetermined sites and sites positioned during the surveys in areas of eucalypt flowering. Surveys included both visual searches (using binoculars) and call play back surveys (using a loud hailer).

Table D4 Targeted Winter Bird Survey Effort

Year	Number of Sites	Approximate Time at each Site	Total Person Hours
2016	8	1 person hour	8
Total Person Hours			**8**

Anabat Echolocation Recording

Threatened micro-bat surveys were undertaken at two locations across the Wambo BioBank Site during November 2015. Calls were recorded using an Anabat SD1 device (hereafter referred to as an 'Anabat'). At each site, the Anabat was positioned at an approximate 30 degree angle and 1 metre above the ground in a waterproof housing. Each detector was positioned towards potential micro-bat flight paths or over water-bodies to increase the likelihood of detecting micro-bat species. The Anabat detector was programmed to start recording from one hour before sunset to one hour after sunrise.

Recordings of bat calls were analysed by Glenn Hoye of Fly By Night Bat Surveys Pty Ltd (a recognised expert in the identification of micro-bat calls). The echolocation calls of species were identified to one of three confidence levels:

- confident
- probable, and
- possible.

All three levels of confidence were treated as positive identifications for the purposes of this ecological assessment.

Survey Results

Surveys of the Wambo BioBank Site identified three Plant Community Types (PCTs) across eight condition classes being:

- HU618 - Slaty Box - Grey Gum Shrubby Woodland on Footslopes of the Upper Hunter Valley, Sydney Basin Bioregion
    - *Moderate to Good Condition*
    - *Moderate to Good Condition - Regeneration*
- HU712 - River Oak Riparian Grassy Tall Woodland of the Western Hunter Valley (Brigalow Belt South)
    - *Moderate to Good Condition*
    - *Moderate to Good Condition – Derived Native Grassland*
- HU817 - Narrow-leaved Ironbark - Bull Oak - Grey Box shrub - grass open forest of the central and lower Hunter
    - *Moderate to Good Condition*
    - *Moderate to Good Condition – Cooba Woodland*
    - *Moderate to Good Condition - Derived Native Grassland*
    - *Moderate to Good Condition - Regeneration*

These PCTs were aligned with types described as part of the VIS Classification Database (OEH 2017c). The PCTs were then categorised into seven vegetation zones. The composition of these vegetation zones is outlined below and in **Figure 7.3** of the main report.

Zone 1 - HU618 Slaty Box - Grey Gum Shrubby Woodland on Footslopes of the Upper Hunter Valley, Sydney Basin Bioregion – Moderate to Good Condition

PCT Name	Slaty Box - Grey Gum Shrubby Woodland on Footslopes of the Upper Hunter Valley, Sydney Basin Bioregion	
Condition	Moderate to Good	
BVT Number	HU618	
Area (ha)	204.7	
Survey Effort	6 biometric plots/transects	
Formation	Dry Sclerophyll Forests (shrubby sub-formation)	
Class	Western Slopes Dry Sclerophyll Forests	
HRVP Map Unit (Peake 2006)	MU7 Narrabeen Footslopes Slaty Box Woodland	
General Description	This vegetation zone occurs on the slopes to the south and west at the transitional zone between the Triassic sandstone and Permian sediments. Disturbances to this community are generally absent, apart from several access tracks.	
Canopy Description	The canopy is sparse to mid-dense and dominated by slaty box (*Eucalyptus dawsonii*), grey box (*Eucalyptus moluccana*) and narrow-leaved ironbark (*Eucalyptus crebra*), 10 to 25 metres in height. Red ironbark (*Eucalyptus fibrosa*) also occurs on the upper slopes in the western portion of the Wambo BioBank Site.	
Mid-storey Description	The mid-storey is generally sparse and dominated by bulloak (*Allocasuarina luehmannii*), coast myall (*Acacia binervia*) and regenerating eucalypts.	
Shrub Layer Description	The shrub layer is sparse to mid-dense. Common species include sticky daisy bush (Olearia *elliptica*), velvet mock olive (*Notelaea microcarpa* var. *microcarpa*), fan wattle (*Acacia amblygona*), white sour bush (*Choretrum candollei*) knife-leaved wattle (*Acacia cultriformis*) and native blackthorn (*Bursaria spinosa*).	
Ground Cover Description	The ground cover vegetation is generally sparse. Common species include barbed wire grass (*Cymbopogon refractus*), purple wiregrass (*Aristida ramosa*), threeawn speargrass (*Aristida vagans*), hooked-hairy panic grass (*Ancistrachne uncinulata*), wiry panic (*Entolasia stricta*), speargrass (*Austrostipa scabra*), many-flowered mat-rush (*Lomandra multiflora* subsp. *multiflora*), rough saw sedge (*Gahnia aspera*), *Lomandra filiformis* subsp. *filiformis*, variable sword-sedge (*Lepidosperma laterale*) and blue trumpet (*Brunoniella australis*).	
Introduced Species	Introduced flora species are uncommon in this vegetation zone, with common prickly pear (*Opuntia stricta*) being the only introduced species recorded.	

PCT Name	Slaty Box - Grey Gum Shrubby Woodland on Footslopes of the Upper Hunter Valley, Sydney Basin Bioregion
Condition	Moderate to Good
TSC Act Status	This vegetation zone is consistent with the *Hunter Valley Footslopes Slaty Gum Woodland in the Sydney Basin VEC* listed under the TSC Act.
EPBC Act Status	The portions of this vegetation zone (87.8 hectares) on Permian derived sediments are consistent with the *Central Hunter Valley Eucalypt Forest and Woodland CEEC* listed under the EPBC Act.

Zone 2 - HU618 Slaty Box - Grey Gum Shrubby Woodland on Footslopes of the Upper Hunter Valley, Sydney Basin Bioregion – Moderate to Good Condition - Regeneration

PCT Name	**Slaty Box - Grey Gum Shrubby Woodland on Footslopes of the Upper Hunter Valley, Sydney Basin Bioregion**	
Condition	**Moderate to Good - Regeneration**	
BVT Number	HU618	
Area (ha)	11.2	
Survey Effort	3 biometric plots/transects	
Formation	Dry Sclerophyll Forests (shrubby sub-formation)	
Class	Western Slopes Dry Sclerophyll Forests	
HRVP Map Unit (Peake 2006)	MU7 Narrabeen Footslopes Slaty Box Woodland	
General Description	This vegetation zone occurs on the lower slopes adjacent to areas of remnant Slaty Box Woodland. This vegetation zone represents young regeneration of this vegetation community after recent disturbance.	
Canopy Description	The canopy is mid-dense and dominated by slaty box (*Eucalyptus dawsonii*) and narrow-leaved ironbark (*Eucalyptus crebra*), 8 to 14 metres in height.	
Mid-storey Description	The mid-storey is generally very sparse and may include bulloak (*Allocasuarina luehmannii*) and regenerating slaty box (*Eucalyptus dawsonii*) and narrow-leaved ironbark (*Eucalyptus crebra*).	
Shrub Layer Description	The shrub layer is absent to very sparse. Shrub species include fan wattle (*Acacia amblygona*), wilga (*Geijera parviflora*), *Sida hackettiana* and straggly lantern-bush (*Abutilon oxycarpum*)	
Ground Cover Description	The ground cover vegetation is generally sparse. Common species include threeawn speargrass (*Aristida vagans*), common couch (*Cynodon dactylon*), speargrass (*Austrostipa scabra*), purple wiregrass (*Aristida ramosa*), barbed wire grass (*Cymbopogon refractus*), slender flat-sedge (*Cyperus gracilis*), bristly cloak fern (*Cheilanthes distans*), *Lomandra filiformis*, rock fern (*Cheilanthes sieberi* subsp. *sieberi*), thyme spurge (*Phyllanthus hirtellus*), caustic weed (*Chamaesyce drummondii*) and many-flowered mat-rush (*Lomandra multiflora* subsp. *multiflora*).	
Introduced Species	Introduced flora species are uncommon in this vegetation zone and include common prickly pear (*Opuntia stricta*), narrow-leaved cotton bush (*Gomphocarpus fruticosus*), fireweed (*Senecio madagascariensis*) and Paddys lucerne (*Sida rhombifolia*).	
TSC Act Status	This vegetation zone is consistent with the *Hunter Valley Footslopes Slaty Gum Woodland in the Sydney Basin VEC* listed under the TSC Act.	

PCT Name	**Slaty Box - Grey Gum Shrubby Woodland on Footslopes of the Upper Hunter Valley, Sydney Basin Bioregion**
Condition	**Moderate to Good - Regeneration**
EPBC Act Status	This vegetation zone is consistent with the *Central Hunter Valley Eucalypt Forest and Woodland CEEC* listed under the EPBC Act.

Zone 3 - HU712 River Oak Riparian Grassy Tall Woodland of the Western Hunter Valley (Brigalow Belt South) – Moderate to Good Condition

PCT Name	River Oak Riparian Grassy Tall Woodland of the Western Hunter Valley (Brigalow Belt South)	
Condition	**Moderate to Good**	
BVT Number	HU712	
Area (ha)	12.6	
Survey Effort	4 biometric plot/transect	
Formation	Forested Wetlands	
Class	Eastern Riverine Forests	
HRVP Map Unit (Peake 2006)	MU30 Hunter Valley River Oak Forest	
General Description	This vegetation zone occurs on the alluvial soils associated with North Wambo Creek that flows through the Wambo BioBank Site. This vegetation zone has a long history of disturbance through past clearance and stock grazing.	
Canopy Description	The canopy is sparse to mid-dense and dominated by river oak (*Casuarina cunninghamiana*) and rough-barked apple (*Angophora floribunda*), 15 to 30 metres in height. There are also occurrences of forest red gum (*Eucalyptus tereticornis*).	
Mid-storey Description	The mid-storey is sparse to mid-dense and includes native rosella (*Hibiscus heterophyllus* subsp. *heterophyllus*), white cedar (*Melia azedarach*), cooba (*Acacia salicina*) and green wattle (*Acacia irrorata* subsp. *irrorata*).	
Shrub Layer Description	The shrub layer is sparse and includes coffee bush (*Breynia oblongifolia*), native blackthorn (*Bursaria spinosa*), and *Sannantha pluriflora*.	
Ground Cover Description	The ground cover vegetation is generally mid-dense to dense. Common species include slender bamboo grass (*Austrostipa verticillata*), weeping grass (*Microlaena stipoides*), common couch (*Cynodon dactylon*), rough saw-sedge (*Gahnia aspera*), and rock fern (*Cheilanthes sieberi* subsp. *sieberi*).	
Introduced Species	Several introduced flora species occur in this vegetation zone and include catsear (*Hypochaeris radicata*), pepper tree (*Schinus areira*), narrow-leaved cotton bush (*Gomphocarpus fruticosus*), flaxleaf fleabane (*Conyza bonariensis*), fireweed (*Senecio madagascariensis*), galenia (*Galenia pubescens*) and fleabane (*Conyza* sp.).	
TSC Act Status	This vegetation community is not consistent with any listed TEC under the TSC Act.	
EPBC Act Status	This vegetation zone is not consistent with any TEC listed under the EPBC Act.	

Zone 4 - HU712 River Oak Riparian Grassy Tall Woodland of the Western Hunter Valley (Brigalow Belt South) – Moderate to Good Condition – Derived Native Grassland

PCT Name	**River Oak Riparian Grassy Tall Woodland of the Western Hunter Valley (Brigalow Belt South)**	
Condition	**Moderate to Good – Derived Native Grassland**	
BVT Number	HU712	
Area (ha)	7.3	
Survey Effort	3 biometric plots/transects	
Formation	Forested Wetlands	
Class	Eastern Riverine Forests	
HRVP Map Unit (Peake 2006)	MU30 Hunter Valley River Oak Forest	
General Description	This vegetation zone occurs on the alluvial soils associated with North Wambo Creek that flows through the Wambo BioBank Site. This vegetation zone has a long history of disturbance through past clearance and stock grazing.	
Canopy Description	Nil	
Mid-storey Description	Nil	
Shrub Layer Description	Nil	
Ground Cover Description	The ground cover vegetation is dense. Common species include common couch (*Cynodon dactylon*), purple wiregrass (*Aristida ramosa*), slender rat's tail grass (*Sporobolus creber*), threeawn speargrass (*Aristida vagans*) red grass (*Bothriochloa macra*), rock fern (*Cheilanthes sieberi* subsp. *sieberi*) and bristly cloak fern (*Cheilanthes distans*).	
Introduced Species	Several introduced flora species occur in this vegetation zone and include fireweed (*Senecio madagascariensis*), common pricvkly pear (*Opuntia stricta*) and narrow-leaved cotton bush (*Gomphocarpus fruticosus*).	
TSC Act Status	This vegetation community is not consistent with any listed TEC under the TSC Act.	
EPBC Act Status	This vegetation zone is not consistent with any TEC listed under the EPBC Act.	

Zone 5 - HU817 Narrow-leaved Ironbark - Bull Oak - Grey Box Shrub - Grass Open Forest of the Central and Lower – Moderate to Good Condition

PCT Name	Narrow-leaved Ironbark - Bull Oak - Grey Box Shrub - Grass Open Forest of the Central and Lower	
Condition	Moderate to Good	
BVT Number	HU817	
Area (ha)	28.5	
Survey Effort	4 biometric plots/transects	
Formation	Grassy Woodlands	
Class	Coastal Valley Grassy Woodlands	
HRVP Map Unit (Peake 2006)	MU10 Central Hunter Box – Ironbark Woodland	
General Description	This vegetation zone occurs on the lower slopes within the southern and western portions of the Wambo BioBank Site. Whilst this community is reasonably intact, apart from several access tracks, the canopy trees are reasonably young and likely to have been subject to logging and grazing in the past.	
Canopy Description	The canopy is sparse and dominated by narrow-leaved ironbark (*Eucalyptus crebra*), with occurrences of bulloak (*Allocasuarina luehmannii*) and grey box (*Eucalyptus moluccana*), 10 to 15 metres in height.	
Mid-storey Description	The mid-storey is generally sparse and dominated by bulloak (*Allocasuarina luehmannii*), cooba (*Acacia salicina*), black cypress pine (*Callitris endlicheri*) and regenerating eucalypts.	
Shrub Layer Description	The shrub layer is sparse. Common species include velvet mock olive (*Notelaea microcarpa* var. *microcarpa*), *Grevillea montana*, fan wattle (*Acacia amblygona*) and native blackthorn (*Bursaria spinosa*).	
Ground Cover Description	The ground cover vegetation is generally sparse to mid-dense. Common species include barbed wire grass (*Cymbopogon refractus*), purple wiregrass (*Aristida ramosa*), speargrass (*Austrostipa scabra*), native wandering Jew (*Commelina cyanea*), many-flowered mat-rush (*Lomandra multiflora* subsp. *multiflora*), berry saltbush (*Einadia hasta*), variable glycine (*Glycine tabacina*), bristly cloak fern (*Cheilanthes distans*), rock fern (*Cheilanthes sieberi* subsp. *sieberi*) and *Lomandra filiformis*.	
Introduced Species	Introduced flora species occur at low abundance in this vegetation zone and comprise fireweed (*Senecio madagascariensis*), common prickly pear (*Opuntia stricta*) and Paddys lucerne (*Sida rhombifolia*).	
TSC Act Status	This vegetation zone is consistent with the *Central Hunter Grey Box-Ironbark Woodland in the New South Wales North Coast and Sydney Basin Bioregions EEC* listed under the TSC Act.	

PCT Name	**Narrow-leaved Ironbark - Bull Oak - Grey Box Shrub - Grass Open Forest of the Central and Lower**
Condition	**Moderate to Good**
EPBC Act Status	This vegetation zone is consistent with the *Central Hunter Valley Eucalypt Forest and Woodland CEEC* listed under the EPBC Act.

Zone 6 - HU817 Narrow-leaved Ironbark - Bull Oak - Grey Box Shrub - Grass Open Forest of the Central and Lower – Moderate to Good – Cooba Woodland Variant

PCT Name	Narrow-leaved Ironbark - Bull Oak - Grey Box Shrub - Grass Open Forest of the Central and Lower	
Condition	Moderate to Good – Cooba Woodland Variant	
BVT Number	HU817	
Area (ha)	4.0	
Survey Effort	2 biometric plots/transects	
Formation	Grassy Woodlands	
Class	Coastal Valley Grassy Woodlands	
HRVP Map Unit (Peake 2006)	No equivalent	
General Description	This vegetation zone occurs on the lower slopes in the northern portion of the Wambo BioBank Site. This community is likely to be derived from the intact Zone 5 - HU817 Narrow-leaved Ironbark - Bull Oak - Grey Box Shrub - Grass Open Forest of the Central and Lower – Moderate to Good Condition which surrounds vegetation zone 6.	
Canopy Description	The canopy is sparse and dominated by cooba (*Acacia salicina*), 3 to 6 metres in height.	
Mid-storey Description	Generally absent.	
Shrub Layer Description	The shrub layer of this vegetation zone is sparse. Common species include velvet mock olive (*Notelaea microcarpa* var. *microcarpa*), violet nightshade (*Solanum brownii*), straggly lantern-bush (*Abutilon oxycarpum*) and brush wilga (*Geijera salicifolia*) and bead bush (*Spartothamnella juncea*).	
Ground Cover Description	The ground cover vegetation is generally dense. Common species include kidney weed (*Dichondra repens*), purple wiregrass (*Aristida ramosa*), red grass (*Bothriochloa macra*), Yadbila grass (*Panicum queenslandicum*), bristly cloak fern (*Cheilanthes distans*), *Lomandra filiformis* subsp. *filiformis* and rock fern (*Cheilanthes sieberi* subsp. *sieberi*).	
Introduced Species	Introduced flora species occur at low abundance in this vegetation zone and comprise narrow-leaved cotton bush (*Gomphocarpus fruticosus*), paddy's lucerne (*Sida rhombifolia*), galenia (*Galenia pubescens*) and *Centaurium* sp.	
TSC Act Status	This vegetation community is not consistent with any listed TEC under the TSC Act.	
EPBC Act Status	This vegetation zone is not consistent with any TEC listed under the EPBC Act. This vegetation zone could be restored to conform to the CEEC with the regeneration of characteristic canopy species.	

Zone 7 - HU817 Narrow-leaved Ironbark - Bull Oak - Grey Box Shrub - Grass Open Forest of the Central and Lower ‑ Moderate to Good – DNG

PCT Name	**Narrow-leaved Ironbark - Bull Oak - Grey Box Shrub - Grass Open Forest of the Central and Lower**	
Condition	**Moderate to Good – DNG**	
BVT Number	HU817	
Area (ha)	52.7	
Survey Effort	5 biometric plots/transects	
Formation	Grassy Woodlands	
Class	Coastal Valley Grassy Woodlands	
HRVP Map Unit (Peake 2006)	No equivalent	
General Description	This vegetation zone occurs on the lower slopes of the Wambo BioBank Site where it has been cleared for grazing.	
Canopy Description	Nil.	
Mid-storey Description	Nil.	
Shrub Layer Description	Nil.	
Ground Cover Description	The ground cover vegetation is generally dense. Common species include purple wiregrass (*Aristida ramosa*), slender rats tall grass (*Sporobolus creber*), common couch (*Cynodon dactylon*), shorthair plumegrass (*Dichelachne micrantha*), clustered everlasting (*Chrysocephalum semipapposum*), paddock lovegrass (*Eragrostis leptostachya*), bristly cloak fern (*Cheilanthes distans*), rock fern (*Cheilanthes sieberi* subsp. *sieberi*).	
Introduced Species	Introduced flora species occur at low abundance in this vegetation zone and comprise narrow-leaved cotton bush (*Gomphocarpus fruticosus*), fireweed (*Senecio madagascariensis*), spear thistle (*Cirsium vulgare*), french flax (*Linum trigynum*), flaxleaf fleabane (*Conyza bonariensis*) and Paddys lucerne (*Sida rhombifolia*).	
TSC Act Status	This vegetation community is not consistent with any listed TEC under the TSC Act.	
EPBC Act Status	A small portion of this vegetation zone (8.8 hectares) is consistent with the *Central Hunter Valley Eucalypt Forest and Woodland CEEC* listed under the EPBC Act where it occurs in gaps or between patches of woodland which are consistent with the CEEC. The remaining vegetation zone could be restored to conform to the CEEC with the regeneration of characteristic canopy species.	

Zone 8 - HU817 Narrow-leaved Ironbark - Bull Oak - Grey Box Shrub - Grass Open Forest of the Central and Lower – Moderate to Good Condition - Regeneration

PCT Name	Narrow-leaved Ironbark - Bull Oak - Grey Box Shrub - Grass Open Forest of the Central and Lower	
Condition	**Moderate to Good - Regeneration**	
BVT Number	HU817	
Area (ha)	13.3	
Survey Effort	4 biometric plots/transects	
Formation	Grassy Woodlands	
Class	Coastal Valley Grassy Woodlands	
HRVP Map Unit (Peake 2006)	MU10 Central Hunter Box – Ironbark Woodland	
General Description	This vegetation zone occurs on the lower slopes within the southern portion of the Wambo BioBank Site. This vegetation zone represents young regeneration of this vegetation community.	
Canopy Description	The canopy is mid-dense to dense and dominated by narrow-leaved ironbark (*Eucalyptus crebra*), with occurrences of bulloak (*Allocasuarina luehmannii*), 6 to 8 metres in height.	
Mid-storey Description	The mid-storey is generally sparse and dominated by bulloak (*Allocasuarina luehmannii*), Melaleuca decora and regenerating narrow-leaved ironbark (*Eucalyptus crebra*).	
Shrub Layer Description	The shrub layer is very sparse and may include velvet mock olive (*Notelaea microcarpa* var. *microcarpa*) and gorse bitter pea (*Daviesia ulicifolia*).	
Ground Cover Description	The ground cover vegetation is generally sparse to mid-dense. Common species include slender rats tall grass (*Sporobolus creber*), barbed wire grass (*Cymbopogon refractus*), purple wiregrass (*Aristida ramosa*), paddock lovegrass (*Eragrostis leptostachya*), bindweed (*Evolvulus alsinoides*), native wandering Jew (*Commelina cyanea*), rock fern (*Cheilanthes sieberi* subsp. *sieberi*) and *Lomandra filiformis*.	
Introduced Species	Introduced flora species occur at low abundance in this vegetation zone and comprise gomphrena weed (*Gomphrena celosioides*), fireweed (*Senecio madagascariensis*) and narrow-leaved cotton bush (*Gomphocarpus fruticosus*).	
TSC Act Status	This vegetation zone is consistent with the *Central Hunter Grey Box-Ironbark Woodland in the New South Wales North Coast and Sydney Basin Bioregions EEC* listed under the TSC Act.	
EPBC Act Status	This vegetation zone is consistent with the *Central Hunter Valley Eucalypt Forest and Woodland* CEEC listed under the EPBC Act.	

Threatened Ecological Communities

Four of the vegetation zones described above and mapped within the Wambo Biobank Site conform to State and Commonwealth listed TECs, comprising:

- HU618 Slaty Box - Grey Gum Shrubby Woodland on Footslopes of the Upper Hunter Valley, Sydney Basin Bioregion – Moderate to Good Condition
    - *Hunter Valley Footslopes Slaty Gum Woodland in the Sydney Basin VEC* (TSC Act).
    - *Central Hunter Valley Eucalypt Forest and Woodland CEEC* (EPBC Act) where this vegetation occurs on Permian derived sediments (87.8 hectares).
- HU618 Slaty Box - Grey Gum Shrubby Woodland on Footslopes of the Upper Hunter Valley, Sydney Basin Bioregion – Moderate to Good Condition - Regeneration
    - *Hunter Valley Footslopes Slaty Gum Woodland in the Sydney Basin VEC* (TSC Act).
    - *Central Hunter Valley Eucalypt Forest and Woodland CEEC* (EPBC Act).
- HU817 Narrow-leaved Ironbark - Bull Oak - Grey Box Shrub - Grass Open Forest of the Central and Lower – Moderate to Good Condition
    - *Central Hunter Grey Box-Ironbark Woodland in the New South Wales North Coast and Sydney Basin Bioregions EEC* (TSC Act).
    - *Central Hunter Valley Eucalypt Forest and Woodland CEEC* (EPBC Act).
- HU817 Narrow-leaved Ironbark - Bull Oak - Grey Box Shrub - Grass Open Forest of the Central and Lower – Moderate to Good – DNG
    - *Central Hunter Valley Eucalypt Forest and Woodland CEEC* (EPBC Act) where it occurs in gaps or between patches of woodland which are consistent with the CEEC (8.8 hectares).
- HU817 Narrow-leaved Ironbark - Bull Oak - Grey Box Shrub - Grass Open Forest of the Central and Lower – Moderate to Good Condition - Regeneration
    - *Central Hunter Grey Box-Ironbark Woodland in the New South Wales North Coast and Sydney Basin Bioregions EEC* (TSC Act).
    - *Central Hunter Valley Eucalypt Forest and Woodland CEEC* (EPBC Act).

Analysis of consistency with the scientific determinations for each TEC was undertaken, with consideration of the advice provided by the NSW Scientific Committee and/or the Commonwealth Threatened Species Scientific Committee guidelines for interpreting listings for species, populations and ecological communities under the TSC Act and EPBC Act respectively.

Ecosystem-credit Species

The following ecosystem credit species are known to occur within the Wambo BioBank Site from surveys or records on the Atlas of NSW Wildlife (OEH 2017a):

- large-eared pied bat (*Chalinolobus dwyeri*)
- eastern bentwing bat (*Miniopterus schreibersii oceanensis*)
- hooded robin (*Melanodryas cucullata*)
- speckled warbler (*Chthonicola sagittata*), and
- little lorikeet (*Glossopsitta pusilla*).

Species-credit Species

One possible threatened flora species, cotoneaster pomaderris (*Pomaderris cotoneaster*) was recorded in the Wambo BioBank Site. Specimens were sent to the Neville Walsh from the National Herbarium of Victoria who is an authority on the *Pomaderris* genus. In the absence of fertile material the specimen was identified as possibly cotoneaster pomaderris (*Pomaderris cotoneaster*), which represents a northern range extension for this typically more southern species. Other possibilities are that it is an unusual form or hybrid of local *Pomaderris* species. Further targeted surveys along North Wambo Creek to collect fertile material of this species would be required to confirm this identification. Little is known about the ecology of this species however, surveys in spring may be a suitable time to collect fertile material. If confirmed, species credits can be generated for this species at the Wambo BioBank Site.

Furthermore, a sample of the likely non-threatened *Lasiopetalum macrophyllum* has also been sent to the National Herbarium of NSW to confirm species identity and rule out the threatened species *Lasiopetalum longistamineum*.

At this stage, no species-credits have been generated for the Wambo BioBank Site.

Plot and Transect Data

Table D5 below outlines the plot and transect data collected from surveys of the Wambo BioBank Site. It includes the ten site attributes that are recorded in each Biometric plot and transect as per Table 2 of the BBAM (OEH 2014c). This data is assessed against benchmark data for PCTs and then entered into the BioBanking Credit Calculator to assess the site value of each PCT at the Wambo BioBank Site.

A full Credit Calculator report is included in **Appendix E**.

Table D5 Plot and Transect Data for the Wambo BioBank Site

Plot Name	NPS	NOS	NMS	NGCG	NGCS	NGCO	EPC	NTH	OR	FL	Easting	Northing	Zone
Zone 1: HU618 - Slaty Box - Grey Gum Shrubby Woodland on Footslopes of the Upper Hunter Valley, Sydney Basin Bioregion - Moderate to Good Condition													
WQ02	20	42.5	6.5	34	6	2	0	1	1	57	307302	6494516	56
WQ09	35	12	3	10	32	2	2	3	1	36	304987	6395728	56
WQ10	21	12.5	4	18	18	2	0	1	1	16	305427	6395148	56
WQ11	25	16.5	2	28	14	4	0	3	1	59	306298	6394710	56
WQ12	22	25.5	3	36	32	14	0	0	1	89	306260	6394912	56
WQ16	26	32.5	17	26	48	10	0	0	1	6	305697	6396155	56
Zone 2: HU618 - Slaty Box - Grey Gum Shrubby Woodland on Footslopes of the Upper Hunter Valley, Sydney Basin Bioregion - Moderate to Good Regeneration Condition													
WQ22	13	45	0	54	0	4	0	0	0.5	0	306632	6395286	56
WQ25	20	25	2	62	8	12	0	1	0.5	27	306240	6395318	56
WQ26	26	23	6	46	4	2	0	0	0.5	8	306366	6395225	56
Zone 3: HU712 - River Oak Riparian Grassy Tall Woodland of the Western Hunter Valley (Brigalow Belt South) - Moderate to Good Condition													
WQ08	32	32	3	24	14	16	2	1	0.67	69	305004	6395154	56
WQ17	17	52.5	0	30	2	8	0	0	0.67	38	305924	6395666	56
WQ20	33	30	9	58	6	16	0	1	0.67	108	305590	6395540	56
WQ21	37	47	22	64	2	38	0	1	0.67	96	305133	6395246	56

Zone 4: HU712 - River Oak Riparian Grassy Tall Woodland of the Western Hunter Valley (Brigalow Belt South) - Moderate to Good DNG Condition													
WQ19	3	0	0	90	0	0	4	0	0	5	306253	6395975	56
WQ23	4	0	0	100	0	0	2	0	0	0	306203	6395839	56
WQ24	10	0	0	92	0	34	4	0	0	0	305876	6395584	56
Zone 5: HU817 - Narrow-leaved Ironbark - Bull Oak - Grey Box shrub - grass open forest of the central and lower Hunter- Moderate to Good Condition													
WQ01	43	13.5	10.5	40	8	20	0	0	1	73	307188	6394976	56
WQ03	31	6	1	18	0	4	0	0	1	3.5	307423	6394981	56
WQ04	37	8	4.4	4.6	16	0	0	0	1	56	307352	6394803	56
WQ15	22	14	9	40	12	20	0	0	1	10	305998	6396396	56
Zone 6: HU817 - Narrow-leaved Ironbark - Bull Oak - Grey Box shrub - grass open forest of the central and lower Hunter – Moderate to Good Cooba Woodland Variant													
WQ13	20	3	0	90	4	6	6	0	0	0	306211	6396188	56
WQ14	21	14	0	76	2	14	4	0	0	0	306186	6396277	56
Zone 7: HU817 - Narrow-leaved Ironbark - Bull Oak - Grey Box shrub - grass open forest of the central and lower Hunter – Moderate to Good DNG Condition													
WQ05	22	0	0	94	2	10	20	0	0.5	0	306767	6395035	56
WQ18	7	0	0	74	0	0	2	0	0.5	0	305977	6395988	56
WQ29	12	0	0	100	0	14	4	0	0.5	0	306290	6395600	56
WQ30	8	0	0	98	0	12	2	0	0.5	0	306476	6395493	56
WQ31	9	0	0	94	0	8	0	0	0.5	0	306863	6395492	56

Zone 8: HU817 - Narrow-leaved Ironbark - Bull Oak - Grey Box shrub - grass open forest of the central and lower Hunter – Moderate to Good Regeneration Condition													
WQ06	16	5.5	0	62	12	2	0	0	0.25	17	307243	6395189	56
WQ07	27	12	3.5	40	2	2	0	1	0.25	12	307311	6395271	56
WQ28	17	24	3	46	2	22	0	1	0.25	23	307246	6395414	56
WQ27	23	27	0	30	14	6	6	2	0.25	14	306706	6395487	56

Highfields BioBank Site

Background

Highfields BioBank Site is located approximately 60 km north west of the Development Site. It comprises land owned by Glencore, located in the Manobalai area, approximately 30 kilometres northwest of Muswellbrook, NSW. Highfields BioBank Site is located within the Brigalow Belt South IBRA bioregion and the Liverpool Range IBRA subregion. The Highfields BioBank Site covers approximately 427 hectares.

Survey Methods

A total of 35 systematic plots/transect surveys were conducted across the Highfields BioBank Site during the surveys undertaken for this assessment. Furthermore, rapid vegetation assessments were undertaken in each of these survey periods.

Reference was made to the VIS Classification Database to identify Plant Community Types (PCTs), as well as reviews of other regional and local vegetation mapping and reporting when designing the field survey. The Highfields BioBank Site PCTs were further stratified into Vegetation Zones (condition states) following the initial field survey of the site to determine the appropriate number of transect/plots required in accordance with the BBAM (OEH 2014c) as outlined in **Table D6** and shown in **Figure D2**.

Table D6 Adequacy of Vegetation Survey in the Highfields BioBank Site

Veg Zone	PCT ID (BVT IDs) and PCT Name *Condition Class*	Area in the Highfields BioBank Site (ha)	Number of Biometric Plots/Transects	
			Required (BBAM 2014)	Undertaken During Survey
3	HU714 – Rough-Barked Apple - red gum - Yellow Box woodland on alluvial clay to loam soils on valley flats in the northern NSW South Western Slopes Bioregion and Brigalow Belt South Bioregion *Moderate to Good Condition*	2.50	2	2
4	HU730 – White Box x Grey Box - red gum - Rough-barked Apple grassy woodland on rich soils on hills in the upper Hunter Valley *Moderate to Good Condition*	158.20	6	7
5	HU730 – White Box x Grey Box - red gum - Rough-barked Apple grassy woodland on rich soils on hills in the upper Hunter Valley *Moderate to Good Condition – Shrubby Variant*	105.60	6	6
6	HU730 – White Box x Grey Box - red gum - Rough-barked Apple grassy woodland on rich soils on hills in the upper Hunter Valley *Moderate to Good Condition – Derived Native Grassland*	39.70	4	4

Veg Zone	PCT ID (BVT IDs) and PCT Name *Condition Class*	Area in the Highfields BioBank Site (ha)	Number of Biometric Plots/Transects	
			Required (BBAM 2014)	Undertaken During Survey
7	HU821 – Blakely's Red Gum - Narrow-leaved Ironbark - Rough-barked Apple shrubby woodland of the upper Hunter *Moderate to Good Condition*	24.90	4	5
8	HU868 – Narrow-leaved Ironbark - Grey Gum shrubby open forest on sandstone ranges of the upper Hunter Valley *Moderate to Good Condition*	90.10	5	6
9	HU868 – Narrow-leaved Ironbark - Grey Gum shrubby open forest on sandstone ranges of the upper Hunter Valley *Low Condition*	6.50	2	5
Total		**427** **(427.45)**	**29**	**35**

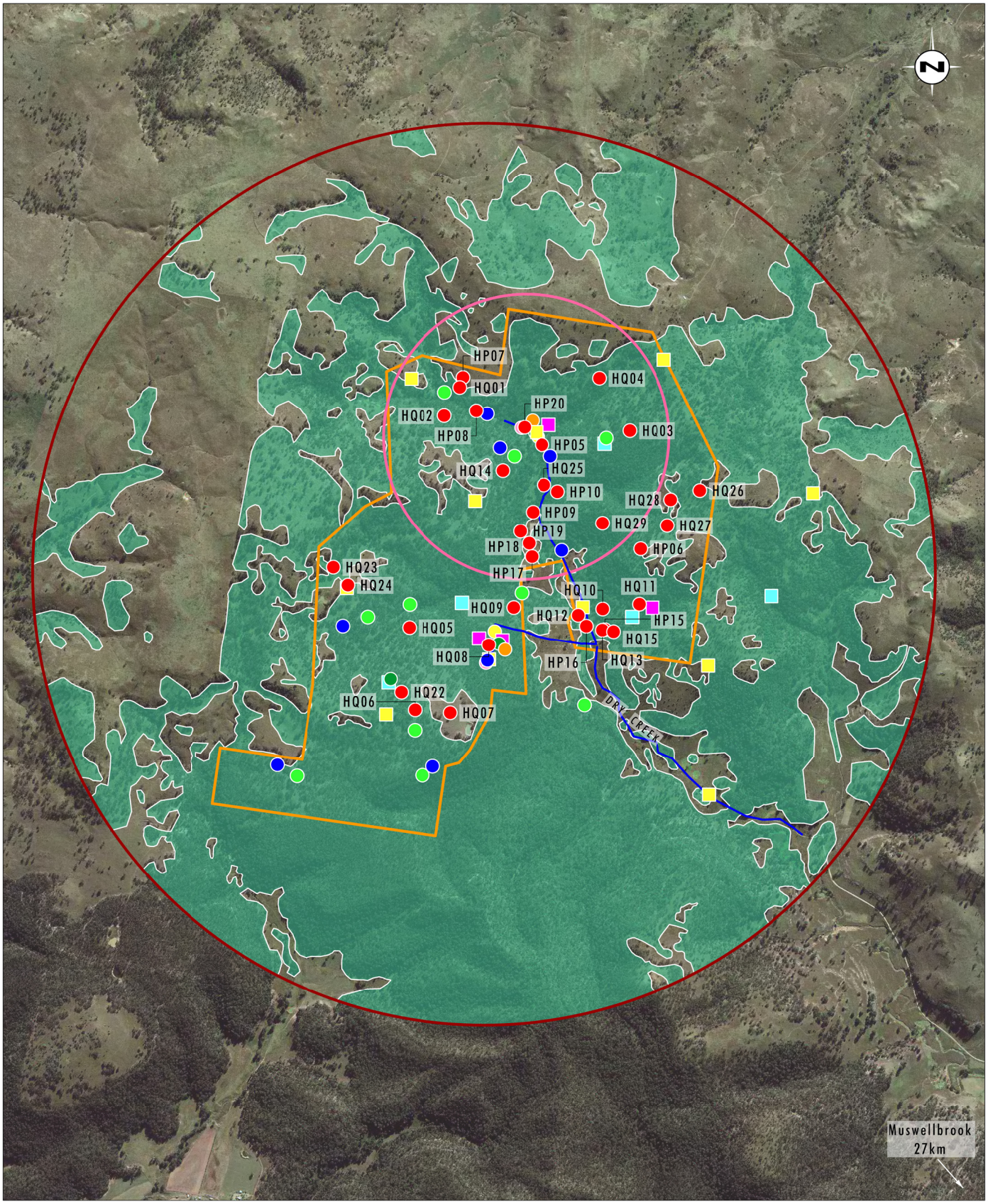

Image Source: Google Earth (2013)
Data Source: LPI NSW (2009)

0 0.5 1.0 1.5km
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Legend

- Highfields BioBank Site
- 100ha Assessment Circle
- 1000ha Assessment Circle
- Native Vegetation
- Plot and Transect Locations
- Winter Birds 2011
- Winter Birds 2013
- Winter Birds 2016
- Habitat Assessment
- Bird Survey, Diurnal Reptile and Amphibian Survey, Spotlighting Survey
- Call Playback
- Harp Trap
- Anabat Survey
- Hair Funnel Trap
- Driving Spotlighting Survey

FIGURE D2

Highfields BioBank Site
Survey Methods

File Name (A4): R01/3890_029.dgn
20170324 10.45

Plot/Transect Data Collected

At each plot/transect data was recorded according to Section 5 of the BBAM (OEH 2014c). This involved setting out 20 x 50 metre and 20 x 20 metre plots and a 50 metre transect. The location of each quadrat was recorded using a hand-held GPS with accuracy of ± 5 metres. The Map Grid of Australia (MGA) coordinate system was used.

At each plot/transect, roughly 45 to 60 minutes was spent searching for all vascular flora species present within the 20 x 20 metre plot. Searches of each 20 x 20 metre plot were generally undertaken through parallel transects from one side of the plot to another. Most effort was spent on examining the groundcover, which usually supported well over half of the species present, however the composition of the shrub, mid-storey, canopy and emergent layers were also thoroughly examined. Effort was made to search the tree canopy and tree trunks for mistletoes, vines and epiphytes.

For each flora species recorded in the plot, the following data was collected in accordance with Table 1 of the BBAM (OEH 2014c):

- stratum/layer in which the species occurs
- growth form
- scientific name and common name
- cover
- abundance.

At each standard flora plot, 10 points along a 50 metre transect were assessed for:

- percentage native overstorey cover
- percentage native mid-storey cover.

In addition, 50 points along a 50 metre transect were assessed for:

- percentage native groundcover (grass)
- percentage native groundcover (shrubs)
- percentage native ground cover (other)
- percentage exotic plant cover.

Additional details were also recorded in each quadrat, including soil texture, drainage and depth; site disturbances; physiography (position in the landscape); and vegetation structure (strata percentage covers, heights and dominant species). Photographic records were also taken at each site.

A preliminary list of species-credit flora species with potential to occur in the Highfields BioBank Site was generated during the literature review, completion of database searches and the TSPD. Searches of the TSPD were undertaken by the Liverpool Range IBRA subregion and Hunter/Central Rivers CMA region.

Targeted surveys were undertaken for the species listed in **Table D7** and included targeted on-ground searches in suitable habitat throughout the Highfields BioBank Site. Searches for these species were undertaken in suitable habitat along numerous walking meandering transects and within the plot/transect surveys. These generally involved walking suitable habitat areas and searching for the targeted species within the Highfields BioBank Site.

Table D7 Species-credit Flora Species Targeted During Survey

Common Name *Scientific Name*	TSC Status	EPBC Status	Required Survey Period^	Survey Technique, Timing and Location
bluegrass *Dichanthium setosum*	V	V	December to May	Opportunistic observations undertaken throughout all Umwelt survey periods.
scant pomaderris *Pomaderris queenslandica*	E		All year	Opportunistic observations undertaken throughout all Umwelt survey periods.

^ Months that surveys are required according to the Threatened Species Profile Database for the Hunter/Central Rivers CMA.

A preliminary list of species-credit fauna species with potential to occur in the Highfields BioBank Site was generated during the literature review, completion of database searches and review of the TSPD. Searches of the TSPD were undertaken by the Liverpool Range IBRA subregion and Hunter/Central Rivers CMA region.

Targeted surveys were undertaken for the species listed in **Table D8** and included a range of survey techniques including targeted searches, Anabat recorders, call playback, spotlighting and remote survey cameras. The seasonal survey requirements for all species-credit fauna species with the potential to occur within the Highfields BioBank Site were met from all survey periods.

Table D8 Species-credit Fauna Species Targeted During Survey

Common Name *Scientific Name*	TSC Status	EPBC Status	Required Survey Period^	Survey Technique, Timing and Location
regent honeyeater *Anthochaera phrygia*	CE	CE	All year	Winter bird surveys targeting this species were undertaken by two ecologists during August 2011, July 2013, August 2015 and August 2016 and comprised a total of 41 person hours of survey.

^ Months that surveys are required according to the Threatened Species Profile Database for the Hunter/Central Rivers CMA (December 2016).

Targeted Winter Bird Surveys

Targeted winter bird surveys were undertaken across the Highfields BioBank Site in 2011, 2013 and 2016. Winter bird surveys targeting the regent honeyeater (*Anthochaera phrygia*) and swift parrot (*Lathamus discolor*) were undertaken by two ecologists during June, July or August each year, and comprised a total of 41 person hours of survey (refer to **Table D9**). Surveys comprised a combination of predetermined sites and sites positioned during the surveys in areas of eucalypt flowering. Surveys included both visual searches (using binoculars) and call play back surveys (using a loud hailer).

Table D9 Targeted Winter Bird Survey Effort

Year	Number of Sites	Approximate Time at each Site	Total Person Hours
2011	11	1 person hour	11
2013	10	1 person hour	10
2015	12	1 person hour	12
2016	8	1 person hour	8
Total Person Hours			**41**

Anabat Echolocation Recording

Threatened micro-bat surveys were undertaken at two locations across the Highfields BioBank Site during April 2011 and April and May 2013. Calls were recorded using an Anabat SD1 device (hereafter referred to as an 'Anabat'). At each site, the Anabat was positioned at an approximate 30 degree angle and 1 metre above the ground in a waterproof housing. Each detector was positioned towards potential micro-bat flight paths or over water-bodies to increase the likelihood of detecting micro-bat species. The Anabat detector was programmed to start recording from one hour before sunset to one hour after sunrise.

Recordings of bat calls were analysed by Glenn Hoye of Fly By Night Bat Surveys Pty Ltd (a recognised expert in the identification of micro-bat calls). The echolocation calls of species were identified to one of three confidence levels:

- confident
- probable, and
- possible.

All three levels of confidence were treated as positive identifications for the purposes of this ecological assessment.

Remote Camera Surveys

The spotted-tailed quoll (*Dasyurus maculatus*) was targeted using remote camera surveys at 20 locations across the Highfields BioBank Site in October 2013. Bushnell Trophy Cam HD cameras were used for the remote camera surveys. At each site, a remote camera was mounted approximately one metre above the ground on a tree trunk and positioned towards a bait station containing chicken meat or canned tuna. Cameras were set to take three photos in quick succession when movement was detected. Remote cameras were set at each site for between three and four 24 hour periods.

Spotlighting Surveys

Driving spotlighting surveys for koalas, squirrel gliders, spotted-tailed quoll and forest owl species were undertaken in April 2011, April and May 2013. Surveys were undertaken in targeted areas between the hours of 8.00 pm and midnight using 30 watt Lightforce hand-held spotlights. Opportunistic fauna records were also made of other fauna species observed during the spotlighting surveys. The surveys were undertaken over two nights with approximately four person hours completed each night. Areas targeted for spotlighting primarily comprised woodland patches dominated by eucalypt species.

Survey Results

Surveys of the Highfields BioBank Site identified four Plant Community Types (PCTs) across seven condition classes being:

- HU714 Rough-Barked Apple - red gum - Yellow Box woodland on alluvial clay to loam soils on valley flats in the northern NSW South Western Slopes Bioregion and Brigalow Belt South Bioregion
    - *Moderate to Good Condition*
- HU730 White Box x Grey Box - red gum - Rough-barked Apple grassy woodland on rich soils on hills in the upper Hunter Valley
    - *Moderate to Good Condition*
    - *Moderate to Good Condition – Shrubby Variant*
    - *Moderate to Good Condition – Derived Native Grassland*
- HU821 Blakely's Red Gum - Narrow-leaved Ironbark - Rough-barked Apple shrubby woodland of the upper Hunter
    - *Moderate to Good Condition*
- HU868 Narrow-leaved Ironbark - Grey Gum shrubby open forest on sandstone ranges of the upper Hunter Valley
    - *Moderate to Good Condition*
    - *Low Condition*

These PCTs were aligned with types described as part of the VIS Classification Database (OEH 2017c). The PCTs were then categorised into seven vegetation zones. The composition of these vegetation zones is outlined below and in **Figure 7.5** of the main report.

Zone 3 - HU714 - Rough-Barked Apple - red gum - Yellow Box woodland on alluvial clay to loam soils on valley flats in the northern NSW South Western Slopes Bioregion and Brigalow Belt South Bioregion – Moderate to Good Condition

PCT Name	**Rough-Barked Apple - Red Gum - Yellow Box woodland on alluvial clay to loam soils on valley flats in the northern NSW South Western Slopes Bioregion and Brigalow Belt South Bioregion**	
Condition	**Moderate to Good**	
PCT Number	HU714	
Area (ha)	2.50	
Survey Effort	2 biometric plots/transects	
Formation	Grassy Woodlands	
Class	Western Slopes Grassy Woodlands	
HRVP Map Unit (Peake 2006)	No equivalent	
General Description	This vegetation zone occurs on alluvial flats associated with drainage lines through the centre of the offset area, typically in areas where a gully opens to the alluvium resulting in an increase in water flow. This community has been subject to past disturbances such as logging and grazing.	
Canopy Description	A very sparse canopy between 12 and 15 metres in height dominates the vegetation community, with dominant species including hybridised Blakely's / forest red gum (*Eucalyptus blakelyi <--> tereticornis*) and rough-barked apple (*Angophora floribunda*).	
Mid-storey Description	The mid-storey is occasionally absent however when it occurs it is sparse between 6 and 10 metres in height, with dominant species including young canopy species, rusty fig (*Ficus rubiginosa*) and forest oak (*Allocasuarina torulosa*).	
Shrub Layer Description	A sparse shrub layer, between 1 and 2 metres in height, occurs with species including velvet mock olive (*Notelaea microcarpa* var. *microcarpa*), narrow-leaved geebung (*Persoonia linearis*) and coffee bush (*Breynia oblongifolia*).	
Ground Cover Description	The ground cover vegetation was generally mid-dense to closed and is dominated by native grasses and forbs. Commonly recorded species include weeping grass (*Microlaena stipoides* var. *stipoides*), spiny-headed mat-rush (*Lomandra longifolia*), tall sedge (*Carex appressa*), purple wiregrass (*Aristida ramosa*), common wheatgrass (*Elymus scaber*), stinking pennywort (*Hydrocotyle laxiflora*), kidney weed (*Dichondra repens*) and hairy panic (*Panicum effusum*).	
Introduced Species	Introduced flora species are common throughout this vegetation zone as it has been exposed to a long history of stock grazing. Dominant species recorded include *Pavonia hastata*, soft brome (*Bromus molliformis*), perennial ryegrass (*Lolium perenne*), hop clover (*Trifolium campestre*) and prairie grass (*Bromus catharticus*)	

PCT Name	**Rough-Barked Apple - Red Gum - Yellow Box woodland on alluvial clay to loam soils on valley flats in the northern NSW South Western Slopes Bioregion and Brigalow Belt South Bioregion**
Condition	**Moderate to Good**
TSC Act Status	This vegetation zone is consistent with the *White Box Yellow Box Blakely's Red Gum Woodland EEC* listed under the TSC Act.
EPBC Act Status	This vegetation zone is consistent with the *White Box Yellow Box Blakely's Red Gum Grassy Woodland and Derived Native Grassland CEEC* listed under the EPBC Act.

Zone 4 - HU730 - White Box x Grey Box - red gum - Rough-barked Apple grassy woodland on rich soils on hills in the upper Hunter Valley – Moderate to Good Condition

PCT Name	White Box x Grey Box - Red Gum - Rough-barked Apple grassy woodland on rich soils on hills in the upper Hunter Valley	
Condition	Moderate to Good	
PCT Number	HU730	
Area (ha)	158.2	
Survey Effort	7 biometric plots/transects	
Formation	Grassy Woodlands	
Class	Coastal Valley Grassy Woodland	
HRVP Map Unit (Peake 2006)	MU11 – Upper Hunter White Box – Ironbark Grassy Woodland	
General Description	This vegetation zone occurs on the fertile Tertiary basalt-derived soils on the upper slopes of the Highfields Offset Area, which have been largely cleared for agricultural purposes and have been historically grazed. Specifically, it occurs on undulating hills on the upper slopes in the east and north and lower slopes in the west.	
Canopy Description	The canopy is sparse to mid-dense and dominated by white/grey box intergrades (*Eucalyptus albens – moluccana*) with occurrences of narrow-leaved ironbark (*Eucalyptus crebra*), 6 to 20 metres in height. Other canopy species such as grey box (*Eucalyptus moluccana*), yellow box (*Eucalyptus melliodora*) and Blakely's red gum (*Eucalyptus blakelyi*) can occur infrequently.	
Mid-storey Description	The mid-storey is sparse to mid-dense ranging from 1 to 8 metres. Common species include velvet mock olive (*Notelaea microcarpa* var. *microcarpa*), shiny-leaved canthium (*Psydrax odoratum*), cooba (*Acacia salicina*), green wattle (*Acacia deanei* subsp. *deanei*), *Choretrum* sp. A and regenerating eucalypts.	
Shrub Layer Description	The shrub layer is typically sparse, ranging from 0.5 to 1 metre, and comprises the above mentioned mid-storey species.	
Ground Cover Description	The ground cover is typically dense with a high diversity of native grasses and forbs. Commonly recorded species include Queensland bluegrass (*Dichanthium sericeum* subsp. *sericeum*), purple wiregrass (*Aristida ramosa*), wallaby grass (*Rytidosperma bipartitum*), red grass (*Bothriochloa decipiens*), snowgrass (*Poa sieberiana* var. *sieberiana*), speargrass (*Austrostipa scabra* subsp. *scabra*), tall chloris (*Chloris ventricosa*), amulla (*Eremophila debilis*), kidney weed (*Dichondra repens*), *Glycine tabacina*, native geranium (*Geranium solanderi*), *Vittadinia sulcata*, yellow burr-daisy (*Calotis lappulacea*) and tufted bluebell (*Wahlenbergia communis*).	
Introduced Species	Introduced species are common in this community due to the long history of stock grazing and fertility of the soil. Common species include saffron thistle (*Carthamus lanatus*), common prickly pear (*Opuntia stricta* var. *stricta*), Paddys lucerne (*Sida rhombifolia*), horehound (*Marrubium vulgare*) and slender celery (*Cyclospermum leptophyllum*).	

PCT Name	White Box x Grey Box - Red Gum - Rough-barked Apple grassy woodland on rich soils on hills in the upper Hunter Valley
Condition	Moderate to Good
TSC Act Status	This vegetation zone is consistent with the *White Box Yellow Box Blakely's Red Gum Woodland EEC* listed under the TSC Act.
EPBC Act Status	This vegetation zone is consistent with the *White Box Yellow Box Blakely's Red Gum Grassy Woodland and Derived Native Grassland CEEC* listed under the EPBC Act.

Zone 5 –HU730 - White Box x Grey Box - red gum - Rough-barked Apple grassy woodland on rich soils on hills in the upper Hunter Valley – Moderate to Good Condition – Shrubby Variant

PCT Name	**White Box x Grey Box - Red Gum - Rough-barked Apple Grassy Woodland on rich soils on hills in the upper Hunter Valley**
Condition	**Moderate to Good – Shrubby Variant**
PCT Number	HU730
Area (ha)	105.60
Survey Effort	6 biometric plots/transects
Formation	Grassy Woodlands
Class	Coastal Valley Grassy Woodland
HRVP Map Unit (Peake 2006)	MU11 – Upper Hunter White Box – Ironbark Grassy Woodland
General Description	This vegetation zone occurs on the fertile Tertiary basalt-derived soils on the upper slopes of the Highfields BioBank Site. It occurs on undulating to steep slopes and sheltered gullies.
Canopy Description	This community is characterised by a sparse canopy, 8 to 20 metres in height, dominated by white/grey box intergrades (*Eucalyptus albens – moluccana*), with occurrences of rough-barked apple (*Angophora floribunda*) and narrow-leaved ironbark (*Eucalyptus crebra*).
Mid-storey Description	A sparse to mid-dense mid-storey is present in this vegetation zone ranging from 1 to 6 metres. Common species included velvet mock olive (*Notelaea microcarpa* var. *microcarpa*), bulloak (*Allocasuarina luehmannii*), shiny-leaved canthium (*Psydrax odoratum*) and cooba (*Acacia salicina*).
Shrub Layer Description	The shrub layer is typically sparse, ranging from 0.5 to 1 metre, and comprises the above mentioned mid-storey species.
Ground Cover Description	The ground cover is typically sparse to mid-dense with commonly recorded species including hairy panic (*Panicum effusum*), snowgrass (*Poa sieberiana* var. *sieberiana*), purple wiregrass (*Aristida ramosa*), threeawn speargrass (*Aristida vagans*), *Glycine tabacina*, berry saltbush (*Einadia hastata*), kidney weed (*Dichondra repens*), slender bamboo grass (*Austrostipa verticillata*), weeping grass (*Microlaena stipoides* subsp. *stipoides*), blue trumpet (*Brunoniella australis*) and wallaby grass (*Rytidosperma fulvum*).
Introduced Species	Introduced species include African olive (*Olea europaea* subsp. *cuspidata*), cobblers pegs (*Bidens pilosa*), Patersons curse (*Echium plantagineum*), narrow-leaved cotton bush (*Gomphocarpus fruticosus*), vervain (*Salvia verbenaca*), spear thistle (*Cirsium vulgare*), Cape weed (*Arctotheca calendula*), and catsear (*Hypochaeris radicata*).
TSC Act Status	This vegetation zone is consistent with the *White Box Yellow Box Blakely's Red Gum Woodland EEC* listed under the TSC Act.
EPBC Act Status	This vegetation zone is consistent with the *White Box Yellow Box Blakely's Red Gum Grassy*

PCT Name	**White Box x Grey Box - Red Gum - Rough-barked Apple Grassy Woodland on rich soils on hills in the upper Hunter Valley**
Condition	**Moderate to Good – Shrubby Variant**
	Woodland and Derived Native Grassland CEEC listed under the EPBC Act.

Zone 6 –HU730 - White Box x Grey Box - red gum - Rough-barked Apple grassy woodland on rich soils on hills in the upper Hunter Valley – Moderate to Good Condition – Derived Native Grassland

PCT Name	**White Box x Grey Box - red gum - Rough-barked Apple grassy woodland on rich soils on hills in the upper Hunter Valley**	
Condition	**Moderate to Good – Derived Native Grassland**	
PCT Number	HU730	
Area (ha)	39.7	
Survey Effort	4 biometric plots/transects	
Formation	Grassy Woodlands	
Class	Coastal Valley Grassy Woodland	
HRVP Map Unit (Peake 2006)	MU11 – Upper Hunter White Box – Ironbark Grassy Woodland	
General Description	This vegetation zone occurs on relatively fertile Tertiary basalt-derived soils on the upper slopes of the Highfields offset area, in areas that are likely to have once been dominated by white box (*Eucalyptus albens*), white/grey box intergrades (*Eucalyptus albens – moluccana*), Blakely's red gum (*Eucalyptus blakelyi*), or a combination of these species, based on the current (post-disturbance) distribution of these species. A history of stock grazing throughout this vegetation zone has left it heavily degraded with introduced flora species common and occurring in high numbers.	
Canopy Description	Not present.	
Mid-storey Description	Not present.	
Shrub Layer Description	Not present.	
Ground Cover Description	The dense ground cover is composed of native and introduced grasses and forbs. Commonly recorded native species include Queensland bluegrass (*Dichanthium sericeum* subsp. *sericeum*), barbed wiregrass (*Cymbopogon refractus*), slender rats tail grass (*Sporobolus creber*), threeawn speargrass (*Aristida vagans*), purple wiregrass (*Aristida ramosa*), red grass (*Bothriochloa macra*), wallaby grass (*Rytidosperma bipartitum*), wallaby grass (*Rytidosperma fulvum*), tall chloris (*Chloris ventricosa*), plains grass (*Austrostipa aristiglumis*), native pennyroyal (*Mentha satureioides*), sheeps bur (*Acaena echinata*) and common woodruff (*Asperula conferta*).	
Introduced Species	Introduced flora species are common throughout this vegetation zone as it has been exposed to a long history of stock grazing. Dominant species recorded include spear thistle (*Cirsium vulgare*), narrow-leaved cotton bush (*Gomphocarpus fruticosus*), catsear (*Hypochaeris radicata*), fireweed (*Senecio madagascariensis*), saffron thistle (*Carthamus lanatus*), hop clover (*Trifolium campestre*), cobblers pegs (*Bidens pilosa*) and purpletop (*Verbena bonariensis*).	

PCT Name	**White Box x Grey Box - red gum - Rough-barked Apple grassy woodland on rich soils on hills in the upper Hunter Valley**
Condition	**Moderate to Good – Derived Native Grassland**
TSC Act Status	This vegetation zone is consistent with the *White Box Yellow Box Blakely's Red Gum Woodland EEC* listed under the TSC Act.
EPBC Act Status	This vegetation zone is consistent with the CEEC *White Box Yellow Box Blakely's Red Gum Grassy Woodland and Derived Native Grassland CEEC* listed under the EPBC Act.

Zone 7 –HU821 Blakely's Red Gum - Narrow-leaved Ironbark - Rough-barked Apple shrubby woodland of the upper Hunter – Moderate to Good Condition

PCT Name	Blakely's Red Gum - Narrow-leaved Ironbark - Rough-barked Apple Shrubby Woodland of the upper Hunter	
Condition	Moderate to Good	
PCT Number	HU821	
Area (ha)	24.90	
Survey Effort	5 biometric plots/transects	
Formation	Dry Sclerophyll Forests (Shrub/grass sub-formation)	
Class	North-west Slopes Dry Sclerophyll Woodlands	
HRVP Map Unit (Peake 2006)	MU29: Upper Hunter Hills Sheltered Moist Forest	
General Description	This vegetation zone is a dominant form of open forest in the Highfields BioBank Site, occurring on the central steep slopes.	
Canopy Description	This vegetation zone is characterised by a sparse canopy, dominated by grey gum (*Eucalyptus punctata*) and narrow-leaved ironbark (*Eucalyptus crebra*), with various associations with rough-barked apple (*Angophora floribunda*), narrow-leaved stringybark (*Eucalyptus sparsifolia*) and Blakelys red gum (*Eucalyptus blakelyi*). This community occurs to 17 to 23 metres in height in sheltered situations.	
Mid-storey Description	The mid-storey layer is very sparse to sparse and ranges from 6 to 10 metres in height. Commonly occurring species include forest oak (*Allocasuarina torulosa*), Port Jackson fig (*Ficus rubiginosa*), kurrajong (*Brachychiton populneus* subsp. *populneus*), black cypress pine (*Callitris endlicheri*), velvet mock olive (*Notelaea microcarpa* var. *microcarpa*) and red ash (*Alphitonia excelsa*).	
Shrub Layer Description	The shrub layer is typically sparse, ranging from 1 to 2.5 metres, and comprises narrow-leaved geebung (*Persoonia linearis*), prickly shaggy pea (*Podolobium ilicifolium*), blunt beard-heath (*Leucopogon muticus*), native blackthorn (*Bursaria spinosa* subsp. *spinosa*), coffee bush (*Breynia oblongifolia*), sweet pittosporum (*Pittosporum undulatum*), Australian indigo (*Indigofera australis*) and native cherry (*Exocarpos cupressiformis*)..	
Ground Cover Description	The groundcover is sparse to mid-dense with species including stinking pennywort (*Hydrocotyle laxiflora*), pomax (*Pomax umbellata*), berry saltbush (*Einadia hastata*), blue flax lily (*Dianella revoluta* var. *revoluta*), kidney weed (*Dichondra repens*), tufted bluebell (*Wahlenbergia communis*), hairy panic (*Panicum effusum*), weeping grass (*Microlaena stipoides* var. *stipoides*), threeawn speargrass (*Aristida vagans*), rough saw-sedge (*Gahnia aspera*), variable saw-sedge (*Lepidosperma laterale*) and poison rock fern (*Cheilanthes sieberi* subsp. *sieberi*).	
Introduced Species	Introduced species include wild aster (*Aster subulatus*), cobblers pegs (*Bidens pilosa*), African olive (*Olea europaea* subsp. *cuspidata*) and fireweed (*Senecio madagascariensis*).	
TSC Act Status	This vegetation community is not consistent with any listed TEC under the TSC Act.	

PCT Name	**Blakely's Red Gum - Narrow-leaved Ironbark - Rough-barked Apple Shrubby Woodland of the upper Hunter**
Condition	**Moderate to Good**
EPBC Act Status	This vegetation zone is not consistent with any TEC listed under the EPBC Act.

Zone 8 –HU868 Narrow-leaved Ironbark - Grey Gum shrubby open forest on sandstone ranges of the upper Hunter Valley – Moderate to Good Condition

PCT Name	Narrow-leaved Ironbark - Grey Gum Shrubby Open Forest on sandstone ranges of the upper Hunter Valley	
Condition	Moderate to Good	
PCT Number	HU868	
Area (ha)	90.10	
Survey Effort	6 biometric plots/transects	
Formation	Dry Sclerophyll Forests (Shrubby Sub-formation)	
Class	Western Slopes Dry Sclerophyll Forests	
HRVP Map Unit (Peake 2006)	MU8 – Western Hunter Narrabeen Footslopes Ironbark – Cypress Pine Woodland	
General Description	This vegetation zone occurs on Narrabeen sandstone and sandy soils on exposed ridges, primarily in the south of the offset area.	
Canopy Description	Typically the vegetation zone is a dry, very-sparse to sparse forest-woodland, with a canopy generally 8 to 20 metres tall. The dominant canopy species is narrow-leaved ironbark (*Eucalyptus crebra*), however black cypress pine (*Callitris endlicheri*) and bulloak (*Allocasuarina luehmannii*) also occur to a lesser extent throughout the community.	
Mid-storey Description	The mid-storey is sparse to mid-dense characterised by young narrow-leaved ironbark (*Eucalyptus crebra*) as well as narrow-leaved geebung (*Persoonia linearis*), bulloak (*Allocasuarina luehmannii*), currawang (*Acacia doratoxylon*), velvet mock olive (*Notelaea microcarpa* var. *microcarpa*), *Choretrum* sp. A, blunt beard-heath (*Leucopogon muticus*), blackthorn (*Bursaria spinosa* subsp. *spinosa*) and coffee bush (*Breynia oblongifolia*). The mid-storey is 1 to 8 metres in height.	
Shrub Layer Description	The shrub layer is typically sparse, ranging from 0.5 to 1 metre, and comprises the above mentioned mid-storey species as well as the low shrubs urn heath (*Melichrus urceolatus*) and native fuchsia (*Correa reflexa*).	
Ground Cover Description	The ground cover varies from sparse to mid-dense but is characteristically low, occurring less than 0.5 metres in height. It comprises a range of sub-shrubs, forbs and grasses including *Hibbertia acicularis*, hoary guinea flower (*Hibbertia obtusifolia*), kidney weed (*Dichondra repens*), yellow-burr daisy (*Calotis lappulacea*), poison rock fern (*Cheilanthes sieberi* subsp. *sieberi*), slender wire lily (*Laxmannia gracilis*), rough saw-sedge (*Gahnia aspera*), threeawn speargrass (*Aristida vagans*), speargrass (*Austrostipa scabra*), purple wiregrass (*Aristida ramosa*), weeping grass (*Microlaena stipoides* var. *stipoides*), variable sword-sedge (*Lepidosperma laterale*), wallaby grass (*Rytidosperma racemosum* var. *racemosum*) and barbed wire grass (*Cymbopogon refractus*).	
Introduced Species	Introduced flora species are uncommon in this vegetation zone, and those that did occur are in low abundance. Species include common prickly pear (*Opuntia stricta var. stricta*), fireweed (*Senecio madagascariensis*), smooth catsear (*Hypochaeris glabra*), Paddys lucerne	

PCT Name	Narrow-leaved Ironbark - Grey Gum Shrubby Open Forest on sandstone ranges of the upper Hunter Valley
Condition	Moderate to Good
	(*Sida rhombifolia*), wall fescue (*Vulpia muralis*), scarlet pimpernel (*Anagallis arvensis*) and *Petrorhagia dubia*.
TSC Act Status	This vegetation community is not consistent with any listed TEC under the TSC Act.
EPBC Act Status	This vegetation community is not consistent with any listed TEC under the EPBC Act.

Zone 9 –HU868 Narrow-leaved Ironbark - Grey Gum shrubby open forest on sandstone ranges of the upper Hunter Valley – Low Condition

PCT Name	**Narrow-leaved Ironbark - Grey Gum shrubby open forest on sandstone ranges of the upper Hunter Valley**	
Condition	**Low Condition – Derived Native Grassland**	
PCT Number	HU868	
Area (ha)	6.50	
Survey Effort	5 biometric plots/transects	
Formation	Dry Sclerophyll Forests (Shrubby Sub-formation)	
Class	Western Slopes Dry Sclerophyll Forests	
HRVP Map Unit (Peake 2006)	Derived form of MU8 – Western Hunter Narrabeen Footslopes Ironbark – Cypress Pine Woodland	
General Description	This vegetation zone is restricted to a single patch in the south of the offset area. It occurs on sandy clay soils, down slope of remnant open forests from which it is derived. Its location on the lower slopes of the open valley in the offset area has exposed this vegetation zone to a long history of stock grazing.	
Canopy Description	A canopy layer is absent from this vegetation zone, however narrow-leaved ironbark (*Eucalyptus crebra*) up to 30 metres occurs scattered throughout the community.	
Mid-storey Description	Not present.	
Shrub Layer Description	Not present.	
Ground Cover Description	This vegetation zone is characterised by a dense ground cover, less than a metre in height. The disturbed state of this vegetation zone has resulted in a high cover of introduced flora species. Native flora species are present but infrequent. Species include weeping grass (*Microlaena stipoides* var. *stipoides*), early spring grass (*Eriochloa pseudoacrotricha*), common fringe-sedge (*Fimbristylis dichotoma*), *Juncus usitatus*, speargrass (*Austrostipa scabra*), berry saltbush (*Einadia hastata*), native wandering Jew (*Commelina cyanea*), variable glycine (*Glycine tabacina*), purple wiregrass (*Aristida ramosa*) and slender rats tail grass (*Sporobolus creber*).	
Introduced Species	Introduced species dominate the ground cover of this vegetation zone. Dominant species include wall fescue (*Vulpia muralis*), *Petrorhagia dubia*, perennial ryegrass (*Lolium perenne*), soft brome (*Bromus hordeaceus*), shivery grass (*Briza minor*), saffron thistle (*Carthamus lanatus*) and Chilean whitlow wort (*Paronychia brasiliana*).	
TSC Act Status	This vegetation community is not consistent with any listed TEC under the TSC Act.	

PCT Name	Narrow-leaved Ironbark - Grey Gum shrubby open forest on sandstone ranges of the upper Hunter Valley
Condition	Low Condition – Derived Native Grassland
EPBC Act Status	This vegetation community is not consistent with any listed TEC under the EPBC Act.

Threatened Ecological Communities

Four of the vegetation zones described above and mapped within the Highfields BioBank Site conform to State and Commonwealth listed TECs, comprising:

- HU714 – Rough-Barked Apple - Red Gum - Yellow Box Woodland on alluvial clay to loam soils on valley flats in the northern NSW South Western Slopes Bioregion and Brigalow Belt South Bioregion – Moderate to Good Condition
    - *White Box Yellow Box Blakely's Red Gum Woodland* EEC (TSC Act).
    - *White Box Yellow Box Blakely's Red Gum Grassy Woodland and Derived Native Grassland* CEEC (EPBC Act).
- HU730 – White Box x Grey Box - Red Gum - Rough-barked Apple Grassy Woodland on rich soils on hills in the upper Hunter Valley – Moderate to Good Condition
    - *White Box Yellow Box Blakely's Red Gum Woodland* EEC (TSC Act).
    - *White Box Yellow Box Blakely's Red Gum Grassy Woodland and Derived Native Grassland* CEEC (EPBC Act).
- HU730 - White Box x Grey Box - Red Gum - Rough-barked Apple Grassy Woodland on rich soils on hills in the upper Hunter Valley – Moderate to Good Condition - Shrubby Variant
    - *White Box Yellow Box Blakely's Red Gum Woodland* EEC (TSC Act).
    - *White Box Yellow Box Blakely's Red Gum Grassy Woodland and Derived Native Grassland* CEEC (EPBC Act).
- HU730 – White Box x Grey Box - Red Gum - Rough-barked Apple Grassy Woodland on rich soils on hills in the upper Hunter Valley – Moderate to Good Condition –Derived Native Grassland
    - *White Box Yellow Box Blakely's Red Gum Woodland* EEC (TSC Act).
    - White Box Yellow Box Blakely's Red Gum Grassy Woodland and Derived Native Grassland CEEC (EPBC Act).

Analysis of consistency with the scientific determinations for each TEC was undertaken, with consideration of the advice provided by the NSW Scientific Committee and/or the Commonwealth Threatened Species Scientific Committee guidelines for interpreting listings for species, populations and ecological communities under the TSC Act and EPBC Act respectively.

Ecosystem-credit Species

The following ecosystem credit species are known to occur within the Highfields BioBank Site from surveys or records on the Atlas of NSW Wildlife (OEH 2017a):

- brown treecreeper (*Climacteris picumnus victoriae*)
- little lorikeet (*Glossopsitta pusilla*)
- scarlet robin (*Petroica boodang*)
- speckled warbler (*Chthonicola sagittata*)
- varied sittella (*Daphoenositta chrysoptera*)
- eastern bentwing bat (*Miniopterus schreibersii oceanensis*)
- eastern cave bat (*Vespadelus troughtoni*)
- large-eared pied bat (*Chalinolobus dwyeri*), and
- southern myotis (*Myotis macropus*).

Species-credit Species

No species-credit species were recorded during the extensive surveys undertaken for this assessment.

Table D10 below outlines the plot and transect data collected from surveys of the Highfields BioBank Site. It includes the ten site attributes that are recorded in each Biometric plot and transect as per Table 2 of the BBAM (OEH 2014c). This data is assessed against benchmark data for PCTs and then entered into the BioBanking Credit Calculator to assess the site value of each PCT at the Highfields BioBank Site.

A full Credit Calculator report is included in **Appendix E**.

Table D10 Plot and Transect Data for the Highfields BioBank Site

Plot Name	NPS	NOS	NMS	NGCG	NGCS	NGCO	EPC	NTH	OR	FL	Easting	Northing	Zone
Zone 3: HU714 - Rough-Barked Apple - red gum - Yellow Box woodland on alluvial clay to loam soils on valley flats in the northern NSW South Western Slopes Bioregion and Brigalow Belt South Bioregion - Moderate to Good Condition													
HQ12	25	19.5	0	80	0	34	22	0	1	8	273707	6440398	56
HP16	28	13.5	8	14	6	28	94	0	1	0	273752	3440337	56
Zone 4: HU730 - White Box x Grey Box - red gum - Rough-barked Apple grassy woodland on rich soils on hills in the upper Hunter Valley - Moderate to Good Condition													
HQ02	45	22	3.5	58	4	10	8	0	1	0	272958	6441513	56
HQ05	47	2.7	4.5	64	6	30	4	3	1	53	272763	6440329	56
HQ06	55	32	11	58	8	24	6	1	1	48	272794	6439869	56
HQ14	47	29	0.5	42	2	10	2	0	1	15	273285	6441206	56
HQ22	42	24.5	8.5	66	4	34	14	6	1	37	272718	6439967	56
HQ27	36	16	35	40	2	54	36	2	1	88	274205	6440899	56
HP06	18	15	0	46	8	24	24	1	1	20	274054	6440769	56
Zone 5: HU730 - White Box x Grey Box - red gum - Rough-barked Apple grassy woodland on rich soils on hills in the upper Hunter Valley - Moderate to Good Shrubby Variant													
HQ01	44	13	23.2	44	22	50	0	2	1	101	273045	6441672	56
HQ03	37	22.5	0	64	14	24	10	1	1	14.5	273994	6441429	56
HQ04	38	13	5	56	6	62	52	0	1	26	273825	6441724	56

HQ23	22	24.5	11	38	2	10	96	1	1	28	272339	6440666	56
HQ26	15	22	7	78	12	48	10	1	1	73	274386	6441095	56
HP20	41	14.5	19.5	78	6	46	24	0	1	10	273406	6441448	56
Zone 6: HU712 - HU730 - White Box x Grey Box - red gum - Rough-barked Apple grassy woodland on rich soils on hills in the upper Hunter Valley - Moderate to Good DNG Condition													
HQ07	24	0	0	70	0	38	44	0	1	8	272992	6439853	56
HQ24	21	0	0	74	0	10	52	0	1	0	272420	6440566	56
HQ28	20	0	0	96	0	26	20	0	1	0	274224	6441043	56
HP07	17	0	0	26	2	22	100	0	1	0	273063	6441728	56
Zone 7: HU821 – Blakely's Red Gum - Narrow-leaved Ironbark - Rough-barked Apple shrubby woodland of the upper Hunter - Moderate to Good Condition													
HQ25	38	23.5	22.5	88	20	46	28	1	0	74	273515	6441126	56
HQ29	40	23	0	70	20	22	2	1	0	106	273842	6440912	56
HP09	49	16	10.5	48	6	36	50	0	0	0	273453	6440974	56
HP08	44	19.5	12.5	44	6	66	64	0	0	0	273137	6441540	56
HP05	29	6.5	6	60	4	38	52	1	0	33	273504	6441350	56
Zone 8: HU868 – Narrow-leaved Ironbark - Grey Gum shrubby open forest on sandstone ranges of the upper Hunter Valley – Moderate to Good Condition													
HQ08	39	20	18.5	38	12	8	0	1	1	51	273206	6440231	56
HQ09	30	5.5	1.5	58	0	34	0	0	1	70	273345	6440441	56
HQ10	53	23	11	36	6	18	4	0	1	22	273843	6440433	56

HQ11	52	4.5	25	66	2	66	2	1	1	53.5	274047	6440460	56
HP19	46	10	6.5	56	14	34	38	2	1	15	273383	6440867	56
HP10	31	18	7	24	0	18	2	0	1	0	273591	6441088	56
Zone 9: HU868 – Narrow-leaved Ironbark - Grey Gum shrubby open forest on sandstone ranges of the upper Hunter Valley – Low Condition													
HQ13	18	0.25	0	0	0	12	92	0	1	24.5	273841	6440315	56
HQ15	24	0	0	2	0	6	82	0	1	17.5	273903	6440306	56
HP18	22	0	0	24	0	28	82	0	1	0	273431	6440800	56
HP17	12	0	0	52	0	6	94	0	1	0	273447	6440725	56
HP15	20	0	0	20	0	40	86	0	1	0	273855	6440318	56

Mangrove BioBank Site

Background

Mangrove BioBank Site is located approximately 41 km northwest of the Development Site and approximately 18 km south of the Highfields BioBank Site. It occurs on land owned by Glencore, located in the Manobalai area, approximately 30 kilometres northwest of Muswellbrook, NSW. Mangrove BioBank Site is located within the Sydney Basin IBRA bioregion and the Kerrabee IBRA subregion. The Mangrove BioBank Site covers approximately 259 hectares.

Survey Methodology

A total of 30 systematic plots/transect surveys were conducted across the Mangrove BioBank Site during the surveys undertaken for this assessment. Furthermore, rapid vegetation assessments were undertaken in each of these survey periods.

Reference was made to the VIS Classification Database to identify PCTs, as well as reviews of other regional and local vegetation mapping and reporting when designing the field survey. The Mangrove BioBank Site PCTs were further stratified into Vegetation Zones (condition states) following the initial field survey of the site to determine the appropriate number of transect/plots required in accordance with the BBAM (OEH 2014c) as outlined in **Table D11** and shown in **Figure D3**.

Table D11 Adequacy of Vegetation Survey in the Mangrove BioBank Site

Veg Zone	PCT ID (BVT IDs) and PCT Name *Condition Class*	Area in the Mangrove BioBank Site (ha)	Number of Biometric Plots/Transects	
			Required (BBAM 2014)	Undertaken During Survey
1	HU599 – River Red Gum / River Oak riparian woodland wetland in the Hunter Valley *Moderate to Good Condition*	1.80	1	2
2	HU599 – River Red Gum / River Oak riparian woodland wetland in the Hunter Valley *Moderate to Good Condition – Derived Native Grassland*	4.20	3	3
3	HU678 – Black Cypress Pine - ironbark +/- Narrow-leaved Wattle low open forest mainly on Narrabeen Sandstone in the Upper Hunter region of the Sydney Basin Bioregion *Moderate to Good Condition*	44.90	4	4
4	HU812 – Forest Red Gum grassy open forest on floodplains of the lower Hunter *Moderate to Good Condition*	15.20	3	3
5	HU812 – Forest Red Gum grassy open forest on floodplains of the lower Hunter *Low Condition*	73.80	3	5

Veg Zone	PCT ID (BVT IDs) and PCT Name *Condition Class*	Area in the Mangrove BioBank Site (ha)	Number of Biometric Plots/Transects	
			Required (BBAM 2014)	Undertaken During Survey
6	HU905 – Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter *Moderate to Good Condition*	20.00	3	5
7	HU905 – Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter *Moderate to Good Condition – Derived Native Grassland*	86.70	5	5
8	HU812 – Forest Red Gum grassy open forest on floodplains of the lower Hunter *Moderate to Good Condition - Poor*	11.90	3	3
	Total	**258 (258.5)**	**25**	**30**

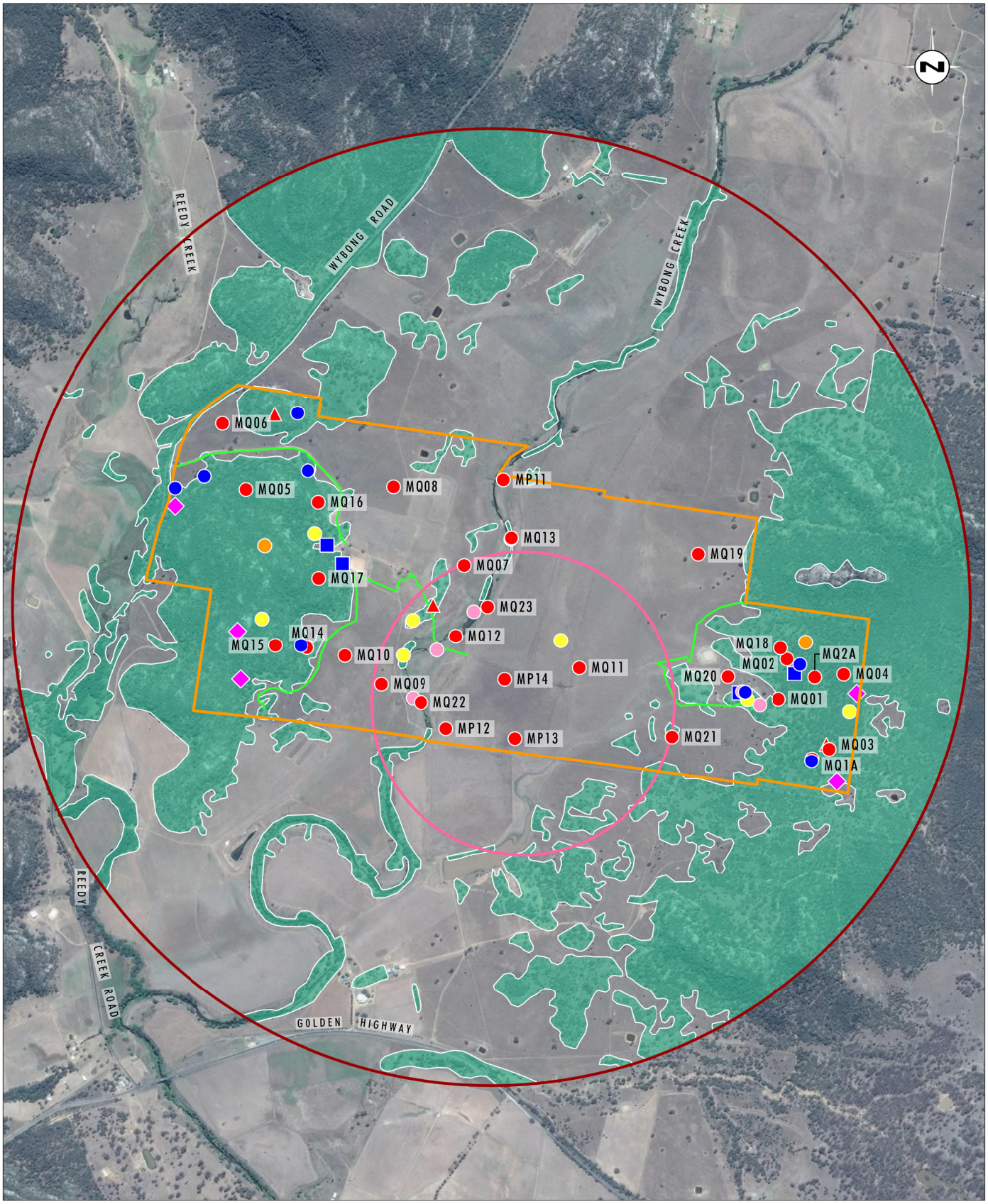


Image Source: Google Earth (Jan 2014)
Data Source: LPI NSW (2009)

0 0.25 0.5 1.0km
1:20 000

Legend

- Mangrove BioBank Site
- 200ha Assessment Circle
- 2000ha Assessment Circle
- Native Vegetation
- Plot Locations
- Winter Birds 2012
- Winter Birds 2016
- Anabat Locations Nov 2015
- Anabat Locations Nov 2015
- Habitat Assessment
- Full Fauna Site (Habitat Assessment, Diurnal Bird Survey, Diurnal Reptile and Amphibian Survey, Spotlight Survey, Hair Funnels and Call Playback)
- Partial Fauna Site (Habitat Assessment, Diurnal Bird Survey and Diurnal Reptile and Amphibian Survey)
- Driving Spotlight Survey

FIGURE D3

Mangrove BioBank Site Survey Methods

File Name (A4): R01/3890_028.dgn
20170322 16.49

Plot/Transect Data Collected

At each plot/transect data was recorded according to Section 5 of the BBAM (OEH 2014c). This involved setting out 20 x 50 metre and 20 x 20 metre plots and a 50 metre transect. The location of each quadrat was recorded using a hand-held GPS with accuracy of ± 5 metres. The Map Grid of Australia (MGA) coordinate system was used. At each plot/transect, roughly 45 to 60 minutes was spent searching for all vascular flora species present within the 20 x 20 metre plot. Searches of each 20 x 20 metre plot were generally undertaken through parallel transects from one side of the plot to another. Most effort was spent on examining the groundcover, which usually supported well over half of the species present, however the composition of the shrub, mid-storey, canopy and emergent layers were also thoroughly examined. Effort was made to search the tree canopy and tree trunks for mistletoes, vines and epiphytes.

For each flora species recorded in the plot, the following data was collected in accordance with Table 1 of the BBAM (OEH 2014c):

- stratum/layer in which the species occurs
- growth form
- scientific name and common name
- cover
- abundance.

At each standard flora plot, 10 points along a 50 metre transect were assessed for:

- percentage native overstorey cover
- percentage native mid-storey cover.

In addition, 50 points along a 50 metre transect were assessed for:

- percentage native groundcover (grass)
- percentage native groundcover (shrubs)
- percentage native ground cover (other)
- percentage exotic plant cover.

Additional details were also recorded in each quadrat, including soil texture, drainage and depth; site disturbances; physiography (position in the landscape); and vegetation structure (strata percentage covers, heights and dominant species). Photographic records were also taken at each site.

A preliminary list of species-credit flora species with potential to occur in the Mangrove BioBank Site was generated during the literature review, completion of database searches and the TSPD. Searches of the TSPD were undertaken by the Kerrabee IBRA subregion and Hunter/Central Rivers CMA region.

Targeted surveys were undertaken for the species listed in **Table D12** and included targeted on-ground searches in suitable habitat throughout the Mangrove BioBank Site. Searches for these species were undertaken in suitable habitat along numerous walking meandering transects and within the plot/transect surveys. These generally involved walking suitable habitat areas and searching for the targeted species within the Mangrove BioBank Site.

Table D12 Species-credit Flora Species Targeted During Survey

Common Name *Scientific Name*	TSC Status	EPBC Status	Required Survey Period^	Survey Technique, Timing and Location
pine donkey orchid *Diuris tricolor*	V	-	September to October	Detailed targeted surveys for this species were undertaken throughout suitable habitat within the site during the September and October 2015 surveys.
Prasophyllum sp. Wybong (aka *Prasophyllum petilum*)	E	E	October	Detailed targeted surveys for this species were undertaken throughout suitable habitat within the site during the September and October 2015 surveys.
small snake orchid *Diuris pedunculata*	E	E	September to November	Detailed targeted surveys for this species were undertaken throughout suitable habitat within the site during the September and October 2015 surveys.

^ Months that surveys are required according to the Threatened Species Profile Database for the Hunter/Central Rivers CMA.

A preliminary list of species-credit fauna species with potential to occur in the Mangrove BioBank Site was generated during the literature review, completion of database searches and review of the TSPD. Searches of the TSPD were undertaken by the Liverpool Range IBRA subregion and Hunter/Central Rivers CMA region.

Targeted surveys were undertaken for the species listed in **Table D3** and included a range of survey techniques including targeted searches, Anabat recorders, call playback and spotlighting. The seasonal survey requirements for all species-credit fauna species with the potential to occur within the Mangrove BioBank Site were met during the survey periods.

Table D13 Species-credit Fauna Species Targeted During Survey

Common Name *Scientific Name*	TSC Status	EPBC Status	Required Survey Period^	Survey Technique, Timing and Location
eastern pygmy-possum *Cercartetus nanus*	V	-	None provided	Spotlighting surveys were undertaken throughout the site in the 2012 surveys.

Common Name *Scientific Name*	TSC Status	EPBC Status	Required Survey Period^	Survey Technique, Timing and Location
koala *Phascolarctos cinereus*	V	V	All year	Targeted SEPP 44 surveys were undertaken throughout the site as well as spotlighting and call playback surveys.
regent honeyeater *Anthochaera phrygia*	CE	CE	All year	Winter bird surveys targeting this species were undertaken by two ecologists in 2012 and 2016, and comprised a total of 13 person hours of survey.

^ Months that surveys are required according to the Threatened Species Profile Database for the Hunter/Central Rivers CMA.

Targeted Winter Bird Surveys

Targeted winter bird surveys were undertaken across the Disturbance Site during 2012 and 2015. Winter bird surveys targeting the regent honeyeater (*Anthochaera phrygia*) and swift parrot (*Lathamus discolor*) were undertaken by two ecologists during June, July or August each year, and comprised a total of 13 person hours of survey (refer to **Table D14**). Surveys comprised a combination of predetermined sites and sites positioned during the surveys in areas of eucalypt flowering. Surveys included both visual searches (using binoculars) and call play back surveys (using a loud hailer).

Table D14 Targeted Winter Bird Survey Effort

Year	Number of Sites	Approximate Time at each Site	Total Person Hours
2012	5	1	5
2016	7	1	7
Total Person Hours			**13**

Anabat Echolocation Recording

Threatened micro-bat surveys were undertaken at three locations across the Mangrove BioBank Site. Calls were recorded using an Anabat. At each site, the Anabat was positioned at an approximate 30 degree angle and 1 metre above the ground in a waterproof housing. Each detector was positioned towards potential micro-bat flight paths or over water-bodies to increase the likelihood of detecting micro-bat species. The Anabat detector was programmed to start recording from one hour before sunset to one hour after sunrise.

Recordings of bat calls were analysed by Glenn Hoye of Fly By Night Bat Surveys Pty Ltd (a recognised expert in the identification of micro-bat calls). The echolocation calls of species were identified to one of three confidence levels:

- confident
- probable, and
- possible.

All three levels of identification confidence were treated as positive identifications.

State Environmental planning Policy 44 – Koala Habitat Assessment

A State Environmental Planning Policy No. 44 – Koala (SEPP 44) habitat assessment was undertaken to determine the potential value of the offset site as habitat for the koala (*Phascolarctos cinereus*). This is determined by assessing whether the eucalypt species present in Schedule 2 of the policy constitute 15 per cent or more of the total number of trees in the upper or lower strata of the tree component. Eucalypt species listed in Schedule 2 of the policy are provided in **Table D15**.

Table D15 Species of Eucalypt listed in Schedule 2 of SEPP 44

Scientific Name	Common Name
Eucalyptus tereticornis	forest red gum
Eucalyptus microcorys	tallowwood
Eucalyptus punctata	grey gum
Eucalyptus viminalis	ribbon or manna gum
Eucalyptus camaldulensis	river red gum
Eucalyptus haemastoma	broad-leaved scribbly gum
Eucalyptus signata	scribbly gum
Eucalyptus albens	white box
Eucalyptus populnea	bimble box or poplar box
Eucalyptus robusta	swamp mahogany
Eucalyptus microcorys	tallowwood

Within each of the habitat assessment sites sampled an assessment of the presence of koala feed tree species (as per **Table D15**) was made. Where koala feed species were present, an assessment of the proportion of feed species (compared to non-feed species) within the canopy was made.

A total of 11 sites were assessed for the presence and percentage composition of SEPP 44 Schedule 2 tree species.

Spotlighting Surveys

Spotlighting searches were undertaken both on foot and from a moving vehicle. Walking spotlighting searches were undertaken by two observers for a period of at least 30 minutes (total of one person hour) on each occasion. Vehicle spotlighting searches were undertaken by the passenger(s) from a slowly moving (first gear, low range) four wheel drive vehicle for a minimum of 1 kilometre. Opportunistic vehicle spotlighting was undertaken whenever driving through the Study Area at night. Walking and vehicle spotlighting searches were undertaken using 30 watt handheld spotlights and head torch.

Spotlight searches specifically targeted: arboreal mammals such as possums and gliders; terrestrial mammals such as kangaroos, wallabies, wombats, quolls, foxes and cats; nocturnal birds such as owls and nightjars; and nocturnal herpetofauna (amphibian and reptile species). Spotlighting also included opportunistic searches for nocturnal reptiles, amphibians and micro-bats.

A total of two hours of walking spotlighting surveys and three kilometres of opportunistic driving spotlighting surveys were undertaken across the Mangrove BioBank Site.

Survey Results

Biometric Vegetation Types and Vegetation Zones

Surveys of the Mangrove BioBank Site identified four PCTs across eight condition classes being:

- HU599 River Red Gum / River Oak riparian woodland wetland in the Hunter Valley
    - *Moderate to Good Condition*
    - *Moderate to Good Condition – Derived Native Grassland*
- HU678 Black Cypress Pine - ironbark +/- Narrow-leaved Wattle low open forest mainly on Narrabeen Sandstone in the Upper Hunter region of the Sydney Basin Bioregion
    - *Moderate to Good Condition*
- HU812 Forest Red Gum grassy open forest on floodplains of the lower Hunter
    - *Moderate to Good Condition*
    - *Moderate to Good Consition – Poor – Exotic Grasslands*
    - *Low Condition*
- HU905 Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter
    - Moderate to Good Condition
    - *Moderate to Good Condition – Derived Native Grassland*

These PCTs were aligned with types described as part of the VIS Classification Database (OEH 2017c). The PCTs were then categorised into eight vegetation zones. The composition of these vegetation zones is outlined below and shown on **Figure 7.7** of the main report.

Zone 1 - HU599 River Red Gum / River Oak riparian woodland wetland in the Hunter Valley - Moderate to Good Condition

PCT Name	River Red Gum / River Oak riparian Woodland Wetland in the Hunter Valley	
Condition	**Moderate to Good**	
PCT Number	HU599	
Area (ha)	1.8	
Survey Effort	2 biometric plots/transects	
Formation	Forested Wetlands	
Class	Eastern Riverine Forests	
HRVP Map Unit (Peake 2006)	MU13 – Hunter Floodplain Red Gum Woodland Complex	
General Description	This vegetation zone occurs as isolated pockets of remnant woodland along Wybong Creek, with five distinct patches mapped. It is characterised by a very sparse woodland canopy above a dense ground layer.	
Canopy Description	The very sparse canopy comprises river oak (*Casuarina cunninghamiana* subsp. *cunninghamiana*) ranging from 6 to 10 metres in height.	
Mid-storey Description	Not present.	
Shrub Layer Description	Not present.	
Ground Cover Description	This vegetation zone has a dense ground layer less than 1 metre in height. Native grasses are common throughout and are dominated by slender bamboo grass (*Austrostipa verticillata*), purple wiregrass (*Aristida ramosa*), common couch (*Cynodon dactylon*), Queensland bluegrass (*Dichanthium sericeum* subsp. *sericeum*) and plains grass (*Austrostipa aristiglumis*). Native forbs are uncommon, including berry saltbush (*Einadia hastata*), swamp dock (*Rumex brownii*) and common everlasting (*Chrysocephalum apiculatum*).	
Introduced Species	The history of grazing pressure in this vegetation zone has resulted in a high number of introduced species. Dominant species include kikuyu grass (*Pennisetum clandestinum*), weeping willow (*Salix babylonica*), prairie grass (*Bromus catharticus*), galenia (*Galenia pubescens*), panic veldtgrass (*Ehrharta erecta*), paspalum (*Paspalum dilatatum*), turnip weed (*Rapistrum rugosum*), saffron thistle (*Carthamus lanatus*), variegated thistle (*Silybum marianum*), great brome (*Bromus diandrus*) and soft brome (*Bromus hordeaceus*).	
TSC Act Status	This vegetation zone is not consistent with any TEC listed under the TSC Act.	
EPBC Act Status	This vegetation is not consistent with any TEC listed under the EPBC Act.	

Zone 2 - HU599 River Red Gum / River Oak riparian woodland wetland in the Hunter Valley - Moderate to Good Condition – Derived Native Grassland

PCT Name	River Red Gum / River Oak riparian woodland wetland in the Hunter Valley	
Condition	Moderate to Good – Derived Native Grassland	
PCT Number	HU599	
Area (ha)	4.2	
Survey Effort	3 biometric plots/transects	
Formation	Forested Wetlands	
Class	Eastern Riverine Forests	
HRVP Map Unit (Peake 2006)	Derived form of MU13 – Hunter Floodplain Red Gum Woodland Complex	
General Description	This vegetation zone occurs along the banks of Wybong Creek up to approximately 50 metres of the banks Introduced flora species are common in the vegetation zone.	
Canopy Description	Not present.	
Mid-storey Description	Recruiting river oak (*Casuarina cunninghamiana* subsp. *cunninghamiana*) was recorded as the sole native species in the mid-storey, ranging in height from 1 to 4 metres.	
Shrub Layer Description	Not present.	
Ground Cover Description	This vegetation zone is characterised by a mid-dense to dense ground layer with a low native species richness. The native grass common couch (*Cynodon dactylon*) was the dominant species in the ground layer and sole native grass species recorded. Native forbs were uncommon, including pale knotweed (*Persicaria lapathifolia*), *Chamaesyce dallachyana*, tufted bluebell (*Wahlenbergia communis*) and swamp dock (*Rumex brownii*). The ground layer was less than 1 metre in height.	
Introduced Species	There has been a history of grazing pressure in this vegetation zone which has resulted in a high number of introduced species. Common species include tall fleabane (*Conyza sumatrensis*), turnip weed (*Rapistrum rugosum*), Noogoora burr (*Xanthium occidentale*), willow-leaved lettuce (*Lactuca saligna*), spiny rush (*Juncus acutus* subsp. *acutus*), weeping willow (*Salix babylonica*), catsear (*Hypochaeris radicata*) and kikuyu grass (*Pennisetum clandestinum*).	
TSC Act Status	This vegetation is not consistent with any TEC listed under the TSC Act.	
EPBC Act Status	This vegetation is not consistent with any TEC listed under the EPBC Act.	

Zone 3 –HU678 - Black Cypress Pine - Ironbark+/-Narrow-leaved Wattle Low Open Forest Mainly on Narrabeen Sandstone in the Upper Hunter Region of the Sydney Basin Bioregion – Moderate to Good Condition

PCT Name	Black Cypress Pine - Ironbark+/-Narrow-leaved Wattle Low Open Forest Mainly on Narrabeen Sandstone in the Upper Hunter Region of the Sydney Basin Bioregion	
Condition	Moderate to Good	
PCT Number	HU678	
Area (ha)	44.9	
Surveys Effort	4 biometric plots/transects	
Formation	Dry Sclerophyll Forests (Shrubby Sub-formation)	
Class	Western Slopes Dry Sclerophyll Forests	
HRVP Map Unit (Peake 2006)	MU 8 – Western Hunter Narrabeen Footslopes Ironbark – Cypress Pine Woodland	
General Description	This vegetation zone is the dominant remnant forest community west of Wybong Creek within the Mangrove BioBank Site. It is restricted to the small hills and a small area of the surrounding flats. It is characterised by an intact multi-species canopy, mid-storey and ground layer.	
Canopy Description	This community supports a very sparse to sparse canopy dominated by red ironbark (*Eucalyptus fibrosa*), currawang (*Acacia doratoxylon*), grey gum (*Eucalyptus punctata*) and black cypress pine (*Callitris endlicheri*). Height of the canopy ranges from 15 to 20 metres. This vegetation zone also comprises very sparse emergent narrow-leaved ironbark (*Eucalyptus crebra*) trees to a height of 25 metres.	
Mid-storey Description	A very sparse to sparse mid-storey is present with dominant species including velvet mock olive (*Notelaea microcarpa*), narrow-leaved geebung (*Persoonia linearis*), *Kunzea* sp. 'Mt Kaputar', blunt beard-heath (*Leucopogon muticus*) and *Prostanthera prunelloides*. The mid-storey varies from 1.5 – 6 metres in height.	
Shrub Layer Description	This vegetation zone lacks a distinct shrub layer, however the abovementioned mid-storey species were also recorded as occurring less than 1 metre in height.	
Ground Cover Description	This vegetation zone is characterised by a sparse to mid-dense ground layer less than 1 metre in height. Common herbs and sub-shrubs included berry saltbush (*Einadia hastata*), rock fern (*Cheilanthes sieberi* subsp. *sieberi*), *Oxalis perennans*, hoary guinea flower (*Hibbertia obtusifolia*), native wandering Jew (*Commelina cyanea*), yellow burr-daisy (*Calotis lappulacea*) and shiny-leaved canthium (*Psydrax odorata*). Native grasses include *Cleistochloa rigida*, purple wiregrass (*Aristida ramosa*), threeawn speargrass (*Aristida vagans*), speargrass (*Austrostipa scabra*), barbed wire grass (*Cymbopogon refractus*), weeping grass (*Microlaena stipoides* var. *stipoides*), slender panic (*Paspalidium gracile*) and long-leaved wallaby grass (*Notodanthonia longifolia*).	

PCT Name	Black Cypress Pine - Ironbark+/-Narrow-leaved Wattle Low Open Forest Mainly on Narrabeen Sandstone in the Upper Hunter Region of the Sydney Basin Bioregion
Condition	Moderate to Good
Introduced Species	Introduced species are uncommon in this vegetation zone and include common prickly pear (*Opuntia stricta* var. *stricta*), *Gomphocarpus* sp., tiger pear (*Opuntia aurantiaca*) and cobblers pegs (*Bidens pilosa*).
TSC Act Status	This vegetation zone is not consistent with any TEC listed under the TSC Act.
EPBC Act Status	This vegetation zone is not consistent with any TEC listed under the EPBC Act.

Zone 4 ‑HU812 – Forest Red Gum Grassy Open Forest on Floodplains of the Lower Hunter – Moderate to Good Condition

PCT Name	Forest Red Gum Grassy Open Forest on Floodplains of the Lower Hunter	
Condition	**Moderate to Good**	
PCT Number	HU812	
Area (ha)	15.2	
Survey Effort	3 biometric plots/transects	
Formation	Forested Wetlands	
Class	Coastal Floodplain Wetlands	
HRVP Map Unit (Peake 2006)	MU13 – Hunter Floodplain Red Gum Woodland Complex	
General Description	This vegetation zone is considered likely to have occurred throughout the lower slopes of the Mangrove BioBank Site, including the now derived native grasslands surrounding Wybong Creek. The remnant woodland form is now restricted to the south-west corner of the site, along a small ephemeral drainage line.	
Canopy Description	The very sparse to sparse canopy is between 13 and 18 metres in height, and dominated by forest red gum (*Eucalyptus tereticornis*), forest/Blakelys red gum hybrids (*Eucalyptus tereticornis* x *blakelyi*), grey box (*Eucalyptus moluccana*) and narrow-leaved ironbark (*Eucalyptus crebra*).	
Mid-storey Description	The vegetation zone occasionally supported a sparse mid-storey to 9 metres in height, comprising younger forest red gum (*Eucalyptus tereticornis*), grey box (*Eucalyptus moluccana*), bulloak (*Allocasuarina luehmannii*), black she-oak (*Allocasuarina littoralis*) and *Melaleuca decora*.	
Shrub Layer Description	A very sparse shrub layer to 1 metre in height, of velvet mock olive (*Notelaea microcarpa* var. *microcarpa*) and bead bush (*Spartothamnella juncea*) is also present within this vegetation zone.	
Ground Cover Description	This vegetation zone is characterised by a diverse, sparse to mid-dense ground layer less than 1 metre in height. Common herbs include kidney weed (*Dichondra repens*), yellow burr-daisy (*Calotis lappulacea*), berry saltbush (*Einadia hastata*), dwarf skullcap (*Scutellaria humilis*), slender tick-trefoil (*Desmodium varians*), native wandering Jew (*Commelina cyanea*) and *Sida hackettiana*. Native grasses include barbed wire grass (*Cymbopogon refractus*), threeawn speargrass (*Aristida vagans*), purple wiregrass (*Aristida ramosa*), Browns lovegrass (*Eragrostis brownii*), hairy panic (*Panicum effusum*), slender rats tail grass (*Sporobolus creber*), open summer-grass (*Digitaria diffusa*) and weeping grass (*Microlaena stipoides* var. *stipoides*). Several species of native sedge are also common within the vegetation zone, namely knob sedge (*Carex inversa*), slender flat-sedge (*Cyperus gracilis*) and tall sedge (*Carex appressa*).	

PCT Name	Forest Red Gum Grassy Open Forest on Floodplains of the Lower Hunter
Condition	Moderate to Good
Introduced Species	Perennial ryegrass (*Lolium perenne*), onion weed (*Asphodelus fistulosus*), common prickly pear (*Opuntia stricta* var. *stricta*), greater beggars ticks (*Bidens subalternans*), flaxleaf fleabane (*Conyza bonariensis*), fireweed (*Senecio madagascariensis*), vervain (*Salvia verbenaca*), common sowthistle (*Sonchus oleraceus*), gomphrena weed (*Gomphrena celosioides*), galenia (*Galenia pubescens*), narrow-leaved cotton bush (*Gomphocarpus fruticosus*) and tiger pear (*Opuntia aurantiaca*) are commonly recorded in this vegetation zone.
TSC Act Status	This vegetation zone is consistent with the *Hunter Floodplain Red Gum Woodland in the NSW North Coast and Sydney Basin Bioregions EEC* listed under the TSC Act.
EPBC Act Status	This vegetation zone is likely to be consistent with the *White Box Yellow Box Blakely's Red Gum Grassy Woodland and Derived Native Grassland CEEC* listed under the EPBC Act.

Zone 5 ‑HU812 – Forest Red Gum Grassy Open Forest on Floodplains of the Lower Hunter – Low Condition – Derived Native Grassland

PCT Name	Forest Red Gum Grassy Open Forest on Floodplains of the Lower Hunter	
Condition	Moderate to Good – Derived Native Grassland	
PCT Number	HU812	
Area (ha)	73.8	
Survey Effort	5 biometric plots/transects	
Formation	Forested Wetlands	
Class	Coastal Floodplain Wetlands	
HRVP Map Unit (Peake 2006)	Derived form of MU24 – Hunter Lowlands Red Gum Forest	
General Description	This vegetation zone is one of the two dominant grassland communities mapped within the Mangrove BioBank Site. It predominantly occurs east of Wybong Creek There are very few scattered trees within the community. The history of stock grazing on the site has resulted in introduced flora species being common in this grassland community.	
Canopy Description	No canopy is present within this community, but there are a small number of scattered yellow box (*Eucalyptus melliodora*) and forest/Blakelys red gum hybrids (*Eucalyptus blakelyi* × *tereticornis*) recorded throughout this vegetation zone.	
Mid-storey Description	Not present.	
Shrub Layer Description	Not present.	
Ground Cover Description	This vegetation zone is characterised by a diverse, mid-dense to dense ground layer less than 1 metre in height. Common herbs include poison pratia (*Pratia concolor*), common everlasting (*Chrysocephalum apiculatum*), rock fern (*Cheilanthes sieberi* subsp. *sieberi*), galvanised burr (*Sclerolaena birchii*) and *Sida hackettiana*. Native grasses include plains grass (*Austrostipa aristiglumis*), common couch (*Cynodon dactylon*), windmill grass (*Chloris truncata*), purple speargrass (*Aristida ramosa*), silky browntop (*Eulalia aurea*), wallaby grass (*Austrodanthonia bipartita*), shorthair plumegrass (*Dichelachne micrantha*) and *Rytidosperma racemosum* var. *racemosum*. Several species of native sedge are also common within the vegetation zone, including common fringe-sedge (*Fimbristylis dichotoma*) and knob sedge (*Carex inversa*).	
Introduced Species	The following introduced flora species are commonly recorded throughout this vegetation zone, including perennial ryegrass (*Lolium perenne*), goose grass (*Eleusine tristachya*), lambs tounges (*Plantago lanceolata*), spear thistle (*Cirsium vulgare*), catsear (*Hypochaeris radicata*), common couch (*Cynodon dactylon*), saffron thistle (*Carthamus lanatus*), *Hypochaeris microcephala* var. *albiflora*, haresfoot clover (*Trifolium arvense*), paspalum (*Paspalum dilatatum*), fireweed (*Senecio madagascariensis*), slender celery (*Cyclospermum*	

PCT Name	Forest Red Gum Grassy Open Forest on Floodplains of the Lower Hunter
Condition	**Moderate to Good – Derived Native Grassland**
	leptophyllum) and *Plantago myosuros* subsp. *myosuros*.
TSC Act Status	The derived native grassland form of this PCT is not consistent with the EEC *Hunter Floodplain Red Gum Woodland in the NSW North Coast and Sydney Basin Bioregions* under the TSC Act.
EPBC Act Status	This vegetation zone is not consistent with any TEC listed under the EPBC Act. The dominance of exotic species in the ground layer excludes this vegetation zone from meeting the condition thresholds of the *White Box Yellow Box Blakely's Red Gum Grassy Woodland and Derived Native Grassland CEEC* listed under the EPBC Act.

Zone 6 ⁻HU905 – Narrow-leaved Ironbark - Grey Box Grassy Woodland of the Central and Upper Hunter – Moderate to Good Condition

PCT Name	Narrow-leaved Ironbark - Grey Box Grassy Woodland of the Central and Upper Hunter	
Condition	**Moderate to Good**	
PCT Number	HU905	
Area (ha)	20.0	
Survey Effort	5 biometric plots/transects	
Formation	Grassy Woodlands	
Class	Coastal Valley Grassy Woodlands	
HRVP Map Unit (Peake 2006)	MU10 – Central Hunter Box – Ironbark Woodland.	
General Description	This vegetation zone is confined to several moderately sized patches on low rises with shallow soils. These patches occur predominantly in the north east corner of the Mangrove BioBank Site, but a number of isolated patches occur in the west.	
Canopy Description	This vegetation zone supports a very sparse to sparse canopy between 10 to 20 metres in height. The dominant canopy species was narrow-leaved ironbark (*Eucalyptus crebra*), with grey gum (*Eucalyptus punctata*) and black cypress pine (*Callitris endlicheri*) occurring less commonly.	
Mid-storey Description	The mid-storey is very sparse and dominated by regenerating narrow-leaved ironbark (*Eucalyptus crebra*), as well as black she-oak (*Allocasuarina littoralis*), velvet mock olive (*Notelaea microcarpa* var. *microcarpa*), blunt beard-heath (*Leucopogon muticus*) and bead bush (*Spartothamnella juncea*). The mid-storey layer ranges from 2 to 10 metres in height.	
Shrub Layer Description	This vegetation zone lacks a distinct shrub layer, however the abovementioned mid-storey species were also recorded as occurring between 1 and 2 metres in height.	
Ground Cover Description	This community is characterised by a sparse to mid-dense ground layer dominated by a diverse number of native flora species less than 1 metre in height. Common herbs and sub-shrubs include sticky everlasting (*Xerochrysum viscosum*), sprawling bluebell (*Wahlenbergia gracilis*), slender wire lily (*Laxmannia gracilis*), rock fern (*Cheilanthes sieberi* subsp. *sieberi*) and common everlasting (*Chrysocephalum apiculatum*). Native grasses include wallaby grass (*Rytidosperma racemosum* var. *racemosum*), shorthair plumegrass (*Dichelachne micrantha*), barbed wire grass (*Cymbopogon refractus*), weeping grass (*Microlaena stipoides* var. *stipoides*), purple wiregrass (*Aristida ramosa*), mountain wallaby grass (*Rytidosperma monticola*), speargrass (*Austrostipa scabra*) and threeawn speargrass (*Aristida vagans*).	
Introduced Species	The introduced species creeping pear (*Opuntia humifusa*), common prickly pear (*Opuntia stricta* var. *stricta*), common sowthistle (*Sonchus oleraceus*), perennial ryegrass (*Lolium perenne*), tiger pear (*Opuntia aurantiaca*), Argentine peppercress (*Lepidium bonariense*), fireweed (*Senecio madagascariensis*), smooth catsear (*Hypochaeris glabra*) and scarlet pimpernel (*Anagallis arvensis*) occur in low abundance in this vegetation zone.	

PCT Name	Narrow-leaved Ironbark - Grey Box Grassy Woodland of the Central and Upper Hunter
Condition	Moderate to Good
TSC Act Status	This vegetation zone is consistent with the *Central Hunter Grey Box – Ironbark Woodland in the NSW North Coast and Sydney Basin Bioregions EEC* listed under the TSC Act.
EPBC Act Status	This vegetation community is not consistent with any listed TEC under the EPBC Act. This vegetation community is excluded from the *Central Hunter Valley Eucalypt Forest and Woodland CEEC* listed under the EPBC Act as the Mangrove Offset does not occur on Permian aged sediments.

Zone 7 ⁻HU905 – Narrow-leaved Ironbark - Grey Box Grassy Woodland of the Central and Upper Hunter – Moderate to Good – Derived Native Grassland

PCT Name	Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter	
Condition	**Moderate to Good – Derived Native Grassland**	
PCT Number	HU905	
Area (ha)	86.7	
Survey Effort	5 biometric plots/transects	
Formation	Grassy Woodlands	
Class	Coastal Valley Grassy Woodlands	
HRVP Map Unit (Peake 2006)	Derived form of MU10 – Central Hunter Box – Ironbark Woodland.	
General Description	This vegetation zone is the dominant derived native grassland community of the low foothills within the Mangrove BioBank Site. It occurs on the western and eastern sides of Wybong Creek.	
Canopy Description	Not present.	
Mid-storey Description	Not present.	
Shrub Layer Description	Not present.	
Ground Cover Description	This community is characterised by a diverse, dense ground layer between 0.5 to 1 metre in height. Common herbs and sub-shrubs include common everlasting (*Chrysocephalum apiculatum*), *Oxalis radicosa*, rock fern (*Cheilanthes sieberi* subsp. *sieberi*), common fringe-sedge (*Fimbristylis dichotoma*), slender wire lily (*Laxmannia gracilis*) and swamp dock (*Rumex brownii*). Native grasses include slender rats tail grass (*Sporobolus creber*), umbrella grass (*Digitaria divaricatissima*), weeping grass (*Microlaena stipoides* var. *stipoides*), hairy panic (*Panicum effusum*), purple wiregrass (*Aristida ramosa*), shorthair plumegrass (*Dichelachne micrantha*), speargrass (*Austrostipa scabra*), silky browntop (*Eulalia aurea*), barbed wire grass (*Cymbopogon refractus*) and common couch (*Cynodon dactylon*).	
Introduced Species	The introduced species *Oenothera mollissima*, catsear (*Hypochaeris radicata*), lambs tongue (*Plantago lanceolata*), French catchfly (*Silene gallica*), hop clover (*Trifolium campestre*), saffron thistle (*Carthamus lanatus*), fireweed (*Senecio madagascariensis*), haresfoot clover (*Trifolium arvense*), wall fescue (*Vulpia muralis*) and scarlet pimpernel (*Anagallis arvensis*) are recorded commonly in this vegetation zone.	
TSC Act Status	The derived native grassland form of this vegetation community is <u>not</u> consistent with the *Central Hunter Grey Box – Ironbark Woodland in the NSW North Coast and Sydney Basin Bioregions EEC* listed under the TSC Act.	
EPBC Act Status	This vegetation zone is not consistent with any TEC listed under the EPBC Act.	

Zone 8 ⁻HU812 – Forest Red Gum grassy open forest on floodplains of the lower Hunter – Moderate to Good – Poor – Exotic Grasslands

PCT Name	Forest Red Gum Grassy Open Forest on Floodplains of the Lower Hunter	
Condition	Moderate to Good – Poor – Exotic Grasslands	
PCT Number	HU812	
Area (ha)	11.90	
Survey Effort	3 biometric plots/transects	
Formation	Forested Wetlands	
Class	Coastal Floodplain Wetlands	
HRVP Map Unit (Peake 2006)	MU13 – Hunter Floodplain Red Gum Woodland Complex	
General Description	This vegetation zone is occurs in areas that have previously been subject to cropping or intensive agriculture. Due to the disturbance that has occurred in this community, it is dominated by introduced flora species.	
Canopy Description	No canopy stratum present.	
Mid-storey Description	No mid-storey stratum present.	
Shrub Layer Description	No shrub stratum present.	
Ground Cover Description	The disturbed state of this vegetation community has resulted in a low cover of native flora species, those recorded within this community included, plains grass (*Austrostipa aristiglumis*), namely knob sedge (*Carex inversa*), *Oxalis chnoodes*, windmill grass (*Chloris truncata*), native sensitive plant (*Neptunia gracilis*), wallaby grass (*Rytidosperma fulfum*), native carrot (*Daucus glochidiatus*) and black rolypoly (*Sclerolaena muricata*).	
Introduced Species	Introduced crop and weed species dominated this community, including mintweed (*Salvia reflexa*), spear thistle (*Cirsium vulgare*), ribwort (*Plantago lanceolata*), turnip weed (*Rapistrum rugosum*), chicory (*Cichorium intybus*), common sowthistle (*Sonchus oleraceus*), button medic (*Medicago orbicularis*) and *Lollium* sp.	
TSC Act Status	This vegetation zone is not consistent with any TEC listed under the TSC Act.	
EPBC Act Status	This vegetation zone is not consistent with any TEC listed under the EPBC Act.	

Threatened Ecological Communities

Two of the vegetation zones described above and mapped within the Mangrove BioBank Site conform to State and Commonwealth listed TECs, comprising:

- HU812 – Forest Red Gum Grassy Open Forest on Floodplains of the Lower Hunter – Moderate to Good Condition
    - *Hunter Floodplain Red Gum Woodland in the NSW North Coast and Sydney Basin Bioregions* EEC
    - *White Box Yellow Box Blakely's Red Gum Grassy Woodland and Derived Native Grassland* CEEC
- HU905 – Narrow-leaved Ironbark - Grey Box Grassy Woodland of the Central and Upper Hunter – Moderate to Good Condition
    - *Central Hunter Grey Box – Ironbark Woodland in the NSW North Coast and Sydney Basin Bioregions* EEC

Analysis of consistency with the scientific determinations for each TEC was undertaken, with consideration of the advice provided by the NSW Scientific Committee and/or the Commonwealth Threatened Species Scientific Committee guidelines for interpreting listings for species, populations and ecological communities under the TSC Act and EPBC Act respectively.

Ecosystem-credit Species

The following ecosystem credit species are known to occur within the Mangrove BioBank Site from surveys or records on the Atlas of NSW Wildlife (OEH 2017a):

- brown treecreeper (*Climacteris picumnus victoriae*)
- glossy black-cockatoo (*Calyptorhynchus lathami*)
- grey-crowned babbler (*Pomatostomus temporalis* subsp. *temporalis*)
- little lorikeet (*Glossopsitta pusilla*)
- speckled warbler (*Circus assimilis*)
- varied sittella (*Daphoenositta chrysoptera*)
- eastern false pipistrelle (*Falsistrellus tasmaniensis*)
- eastern bentwing bat (*Miniopterus schreibersii oceanensis*)
- eastern cave bat (*Vespadelus troughtoni*)
- large-eared pied bat (*Chalinolobus dwyeri*)
- southern myotis (*Myotis macropus*), and
- yellow-bellied sheathtail bat (*Saccolaimus flaviventris*).

Species-credit Species

Two species-credit species were recorded during extensive surveys across Mangrove BioBank Site. **Table D16** below outlines the species-credits generated for the site.

Table D16 Predicted Species-credit Species Recorded in the Mangrove BioBank Site

Species Name	Threatened Species Offset Multiplier	Species Credits Generated
pine donkey orchid *Diuris tricolor*	1.33	7,909
southern myotis *Myotis macropus* (breeding habitat being hollow-bearing trees within 200m of Wybong Creek)	7.7	21

Table D17 below outlines the plot and transect data collected from surveys of the Mangrove BioBank Site. It includes the ten site attributes that are recorded in each Biometric plot and transect as per Table 2 of the BBAM (OEH 2014c). This data is assessed against benchmark data for PCTs and then entered into the BioBanking Credit Calculator to assess the site value of each PCT at the Mangrove BioBank Site.

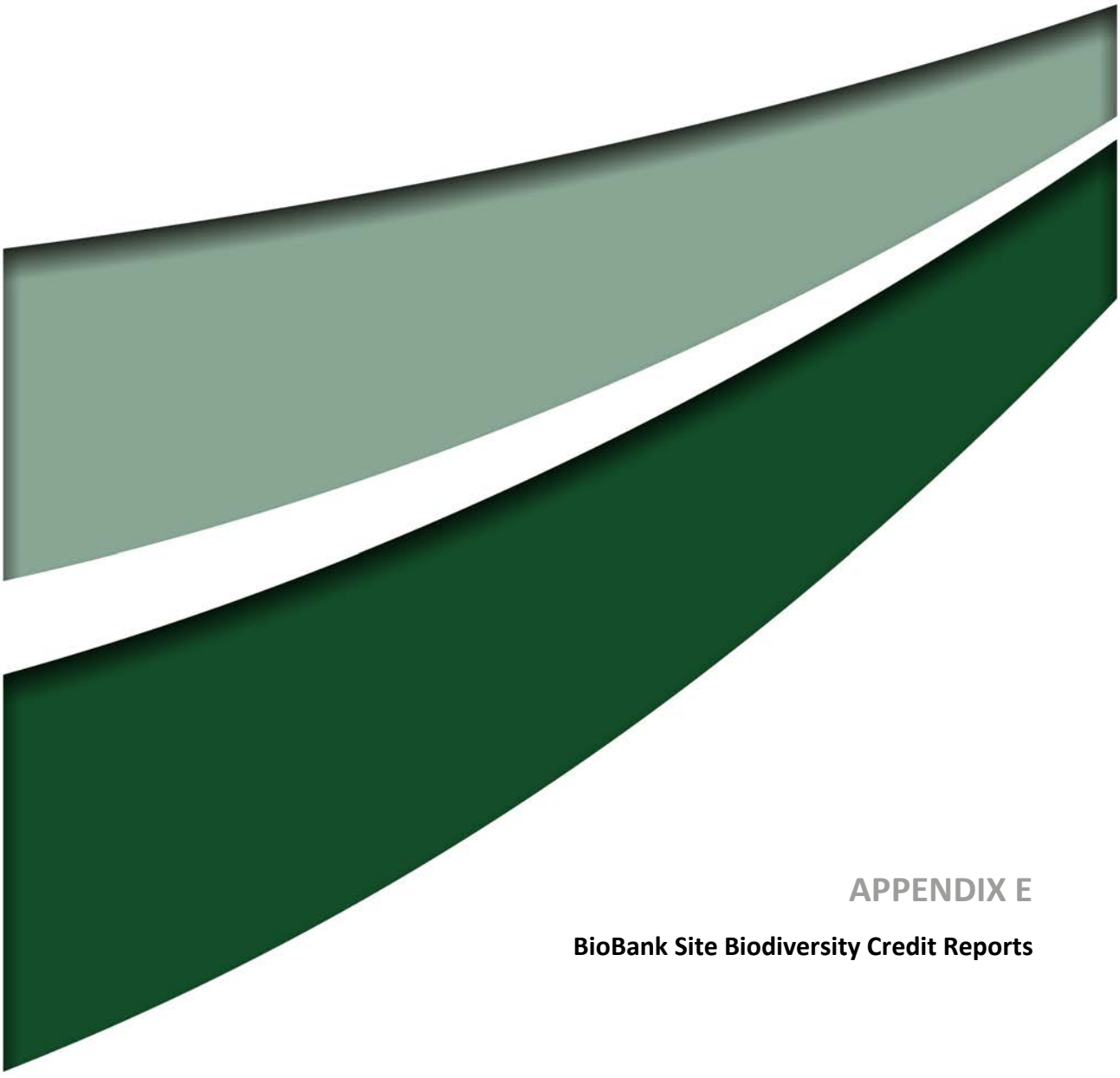
A full Credit Calculator report is included in **Appendix E**.

Table D17 Plot and Transect Data for the Mangrove BioBank Site

Plot Name	NPS	NOS	NMS	NGCG	NGCS	NGCO	EPC	NTH	OR	FL	Easting	Northing	Zone
Zone 1: HU599 – River Red Gum / River Oak riparian woodland wetland in the Hunter Valley - Moderate to Good Condition													
MQ13	5	0.5	0	36	0	0	14	0	0.5	53	277650	6422357	56
MQ23	18	0	0	56	0	0	90	1	0.5	0	277562	6422101	56
Zone 2: HU599 – River Red Gum / River Oak riparian woodland wetland in the Hunter Valley - Moderate to Good DNG Condition													
MQ12	2	0	0	98	0	0	40	0	1	0	277444	6421992	56
MQ22	6	0	0	74	0	0	26	0	1	0	277314	6421745	56
MP11	7	0	0	28	0	4	32	0	1	0	277620	6422575	56
Zone 3: HU678 – Black Cypress Pine - ironbark +/- Narrow-leaved Wattle low open forest mainly on Narrabeen Sandstone in the Upper Hunter region of the Sydney Basin Bioregion - Moderate to Good Condition													
MQ05	30	4.7	23.7	70	6	20	4	0	1	104	276662	6422539	56
MQ15	26	7	5.2	40	4	20	0	0	1	132	276771	6421958	56
MQ16	31	7.5	46	16	2	0	0	0	1	15	276932	6422492	56
MQ17	31	14	12.2	14	2	2	0	1	1	111	276934	6422207	56
Zone 4: HU812 – Forest Red Gum grassy open forest on floodplains of the lower Hunter- Moderate to Good Condition													
MQ01	56	23	0.5	54	4	10	4	0	1	8	278646	6421757	56
MQ03	45	15	3.5	64	6	6	0	0	1	79	278834	6421571	56
MQ1A	46	14	0.4	56	2	30	8	0	1	18	278771	6421535	56

Zone 5: HU812 – Forest Red Gum grassy open forest on floodplains of the lower Hunter- Low Condition													
MQ07	16	0	0	46	0	22	88	0	0.3	0	277475	6422255	56
MQ09	19	0	0	14	0	6	98	0	0.3	0	277166	6421813	56
MQ11	17	0	0	32	0	16	66	0	0.3	0	277904	6421874	56
MQ20	24	0	0	86	2	14	32	0	0.3	0	278457	6421841	56
Zone 6: HU905 – Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter– Moderate to Good Condition													
MQ02	40	4.5	4	46	0	48	0	0	1	38	278678	6421907	56
MQ04	25	21	0.5	34	6	8	6	1	1	120	278888	6421850	56
MQ14	37	14	1.5	66	0	6	8	0	1	30	276889	6421949	56
MQ18	44	2.2	3	50	4	26	2	0	1	57	278654	6421948	56
MQ2A	57	22.5	1	54	2	40	6	1	1	14	278781	6421839	56
Zone 7: HU905 – Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter– Moderate to Good DNG Condition													
MQ06	24	0	0	82	0	22	20	0	1	0	276575	6422785	56
MQ08	19	0	0	90	0	2	24	0	1	0	277211	6422549	56
MQ10	20	0	0	56	0	14	64	0	1	0	277031	6421920	56
MQ19	16	0	0	58	0	18	74	0	1	1	278347	6422297	56
MQ21	21	0	0	42	0	10	86	0	1	3	278250	6421617	56

Zone 8: HU812 – Forest Red Gum grassy open forest on floodplains of the lower Hunter- Moderate to Good Poor Condition													
MP14	3	0	0	4	0	4	58	0	0	0	277625	6421831	56
MP13	6	0	0	8	0	4	56	0	0	0	277663	6421611	56
MP12	3	0	0	2	0	0	72	0	0	0	277407	3421648	56



APPENDIX E

BioBank Site Biodiversity Credit Reports

BioBanking credit report

This report identifies the number and type of credits required at a BIOBANK SITE

Date of report: 19/05/2017 Time: 1:34:22PM Calculator version: v4.0

Biobank details

Proposal ID:	177/2017/4270B
Proposal name:	Wambo BioBank Site
Proposal address:	Jerrys Plains Road Jerrys Plains NSW 2330
Proponent name:	United Collieries Pty Ltd
Proponent address:	134 Jerrys Plains Road Warkworth NSW 2330
Proponent phone:	
Assessor name:	Kate Connolly
Assessor address:	75 York St Teralba NSW 2284
Assessor phone:	02 4950 5322
Assessor accreditation:	177

Additional information required for approval:

- ☐ Use of local benchmark
- ☐ Expert report...
- ☐ Request for additional gain in site value

Ecosystem credits summary

Plant Community type	Area (ha)	Credits created
Narrow-leaved Ironbark - Bull Oak - Grey Box shrub - grass open forest of the central and lower Hunter	98.50	1,513.00
River Oak riparian grassy tall woodland of the western Hunter Valley (Brigalow Belt South Bioregion and Sydney Basin Bioregion)	19.90	339.00
Slaty Box - Grey Gum shrubby woodland on footslopes of the upper Hunter Valley, Sydney Basin Bioregion	215.90	3,608.00
Total	334.30	5,460

Credit profiles

1. Narrow-leaved Ironbark - Bull Oak - Grey Box shrub - grass open forest of the central and lower Hunter, (HU817)

Number of ecosystem credits created	1,513
IBRA sub-region	Hunter

2. Slaty Box - Grey Gum shrubby woodland on footslopes of the upper Hunter Valley, Sydney Basin Bioregion, (HU618)

Number of ecosystem credits created	3,608
IBRA sub-region	Hunter

3. River Oak riparian grassy tall woodland of the western Hunter Valley (Brigalow Belt South Bioregion and Sydney Basin Bioregion), (HU712)

Number of ecosystem credits created	339
IBRA sub-region	Hunter

Species credits summary

Additional management actions

Additional management actions are required for:

Vegetation type or threatened species	Management action details
Narrow-leaved Ironbark - Bull Oak - Grey Box shrub - grass open forest of the central and lower Hunter	Exclude commercial apiaries
Narrow-leaved Ironbark - Bull Oak - Grey Box shrub - grass open forest of the central and lower Hunter	Exclude miscellaneous feral species
Narrow-leaved Ironbark - Bull Oak - Grey Box shrub - grass open forest of the central and lower Hunter	Feral and/or over-abundant native herbivore control
Narrow-leaved Ironbark - Bull Oak - Grey Box shrub - grass open forest of the central and lower Hunter	Fox control
Narrow-leaved Ironbark - Bull Oak - Grey Box shrub - grass open forest of the central and lower Hunter	Slashing
River Oak riparian grassy tall woodland of the western Hunter Valley (Brigalow Belt South Bioregion and Sydney Basin Bioregion)	Exclude commercial apiaries
River Oak riparian grassy tall woodland of the western Hunter Valley (Brigalow Belt South Bioregion and Sydney Basin Bioregion)	Exclude miscellaneous feral species
River Oak riparian grassy tall woodland of the western Hunter Valley (Brigalow Belt South Bioregion and Sydney Basin Bioregion)	Feral and/or over-abundant native herbivore control
River Oak riparian grassy tall woodland of the western Hunter Valley (Brigalow Belt South Bioregion and Sydney Basin Bioregion)	Fox control
Slaty Box - Grey Gum shrubby woodland on footslopes of the upper Hunter Valley, Sydney Basin Bioregion	Exclude commercial apiaries
Slaty Box - Grey Gum shrubby woodland on footslopes of the upper Hunter Valley, Sydney Basin Bioregion	Exclude miscellaneous feral species
Slaty Box - Grey Gum shrubby woodland on footslopes of the upper Hunter Valley, Sydney Basin Bioregion	Feral and/or over-abundant native herbivore control
Slaty Box - Grey Gum shrubby woodland on footslopes of the upper Hunter Valley, Sydney Basin Bioregion	Fox control
Slaty Box - Grey Gum shrubby woodland on footslopes of the upper Hunter Valley, Sydney Basin Bioregion	Slashing

BioBanking credit report

This report identifies the number and type of credits required at a BIOBANK SITE

Date of report: 24/11/2016 Time: 7:00:16PM Calculator version: v4.0

Biobank details

Proposal ID:	177/2016/2415B
Proposal name:	Highfields Offset Site
Proposal address:	Highfields Road Highfields NSW 2222
Proponent name:	Glencore
Proponent address:	Highfields Road Highfields NSW 2222
Proponent phone:	(02) 49 123 456
Assessor name:	Kate Connolly
Assessor address:	75 York St Teralba NSW 2284
Assessor phone:	02 4950 5322
Assessor accreditation:	177

Additional information required for approval:

- ☐ Use of local benchmark
- ☐ Expert report...
- ☐ Request for additional gain in site value

Ecosystem credits summary

Plant Community type	Area (ha)	Credits created
Blakely's Red Gum - Narrow-leaved Ironbark - Rough-barked Apple shrubby woodland of the upper Hunter	24.90	534.00
Narrow-leaved Ironbark - Grey Gum shrubby open forest on sandstone ranges of the upper Hunter Valley	96.60	1,145.00
Rough-Barked Apple - red gum - Yellow Box woodland on alluvial clay to loam soils on valley flats in the northern NSW South Western Slopes Bioregion and Brigalow Belt South Bioregion	2.50	20.00
White Box x Grey Box - red gum - Rough-barked Apple grassy woodland on rich soils on hills in the upper Hunter Valley	303.50	3,592.00
Total	427.50	5,291

Credit profiles

1. Rough-Barked Apple - red gum - Yellow Box woodland on alluvial clay to loam soils on valley flats in the northern NSW South Western Slopes Bioregion and Brigalow Belt South Bioregion, (HU714)

Number of ecosystem credits created	20
IBRA sub-region	Liverpool Range - Hunter/Central Rivers

2. White Box x Grey Box - red gum - Rough-barked Apple grassy woodland on rich soils on hills in the upper Hunter Valley, (HU730)

Number of ecosystem credits created	3,592
IBRA sub-region	Liverpool Range - Hunter/Central Rivers

3. Blakely's Red Gum - Narrow-leaved Ironbark - Rough-barked Apple shrubby woodland of the upper Hunter, (HU821)

Number of ecosystem credits created	534
IBRA sub-region	Liverpool Range - Hunter/Central Rivers

4. Narrow-leaved Ironbark - Grey Gum shrubby open forest on sandstone ranges of the upper Hunter Valley, (HU868)

Number of ecosystem credits created	1,058
IBRA sub-region	Liverpool Range - Hunter/Central Rivers

5. Narrow-leaved Ironbark - Grey Gum shrubby open forest on sandstone ranges of the upper Hunter Valley, (HU868)

Number of ecosystem credits created	87
IBRA sub-region	Liverpool Range - Hunter/Central Rivers

Species credits summary

Additional management actions

Additional management actions are required for:

Vegetation type or threatened species	Management action details
Blakely's Red Gum - Narrow-leaved Ironbark - Rough-barked Apple shrubby woodland of the upper Hunter	Exclude commercial apiaries
Blakely's Red Gum - Narrow-leaved Ironbark - Rough-barked Apple shrubby woodland of the upper Hunter	Exclude miscellaneous feral species
Blakely's Red Gum - Narrow-leaved Ironbark - Rough-barked Apple shrubby woodland of the upper Hunter	Feral and/or over-abundant native herbivore control
Blakely's Red Gum - Narrow-leaved Ironbark - Rough-barked Apple shrubby woodland of the upper Hunter	Fox control
Blakely's Red Gum - Narrow-leaved Ironbark - Rough-barked Apple shrubby woodland of the upper Hunter	Slashing
Narrow-leaved Ironbark - Grey Gum shrubby open forest on sandstone ranges of the upper Hunter Valley	Exclude commercial apiaries
Narrow-leaved Ironbark - Grey Gum shrubby open forest on sandstone ranges of the upper Hunter Valley	Exclude miscellaneous feral species
Narrow-leaved Ironbark - Grey Gum shrubby open forest on sandstone ranges of the upper Hunter Valley	Feral and/or over-abundant native herbivore control
Narrow-leaved Ironbark - Grey Gum shrubby open forest on sandstone ranges of the upper Hunter Valley	Fox control
Narrow-leaved Ironbark - Grey Gum shrubby open forest on sandstone ranges of the upper Hunter Valley	Slashing
Rough-Barked Apple - red gum - Yellow Box woodland on alluvial clay to loam soils on valley flats in the northern NSW South Western Slopes Bioregion and Brigalow Belt South Bioregion	Exclude commercial apiaries
Rough-Barked Apple - red gum - Yellow Box woodland on alluvial clay to loam soils on valley flats in the northern NSW South Western Slopes Bioregion and Brigalow Belt South Bioregion	Exclude miscellaneous feral species
Rough-Barked Apple - red gum - Yellow Box woodland on alluvial clay to loam soils on valley flats in the northern NSW South Western Slopes Bioregion and Brigalow Belt South Bioregion	Feral and/or over-abundant native herbivore control
Rough-Barked Apple - red gum - Yellow Box woodland on alluvial clay to loam soils on valley flats in the northern NSW South Western Slopes Bioregion and Brigalow Belt South Bioregion	Fox control
Rough-Barked Apple - red gum - Yellow Box woodland on alluvial clay to loam soils on valley flats in the northern NSW South Western Slopes Bioregion and Brigalow Belt South Bioregion	Slashing

White Box x Grey Box - red gum - Rough-barked Apple grassy woodland on rich soils on hills in the upper Hunter Valley	Exclude commercial apiaries
White Box x Grey Box - red gum - Rough-barked Apple grassy woodland on rich soils on hills in the upper Hunter Valley	Exclude miscellaneous feral species
White Box x Grey Box - red gum - Rough-barked Apple grassy woodland on rich soils on hills in the upper Hunter Valley	Feral and/or over-abundant native herbivore control
White Box x Grey Box - red gum - Rough-barked Apple grassy woodland on rich soils on hills in the upper Hunter Valley	Fox control
White Box x Grey Box - red gum - Rough-barked Apple grassy woodland on rich soils on hills in the upper Hunter Valley	Slashing

BioBanking credit report

This report identifies the number and type of credits required at a BIOBANK SITE

Date of report: 9/03/2017 Time: 5:03:14PM Calculator version: v4.0

Biobank details

Proposal ID:	0020/2015/1964B
Proposal name:	Mangrove Offset Site
Proposal address:	road town
Proponent name:	business
Proponent address:	road town
Proponent phone:	0222222222
Assessor name:	Kate Connolly
Assessor address:	75 York St Teralba NSW 2284
Assessor phone:	02 4950 5322
Assessor accreditation:	177

Additional information required for approval:

- ☐ Use of local benchmark
- ☐ Expert report...
- ☐ Request for additional gain in site value

Ecosystem credits summary

Plant Community type	Area (ha)	Credits created
Black Cypress Pine - ironbark +/- Narrow-leaved Wattle low open forest mainly on Narrabeen Sandstone in the Upper Hunter region of the Sydney Basin Bioregion	44.90	783.00
Forest Red Gum grassy open forest on floodplains of the lower Hunter	100.90	1,449.00
Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter	106.70	1,732.00
River Red Gum / River Oak riparian woodland wetland in the Hunter Valley	6.00	106.00
Total	258.50	4,070

Credit profiles

1. Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter, (HU905)

Number of ecosystem credits created	1,732
IBRA sub-region	Kerrabee - Hunter/Central Rivers

2. Black Cypress Pine - ironbark +/- Narrow-leaved Wattle low open forest mainly on Narrabeen Sandstone in the Upper Hunter region of the Sydney Basin Bioregion, (HU678)

Number of ecosystem credits created	783
IBRA sub-region	Kerrabee - Hunter/Central Rivers

3. River Red Gum / River Oak riparian woodland wetland in the Hunter Valley, (HU599)

Number of ecosystem credits created	106
IBRA sub-region	Kerrabee - Hunter/Central Rivers

4. Forest Red Gum grassy open forest on floodplains of the lower Hunter, (HU812)

Number of ecosystem credits created	369
IBRA sub-region	Kerrabee - Hunter/Central Rivers

5. Forest Red Gum grassy open forest on floodplains of the lower Hunter, (HU812)

Number of ecosystem credits created	1,080
IBRA sub-region	Kerrabee - Hunter/Central Rivers

Species credits summary

Common name	Scientific name	Extent of impact Ha or individuals	Number of species credits created
Pine Donkey Orchid	Diuris tricolor	1,114.00	7,909
Pine Donkey Orchid	Diuris tricolor	0.00	7,909
Southern Myotis	Myotis macropus	3.00	21

Additional management actions

Additional management actions are required for:

Vegetation type or threatened species	Management action details
Black Cypress Pine - ironbark +/- Narrow-leaved Wattle low open forest mainly on Narrabeen Sandstone in the Upper Hunter region of the Sydney Basin Bioregion	Exclude commercial apiaries
Black Cypress Pine - ironbark +/- Narrow-leaved Wattle low open forest mainly on Narrabeen Sandstone in the Upper Hunter region of the Sydney Basin Bioregion	Exclude miscellaneous feral species
Black Cypress Pine - ironbark +/- Narrow-leaved Wattle low open forest mainly on Narrabeen Sandstone in the Upper Hunter region of the Sydney Basin Bioregion	Feral and/or over-abundant native herbivore control
Black Cypress Pine - ironbark +/- Narrow-leaved Wattle low open forest mainly on Narrabeen Sandstone in the Upper Hunter region of the Sydney Basin Bioregion	Fox control
Forest Red Gum grassy open forest on floodplains of the lower Hunter	Exclude commercial apiaries
Forest Red Gum grassy open forest on floodplains of the lower Hunter	Exclude miscellaneous feral species
Forest Red Gum grassy open forest on floodplains of the lower Hunter	Feral and/or over-abundant native herbivore control
Forest Red Gum grassy open forest on floodplains of the lower Hunter	Fox control
Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter	Exclude commercial apiaries
Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter	Exclude miscellaneous feral species
Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter	Feral and/or over-abundant native herbivore control
Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter	Fox control
Pine Donkey Orchid	Control of feral pigs
Pine Donkey Orchid	Feral and/or over-abundant native herbivore control
River Red Gum / River Oak riparian woodland wetland in the Hunter Valley	Exclude commercial apiaries
River Red Gum / River Oak riparian woodland wetland in the Hunter Valley	Exclude miscellaneous feral species

River Red Gum / River Oak riparian woodland wetland in the Hunter Valley	Feral and/or over-abundant native herbivore control
River Red Gum / River Oak riparian woodland wetland in the Hunter Valley	Fox control
River Red Gum / River Oak riparian woodland wetland in the Hunter Valley	Slashing
Southern Myotis	Maintain or re-introduce natural flow regimes

GLENCORE

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