Appendix 6

Agricultural Impact Statement

UNITED WAMBO OPEN CUT COAL MINE PROJECT

Agricultural Impact Statement

FINAL

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

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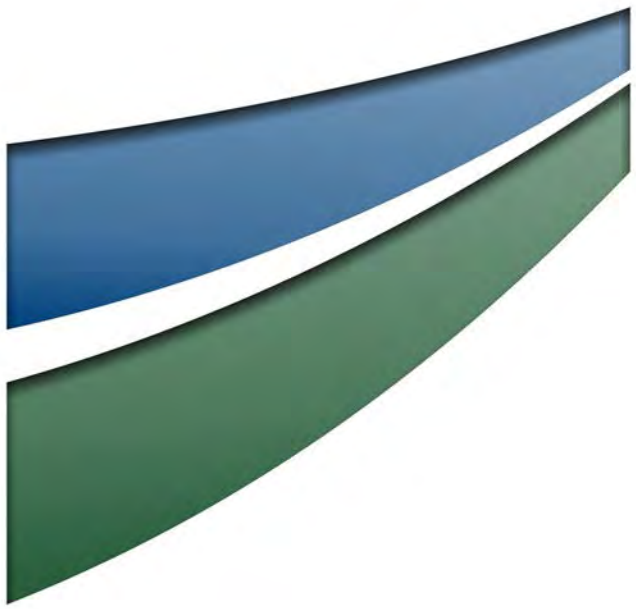
Executive Summary



This report assesses the impacts of the proposed United Wambo Open Cut Coal Mine Project (the Project) on the agricultural resources and agricultural enterprises on the Project Area and its locality. The report has been prepared in accordance with the NSW Guideline for Agricultural Impact Statements (NSW Government 2012).

The United and Wambo Mine lands were historically cleared and used for grazing. Aerial photos from that time reveal significant land degradation from extensive clearing and soil loss. This part of the Hunter Valley has been in mine ownership and use since the 1980s.

The majority of the Project Area subject to approved mining, or has been heavily disturbed by past land uses including agriculture and mining, or is covered with dense vegetation. Within the Project Area, the only agricultural use is a small area (approximately 30 hectares) of land owned by Wambo Mine and leased for cattle grazing.

The assessment reviews the agricultural resources of these areas and of the Project Area. Field sampling is concentrated over 31 hectares in the north-west corner of the Project Area which is mapped at the regional scale as having good land and soil capability, including potential biophysical strategic agricultural land (BSAL). Some field sampling was also conducted in other selected less disturbed but low land and soil capability parts of the Project Area, to confirm its constraints for any agricultural use.

Five soil types have been identified, reflecting the geological and geomorphic context of the Project Area.

The majority of the site lies within the Jerrys Plains soil landscape. Soils mapped in the field within this soil landscape are Subnatric and Mesonatric Sodosols, with some areas of Chromosol. These soils have multiple constraints for agricultural use.

In the northwest corner of the Project Area, the soils reflect the interaction of Sodosol hillslope and footslope profiles with colluvial footslope materials, alluvial valley fills associated with minor tributaries of the Hunter River system and the extreme outer margin of the alluvium associated with the Hunter River itself. Soil types include Subnatric and Mesonatric Sodosols, and very small areas of Eutrophic Dermosol, Eutrophic Chromosol and Epipedal Vertosol. Only the Epipedal Vertosol soils meet the criteria for BSAL.

Across the assessed areas of the Project Area, the soil resource represents Land and Soil Capability Classes 4 and 5 land, with a small area of class 3 land. At the conclusion of mining, it is proposed to rehabilitate the land and soil resources to broadly the same mix of land and soil capability. The proposed rehabilitation plan includes returning the northwest corner of the Project Area to Land and Soil Capability Class 4. A second area, along the southern boundary of the current approved Wambo Mine area is also proposed to be returned to Land and Soil capability Class 4 land. This proposal reflects consultation with rural residents of the district who have requested that the better grazing land on the Project Area should be available for agriculture after mining. The remainder of the site will be rehabilitated to class 5 to 7 land, with a focus on native vegetation and habitats. This is consistent with the *Synoptic Plan – Integrated landscapes and Coal Mine Rehabilitation in the Hunter Valley of NSW* (Department of Mineral Resources 1999) and with regional biodiversity planning. These proposed rehabilitation arrangements, and the character of the existing resource, mean that the impact of the Project on agricultural resources will be low.

Currently, the United and Wambo mine lands are almost surrounded by other mining land, with National Park further to the south. Cattle grazing occurs to the north west on the Hunter floodplain and around Bulga. There is one dairy farm at Jerrys Plains (although dairying was previously a much more significant industry in the locality, with up to 16 farms in the 1980s). There are also two small vineyards at Bulga, one of which is mine owned. The nearest horse studs (part of the Equine Critical Industry Cluster) are some distance to the north-west, the closest boundary being 6km from the project area. The distribution of existing land uses in the locality and the design and management of mining operations mean that the impact of the Project on surrounding agricultural enterprises will be low.

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1.0 Introduction

The United and Wambo 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 Agricultural Impact Statement (AIS) provides an assessment of the potential impacts of the Project on the agricultural resources, agricultural industries and agricultural productivity of the Project Area and the locality of the Project. The AIS has been undertaken in accordance with the Secretary's Environmental Assessment Requirements (SEARs) and relevant guidelines or policies, including the Strategic Regional Land Use Policy Guideline for Agricultural Impact Statements (NSW government 2012) and the Agricultural Impact Statement Technical Notes (Department of Primary Industries 2013).

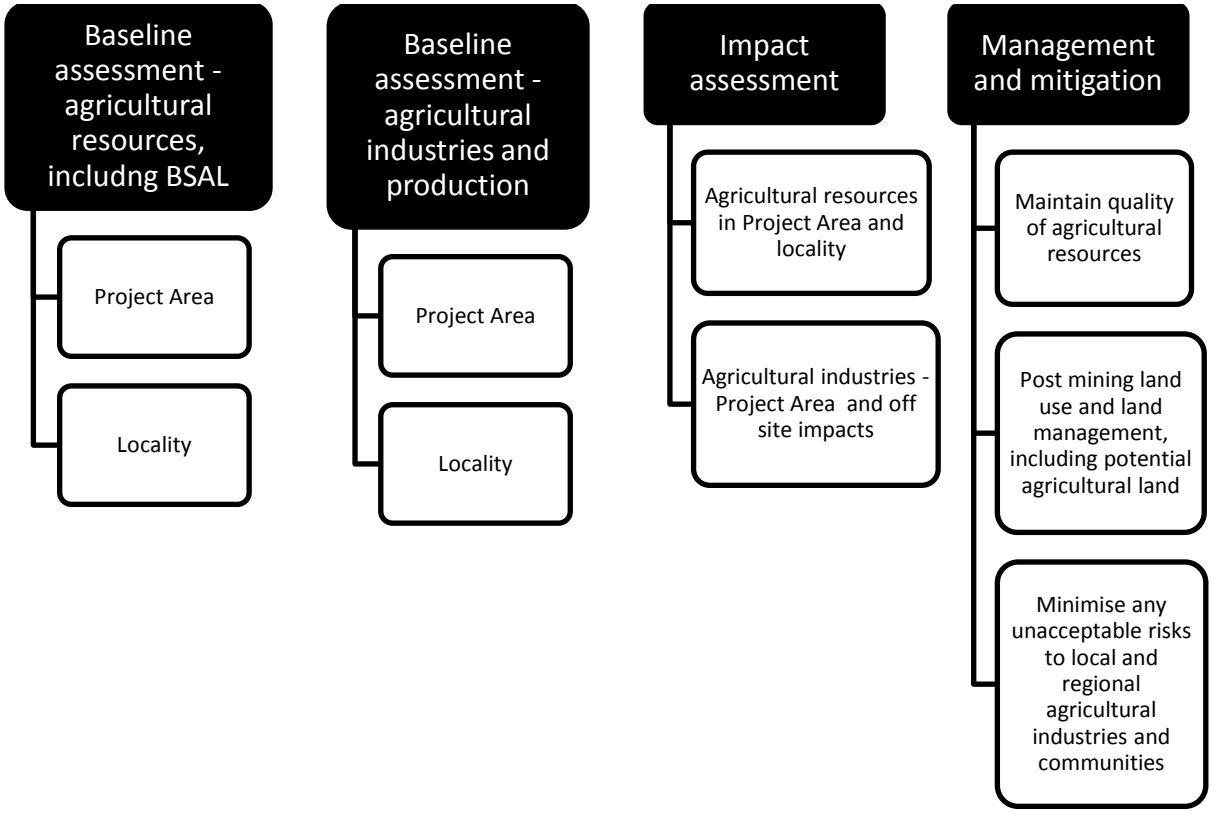
The AIS provides:

- baseline information about current agricultural resources and agricultural production of the Project Area and locality
- information about the potential impacts of the proposed mine on the agricultural resources and enterprises in the Project Area and locality
- an assessment of the significance of potential impacts, based on a risk assessment process
- proposed measures to mitigate and minimise any risks to agricultural resources and industries of the Project Area and its locality.

The framework for assessment is shown graphically below.

FIGURE 1.1

Locality Plan



1.1 Project Overview

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 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 has approval for continued open cut mining until March 2017 (with a modification lodged to extend this to 2020). Due to the progression of mining being slower than originally planned, there will be substantial coal resources remaining in this approved mining area at March 2017 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.

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).
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.

Key Project Components/Aspects	Proposed Operations
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.

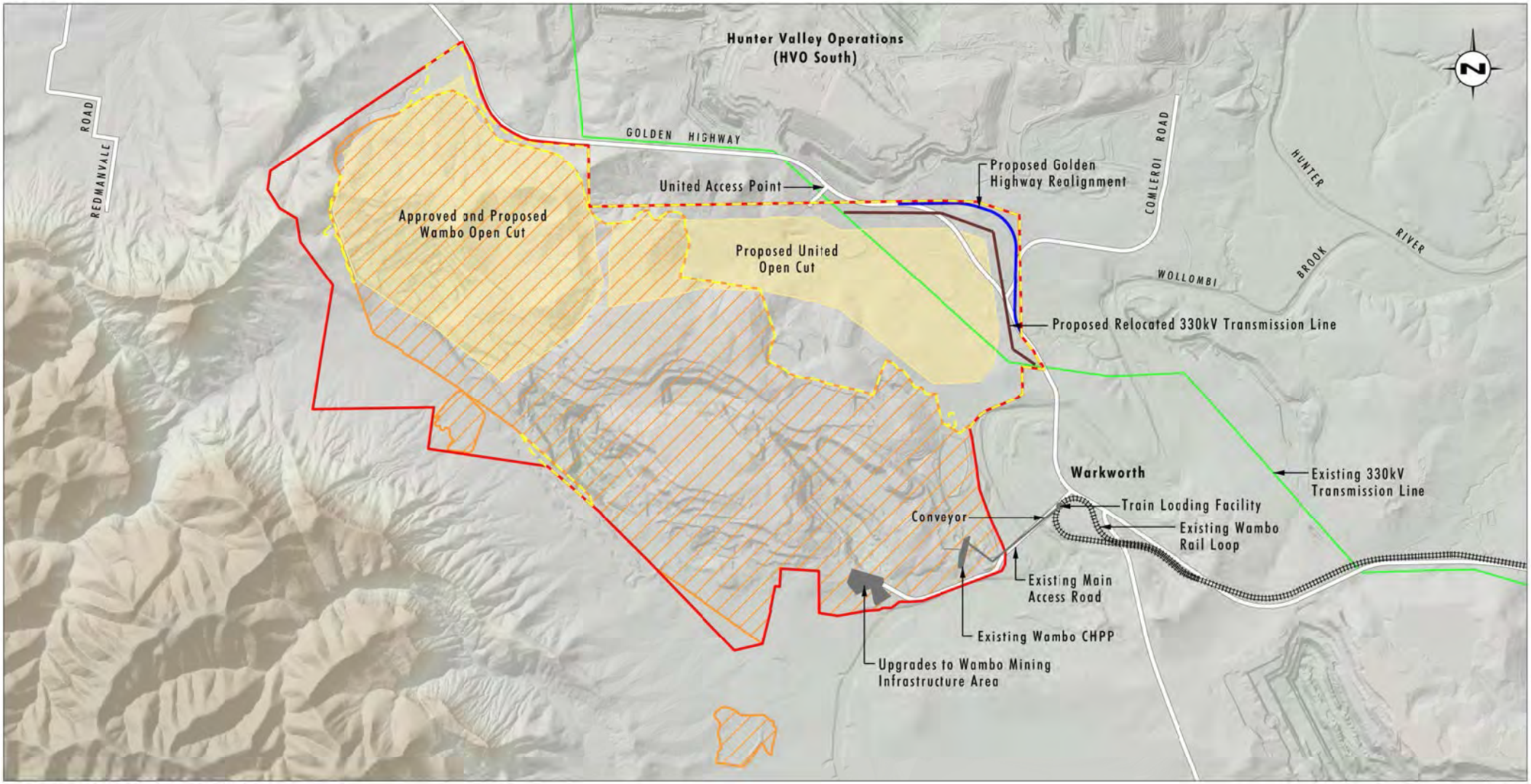


Image Source: United LiDAR (2015)
Data Source: Glencore (2015)

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Legend

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

FIGURE 1.2

Overview of The Project

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United Collieries 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 Coal is a subsidiary of Peabody Energy Australia Pty Limited (Peabody).

1.2 The Project Area, Disturbance Area and Locality

In this report, the terms relating to the definition of the Project Area and its context have the following meanings:

Project Area

For the purpose of the EIS, the Project Area is the area covered by the Development Application. The Project Area (refer to **Figure 1.2**) is approximately 3036 hectares in area, of which approximately 2027 hectares (approximately 67%) is land with an existing surface mining approval. For the purpose of the AIS, the land covered by the existing mining approval is excluded from detailed analysis and assessment. The AIS focuses on those parts of the Project Area which:

- are not part of a current mining approval
- have not been extensively disturbed by historical mining operations and/or are not part of approved rehabilitation plans for native vegetation.

Section 2.5 provides further detail about the identification of these areas.

The Project Area includes approximately 50 hectares of land that is currently used for dry land cattle grazing, which is located within the existing Wambo mine lease.

Additional Disturbance Area

Most activities associated with the construction or carrying out of the Project involve some degree of surface disturbance although much of the affected land has been previously disturbed by existing or historical activities, or is currently approved for disturbance. The approved Wambo Surface Development Area shown on **Figure 1.2** is currently approved for disturbance and ongoing surface disturbance works will occur within the area over the life of the Project. As this area has previously been assessed and approved for disturbance (under both NSW and Commonwealth legislation), and as much of it has been or will be disturbed prior to the determination of the Project, no further assessment of the disturbance of this area is required as part of this EIS.

Where possible, as part of the implementation of the Project, activities will be undertaken in a manner that limits the amount of physical ground disturbance. **Figure 1.2** identifies the areas within the Project Area that have been identified as potentially being disturbed as a result of the Project. Not all of the area identified as being within the disturbance footprint will necessarily be disturbed as a result of the Project. However, due to the difficulty in accurately defining the precise location of access tracks, infrastructure alignments and water management infrastructure and impact areas associated with the development of Project components over the life of the Project, buffers around areas that are known to be, or are likely to be disturbed as a result of the Project, have been applied so that the maximum potential footprint of the Project has been identified and assessed.

The total conceptual additional disturbance area (hereafter referred to as the additional disturbance area) has been identified as being approximately 714 hectares.

Some parts of the Project Area, particularly along the western and south western boundaries, will not be disturbed by the Project and there will be no change to existing agricultural resources on these areas (refer to **Figure 1.2**).

Biodiversity Offset Areas

There are three potential biodiversity offset sites identified as part of the Project including Highfields Offset Area, Mangrove Offset Site and Wambo Offset Site. These are shown in **Figure 1.3**.

The AIS includes a desktop assessment of the potential impacts of the Project on the agricultural resources and agricultural industries of the offset areas even though there is no physical disturbance proposed for these sites.

United Wambo Locality

The AIS Technical Notes (DPI 2013) define the locality of a Project as the relevant parish. For the purpose of this assessment the 'locality' of the Project is considered to be an area contained within a 10 kilometre radius of the centre of the Project Area. This context locality is shown on **Figure 1.4**.

The Project Area is surrounded predominantly by existing mining activities and operations, including Coal and Allied's HVO at the Carrington, North Pit, Cheshunt, Riverview and South Lemington Pits and their associated buffer lands. A number of mines are located further south including Mount Thorley Warkworth and Bulga Coal.

Grazing and fodder operations are still widespread in the locality, occurring at a number of properties along the Golden Highway and the outskirts of Jerrys Plains. Irrigated agriculture is currently being undertaken along the alluvial floodplains of the Hunter River to the north of the Golden Highway. A small number of olive groves and vineyards are located south of Jerrys Plains (refer to **Figure 1.4**).

Region

The Project Area and its locality are situated close to the boundary between the broader Singleton and Muswellbrook local government areas (LGA) in the Upper Hunter Valley Region.

1.3 Report Structure

Section 1.0 describes the Project and the general approach to the scope of the assessment.

Section 2.0 provides an overview of the NSW AIS requirements, aims and objectives of the assessment and the scope, scale and method of the assessment.

Section 3.0 provides information regarding the agricultural resources of the Project Area, including the proposed biodiversity offset areas. Information presented includes previous mapping of land and soil characteristics including biophysical strategic agricultural land (BSAL). Site specific details on slope and land characteristics, soil types and land and soil capability are presented, drawing on a detailed site-specific soil survey and sampling program.

Section 4.0 provides information about the agricultural resources of the locality of the Project Area.

Section 5.0 provides an outline of the agricultural enterprises and infrastructure of the Project Area, the locality and its regional context (the Singleton area of the Upper Hunter Valley). This includes estimated production values, historical agricultural enterprises, strategic rural land, and current agricultural uses and enterprises. It discusses the overall agricultural value of the Proposed Disturbance Area in the context of its surrounding locality and broader region.

Section 6.0 provides an assessment of the level of impact the Project may have on agricultural resources and enterprises. Permanent and temporary impacts are identified, for the project Area and its locality. The extent of the potential impacts is evaluated using a risk assessment process that incorporates information about existing agricultural resources, the production and productivity of existing enterprises and proposed post mining landforms, soils, water resources and land uses.

Section 7.0 proposes mitigation measures to be implemented to reduce the risk of impact on agricultural resources and enterprises. **Section 7.0** also includes proposed measures to monitor the performance of the Project in relation to commitments about future agricultural resources and productivity.

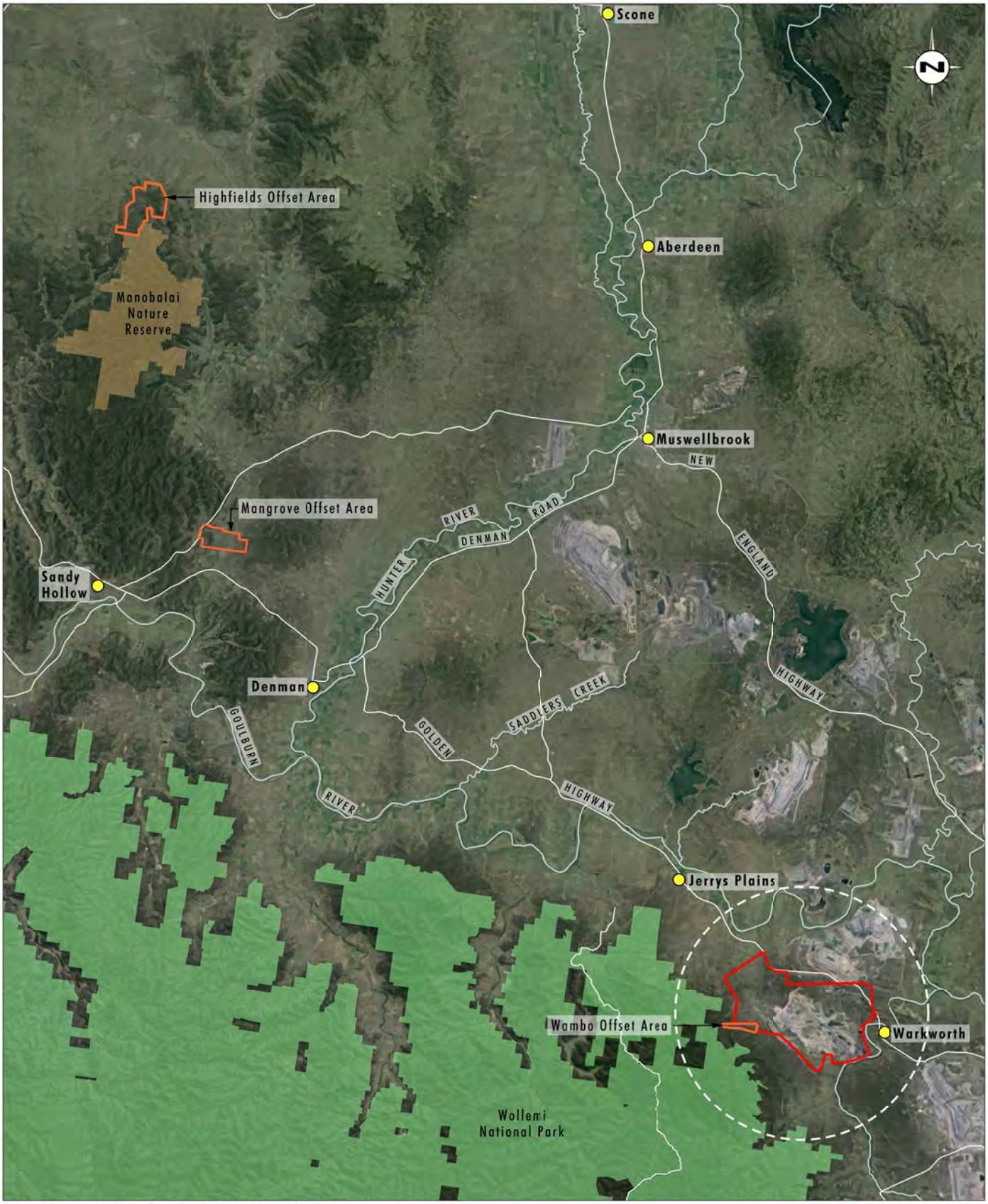

Image Source: Google Earth, Landsat (2013)
Data Source: LPI (2013)

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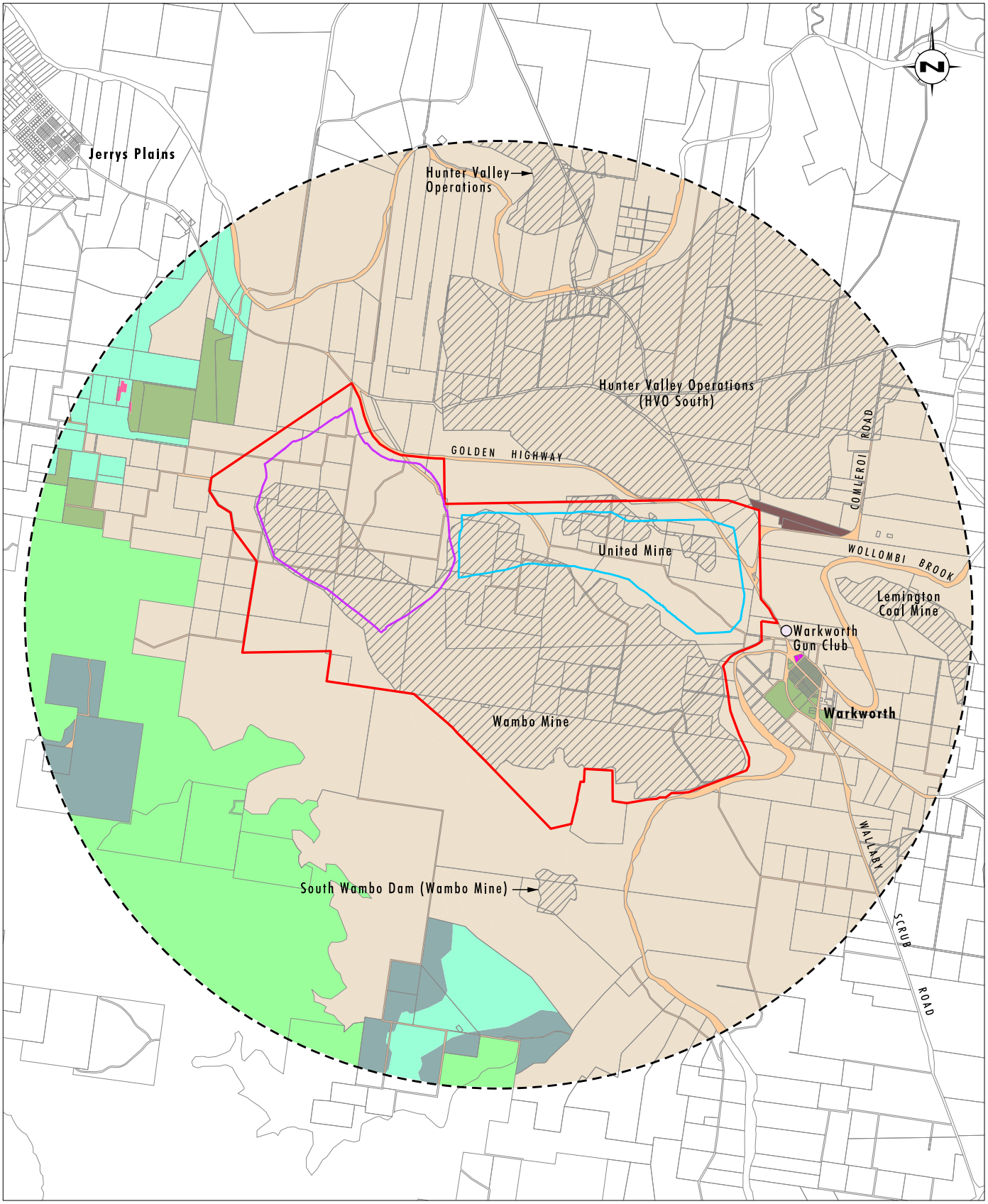
Legend

- Project Area
- Proposed Offsets
- National Park
- Nature Reserve

FIGURE 1.3

Offset Area Locations in Relation to the Project Area



Data Source: LPMA (2009), Department of Natural Resources (2005)

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Legend

- Project Area
- Proposed Conceptual United Open Cut Pit
- Proposed Conceptual Wambo Open Cut Realignment
- Woodland Area - Private Management
- Mixed Grazing Land
- Cropping Land
- Mining Operations and Buffer Land
- National Park
- Private Vineyards
- Gliding Club
- Government Authority (Federal, State or Local)
- Rural Residential
- Extent of Existing Mining (as of 2015)

FIGURE 1.4

Locality of the Project and Land Uses

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2.0 Agricultural Impact Assessment Requirements and Project Scope and Approach

This section outlines the agricultural impact assessment requirements which apply to the Project. These include the SEARs, the *State Environmental Planning Policy (Mining, Petroleum Production and Extractive Industries) 2007* (Mining SEPP), and the *Upper Hunter Strategic Regional Land Use Plan* (DP&I, 2012a). Other guideline documents (noted below) describe the evidence necessary to demonstrate that the relevant requirements have been met.

2.1 Secretary's Environmental Assessment Requirements

The DPE issued the SEARs for the Project on 15 December 2015. The SEARs outline the specific requirements to be addressed in the EIS for the Project, including the specific requirement for the assessment of impacts on strategic agricultural land. Specifically, the requirements in relation to the preparation of the AIS are provided in **Table 2.1** below.

Table 2.1 SEARs Relating to the Preparation of an Agricultural Impact Statement

Assessment Requirements	Relevant Section of AIS
Agriculture – including:	
• An assessment of the likely impacts of the development on the soils and land capability of the site, paying particular attention to the recommendations of any required Gateway Certificate or Site Verification Certificate relating to the assessment of Biophysical Strategic Agricultural Land (BSAL) and Critical Industry Cluster land, and having regard to the EPA's, DRE's and NOW's requirements.	**Section 6.0** Evidence to support this assessment is in **Sections 3.0**, **4.0** and **5.0**
• Justification for any significant long term changes to the potential agricultural productivity of land post-mining, paying particular attention to any highly productive agricultural land that would be affected by the development; and	**Section 7.0**
• An assessment of the compatibility of the development with other land uses in the vicinity of the development, in accordance with the requirements of Clause 12 of *State Environmental Planning Policy (Mining, Petroleum Production and Extractive Industries) 2007;*	**Sections 5.0**, **6.0** and **7.0**

Consistent with the SEARs for the Project, the AIS has been prepared in accordance with:

- Upper Hunter SRLUP (DP&I 2012a) (refer to **Section 2.2**)
- the Mining SEPP (refer to **Section 2.3**)
- *Guideline for Agricultural Impact Statements* (DP&I 2012b)
- *Agricultural Impact Statement Technical Notes* (DP&I 2012c).

Section 2.4 provides details of the requirements of the guidelines and technical notes and where relevant information can be found in this report.

2.2 Upper Hunter Strategic Regional Land Use Plan

The Project is located within the area covered by the Upper Hunter SRLUP. The Upper Hunter SRLUP (DP&I 2012) identifies agricultural land that is considered to be of strategic significance because of its land capability, productivity or other economic and social value to the region. Mapping in the SRLUP is at regional scale, and the land may be mapped as BSAL, based on its land and soil characteristics, or it may be mapped as a CIC, based on specific production and economic values, such as viticulture, equine and associated rural tourism. The locations of BSAL and CICs in the locality are shown in **Figure 2.1**.

The Interim Protocol (OEH and OASFS 2012) requires that BSAL lands are verified at the project scale, to ensure that decisions about agricultural land use are based on sound information and that land is used for the purposes for which it is best suited.

Accordingly, the AIS evaluates the potential for the Project to impact on:

- Agricultural land that is mapped in the Upper Hunter SRLUP as BSAL (or could be mapped as BSAL), within or in close proximity (within approximately 2 kilometres) to the Project Area. For land to qualify as BSAL in the Upper Hunter SRLUP, it must be land with Land and Soil Capability (LSC) Classes 1 or 2 and have moderate to high soil fertility (refer to **Section 3.4.3** for detail). Class 3 land may also qualify as BSAL if it has high soil fertility. Access to quality agricultural water supply is also considered. BSAL mapped at a regional scale within the additional disturbance area has been assessed and mapped using the Interim Protocol (OEH and OASFS 2013). The results of verification processes confirm there is no BSAL in the area requiring new mining leases (refer to **Appendix A**).

- Agricultural land that is within a CIC, within or in close proximity to the Project Area. The Upper Hunter SRLUP defines Agricultural industries as industries that produce plants or livestock or are a directly associated service, processing or marketing industry, commercially reliant on agricultural products. Agricultural industries are made up of agricultural enterprises.

- Agricultural resources of the additional disturbance area and the surrounding locality. The *SRLUP Guideline for Agricultural Impact Statements* (DP&I 2012b) defines agricultural resources as the land on which agriculture is dependent and the associated water resources. 'Land' is characterised by soil characteristics (types, depth, fertility, hazards), topography and slope, climate conditions and water resources; agricultural resources also includes key agricultural support infrastructure such as roads and railways for transporting produce.

- Other agricultural land uses and infrastructure, within or in close proximity to the Project Area, or where relevant, more broadly in the region.

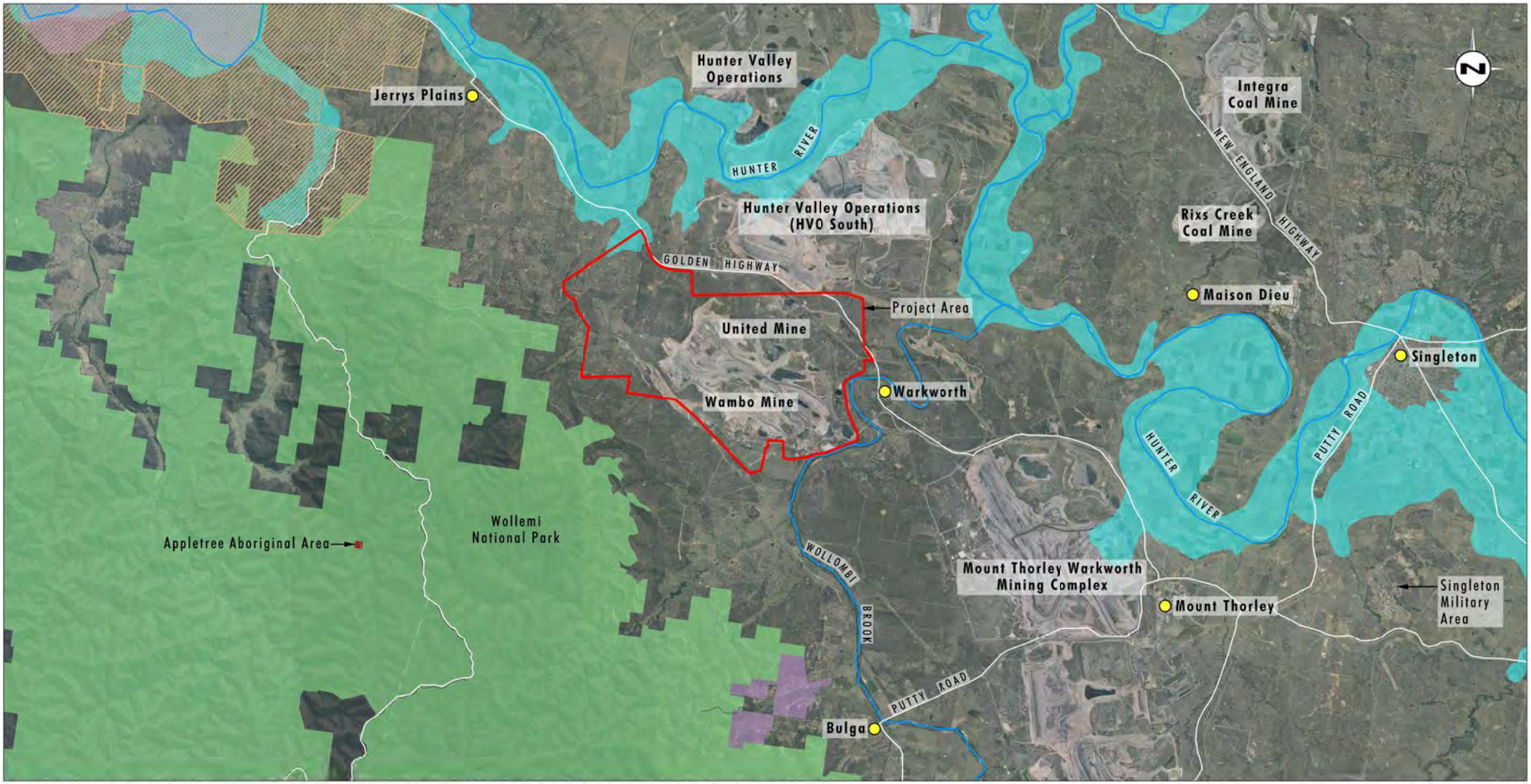

Image Source: AAM (2012), United (2015), Google Earth - CNES/Astrium 2016, Sinclair Knight Merz 2016, (2008)
Data Source: Glencore (2015), Minview (2015)

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Legend

- Project Area
- National Park
- Aboriginal Area
- SRLUP Viticulture CIC
- SRLUP Equine CIC
- Regionally Mapped Biophysical Strategic Agricultural Land
- Road
- River

FIGURE 2.1

Location of Biophysical Strategic Agricultural Land and Critical Industry Clusters

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2.3 Mining SEPP

The Mining SEPP requires certain types of development to verify whether the proposed site is on BSAL and whether the Gateway Process applies to the development application. The *Interim Protocol for Site Verification and Mapping of Biophysical Strategic Agricultural Land* (OEH and OAS&FS 2013) requires that regional scale mapping of BSAL is verified for land within the project area, subject to exclusions. The verification of BSAL within the Project Area has been undertaken as part of the detailed identification of soil resources (refer to **Appendix A**) and confirms that there is no BSAL in the areas requiring new mining leases.

The Upper Hunter Strategic Regional Land Use Plan (Upper Hunter SRLUP) (DP&I 2012a) identified and mapped Biophysical Strategic Agricultural Land (BSAL) at the regional scale. A small area (31 hectares) of BSAL is mapped at the regional scale in the north western corner of the Project Area, at the margin of a larger area of BSAL which extends across the adjacent alluvial flats of the Hunter River (refer to **Figure 2.1**). The AIS provides evidence to refine the mapping of BSAL in this locality and specifically assesses the potential impacts of the Project on the agricultural resources and industries associated with this BSAL.

2.4 Requirements of the Agricultural Impact Statement Guideline and Technical Notes

Specific relevant requirements of the guidelines and technical notes are summarised in **Table 2.2**, which also identifies the relevant section of the AIS where the required information is provided.

Table 2.2 Summary of AIS Guidelines

Section of AIS Technical Notes	Assessment Requirements	Relevant Section of AIS
Item 1.0	**Define the Project** This includes: • a description of land to be temporarily removed from agriculture during the operation of the Project , and the period of time; • the location and area to be returned to agriculture post project and its productive potential relative to pre project; • the location and area of land that will not be returned to agriculture, including areas to be used for environmental plantings or biodiversity offsets. Where land is intended to be rehabilitated back to agricultural use, the AIS must provide sufficient evidence that the proposed level of rehabilitation is feasible and sustainable. • the agricultural enterprises to be undertaken on any buffer or offset zone lands for the life of the project, compared with enterprises conducted prior to the project.	**Section 1.0**
Item 6.0	**Consultation** Document consultation with adjoining land-users and government departments, including a consultation strategy and results of its implementation.	**Section 2.6**

Section of AIS Technical Notes	Assessment Requirements	Relevant Section of AIS
Baseline assessment of the project area[1]		
Item 2.1 and Item 2.2 of the AIS Technical Notes	**Agricultural resources** Detailed assessment of the agricultural resources of the Project Area, including description and mapping of soils, slope, land characteristics and water characteristics.	**Sections 3.1, 3.2, 3.3, 3.4**
Item 2.1	Sampling of soils in the Proposed Disturbance Area at a scale of 1:25,000 or larger, targeted after desktop analysis of spatial variations in landscape and soil types.	**Section 2.5**
Item 2.1 and Item 2.2	A table showing the area of land and soil capability (LSC) Classes in the Project Area, before and after mining. Specific soil testing requirements, to establish land and soil capability, are set out in the Technical Notes. Soil chemistry relevant to land and soil capability must be established by testing. Where soils have been degraded through neglectful management practices, rehabilitation may be required to achieve a district standard, rather than the pre testing level.	**Section 3.4.4**
	BSAL needs to be verified for the whole Project Area, including surrounding buffer zones and offset areas. In areas where SRLUPs exist (such as the Hunter), BSAL verification must be conducted for the whole area, not just the area nominally mapped as BSAL in the SRLUP.	**Section 3.4.5**
Item 2.3 of the AIS Technical Notes	**Agricultural enterprises and production** Relevant history of agricultural enterprises within the Project area and its buffer land or offset areas Ten years of history of agricultural enterprises in the Project Area, including crop yields and stock numbers where possible. Include information on management, such as fertiliser inputs, levels of cultivation, livestock intensity etc. Include information about the management of agricultural enterprises, such as inputs of fertiliser, lime, water and pesticides; management styles; levels of cultivation and intensity of use.	**Section 5.0**

Section of AIS Technical Notes	Assessment Requirements	Relevant Section of AIS
Baseline assessment of the surrounding locality		
Item 3.1, including 3.1.1, 3.1.2, 3.1.4, , 3.1.6, 3.1.7	**Identify the agricultural resources within the surrounding locality of the Project Area**. The AIS must contain maps/information of the locality surrounding the Project, which describes existing agricultural resources, including: • Soil characteristics, types and depth • Topography and slope. Use available soil maps and terrain mapped with a minimum of 20 m contour intervals • Provide information about vegetation type and condition, particularly if the vegetation has a bearing on the agricultural resources of the locality • Key agricultural support infrastructure • Water resources and other water users' extraction locations • Location and type of agricultural industries • Climate conditions as they relate to agriculture, using data from Bureau of Meteorology	**Section 4.0**
Item 3.1.5, Item 3.2	**Agricultural enterprises and production** Describe current agricultural enterprises and commodities being produced in the surrounding locality. Identify locations and production levels of different commodities and variations over time, as affected by market conditions and climate variability.	**Section 5.4**
Assessment of Impacts on agricultural resources or industries		
Item 4.0	**Identify and assess the impacts of the Project on agricultural resources or industries in the Project Area**, including land and/or agricultural infrastructure that would be temporally or permanently removed from production. Land that will not be returned to agriculture must be shown on a map and any changes to the land and soil capability class or productivity must be quantified and explained. When referring to agricultural resources, consider both biophysical resources and infrastructure. Provide evidence to support proposed sustainable land capability for any land proposed to be returned to agriculture within the Project Area. Offset areas which have been purchased to use for agriculture should be identified and mapped. Agricultural uses in buffer areas should be similar to pre mining and consistent with similar lands in the district.	**Section 6.0 and Section 7.0**
Item 4.2	Account for any physical movement of water away from agriculture.	**Section 6.0**

Section of AIS Technical Notes	Assessment Requirements	Relevant Section of AIS
Item 4.1.1	Present a risk matrix for each possible consequence of the project (as per Appendix 3 of Interim Protocol for site verification and mapping of BSAL).	**Section 6.3**
Item 4.1.3	Identify uncertainty associated with the Project's impacts and proposed mitigation measures.	**Section 6.2.3 and Section 7.2**
Item 4.1.4	**Further risks on and off site** Consider indirect risks such as: weeds, feral animals and other pests/diseases that could affect agricultural productivity. Document how these biosecurity issues will be managed. Environmental weds that detract from agricultural production or biodiversity rehabilitation should be documented in order to identify site management and rehabilitation risks and requirements. Impact of dust on agriculture; impact of vibration and explosions on animal welfare; impacts of noise on surrounding properties (on humans and animals); impacts on any increased traffic loads on livestock mortality and the safety of agricultural workers.	**Section 6.0** and **Section 7.0**
	In quantifying impacts on current levels of agricultural support services, processing and value adding industries, consider the extent to which mining is the 'causal' factor.	**Section 6.0**
Items 4.3, 4.3.1, 4.3.2, 4.3.3, 4.3.4	Assess Socio Economic Impacts. The AIS must include description (and quantification) of impacts on: • agricultural support services • processing and other value adding industries • visual amenity, landscape values and tourism infrastructure for farm based agricultural tourism. Describe and quantify the impact on the pool of labour for agriculture and whether labour will be sourced from outside the locality (e.g. FIFO). Identify relevant critical mass thresholds of agricultural enterprises needed to attract and maintain investment in agriculture.	**Section 6.0**

Section of AIS Technical Notes	Assessment Requirements	Relevant Section of AIS
Mitigation options and commitments		
Item 5.0, including Items 5.1, 5.2, 5.3, 5.4, 5.5, 5.6 and 5.7	Identify and cost options for minimising adverse impacts on agricultural resources, including agricultural lands, enterprises and infrastructure at the local and regional level: • describe project alternatives • describe monitoring programs to assess predicted versus actual impacts and consultation with affected land users • describe measures to manage mine impacts in adverse conditions (such as trigger points for production to cease in dry, windy conditions) • discuss assumptions made about the effectiveness of mitigation /remedial actions • all proposals for rehabilitation to a specified standard should be backed up with evidence (previous successful examples and/or peer reviewed journal articles).	**Sections 6 and 7**

[1] The assessment has concentrated on the determination of impacts within the additional disturbance area, as it represents the area that has not previously been approved for disturbance.

2.5 Scope and Method of Assessment

The scope of assessment for the AIS is determined by the Project definition and the requirements outlined in **Sections 2.1** to **2.4**. This section discusses the approach used in this assessment to identify, evaluate and manage the potential risks to agricultural resources and enterprises that may occur as a result of the Project.

2.5.1 Components of the Project for assessment

As discussed in **Section 1.2**, the approved Wambo Surface Development Area is currently approved for disturbance and ongoing surface disturbance works will occur within the area over the life of the Project. The Project Area, including the additional disturbance area, has been highly modified by previous and existing mining activities. As a result there are minimal areas with land and soil resources suitable for agriculture.

This assessment will focus on the additional disturbance area associated with the Project (refer to **Figure 1.2**). Based on previous disturbance and available information, this report focuses on an area in the northwest corner of the Project Area which has been mapped as BSAL at a regional scale (refer to **Figure 2.1**)

Three potential biodiversity offset areas that are within the broad Upper Hunter region, but separate from the main Project Area (refer to **Figure 1.3**). The currently proposed offset areas are:

- Highfields Offset Site (428 hectares)
- Mangrove Offset Site (259 hectares)

- Wambo Offset Site (56 hectares).

These potential offset sites for the Project have been assessed based on desktop review of available information. Information is provided in **Section 3.1.1**.

2.5.2 Review of other biophysical, social and economic studies as they relate to agriculture

The AIS integrates the results of physical resources assessments and socio-economic studies. It addresses the biophysical resources (which support agricultural land uses) of the landscape (i.e. the relevant parts of the Project Area and the locality). It also considers the value of agricultural land use to the communities that live in this landscape in terms of social well being and economic viability.

Close interaction and feedback between these biophysical and socio-economic values is a feature of the regional landscape over the entire period of European settlement in the Upper Hunter, with the condition of the biophysical resources and farmer choices about agricultural enterprises and products varying with climate variability, land management practices, regulation, social trends and economic conditions

To provide a thorough analysis of the potential impact of the Project on agricultural resources and agricultural land uses and communities, the AIS draws on several other studies which have been completed as part of the EIS for the Project to provide detailed analysis of water and biodiversity resources, social issues and economic issues associated with agricultural resources and land uses.

Relevant detailed technical reports prepared for the Project, which have informed the AIS, include:

- Social Impact and Opportunities Assessment
- Surface Water Assessment
- Groundwater Impact Assessment
- Historic Heritage Assessment
- Upper Hunter Strategic Assessment Statement of Consistency (biodiversity)
- Mine closure and rehabilitation strategy.

2.5.3 Landform and Soil Data and Methods

The AIS has taken into account the following information:

- A preliminary scoping exercise based on desk top review of relevant literature on land capability, land use and rehabilitation, and regional agricultural production data, as well as initial input from local landholders, collected during the consultation phase. The preliminary evaluation informs the level of detail required in the definition of agricultural resources and assessment of impact. The preliminary evaluation included:
    - Kovac M. and Lawrie J.W. (1991). *Soil Landscapes of the Singleton 1:250 000 Sheet*. Soil Conservation Service of NSW, Sydney.
    - Office of Environment and Heritage (OEH). (2012). The Land and Soil Capability Assessment Scheme; Second Approximation.

- Regional soil fertility mapping (OEH 2012).
- Regional scale mapping of Land and Soil Capability (LSC) and soil fertility prepared for the Upper Hunter SRLUP (DP&I 2012a).

- Detailed terrain mapping using contours produced from LiDAR analysis (2012) and aerial photogrammetry (2015).
- Site inspection, detailed soil survey and soil sampling. Samples of topsoil and subsoil were tested by a NATA registered laboratory for parameters set out in references identified in the AIS Technical Notes (DPI 2013a). Further details are provided in **Section 2.5.4, Section 3.4** and **Appendix A**.
- Desktop mapping and ground truthing of actual land use in the local context of the Project.
- Regional statistical information on agricultural production.
- Interviews with local land holders and land managers.

In addition, the preparation of the AIS has taken into account key references for understanding regional patterns of agricultural resources, including:

- Contour mapping at 1:25,000.
- Regional vegetation maps, prepared for the former Hunter-Central Rivers Catchment Management Authority (HCRCMA).
- Rainfall and climate statistics released by Bureau of Meteorology (BOM).
- *Water Sharing Plan for the Hunter Regulated River Water Source 2003* and *Water Sharing Plan for the Hunter Unregulated and Alluvial Water Sources 2009*.

These regional studies, as they apply to the context locality of the Project Area, are outlined in **Sections 3.1** and **3.3**. Regional scale studies are also used to identify the resources of the proposed offset properties.

2.5.4 Soil sampling and testing methods

2.5.4.1 Considerations to determine soil sampling requirements

The AIS Technical Notes (2013) require soil sampling of the Project disturbance area at a minimum scale of 1:25,000. However, the Technical Notes also stress the value of using existing information such as aerial photographs and detailed terrain mapping to identify the extent of variation on soil character across the site and to enable targeted detailed survey. The logic used to determine appropriate sampling requirement for the Project is outlined below.

Historical land use and ground surface disturbance

The Project Area was historically agricultural land, used for grazing. Aerial photographs from 1963, 1971, 1983, 1992 and 2001 (refer to **Figures 2.2** to **2.6**) provide evidence of:

- The extent of land clearing that occurred in the area, with virtually the entire Project Area having been completely cleared by 1983, including steep land and areas with rock outcrop.

- The impact of land clearing and grazing on soil condition. The historical aerial photos show clearly areas of sheet erosion and erosion along the valley flats of Redbank Creek in the 1960s, 1970s and 1980s. Dean-Jones and Mitchell (1988) reported on the impacts of historical topsoil erosion and stream erosion on the stratigraphy and integrity of the valley fill along Redbank Creek.

- Historical use of the flats along North Wambo Creek for cropping, particularly in the 1960s and 1970s. The majority of this land is within the existing approved Wambo Mine.

- The extent of historical mining disturbance, with surface operations clearly evident from the early 1980s.

Further information about historical land uses on the site is in **Section 5.3.2**.

The Project Area has been part of Wambo and United mining lease areas and operations since the 1960 and 1980s respectively. The ground surface of the Project Area has been extensively disturbed by approved mining operations over that time. The total area affected by previous extensive land surface disturbance is shown in **Figure 2.7**. Areas that have been identified as previously being disturbed have been excluded from the area over which soil survey has been conducted for the purpose of the AIS.

Soil sampling has focused on an area in the northwest corner of the Project Area that has the highest potential to be suitable for agricultural purposes.

Desktop assessment also confirmed that the area of low potential for agricultural suitability in the eastern part of the Project Area did not warrant detailed soil sampling as it is of low land capability (Classes 4 and 5) and mapped as solodic soils, which are known to be of low fertility. Also this area is fragmented by existing mining, and public infrastructure, further limiting potential for agricultural use.

Existing approved mining areas

The existing approved Wambo Surface Development Area has been excluded from the detailed soil assessment as it has an existing approval for disturbance (refer to **Figure 2.7**).

Areas outside the additional disturbance area

Parts of the overall Project Area that are not proposed to be disturbed by the Project are also excluded from the agricultural impact assessment (refer to **Figure 1.2**). The value of agricultural resources in these areas will not change as a result of the Project. These areas are within the current Wambo Mine buffer land and are not currently used for any agricultural enterprise.

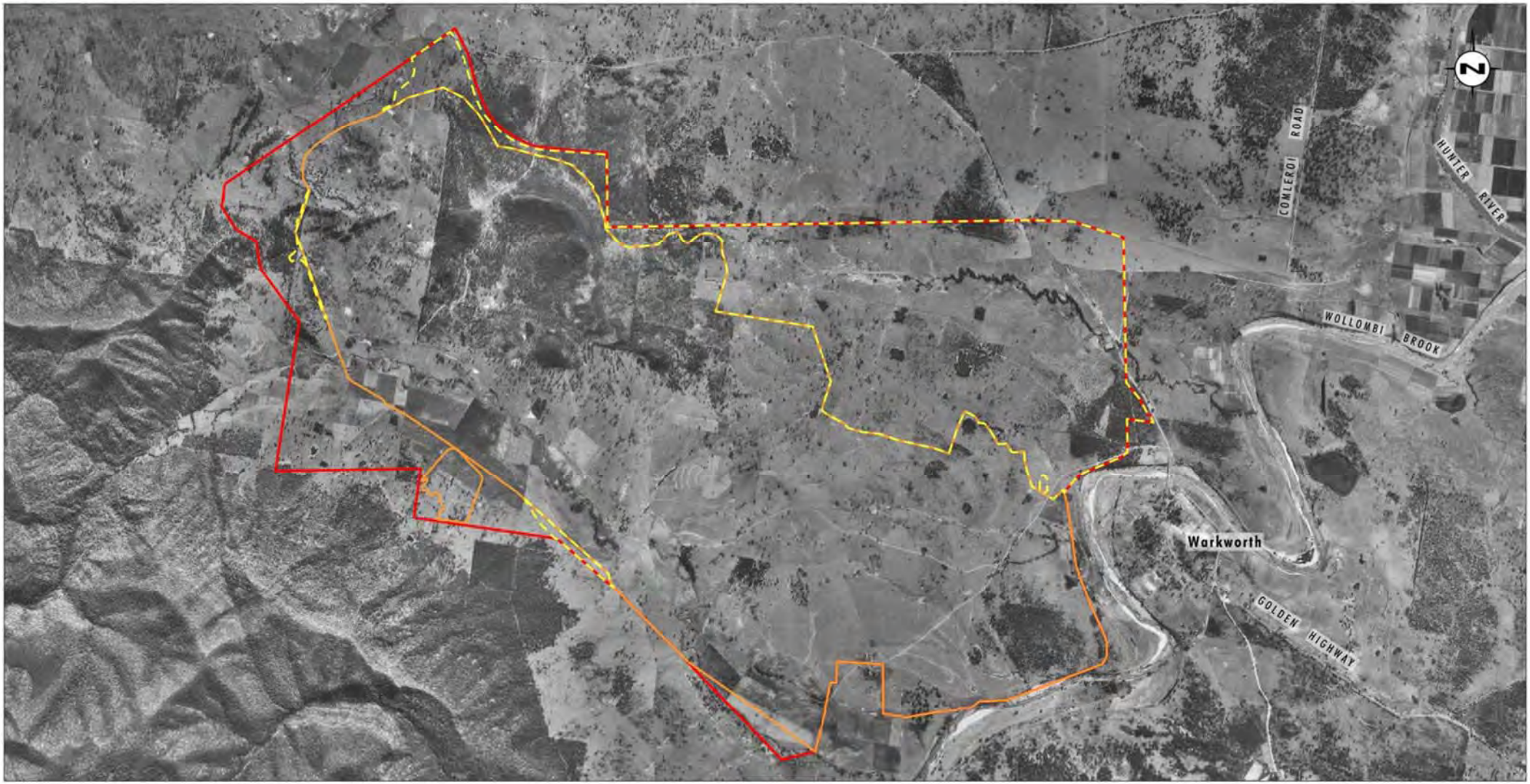

Image Source: Land and Property Management Authority
Base Data Source: Glencore (2015)

0 1.0 2.0 2.5km
1:50 000

Legend

- Project Area
- Approved Wambo Surface Development Area
- Conceptual Additional Disturbance Area

FIGURE 2.2

Aerial Photograph 1963

File Name (A4): R07/3509_4.10.dgn
20160715 9.52

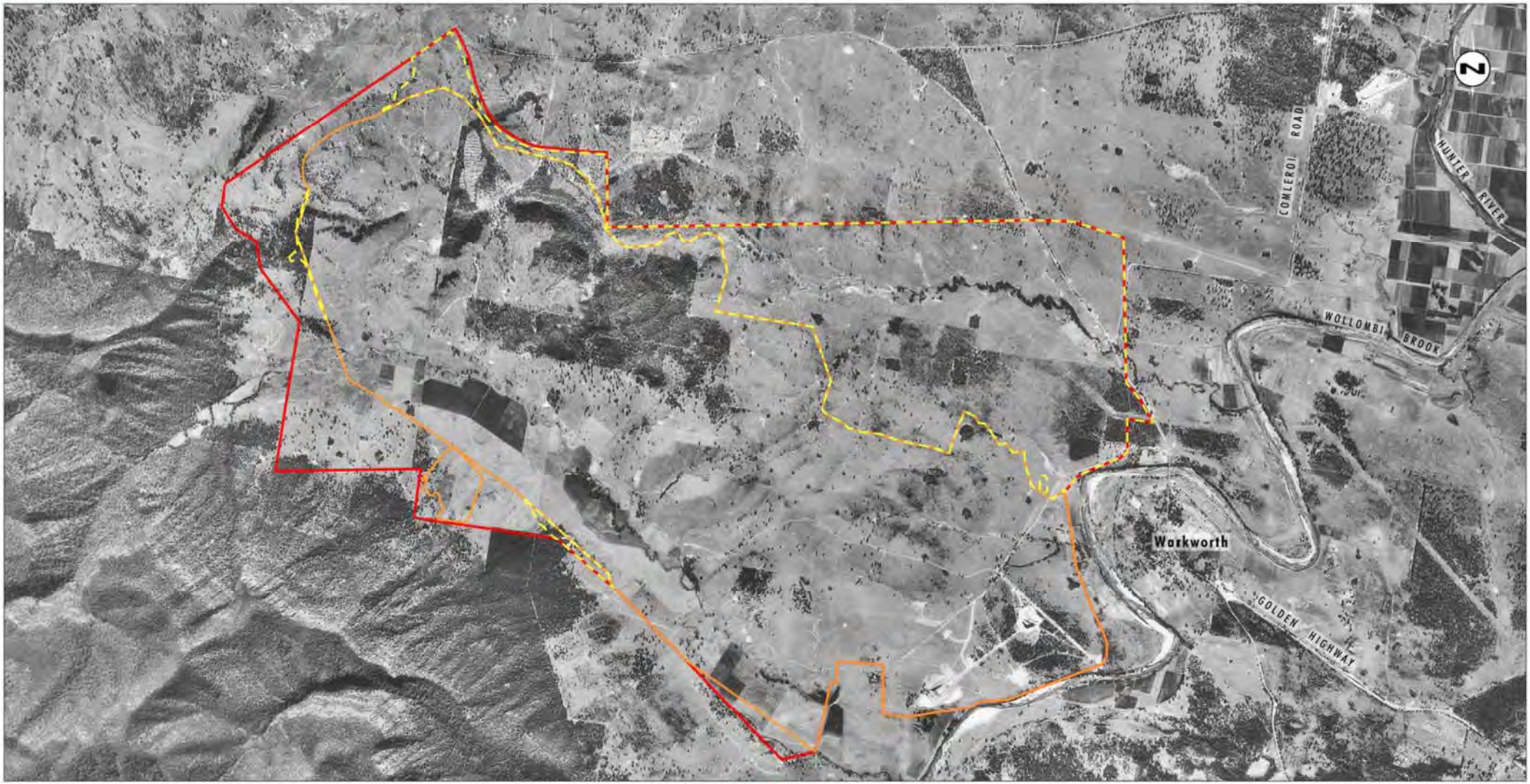

Image Source: Land and Property Management Authority
Base Data Source: Glencore (2015)

0 1.0 2.0 2.5km
1:50 000

Legend

- Project Area
- Approved Wambo Surface Development Area
- Conceptual Additional Disturbance Area

FIGURE 2.3

Aerial Photograph 1971

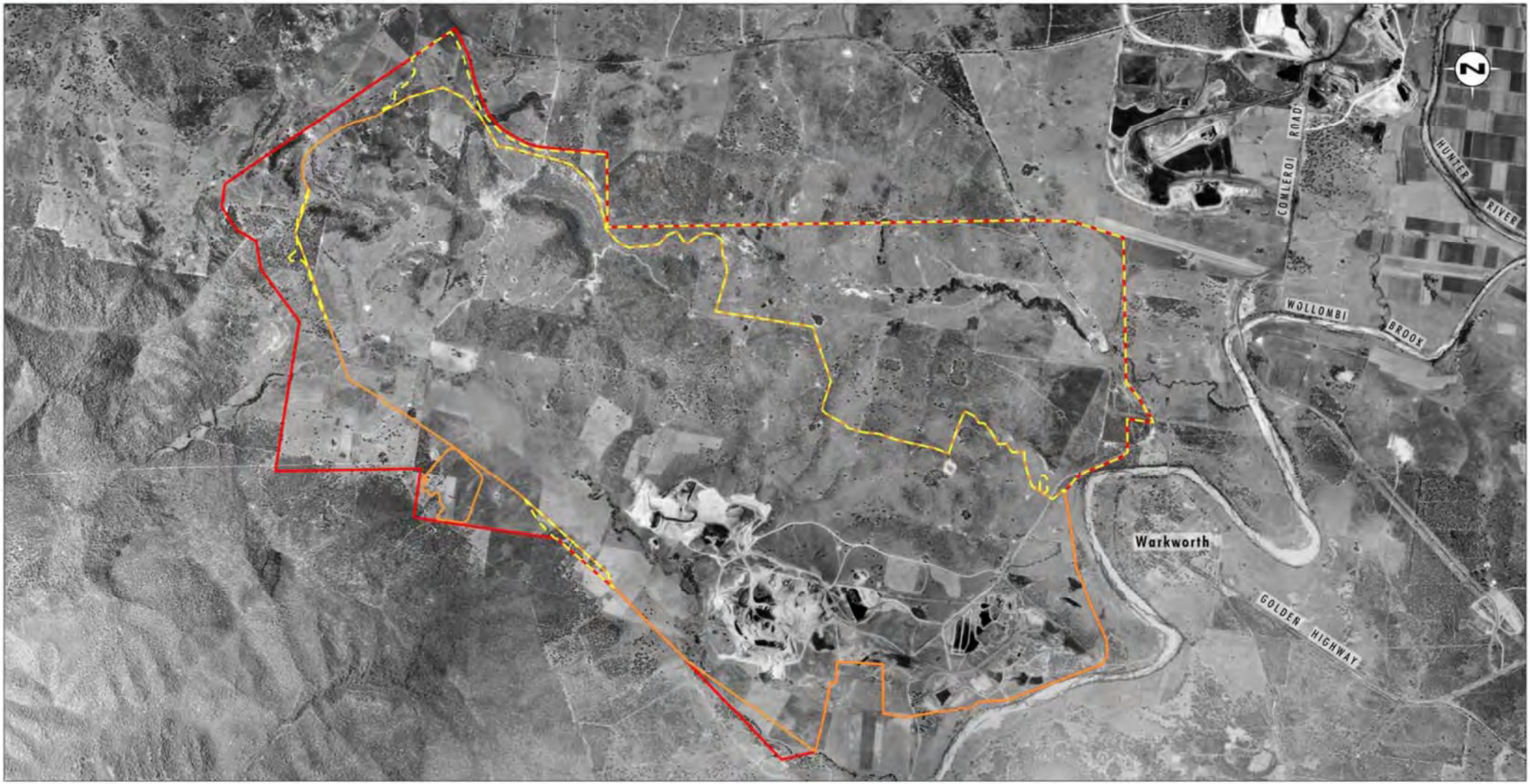

Image Source: Land and Property Management Authority
Base Data Source: Glencore (2015)

0 1.0 2.0 2.5km
1:50 000

Legend

- Project Area
- Approved Wambo Surface Development Area
- Conceptual Additional Disturbance Area

FIGURE 2.4

Aerial Photograph 1983

Image Source: Land and Property Management Authority
Base Data Source: Glencore (2015)

0 1.0 2.0 2.5km
1:50 000

Legend

- Project Area
- Approved Wambo Surface Development Area
- Conceptual Additional Disturbance Area

FIGURE 2.5

Aerial Photograph 1992

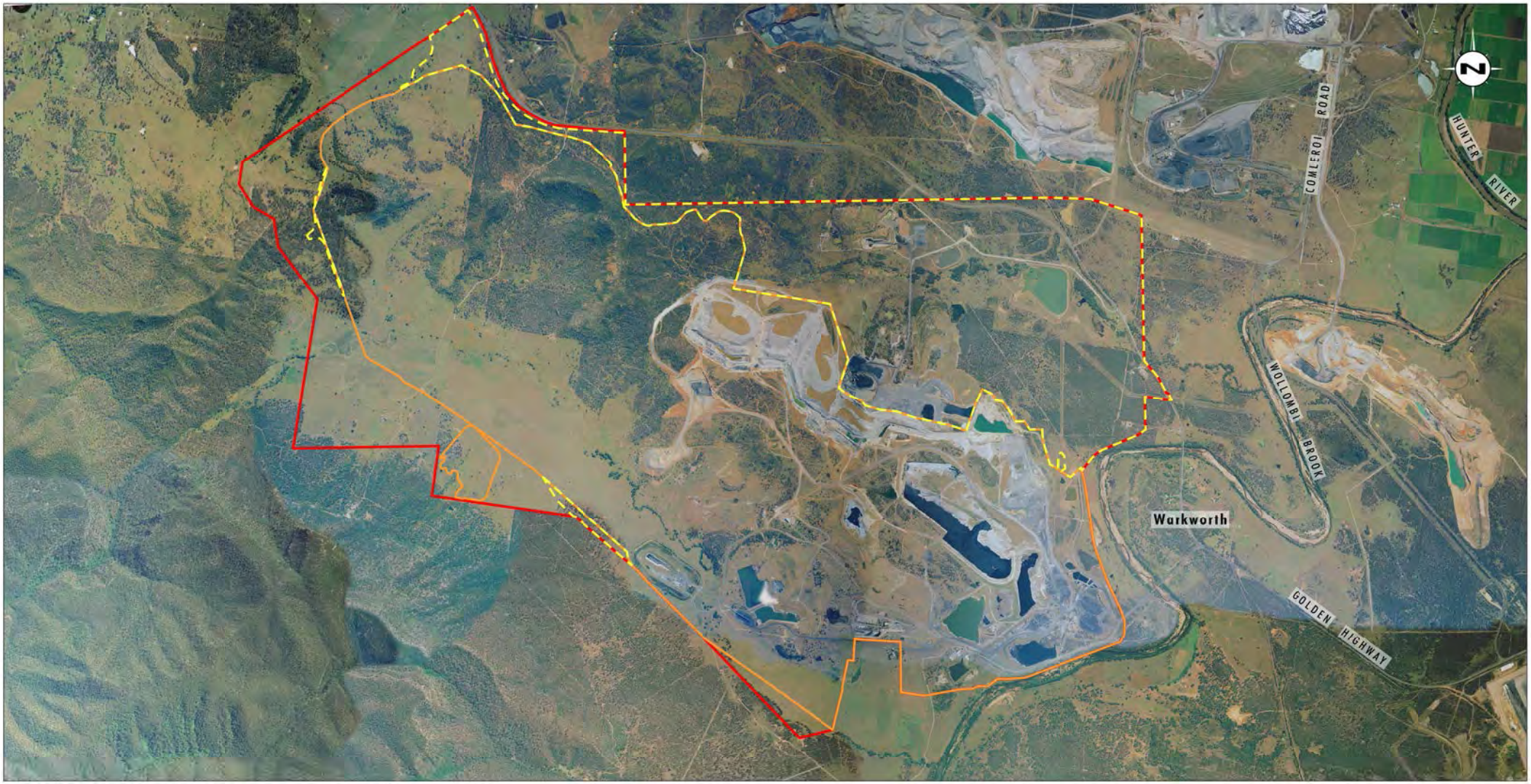

Image Source: Land and Property Management Authority
Base Data Source: Glencore (2015)

0 1.0 2.0 2.5km
1:50 000

Legend

- Project Area
- Approved Wambo Surface Development Area
- Conceptual Additional Disturbance Area

FIGURE 2.6

Aerial Photograph 2001

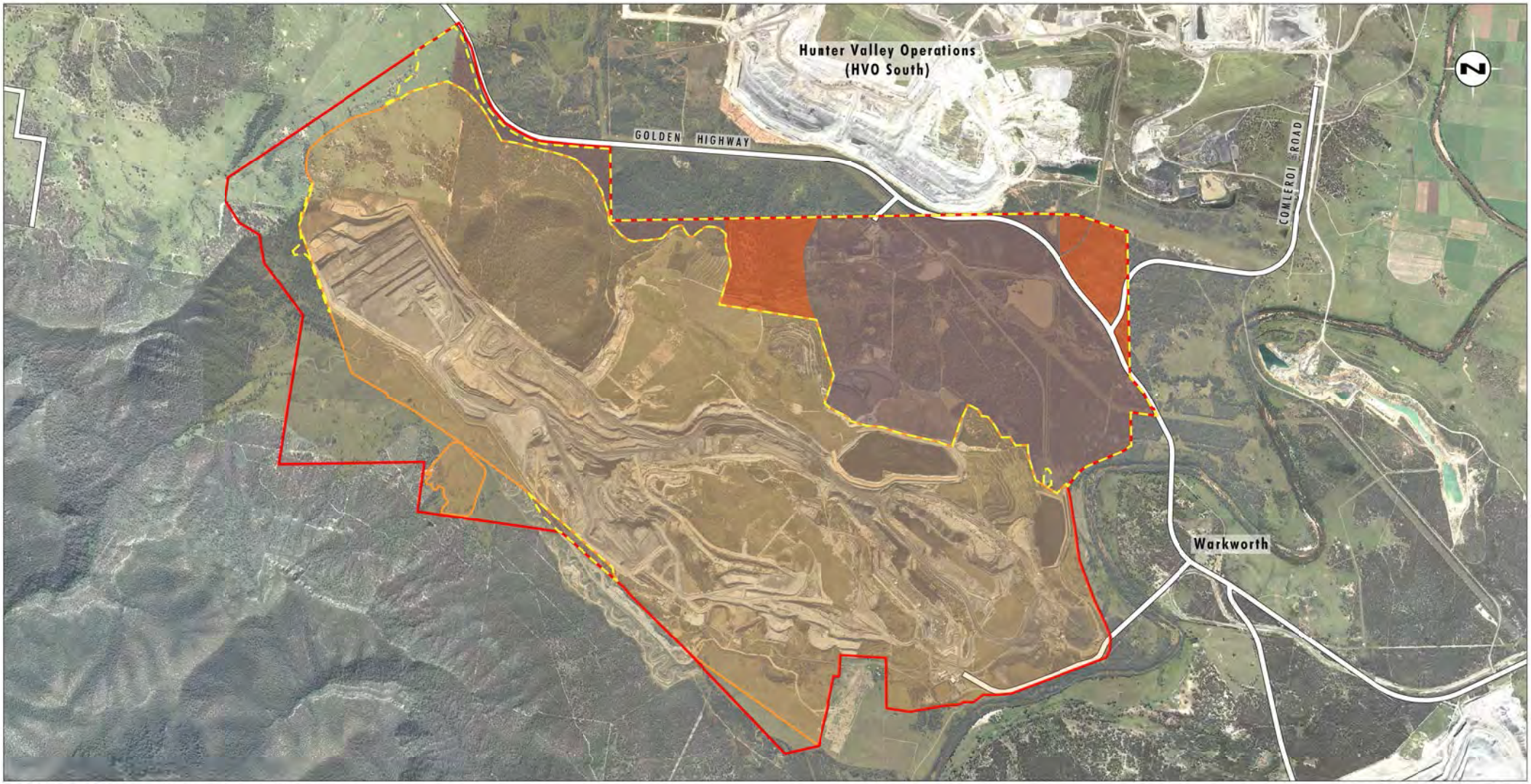

Image Source: AAM (2012), United (2015)
Data Source: Glencore (2014)

0 1.0 2.0 2.5km
1:50 000

Legend

- Project Area
- Conceptual Additional Disturbance Area
- Approved Wambo Surface Development Area
- Areas Impacted by Land Degradation
- Previously Disturbed Areas

FIGURE 2.7

Project Area Land Condition

File Name (A4): R07/3509_419.dgn
20160715 10:26

Dense remnant native vegetation

Ecological surveys and assessments which have been conducted for the Project Area identified areas of regenerating remnant vegetation. Widespread past clearing has resulted in most woodland areas being less than approximately 55 years in age with most woodland areas dominated by regenerating and middle-aged trees of less than 32 years of age.

The Project Area also contains large areas of cleared and disturbed land, and native vegetation communities providing woodland, riparian, shrubland and grassland habitat and rehabilitated communities. Due to widespread clearing within the local area, the vegetation within the Project Area is fragmented from other stands of vegetation within the landscape.

The additional disturbance area of approximately 714 hectares includes one critically endangered ecological community (CEEC) listed under the EPBC Act and five threatened ecological communities (EEC) listed under the *Threatened Species Conservation Act 1995* (TSC Act).

The CEEC and EEC coincide with the remnants of the original vegetation on the Project Area, which were cleared for agriculture but have since regenerated (refer to **Figures 2.2** to **2.6**).

Detailed soil survey has not been conducted in these portions with dense, good quality native vegetation, mapped as CEEC or EEC. It should be noted that these areas are part of the Jerrys Plains soil landscape. In the narrow strip along the northern boundary of the Project Area, slopes are mapped in the classes 10-20%, 20-33% or 33-50%. This is low LSC land (Class 5 at best), with low fertility, making it unsuitable for any form of intensive agriculture. These characteristics are discussed further in **Section 3.4.**

2.5.4.2 Soil assessment area for the purpose of agricultural impact assessment

The soil assessment for the AIS therefore focuses on the additional disturbance area in the northwest corner of the Project Area which will be associated with a minor extension of the Wambo Open Cut and ancillary mining infrastructure primarily water management structures, including a dam. For this part of the Project Area, the following factors have been taken into account in determining the soil sampling strategy for the Project:

- previous regional scale soil mapping (refer to **Section 3.4.1**), including mapping of BSAL and soil mapping conducted for previous environmental assessments in the locality
- slope and rockiness (refer to **Section 3.3**)
- evidence of land degradation from past land use (refer to **Figure 2.7** for areas affected by significant sheet erosion)
- size of individual patches of land that are not extensively affected by previous mining operations.

The additional disturbance area in the northwest corner of the Project Area is shown on **Figure 2.8**.

Three soil landscapes dominate the Project Area overall (refer to **Figure 2.9** and **Section 3.4.1**):

- Jerrys Plains – this soil landscape covers the majority of the Project Area.
- Bulga
- Benjang.

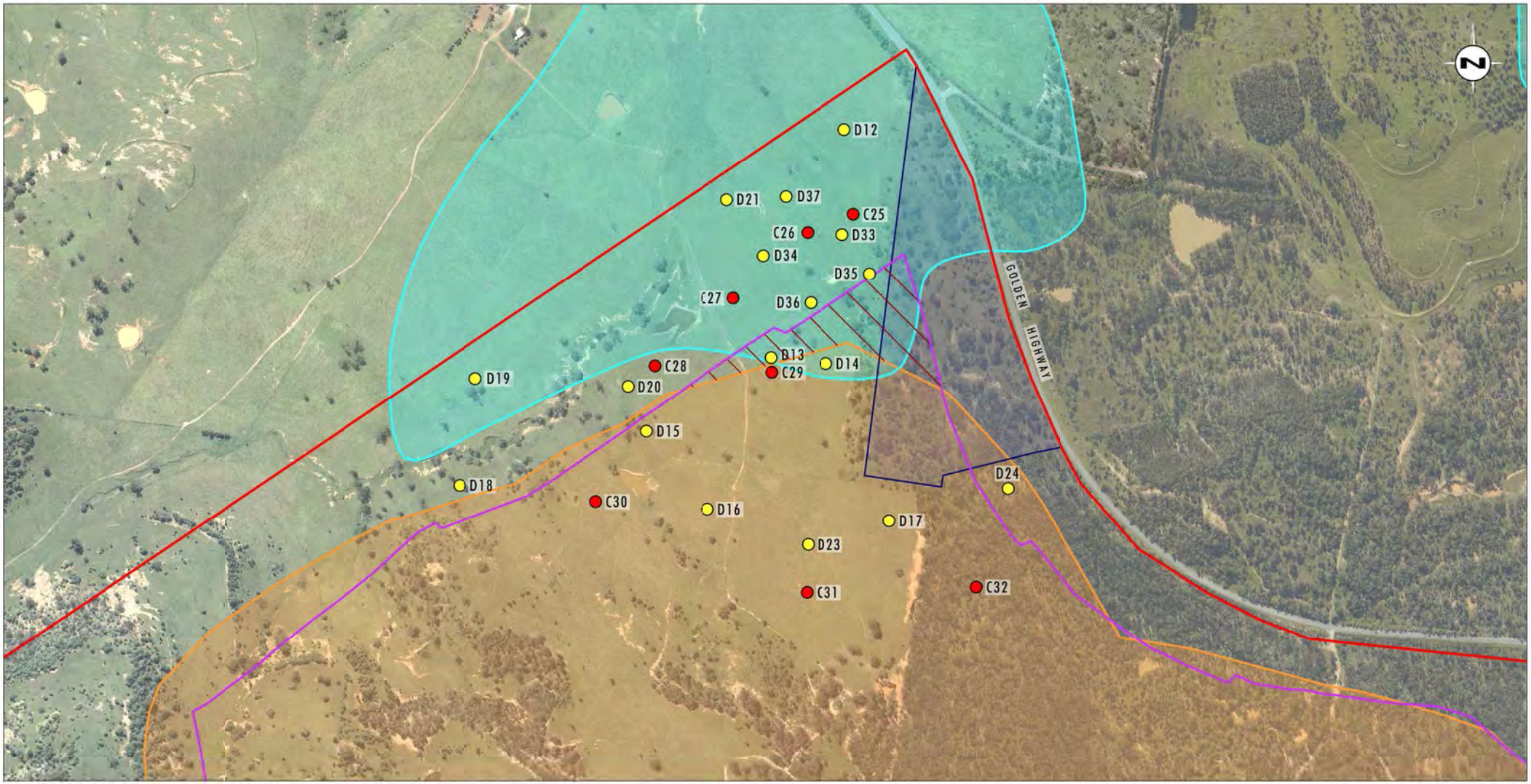

Image Source: AAM (2012), United (2015)
Data Source: Glencore (2014)

0 100 250 500m
1:10 000

Legend

- Project Area
- Proposed Wambo Open Cut Area
- Approved Wambo Surface Development Area
- Detailed SVC Assessment Area
- Crown Land (Access not Available)
- Regionally Mapped Biophysical Strategic Agricultural Land
- Detailed Sites
- Check Sites

FIGURE 2.8

Detailed Soil Assessment Sites and Check Sites in Northwest of Project Area

File Name (A4): R07/3509_418.dgn
20160322 15.22

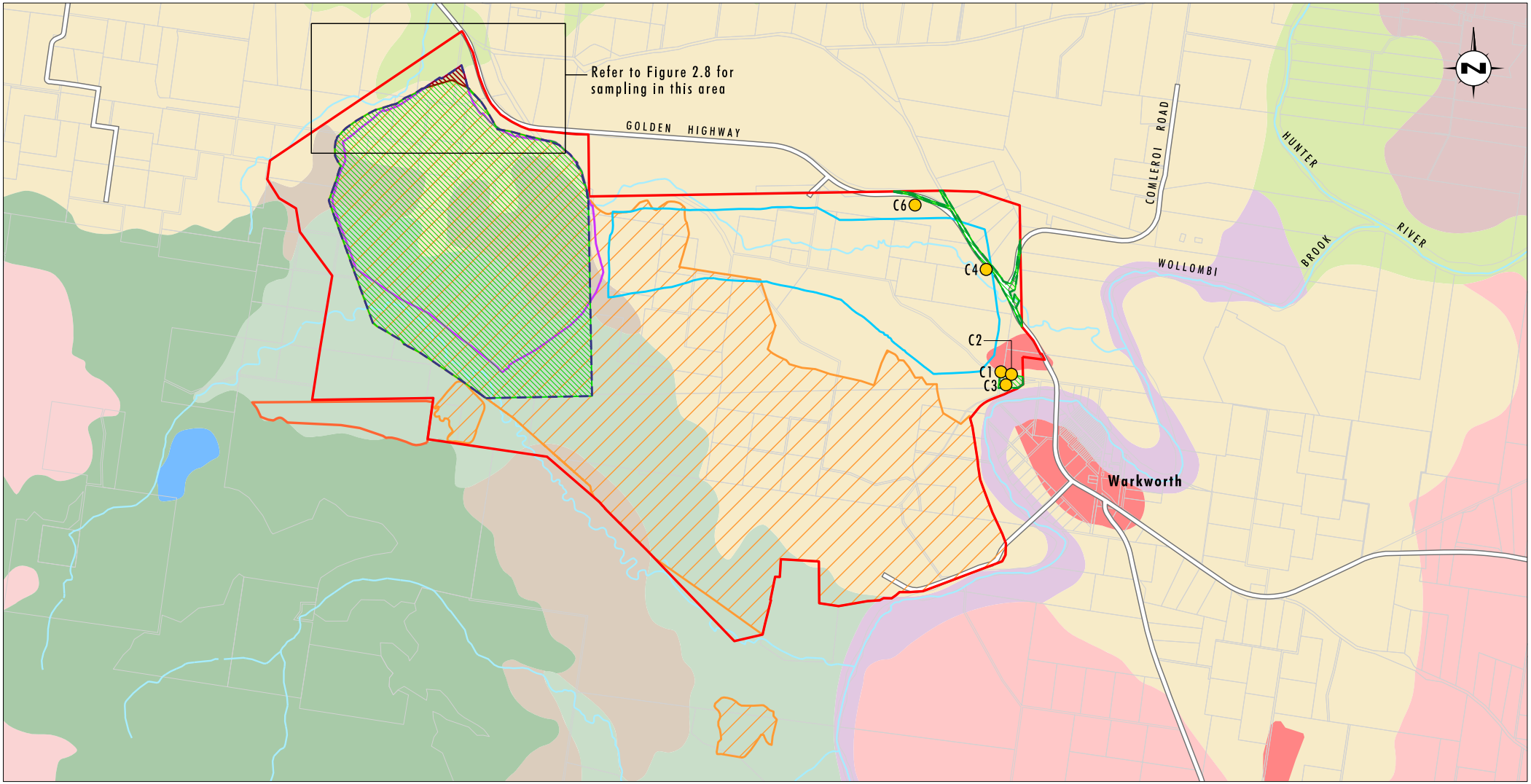

Image Source: United (2015)
Data Source: LPMA (2009), OEH (2013)

0 1.0 2.0 3.0km
1:60 000

Legend

- Project Area
- Proposed Conceptual United Open Cut Pit
- Proposed Conceptual Wambo Open Cut Realignment
- Approved Wambo Surface Development Area
- Soil Sampling Location
- Area Requiring New Subsurface Mining Lease
- Area requiring New Surface Mining Lease
- Verification Application Area
- Verification Assessment Area
- Wambo Offset Site
- Benjang Soil Landscape
- Branxton Soil Landscape
- Bulga Soil Landscape
- Hunter Soil Landscape
- Jerrys Plains Soil Landscape
- Lees Pinch Soil Landscape
- Ogilvie Soil Landscape
- Three Ways Soil Landscape
- Warkworth Soil Landscape

FIGURE 2.9

Soil Sampling Locations outside Detailed Verification Assessment Area

File Name (A4): R07/3509_351.dgn
20160525 14.05

These three soil landscapes and the mix of soil types within them are widespread in the central lowlands of the Hunter Valley and their character and limitations are well known. They are dominated by solodic (sodosol) soils with low to moderately low fertility and significant constraints such as sodicity and salinity. Detailed soil survey is not necessary to confirm the soil types, their land and soil capability and the constraints to agricultural use. There is evidence from a number of previous mining projects that post mining rehabilitation can readily achieve land and soil capabilities equivalent to the pre mining capability of these soils, which apart from a small area of Class 3 land, are Class 4 at best and frequently Class 5 to Class 7 (refer to **Section 3.4.4**).

There is limited value to be gained from detailed soil survey in this soil landscape. A small number of soil profiles were recorded (from shallow hand excavated pits) in the field and samples collected for testing, to illustrate the soil types and land and soil capability in this part of the Project Area. The soil profiles and soil qualities are reported in **Section 3.4**.

A small area of Hunter Soil Landscape (totalling approximately 32 hectares) is mapped at the regional scale in the northwest corner of the Project Area and within the additional disturbance area. This land is at the margin of the higher fertility Hunter Soil Landscape, where it intersects with the alluvial valley fills sourced from tributary catchments that drain the low fertility Jerrys Plains and Benjang Soil landscapes. A total of approximately 31.7 hectares of BSAL is regionally mapped in this locality, inside the Project Area boundary.

Because the mapped land in the Hunter Soil Landscape within the Project Area is at the extreme margin of the soil landscape, certainty about the accuracy of the mapping at the project scale is relatively low. Detailed soil investigations have focused in this area to provide higher resolution information about soil types, land and soil capability and land and soil constraints. The Site Verification Certificate (SVC) application lodged for the Project (refer to **Appendix A**) provides detailed information about soils in this area. Additional soil details are presented in **Section 3.4.4** of this report, to provide information about soils at the margin of the mapped Hunter Soil Landscape, that are within the Project Area but outside the SVC Application Area. This additional area, outside the SVC Application Area is 27.9 hectares.

2.5.4.3 Verification of Biophysical Strategic Agricultural Land

The majority of the Project Area is located within existing mining lease areas (refer to **Figure 2.10**), however further mining leases are required for the Project (refer to **Figure 2.9**). There are small portions of land within the boundary of CCL775 over which United Collieries does not hold relevant surface mining leases, primarily associated with the current route of the Golden Highway and small parcels of land in the south east corner of CCL775. A new mining lease is required for the proposed deeper mining below ML1572 although the area is already disturbed and covered by an existing surface mining lease. A SVC application has been prepared for this area (totalling 3.8 hectares) and a copy of the SVC Application report is included in **Appendix A**. The verification application area is shown in **Figures 2.8** and **2.9**.

The areas over which a new mining lease will be required have been refined as the Project has developed, to take into account the iterative refinement of the project design, including consideration of environmental values and to minimise conflicts with potential BSAL land.

Verification of the BSAL mapping was conducted in accordance with the criteria outlined in the *Interim Protocol for Site Verification and Mapping of Biophysical Strategic Agricultural Land* (OEH and OASFS 2013).

The Interim Protocol (NSW Government 2013) applies a 12 step verification process. The site must meet all 12 criteria, including being greater than 20 hectares in area to be assessed as BSAL. That is, if any of the conditions are not met, the site is rejected as BSAL and the remaining conditions are not assessed.

The SVC Application documents a program of field observations and sampling of soils in the SVC Application Area, particularly providing details about the actual extent of soil types that are consistent with the definition of BSAL as set out in the Interim Protocol (NSW Government 2013).

There are 31 hectares of BSAL mapped at the regional scale within the Project Area, including the SVC Application Area (3.0 hectares of BSAL, within a detailed assessment area of 3.8 hectares). Detailed field testing of soils in this area was conducted to ensure accurate mapping of higher quality soil resources and to inform planning of post mining land and soil resources and land uses.

United lodged a site verification certificate application in respect of the small section of the Project Area for which a mining lease is required on 11 May 2016. A site verification certificate was issued on 9 June 2016.

2.5.4.4 Summary of soil testing

Fieldwork for the soil survey, including verification of BSAL and survey to confirm land and soil capability in other relevant parts of the Project Area, was undertaken during 2015 and 2016.

Soil sampling locations and sampling statistics are shown **Figures 2.8** and **2.9** and **Table 2.3**.

Table 2.3 Soil Sampling Observations and Density in the Project Area

Location	Area (ha)	Detailed test pit Sites	Number of Soil Auger Sites	Laboratory Analysis Samples	Number of Mapping Observation Sites
Northwest corner, mapped as BSAL, outside SVC Application Area	27.9	D12, D18, D19, D20, D21, D33, D34, D35, D36, D37 (i.e. averaging 1 pit per 2.5 hectares)	C25, C26, C27, C28	From all detailed test pit sites Refer to **Section 3.4** and **Appendix A**	General observations across entire area
Relatively undisturbed land, not in CEEC/EEC and dense vegetation in proposed United Open Cut area	43.4 hectares	None	Shovel pits 1, 2, 3, 4, 5, 6 and 7 (refer to **Figure 2.9**)	Samples from A and upper B horizon from each of these shallow pits	General observations across this area and adjacent areas of CEEC/EEC

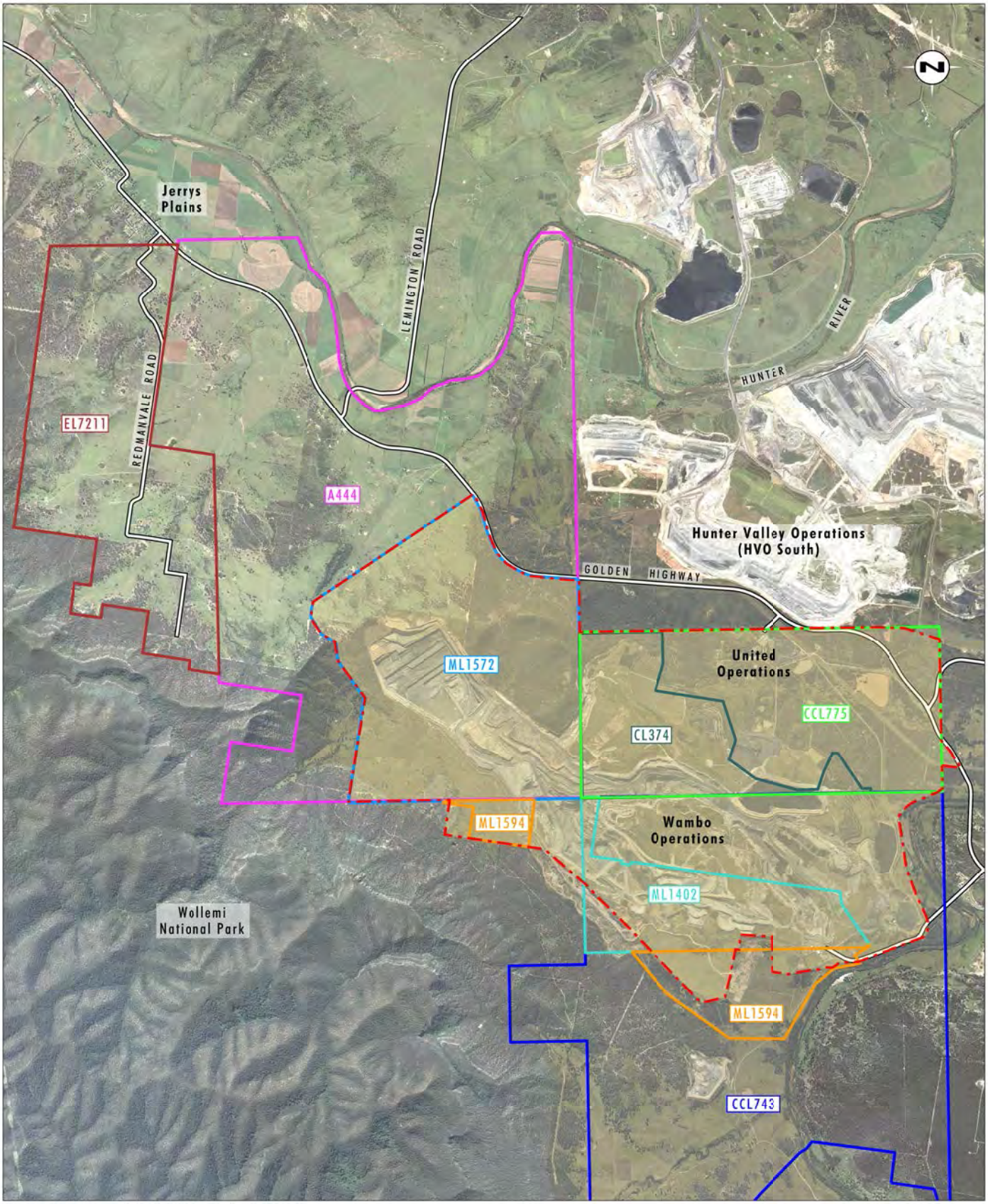

Image Source: AAM (2012), United (2015)
Data Source: Glencore (2015)

0 1.0 2.0 3.0km
1:70 000

Legend

- Project Area
- A444
- CL374
- CCL743
- CCL775
- EL7211
- ML1402
- ML1572
- ML1594

FIGURE 2.10

Existing Mining and Exploration Lease Titles

File Name (A4): R07/3509_269.dgn
20160407 11:03

2.6 Consultation

The AIS Guideline (DP&I, 2012b) requires information about engagement with stakeholders including landholders and government departments.

A comprehensive community and stakeholder engagement program was implemented during the preparation of the EIS. Relevant to the AIS, the engagement program included:

- survey and interviews with agricultural landholders in the locality
- open days/information days
- newsletters and web site delivery of information
- focus group workshops on particular issues
- meeting with NSW DPI Agriculture
- opportunities to make submissions during the preparation of the EIS and during exhibition of the EIS.

Surveys, interviews and workshops highlighted the following issues, concerns and opportunities in relation to agricultural resources and enterprises on the Project Area and in the locality:

- balancing the long term impacts to agriculture and benefits of mining in the region
- agricultural management of mine owned lands leased to third parties
- concerns that mined lands would be all rehabilitated for conservation instead of balancing agricultural land uses
- the historic connections of the locality to dairying, pasture and other agricultural land uses.

3.0 Agricultural Resources within the Project Area

At the regional scale, natural resources which are relevant to potential agricultural uses of the landscape have been mapped and documented in multiple studies in the Hunter Region over more than 30 years. Mapping of these resources is generally at scales of 1:100,000 to 1:250,000, suitable for distinguishing broad classes, spatial patterns and regional gradients of terrain, water supply, soil type and vegetation.

This section addresses matters covered under Item 2.1 of the AIS Technical Notes.

3.1 Vegetation of Project Area

As discussed in **Section 2.0**, virtually the entire Project Area has been cleared in the past, with the maximum area of vegetation clearance evident in aerial photographs from the 1980s.

The current distribution of vegetation types in the Additional Disturbance Area is shown in **Figure 3.1**. Much of this vegetation, including vegetation currently mapped as CEEC or EEC, is regrowth following extensive clearing in the twentieth century associated with dryland sheep and cattle grazing in the area.

Vegetation mapping of the Additional Disturbance Area was completed as part of the Upper Hunter Strategic Assessment (UHSA), undertaken in accordance with the relevant provisions of the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act). A total of 12 vegetation zones were identified across the additional disturbance area (refer to **Table 3.1**).

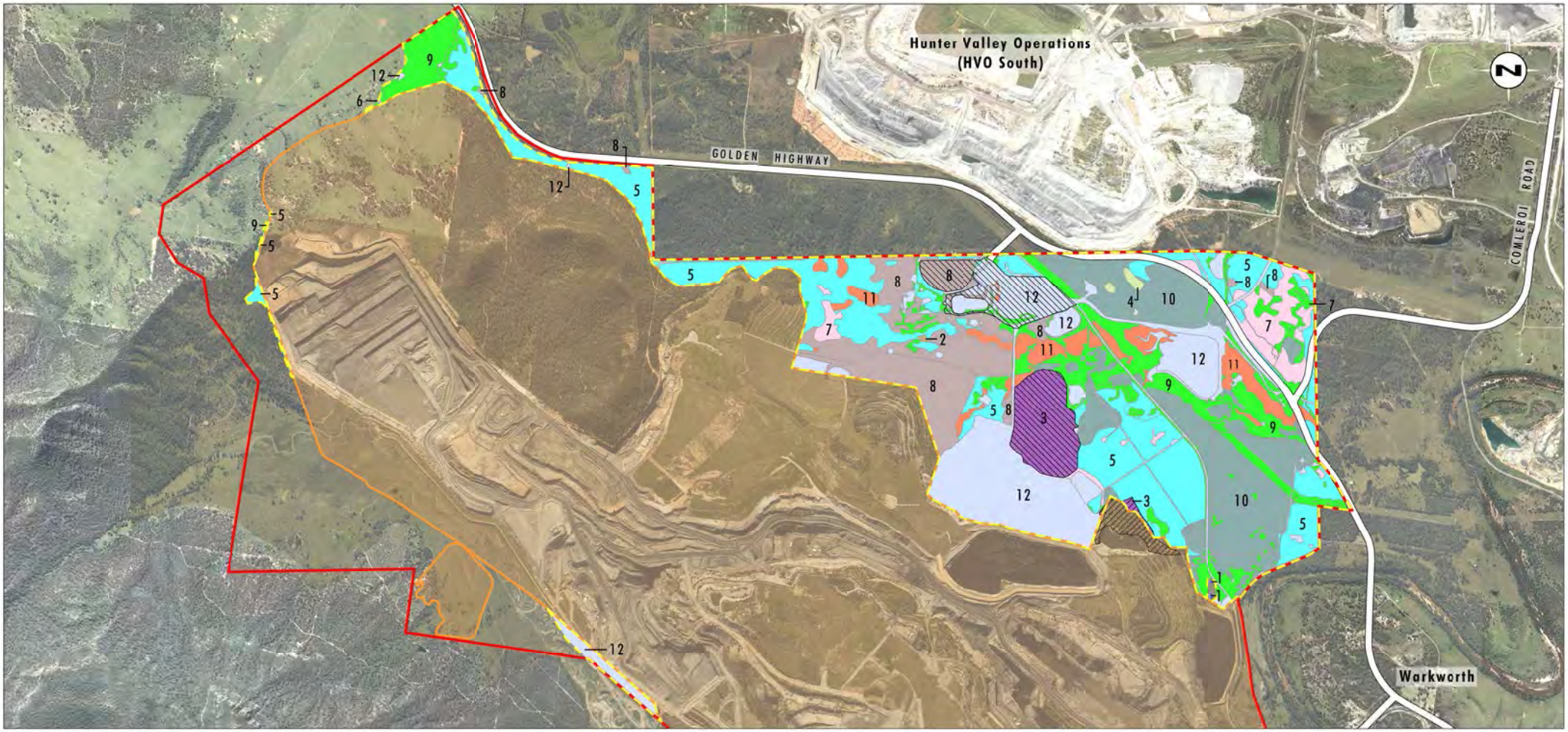

Image Source: AAM (2012), United (2015)
Data Source: Glencore (2014)

Legend

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

FIGURE 3.1

Vegetation Types of the Disturbance Area

File Name (A4): R07/3509_271.dgn
20160715 10:45

Table 3.1 Additional Disturbance Area Vegetation Zones

Vegetation Zone No.	Vegetation Zone	Area	Threatened Ecological Community
2	HU812 – Moderate to Good Condition Forest Red Gum grassy open forest on floodplains of the lower Hunter	0.29	Hunter Floodplain Red Gum Woodland EEC (TSC Act)
3	HU816 – Moderate to Good Condition – Plantation/Rehabilitation Spotted Gum - Narrow-leaved Ironbark shrub - grass open forest of the central and lower Hunter	29.42	Central Hunter Ironbark – Spotted Gum – Grey Box Forest EEC (TSC Act) 1.17 ha Central Hunter Valley Eucalypt Forest and Woodland CEEC (EPBC Act)
4	HU869 – Moderate to Good Condition Grey Box - Slaty Box shrub - grass woodland on sandstone slopes of the upper Hunter and Sydney Basin	1.56	Hunter Valley Footslopes Slaty Gum Woodland VEC (TSC Act) 1.13 ha Central Hunter Valley Eucalypt Forest and Woodland CEEC (EPBC Act)
5	HU905 – Moderate to Good Condition Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter	175.06	Central Hunter Grey Box – Ironbark Woodland EEC (TSC Act) 169.40 ha Central Hunter Valley Eucalypt Forest and Woodland CEEC (EPBC Act)
6	HU905 - Moderate to Good Condition - Thinned Canopy	0.08	Central Hunter Grey Box – Ironbark Woodland EEC (TSC Act) 0.08 ha Central Hunter Valley Eucalypt Forest and Woodland CEEC (EPBC Act)
7	HU905 – Moderate to Good Condition – Regeneration	26.77	Central Hunter Grey Box – Ironbark Woodland EEC (TSC Act) 23.01 ha Central Hunter Valley Eucalypt Forest and Woodland CEEC (EPBC Act)
8	HU905 – Moderate to Good Condition – Cooba Open Shrubland	80.89	N/A

Vegetation Zone No.	Vegetation Zone	Area	Threatened Ecological Community
9	HU905 – Low Condition – Derived Native Grassland	101.69	20.71 ha Central Hunter Valley Eucalypt Forest and Woodland CEEC (EPBC Act)
10	HU906 – Moderate to Good Condition Bull Oak grassy woodland of the central Hunter Valley	118.62	3.1 ha Central Hunter Grey Box – Ironbark Woodland EEC (TSC Act) 8.02 ha Central Hunter Valley Eucalypt Forest and Woodland CEEC (EPBC Act)
11	HU945 – Moderate to Good Condition Swamp Oak - Weeping Grass grassy riparian forest of the Hunter Valley	31.61	N/A
12	Cleared land (including disturbed land, mixed species revegetation plantation and water bodies)	149.97	N/A
Total		**714**	

HU### = Hunter Biometric Vegetation Type Number

As outlined in **Section 2.5.4**, the additional disturbance area of approximately 714 hectares includes one CEEC listed under the EPBC Act and five threatened ecological communities listed under the *Threatened Species Conservation Act 1995* (TSC Act), being:

- Central Hunter Valley Eucalypt Forest and Woodland CEEC (223.5 ha) (EPBC Act)
- Hunter Floodplain Red Gum Woodland EEC (0.29 ha) (TSC Act)
- Central Hunter Ironbark – Spotted Gum – Grey Box Forest EEC (29.4 ha) (TSC Act)
- Hunter Valley Footslopes Slaty Gum Woodland VEC (1.6 ha) (TSC Act)
- Central Hunter Grey Box – Ironbark Woodland EEC (205 ha) (TSC Act).

3.1.1 Vegetation of offset areas

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, in accordance with the UHSA. Vegetation communities within the Highfields, Mangrove and Wambo Offset Areas are shown on **Figures 3.2**, **3.3** and **3.4**.

These figures indicate the following features of the vegetation of the potential offset areas:

- The offset areas contain extensive areas of native vegetation in good condition.
- Exotic grassland, which could be considered as agricultural land (pasture) does not occur at Highfields, but there are areas of derived native grassland along Dry Creek. Approximately 9 hectares of exotic grassland is present on the Mangrove property. Mangrove also includes an area of poor condition derived native grassland, along Wybong Creek. There is no exotic grassland in the Wambo offset area.
- Poor quality derived native grassland at Mangrove is on land affected by soil degradation – notably salinity.
- The vegetation that is present in each of the offset areas includes a number of EECs which would limit future clearing options.
- The offset areas (particularly Highfields and Wambo) include steep land, including land with rock outcrop.

It is of note that areas of agricultural value within the proposed offset properties have been excluded and will not form part of the offset. It is intended that these areas will continue to be prioritised for agricultural use.

Further details regarding vegetation in the Project Area can be found in the UHSA Statement of Consistency Report (Umwelt 2016) for the Project.

It is noted that the Highfields Offset Site includes approximately 10 hectares of BSAL mapped on a regional scale. There is no regionally mapped BSAL within the Mangrove Offset Area and the Wambo Offset Area. As the Biodiversity Offset Strategy for the Project has not been formalised, verification of the BSAL within the Highfields Offset Site has not yet been completed.

Utilising the Highfields Offset Area as a biodiversity offset site does not change the BSAL properties, if any, of the area. Therefore, there would be no impacts to BSAL, if present, within the Highfields Offset Area as a result of the Project.

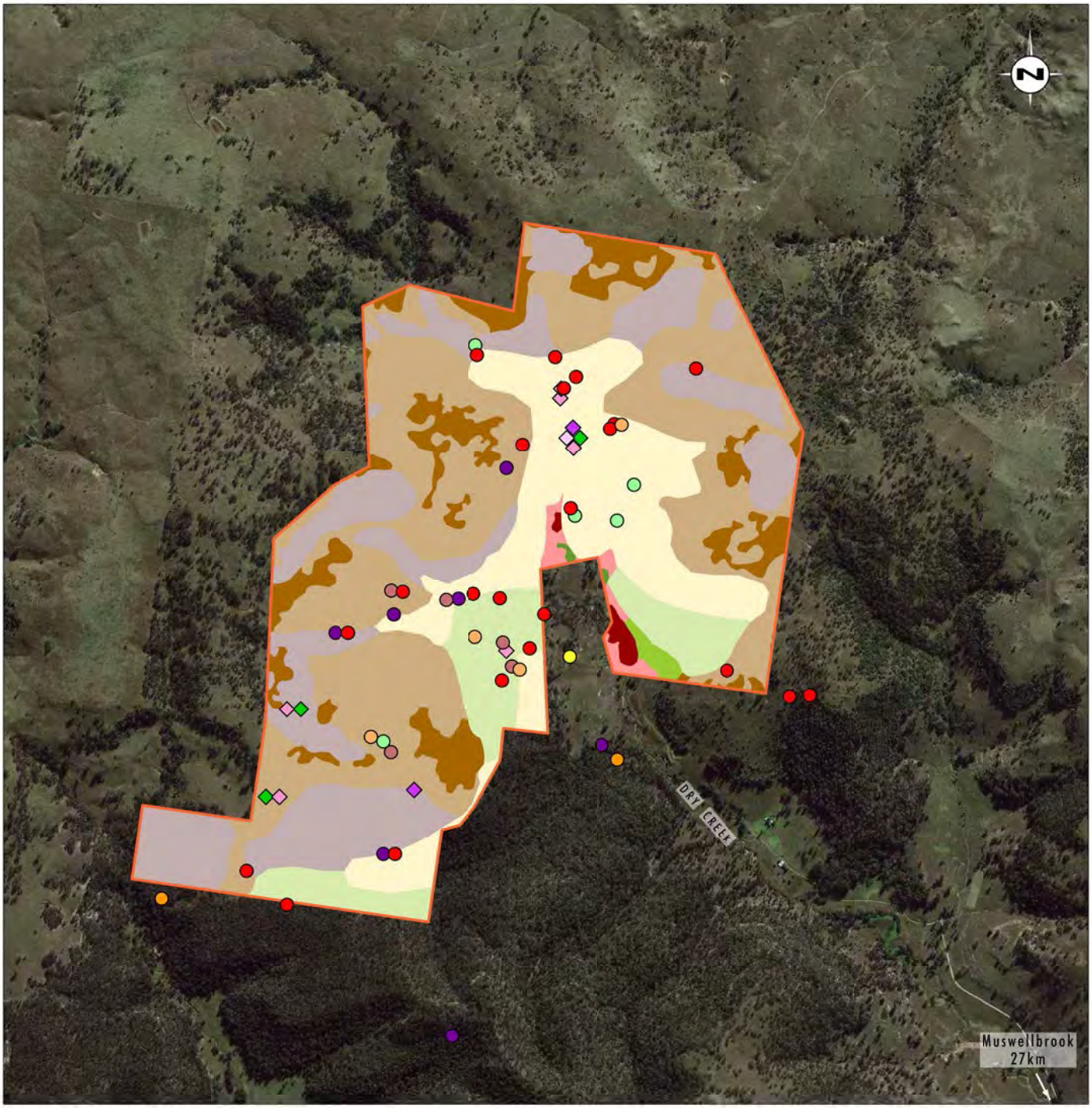

Image Source: Google Earth (2013)
Data Source: ATLAS (2016), Umwelt (2016), United (2015)

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Legend

- Highfields Offset Site
- 1 - HL701 - Narrow-leaved Ironbark +/- Grey Box grassy woodland of the upper Hunter Valley, mainly Sydney Basin Bioregion – Moderate to Good Condition
- 2 - HL701 - Moderate to Good Condition - Derived Native Grassland
- 3 - HL714 - 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
- 4 - HL730 - 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
- 5 - HL730 - Moderate to Good Condition - Shrubby Variant
- 6 - HL730 - Moderate to Good Condition - Derived Native Grassland
- 7 - HL821 - Blakely's Red Gum - Narrow-leaved Ironbark - Rough-barked Apple Shrubby Woodland of the upper Hunter - Moderate to Good Condition
- 8 - HL868 - Narrow-leaved Ironbark - Grey Gum Shrubby Open Forest on sandstone ranges of the upper Hunter Valley - Moderate to Good Condition
- 9 - HL868 - 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 3.2

Highfields Offset Site
Biodiversity Features

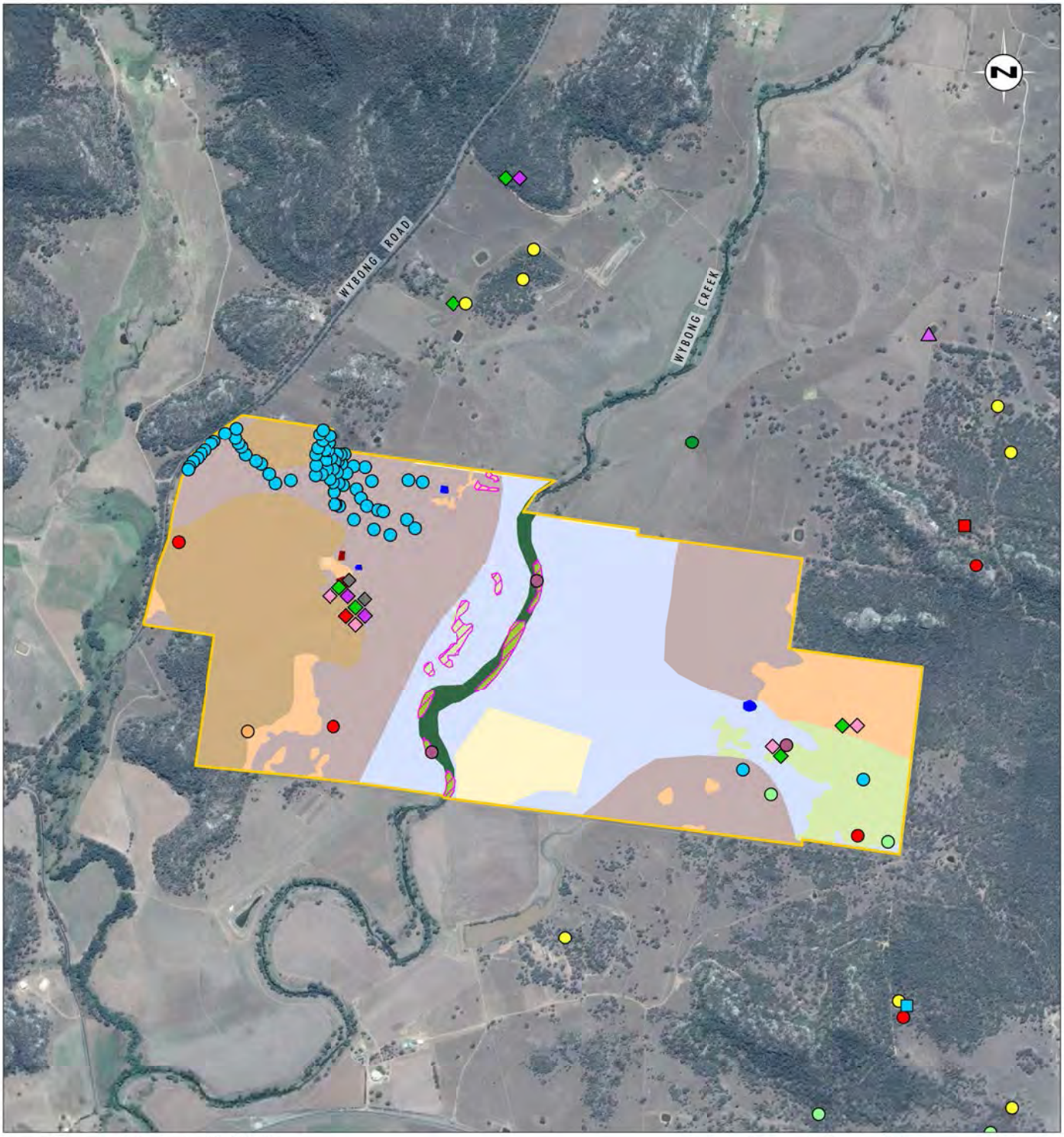

Image Source: Google Earth (2013)
Data Source: ATLAS (2016), Umwelt (2016), United (2015)

0 0.25 0.5 1.0km
1:20 000

Legend

- Mangrove Offset Site
- 1 - HL599 - River Red Gum / River Oak Riparian Woodland Wetland in the Hunter Valley - Moderate to Good Condition
- 2 - HL599 - Moderate to Good Condition - Derived Native Grassland
- 3 - HL678 - 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 - HL812 - Forest Red Gum Grassy Open Forest on Floodplains of the Lower Hunter - Moderate to Good Condition
- 5 - HL812 - Low Condition - Derived Native Grassland
- 6 - HL905 - Narrow-leaved Ironbark - Grey Box Grassy Woodland of the central and upper Hunter - Moderate to Good Condition
- 7 - HL905 - Moderate to Good Condition - Derived Native Grassland
- 8 - HL812 - 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
- Grey-crowned Babbler (eastern subspecies)
- Koala
- Large-eared Pied Bat
- Southern Myotis
- Speckled Warbler
- Square-tailed Kite
- Squirrel Glider
- Varied Sittella
- Yellow-bellied Sheathtail-bat

FIGURE 3.3

Mangrove Offset Site Biodiversity Features

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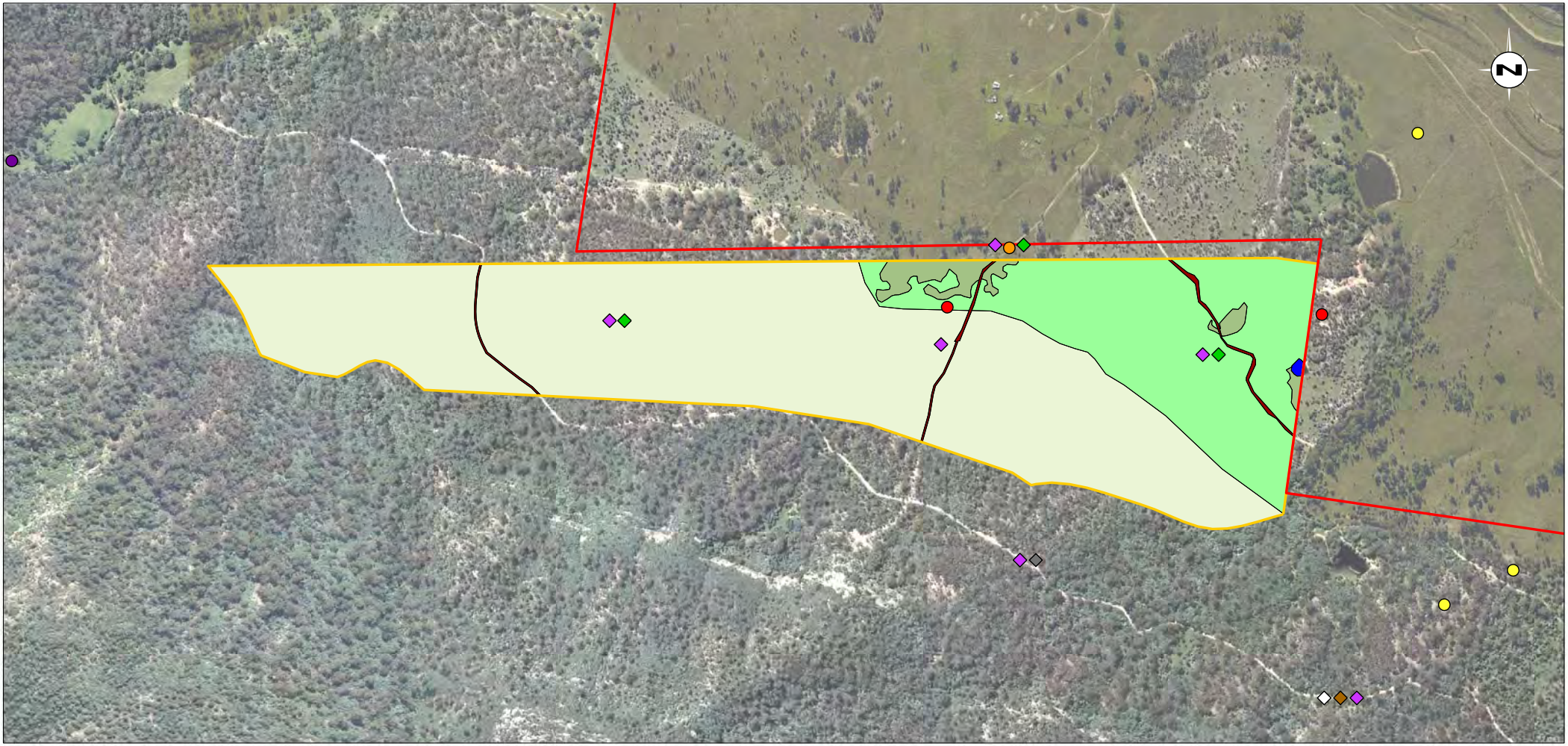

Image Source: Google Earth (2013)
Data Source: ATLAS (2016), Umwelt (2016), United (2015)

Legend

- Project Area
- Wambo Offset Site
- 1 - HU817 - Narrow-leaved Ironbark - Bull Oak - Grey Box Shrub - Grass Open Forest of the central and lower Hunter - Moderate to Good Condition
- 2 - HU817 - Moderate to Good Condition - Derived Native Grassland
- 3 - HU869 - Grey Box - Slaty Box Shrub-Grass Woodland on sandstone slopes of the upper Hunter and Sydney Basin - Moderate to Good Condition
- Cleared Land
- Water Body
- East-coast Freetail-bat
- Eastern Bentwing-bat
- Grey-crowned Babbler (eastern subspecies)
- Hooded Robin (south-eastern form)
- Large-eared Pied Bat
- Little Bentwing-bat
- Little Lorikeet
- Speckled Warbler
- Yellow-bellied Sheathtail-bat

FIGURE 3.4

Wambo Offset Site
Biodiversity Features

File Name (A4): R07/3509_417.dgn
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3.2 Water Resources of the Project Area

The Project Area is located within the catchments of Wollombi Brook and Waterfall Creek, which are both tributaries of the Hunter River. The majority of the Project Area lies within the Wollombi Brook catchment. Wollombi Brook is located to the east and south of the Project Area and flows into the Hunter River approximately 5 kilometres northeast of 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 (refer to **Figure 3.5**). The existing United Mine and Wambo Mine Water Management Systems (WMS) 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 flows in a generally south-easterly direction through and along the southern flank of the Project Area, 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 to the Hunter River. Redbank Creek flows through the centre of the United Mine site and into a clean water catch dam, with United Collieries holding a licence to use water from this dam for mining operations.

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 Project Area does not have frontage to the Hunter River. Agricultural land on the Hunter floodplain, north of the Project Area is irrigated with water from the Hunter River and/or local groundwater.

Waterfall Creek, North Wambo Creek and Redbank Creek are all ephemeral drainage lines, with no flow or limited flow for much of the year. The condition of these tributaries has been significantly degraded by past land use, including changes to channel form, bank erosion and loss of intermittent deeper pools that could hold water through the summer season.

In the northwest corner of the Project Area, water resources for grazing are provided by a series of dams constructed on low order drainage lines. In non drought periods, these contain water through all seasons. Also in the northwest corner of the Project Area there are scattered 'pools' across the area where tributary alluvial has merged with the outer margin of Hunter alluvium over a very long period. These may hold water through the winter and are indicative of occasional water-logging of this very low gradient area.

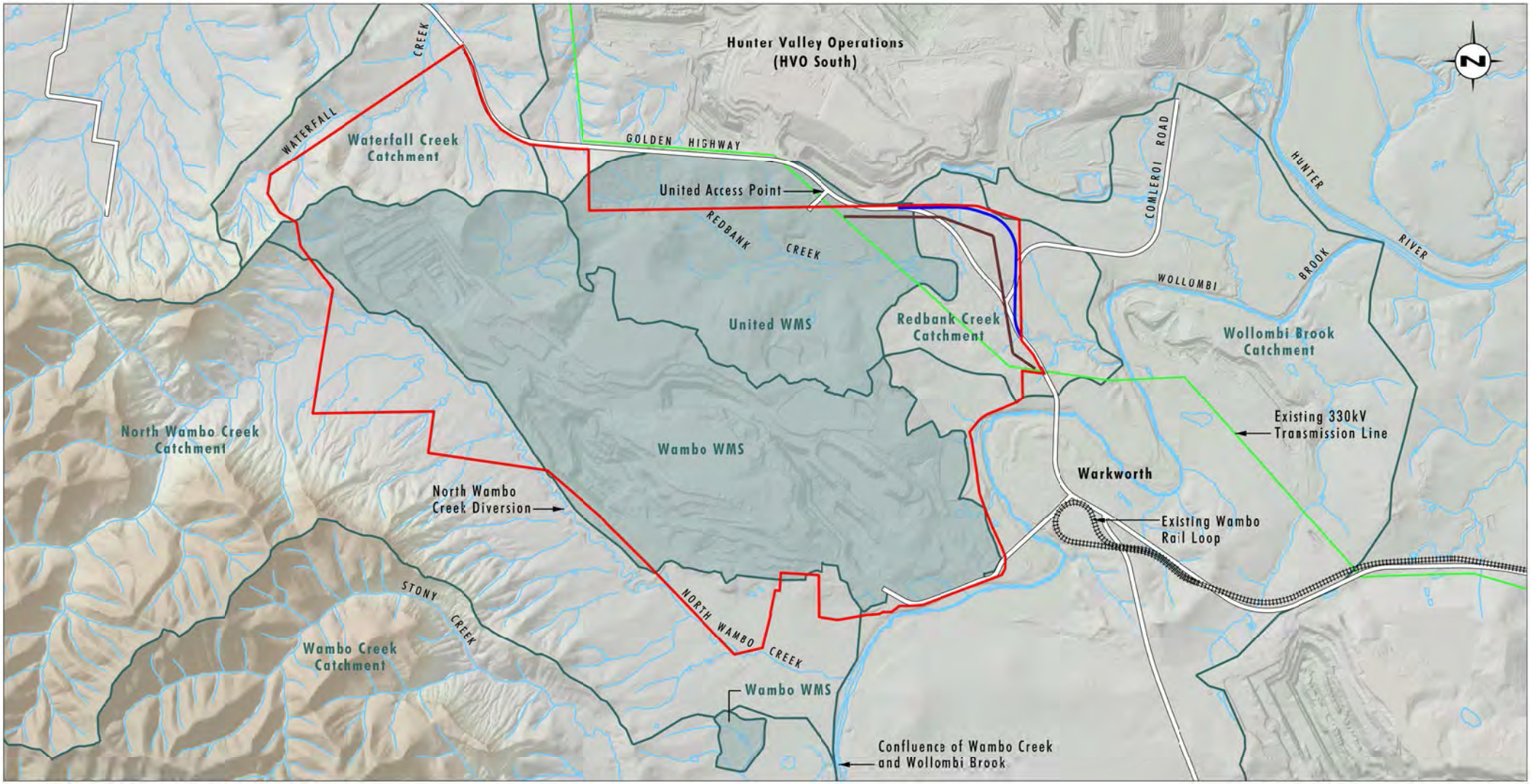

Image Source: AAM (2012), United (2015)
Data Source: Glencore (2014)

Legend

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

FIGURE 3.5

Project Area
Surface Water Catchment Context

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3.3 Landform, slope and presence of rock in the Project Area

Slope and terrain units within the Project Area have generally been determined from a detailed Digital Terrain Model (DTM), which was derived from LiDAR data (aerial laser scanning, dated 2012). **Figure 3.6** shows slopes across the Project Area and the immediate locality. **Figure 3.7** shows more detailed terrain characteristics for the northwest corner of the Project Area, where survey effort has been concentrated.

The DTM enables rapid preparation of contours and calculation of slope angle and slope form. Slope forms and landforms have also been described in the field during the detailed soil survey.

The natural landforms of the overall Project Area include undulating flat and terraced slopes, low hills, rolling steeper hills and steeper slopes with rock outcrop including boulders and low cliffs. These landforms reflect the interbedded sandstones, conglomerates, mudstones and tuffs from the Singleton Coal Measures which underlie the site.

In the proposed United Open Cut, slope classes are almost exclusively within the range from 1 to 10%. There are very small patches of slopes of 25% or more. Slopes remaining after past open cut mining operations in disturbed parts of the Project Area include steep slopes, rock benches, undulating hills and some flat areas (refer to **Figure 3.6**).

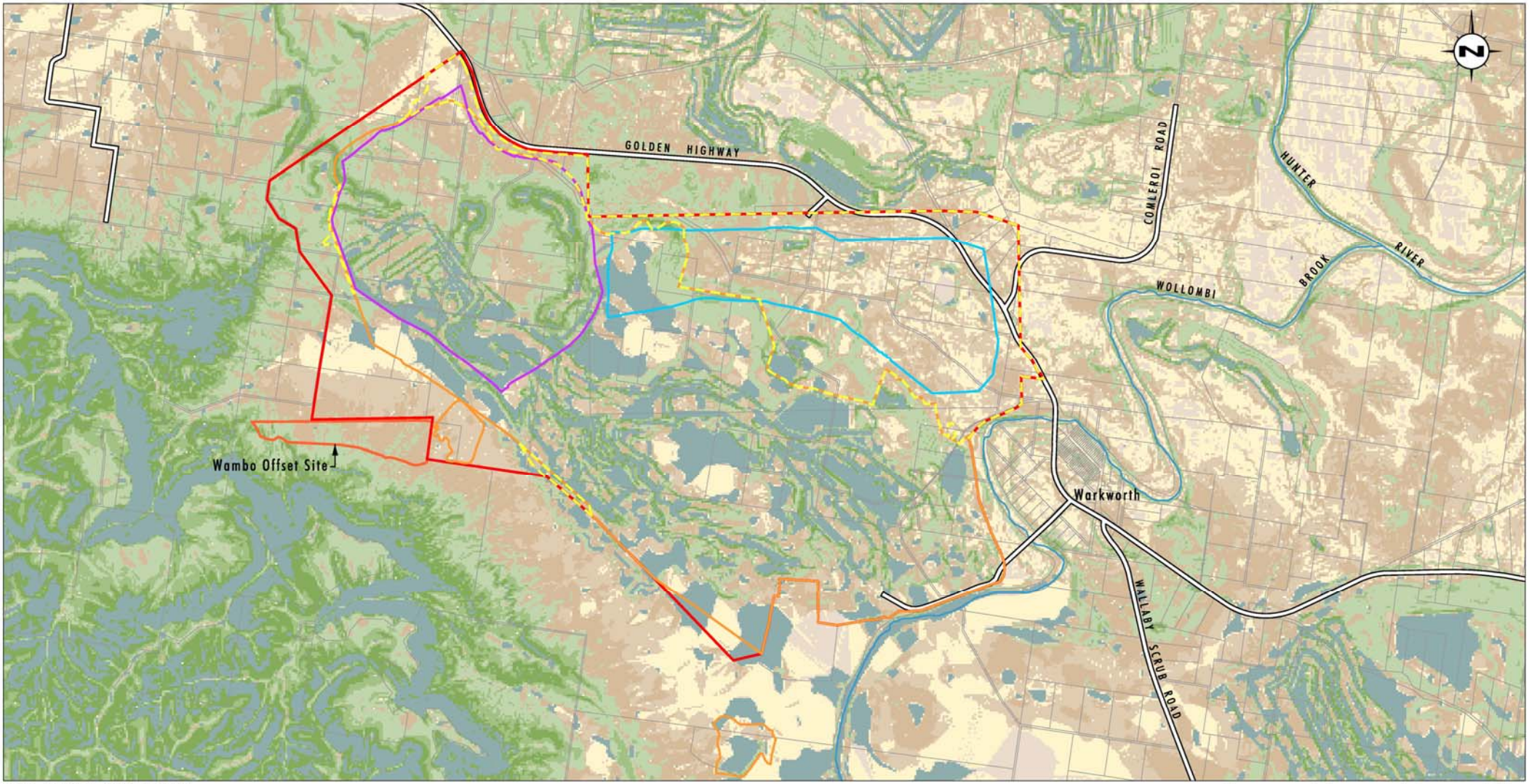
The northwest corner of the Project Area where detailed assessment of agricultural resources has been conducted (refer to **Figure 3.7**) has gentle slopes (generally 1-3% and 3-5%), either as extensive mid slope benches or as footslopes that intergrade with alluvial materials in tributary drainage line valley fills. There is generally no bedrock outcrop on these slopes, but surface float of cobbles to small boulders may be present and bedrock is present at shallow depths on the benches, impeding drainage.

Table 3.2 describes and quantifies the area occupied by each slope class within the additional disturbance area, as shown in **Figure 3.6**.

Table 3.2 Distribution of Slope Classes in the Additional Disturbance Area

Slope Class*	Area occupied within the Additional Disturbance Area (ha)
<1% (Class 1)	18.8
1-3% (Class 2)	137.8
3-5% (Class 3)	209.6
5-10% (Class 3)	207.5
10-20% (Classes 4 and 5)	98.0
20-33% (Class 6)	12.5
33-50% (Class 7)	5.2
>50% (Class 8)	24.2

* Corresponding Land and Soil Classification Class (if no other constraints are present) shown in brackets



Data Source: OEH (2013)

0 1.0 2.0 3.0km
1:60 000

Legend

- Project Area
- Conceptual Additional Disturbance Area
- Approved Wambo Surface Development Area
- Proposed Conceptual United Open Cut Pit
- Proposed Conceptual Wambo Open Cut Realignment
- Wambo Offset Site

Slope Ranges:

- <1%
- 1-3%
- 3-5%
- 5-10%
- 10-20%
- 20-33%
- 33-50%
- >50%

FIGURE 3.6

Slopes across Project Area and Locality

File Name (A4): R07/3509_146.dgn
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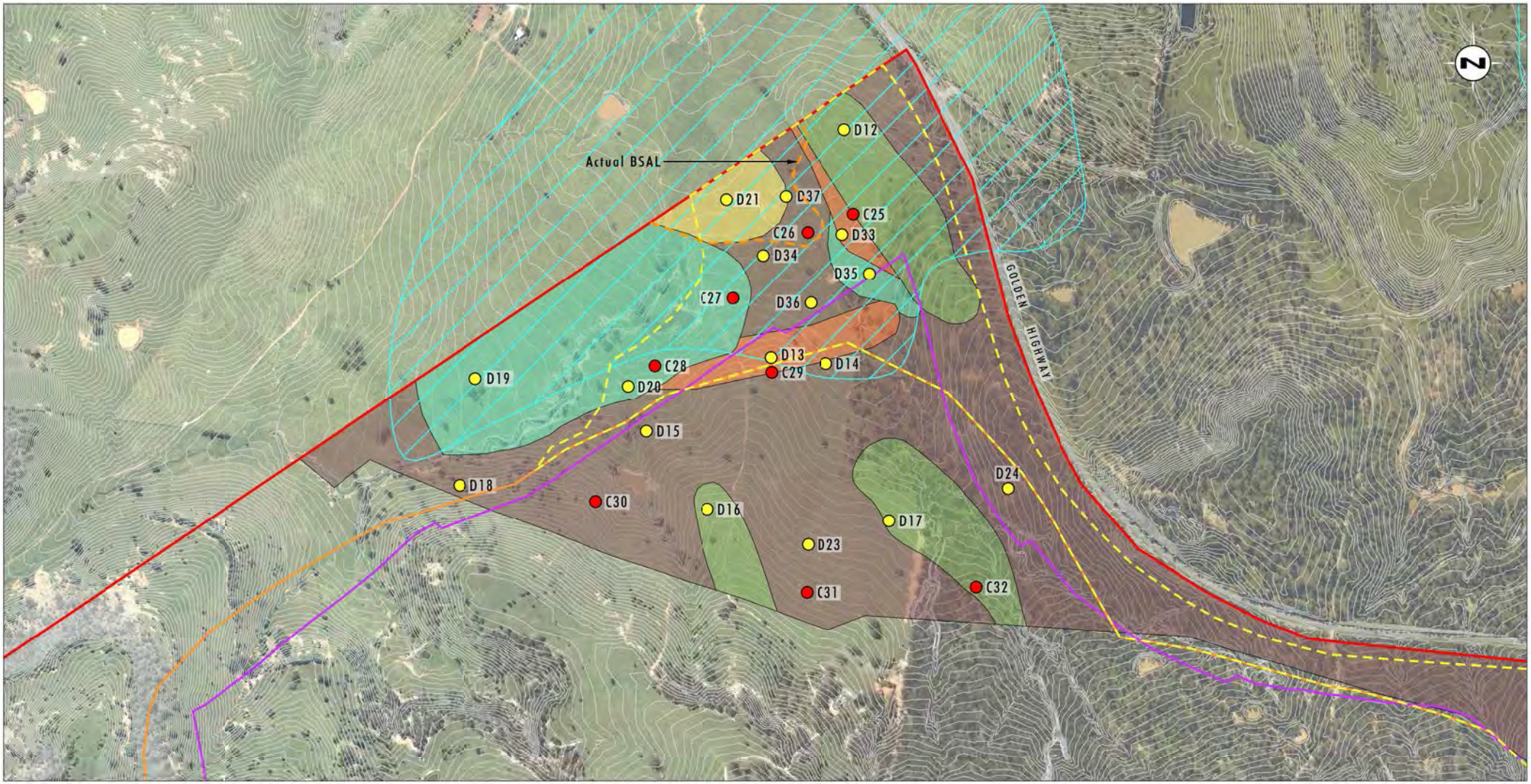


Image Source: AAM (2012), United (2015)
Data Source: Glencore (2014)
Note: 1m Contour Interval

0 100 250 500m
1:10 000

Legend

- Project Area
- Approved Wambo Surface Development Area
- Conceptual Additional Disturbance Area
- Proposed Open Cut Area
- Regionally Mapped Biophysical Strategic Agricultural Land
- Confirmed Actual BSAL - within Project Area
- Epipedal Vertosol
- Eutrophic Dermosol
- Eutrophic Chromosol
- Mesonatric Sodosol
- Subnatric Sodosol
- Detailed Sites
- Check Sites

FIGURE 3.7

Land Characteristics and Sampling Details, Northwest of Project Area

File Name (A4): R07/3509_245.dgn
20160322 16:32

Table 3.3 shows areas of slope classes in the northwest corner of the Project Area.

Table 3.3 Slope classes in northwest corner of Project Area

Slope Class*	Area occupied within the northwest corner of the Project Area (ha)
<1% (Class 1)	2.0
1-3% (Class 2)	22.6
3-5% (Class 3)	24.1
5-10% (Class 3)	15.8
10-20% (Classes 4 and 5)	1.1
20-33% (Class 6)	0.1
33-50% (Class 7)	0

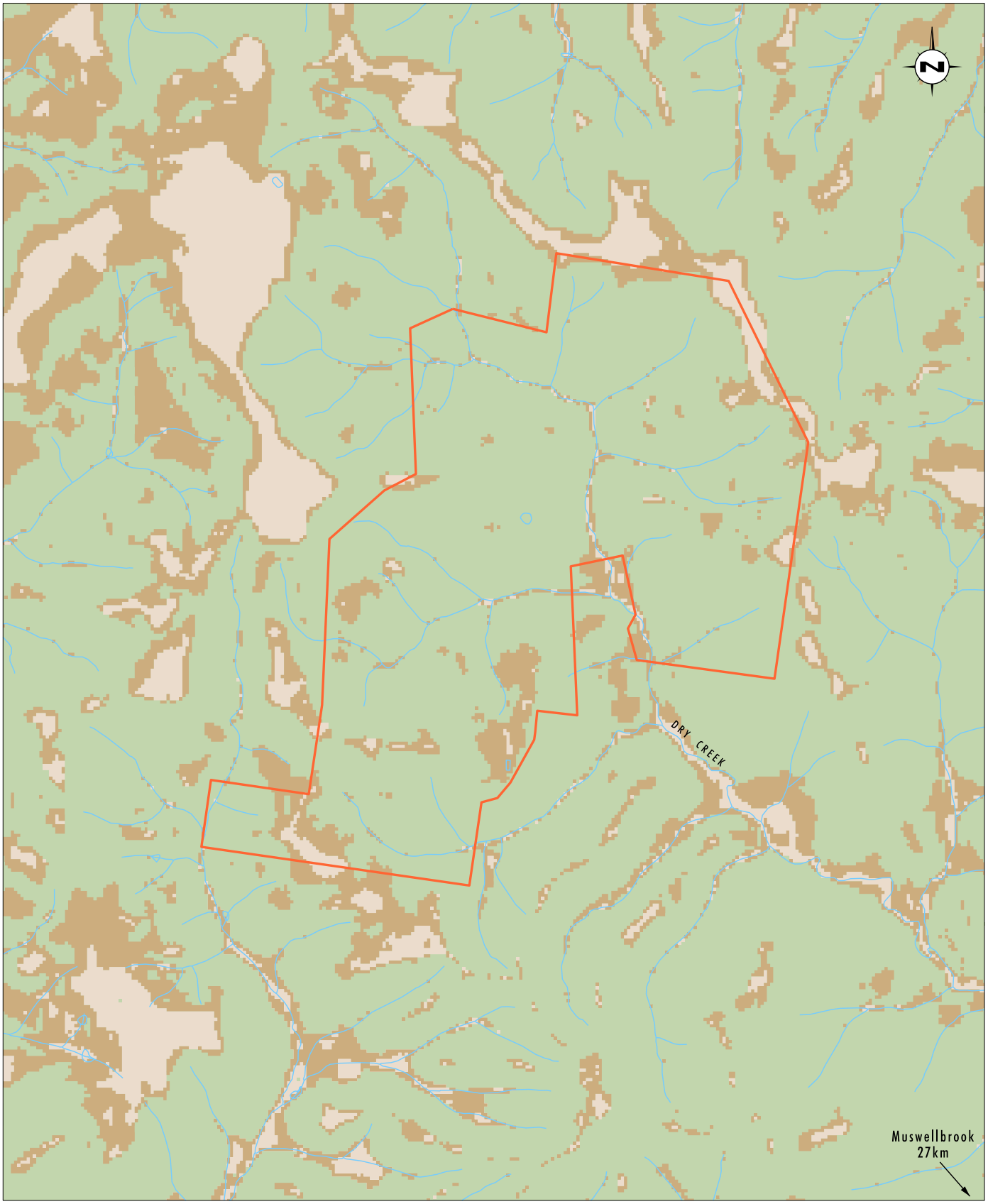
* Corresponding Land and Soil Classification Class (if no other constraints are present) shown in brackets

Table 3.4 summarises the distribution of slopes in the three offset areas, based on **Figures 3.8** and **3.9**.

Table 3.4 Distribution of slope classes in offset areas

Slope class	Area occupied, Highfields (hectares)	Area occupied, Mangrove (hectares)	Area occupied, Wambo (hectares)
<5%	10.6	132.9	2.9
5-10%	43.0	64.3	34.0
>10%	379.9	61.7	19.4

*Land with slope class of >10% cannot be classified greater than Class 4.



Data Source: United (2015), LPI (2009)

0 0.5 1.0 1.5km

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Legend

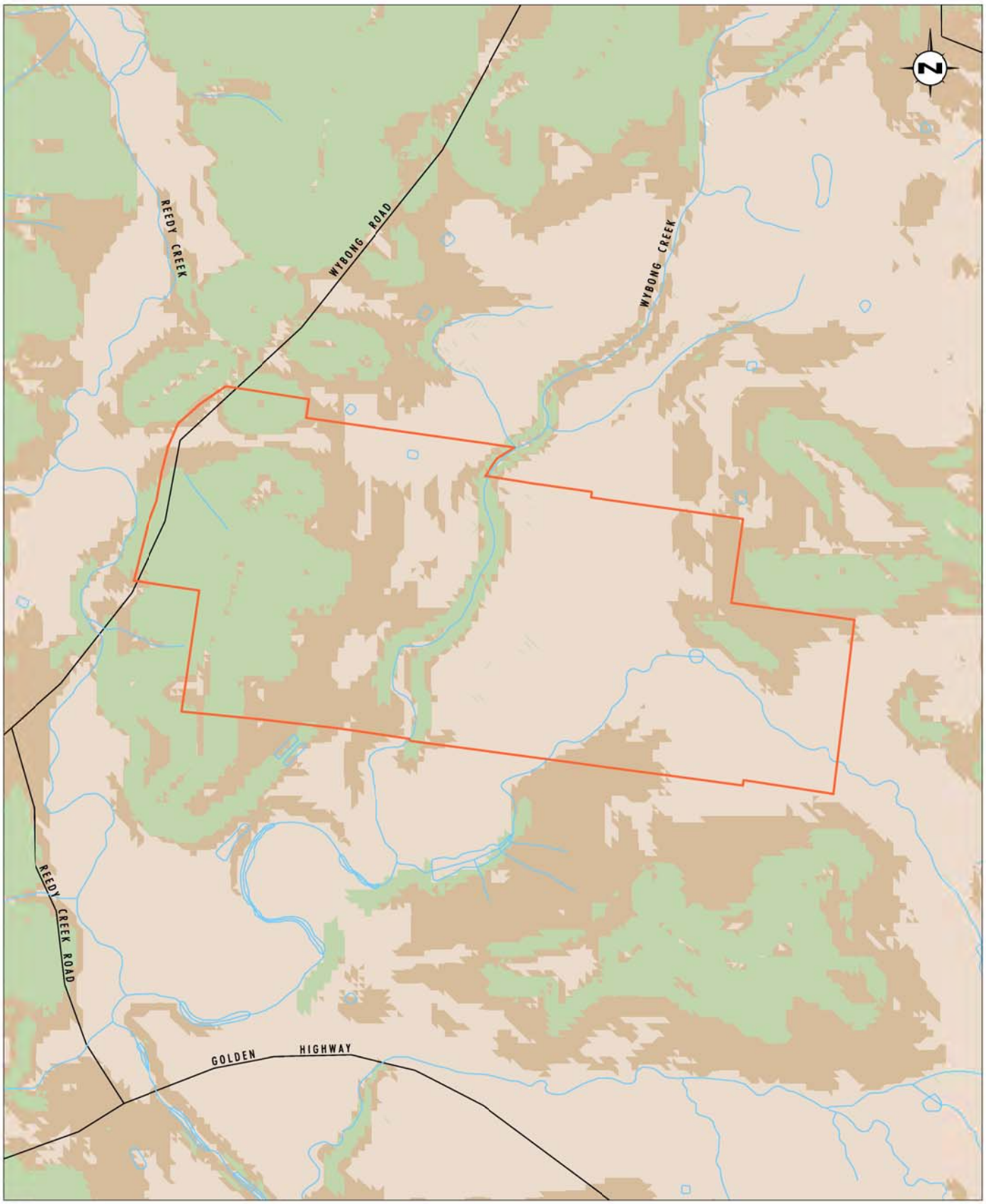
- Highfields Offset Site

Slopes:

- <5%
- 5 to 10%
- >10%

FIGURE 3.8

Highfields Offset Site Slopes



Data Source: Office of Environment and Heritage (OEH) SRLUP Mapping (2012), LPI (2009)

0 0.25 0.5 1.0km
1:20 000

Legend

- Mangrove Offset Site

Slopes:

- <5%
- 5 to 10%
- >10%

FIGURE 3.9

Mangrove Offset Site Slopes

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3.4 Soil Types and Soil Fertility of the Project Area

3.4.1 Soil landscapes of the Project Area and offset areas

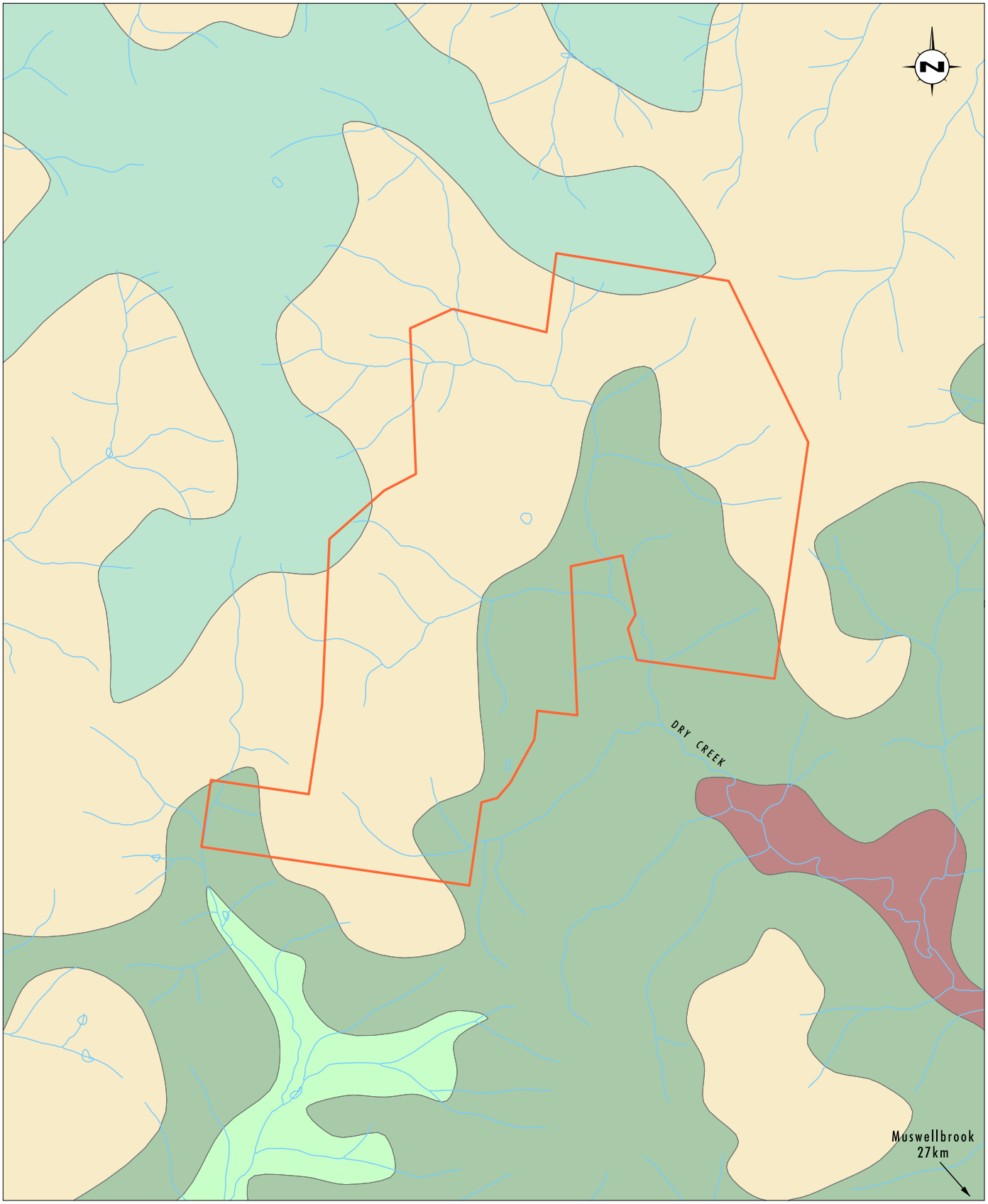
Soil landscapes are defined by distinctive associations of terrain, soil and vegetation at the landscape scale which provide an integrated picture of the physical character of the landscape.

For the Upper Hunter region, soil landscape mapping and descriptions were completed by Kovac and Lawrie (1991) at a scale of 1:250,000. The soil landscapes relevant to the Project Area and offset areas are detailed below (refer to **Table 3.5**) and shown in **Figures 2.9** (for the Project Area), **3.10** and **3.11**. Key conclusions from this regional scale information regarding the landscape of the Project Area, including the additional disturbance area and the broader Project Area, include:

- The soils of the Project Area are dominated by the Jerrys Plains soil landscape. Soils are generally texture contrast profiles of varying depths, and have low fertility. They are subject to a number of hazards that affect their suitability for agricultural uses, including salinity, structural decline, susceptible to sheet erosion and potential for poor drainage and waterlogging. The small detailed assessment areas for the agricultural resources of the Project Area are within the Jerrys Plains soil landscape.

- A small area close to the margin of the Hunter Soil Landscape is mapped at the regional scale in the northwest corner of the Project Area. The soil types of the Hunter Soil Landscape are the deep alluvial loams on the Hunter River floodplain. These soils are also mapped as BSAL in the Upper Hunter SLRUP. The alluvial valley fills of tributaries of the Hunter River are also mapped in the Hunter Soil Landscape at the regional scale. Detailed soil survey and testing prepared for the Project demonstrates that a maximum of only 3.8 hectares of the soil within the Project Area meets the requirements for BSAL (refer to **Section 3.4.5.2**). **Section 3.4.5** provides details of the SVC assessment and other detailed soil survey in the northwest corner of the Project Area.

- Regional scale mapping of soil types in the potential offset areas for the Project indicates diverse profile forms and levels of fertility. However the land and soil capability class is consistently class 4, and is often class 5, 6, 7 or 8. These soils are highly constrained in terms of agricultural uses.



Data Source: Xstrata (2009)

0 0.5 1.0 1.5km

1:25 000

Legend

- Highfields Offset Site
- Regional Soil Landscapes Mapping:
  - Ant Hill Soil Landscape
  - Bow Soil Landscape
  - Lees Pinch Soil Landscape
  - Sandy Hollow Soil Landscape
  - Merriwa Soil Landscape

FIGURE 3.10

Highfields Offset Site
Regional Soil Landscapes Mapping

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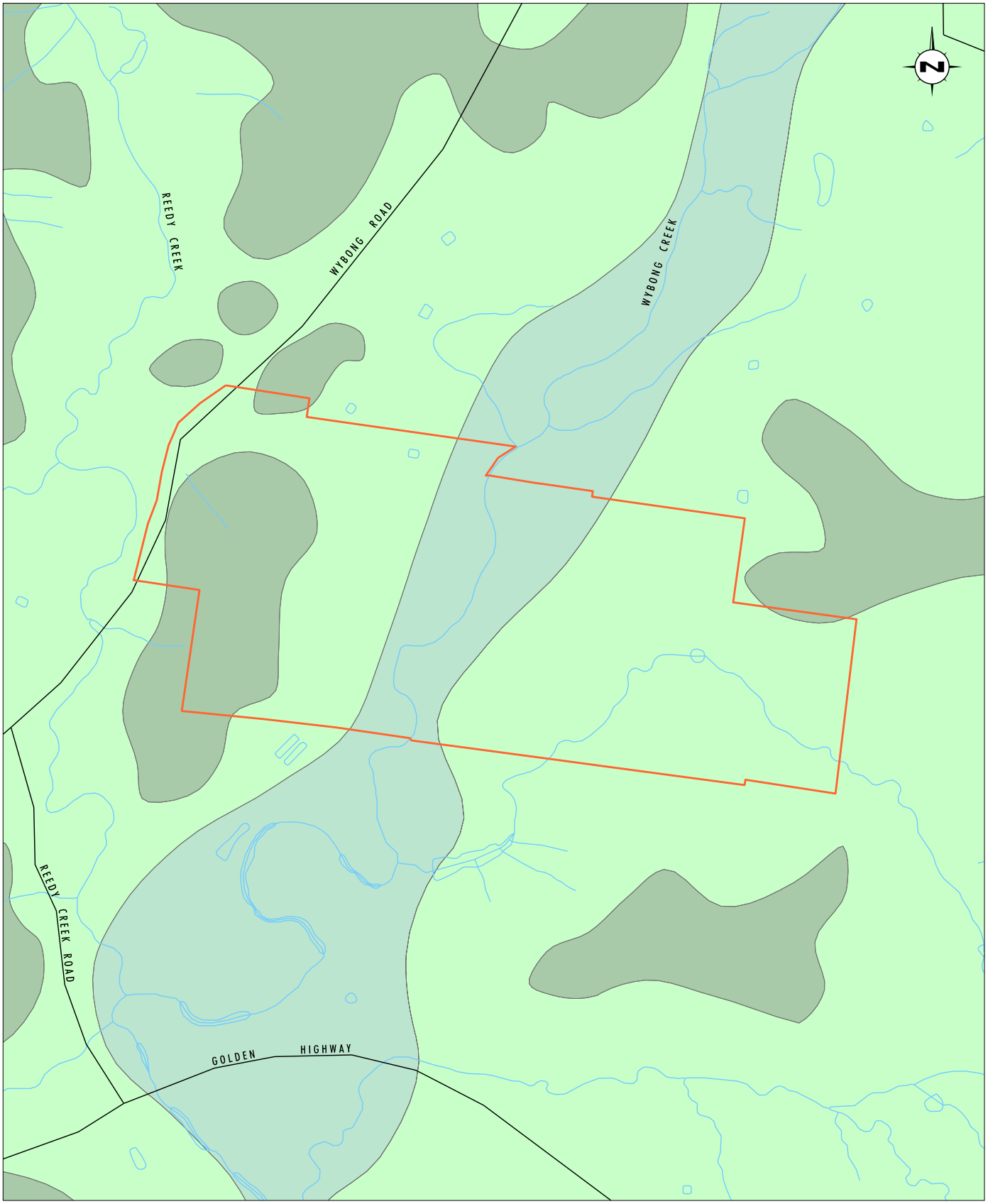


Data Source: Office of Environment and Heritage (OEH) SRLUP Mapping (2012), LPI (2009)

0 0.25 0.5 1.0km

1:20 000

Legend

- Mangrove Offset Site

Regional Soil Landscapes Mapping:

- Lees Pinch Soil Landscape
- Sandy Hollow Soil Landscape
- Wollombi Soil Landscape

FIGURE 3.11

Mangrove Offset Site
Regional Soil Landscapes Mapping

Table 3.5 Soil Landscape Characteristics

Soil Landscape	Terrain	Soil Profile Types	Other Characteristics	Hazards
Present in the Project Area and the area assessed in detail in the AIS				
Jerrys Plains *(Project Area and Locality)*	Covers the undulating hills to the south and west of Jerrys Plains.	The main soils are Soloths on the crests to midslopes, with Solodic Soils on the lower slopes and in the drainage depressions.	Profile depth 60-300 cm pH 6.0-8.5 Low soil fertility Poorly to moderately well drained, with moderate water holding capacity. Generally land and soil capability classes 4 and 5 (refer to **Section 3.4.4**)	Susceptible to severe gully erosion in some drainage lines with areas of severe salting also occur in many of the drainage lines. Susceptible to minor sheet erosion on some disturbed areas on hillslopes. Low to high soil salinity.
Hunter *(North west corner of the Project Area and Locality)*	Occurs throughout the floodplains of the Hunter River and its tributaries.	The main soils of this landscape are all formed in alluvium.	Profile depth 40-300 cm pH 5.5-7.5 Low to moderate soil fertility Drainage varies from rapid and imperfectly drained, to moderately well drained. Low to high water holding capacity. Generally land and soil capability classes 2 and 3 (refer to **Section 3.4.4**)	Susceptible to minor stream bank erosion on watercourses and minor sheet and gully erosion.

Soil Landscape	Terrain	Soil Profile Types	Other Characteristics	Hazards
Present in the broader Project Area				
Benjang *(Project Area, outside Additional Disturbance Area and Locality)*	Occurs on rounded rolling hills to the west, with large open valleys, benched slopes and some sandstone cliffs.	The main soils are red, yellow and brown Solodic Soils (sodosols) on the steeper benched country with hard rocks where the near horizontal bedding has resulted in poor soil drainage.	Profile depth 40-120 cm pH 6.0-8.5 Low soil fertility Drainage varies from rapid and poorly drained, to moderately well drained. Low to high water holding capacity. Generally land and soil capability classes 4 and 5 (refer to **Section 3.4.4**)	Susceptible to minor to severe sheet erosion on cleared hilltops with Solodic Soils (sodosols). Minor rill and gully erosion on mid to lower slopes. Low to high soil salinity.
Bulga *(Project Area, outside the Additional Disturbance Area, and Locality)*	Covers the colluvial slopes of the area surrounding the steep Lees Pinch and Watagan soil landscapes.	The main soils are yellow Soloths on the upper to midslopes, with associated yellow Solodic Soils and brown Solodic Soils. There are Brown Earths on the lower slopes.	Profile depth 90- 120cm pH 6.0-7.0 Low soil fertility Poorly drained to well drained, with low to moderate water holding capacity. Generally land and soil capability class 4 (refer to **Section 3.4.4**)	Susceptible to minor to moderate sheet erosion, with recently disturbed areas showing minor drilling. Low to high soil salinity.
Warkworth *(a very small area within the Project Area, almost entirely outside the*	Covers the linear sand dunes found on the old river terraces of the Hunter River downstream from Warkworth.	The main soils are Siliceous Sands.	Profile depth 300+ cm pH 6.0 Low soil fertility Rapidly drained, with low water holding capacity. Generally land and soil capability class 3	Susceptible to minor sheet erosion where disturbed. Low soil salinity.

Soil Landscape	Terrain	Soil Profile Types	Other Characteristics	Hazards
Additional Disturbance Area, and Locality)			to 5 (refer to **Section 3.4.4**)	
Present only in the locality				
Ogilvie *(Locality)*	Covers steep hills and escarpments with sandstone and conglomerate outcrops forming cliffs	The main soils are shallow loams and sands with other soils including brown Solodic Soils on the lower parts of slopes.	Profile depth +90cm pH 5.0-6.5 Low soil fertility Moderately-well to rapidly drained Generally land and soil capability classes 6, 7 and 8 (refer to **Section 3.4.4**)	Minor sheet erosion is common. Some mass movement seen in road cuttings. Low to moderate soil salinity.
Three Ways *(Locality)*	Covers rugged hills with rounded summits and sandstone cliffs with steep scree slopes.	The main soils are Brown Podzolic Soils and Yellow Podzolic Soils on summits on stable surfaces between sandstone pillars	Profile depth +110cm pH 5.5-7.0 Low soil fertility Poorly to rapidly drained Generally land and soil capability classes 6, 7 and 8 (refer to **Section 3.4.4**)	Minor to moderate sheet erosion where the surface has been disturbed. Moderate gully and rill erosion in some areas. Low soil salinity.

Soil Landscape	Terrain	Soil Profile Types	Other Characteristics	Hazards
Present in the potential offset areas				
Lees Pinch *(Mangrove Potential Offset Site)* *(Highfields Potential Offset Area)*	Covers rolling to steep hills in the mountains to the south-west, including sandstone and conglomerate cliffs, bluffs and boulder float.	The main soils are shallow Siliceous Sands with shallow loams on local occurrences of finer texture rocks.	Profile depth <100cm pH 4.0-7.5 Low soil fertility Well to rapidly drained, with low to moderate water holding capacity. Generally land and soil capability classes 6, 7 and 8 (refer to **Section 3.4.4**)	Susceptible to moderate sheet and rill erosion where disturbed. Low to high soil salinity.
Sandy Hollow *(Mangrove Potential Offset Area)*	Covers smooth and gentle rises and slopes in the central Goulburn Valley, the south-eastern part of the Merriwa Plateau and the northern part of the southern mountains.	The main soils are red and yellow Solodic Soils on the upper and midslopes with yellow and brown Solodic Soils on the lower slopes.	Profile depth <120cm pH 5.5-8.5 Low soil fertility Rapidly to moderately well drained Generally land and soil capability classes 4 and 5 (refer to **Section 3.4.4**)	Moderate gully erosion in drainage lines. Minor sheet and rill erosion on slopes. Low to high soil salinity.
Wollombi *(Mangrove Potential Offset Area)*	Covers the valley flats and undulating rises of the Wollombi Brook and its tributaries south of Singleton.	The main soils are Alluvial Soils.	Profile depth +500cm pH 6.0-6.5 Low soil fertility Well to rapidly drained Generally land and soil capability class 4 (refer to **Section 3.4.4**)	Moderate stream bank erosion along watercourses. Low soil salinity.

Soil Landscape	Terrain	Soil Profile Types	Other Characteristics	Hazards
Ant Hill *(Highfields Potential Offset Area)*	Covers much of the Merriwa Plateau in the north-east of the region.	The main soils are Black Earths situated on the mid to lower slopes.	Profile depth 40-80+cm pH 7.0-9.0 High soil fertility Moderately to well drained Generally land and soil capability classes 4, 5 and 6 (refer to **Section 3.4.4**)	Severe gully erosion occurs in the drainage lines, especially in associated with Black Earths. Low soil salinity.
Bow (*Highfields Potential Offset Area*)	Covers undulating rises, low hills and undulating valleys adjacent to the Ant Hill soil landscape.	The main soils are Black Earths on the slopes, with occasional Red Clays or Lithosols on crests.	Profile depth +100cm pH 7.0-8.5 Moderate to high soil fertility Imperfectly to well drained Generally land and soil capability classes 3 and 5 (refer to **Section 3.4.4**)	Minor sheet erosion on crests and some slopes with Black Earths.

Source: Kovak and Lawrie 1991

3.4.2 Soil profile types

Characteristics of the soil profile types in the additional disturbance area in the northwest corner of the Project Area are summarised in **Table 3.6**.

Characteristics of soil types that are present in the eastern part of the additional disturbance area, which has been extensively disturbed by previous agricultural and mining land uses, are described at the end of **Table 3.6**. The location of soil profiles are shown on **Figures 2.8** and **2.9**.

Two types of soil profile descriptions were undertaken being detailed sites (e.g. D12) and check sites (e.g. C2). Detailed sites are soil profile inspection sites that are described in sufficient detail to allow all major physical and chemical soil features of relevance to BSAL to be clearly identified. Check sites are examined in sufficient detail to allocate the site to a soil type and soil map unit. Check sites are commonly used to accurately position the boundaries of soil map units, to describe the variability within a soil map unit and to validate soil predictions. Check sites complement detailed sites.

Table 3.6 Soil profile characteristics

Profile number and soil type	Description
D12 **Brown Eutrophic Chromosol** **Northcote Principal Profile Form Db2.13** **Not BSAL – profile is too shallow, elevated pH in B horizon.**	Profile situated on crest of low spur, extending out from hillslope area. Local relief approximately 2.5m, slope less than 3%. Cleared ironbark woodland with grassy understory, not cultivated. There is 100 per cent ground cover. The pit reached bedrock (weathered fossiliferous sandstone) at approx 700mm. The surface is hardsetting. Occasional cobble float on the surface, comprising ironstone and indurated sandstone or conglomerate. Surface sets hard when dry. A0: 0-9cm. 7.5YR3/3 (slightly moist) clay loam, includes scattered coarse angular stones and abundant roots; pH 6.0; weak polyhedral peds; abrupt horizon boundary. A1: 9-45cm. 7.5YR4/4 (slightly moist) clay loam with faint root lines and burrows; pH 6.5. Strongly pedal (polyhedral); few scattered stones; clear boundary B1: 45-63cm. 10YR5/4 (slightly moist) heavy clay; pH 8.5; moderate pedality, polyhedral peds, few scattered stones; pH 8.5. Rock at base – weathered sandstone with fossils.
D21 **Epipedal vertosol** **Northcote Principal Profile Form Ug6.31** **This profile meets the BSAL criteria**	Profile situated on the valley flat, with very low gradient (slope less than 3%), within transition from bedrock soils to alluvial soils. This profile is at the northern extremity of the project area, and closets to soils which would meet the criteria for Hunter Soil Landscape. Extensively cleared grassland, probably not cultivated; 100% ground cover. Imperfectly drained (intermittently ponded water in this area). No surface gravel; surface cracks up to 15mm wide when dry; surface sets hard when dry. A1: 0-19cm. 7.5YR5/2 medium clay, whole coloured; no stones, abundant roots; pH 6.0. Strong pedality, subangular blocky peds. Gradual boundary.

Profile number and soil type	Description
	B1: 19-73cm. 10YR3/4, with faint yellow/grey mottle (10%), mostly following root lines. No stones. pH 7.0. Strong pedality with sub angular blocky peds; gradual boundary. B2 73-90cm (and continues). 7.5YR3/4 with faint yellow/grey mottle, medium heavy clay. Strong pedality, smooth faced, subangular blocky.
D33 **Red/brown eutrophic dermosol** **Northcote Principal Profile Form Gn3.55** **This profile is not BSAL as it does not meet fertility criteria.**	Profile in slight depression in drainage flat of tributary drainage line. Shallow pool and channel are located between this profile and Profile D37 and occasional pools are scattered across the landform. Slope less than 3%. Imperfectly to poorly drained. Cleared woodland with grassy understory. 100% groundcover, mixed pasture grasses. Surface sets hard when dry. A1, 0-15cm. 10YR5/3 (dry) clay loam. Many roots. No mottles, no segregations, no stones. pH 6.0. Weak pedality, rough faced. Abrupt boundary. Clear boundary A2, 15-28cm. 10YR5/3 fine sandy loam, with pale fleck throughout, but not bleached. A few stones (angular gravel). pH 6.5. Likely part of an alluvial deposit (a1 and A2) overlying clay B. Clear boundary. B1, 28-52cm. 7.5YR4/4 (very slightly moist) light clay red brown with 10-20% faint yellow grey mottle. Includes a few stones. pH 7.5. Moderate pedality B2, 52-80cm and continuing. 5YR4/6 (slightly moist) medium clay. Strong colour and fabric contrast to materials above. No stones, whole coloured, no concretions. pH 8.0. Moderate pedality, smooth faced peds.
D34 **Brown mesonatric sodosol** **Northcote Principal Profile Form Db1.31** **This profile is too shallow to be BSAL, also pH too high.**	Profile on very low relief (1-2m), very low gradient (less than 3%) spur, extending from footslope into alluvial wash out area. Cleared ironbark woodland with grassy understory. 100% groundcover of voluntary pasture and weeds, no cultivation. Surface is hardset and cracked (dry). A1, 0-10cm. 7.5YR5/3 (dry) sandy clay loam. Multiple roots. Slightly flecked appearance as if discontinuous small patches of bleached A2 material. Depth of A1 varies, wavy abrupt boundary. pH 6.5. Weak pedality, rough faced peds, sub angular blocky. B1, 10-39cm. 7.5YR4/4 (dry) medium clay; colour varies with a faint blend of 5YR4/4. Wide cracks, few fine roots. pH 6.5. Strong pedality, rough faced subangular blocky peds. No stones, no concretions, no mottles. Sharp boundary. B2, 39-63cm. 5YR4/4 (slightly moist) medium heavy clay, with occasional white fleck, but not mottled. pH 9.0 (likely to be sodic). This material is underlain by weathering bedrock (mudstone and sandstone) in the base of the pit. Occasional stones in the B2 from the bedrock.
D35 **Brown subnatric sodosol**	Profile situated on low gradient footslope, running out to flat (same landform at D36), but on opposite side of drainage line runout area. Landform at D35 continues to the low spur and which D12 is situated.

Profile number and soil type	Description
Northcote Principal Profile Form Db1.31 **This profile is not BSAL as it does not meet fertility criteria.**	Local relief is less than 1m. Slope is less than 3%. Cleared ironbark woodland with grassy understory. Imperfectly drained. 100% ground cover of grass, no cultivation. Surface soil sets hard. A1, 0-17cm. 10YR5/3 (dry) clay loam, no sand, no stones, no concretions, no mottles. pH 6.5. Moderate pedality, rough faced, sub angular blocky, 50-100mm, breaking to 20-50mm. Abundant roots and burrows, flecky appearance. Sharp boundary. A2, 17-21cm. 10YR7/3 (dry) clay loam. Thin bleached layer that hugs closely the top of the underlying B horizon (sharp but undulating boundary). pH 6.5. Moderate pedality, rough faced, subangular blocky. B1, 21-49cm. 7.5YR4/6 (dry) medium heavy clay. No Stones, no concreations, no mottles. Strong pedality, subanglar blocky, including large clods peds to 200mm. Cracks along ped faces (in dry condition). Clear boundary. B2, 49-80cm and continuing. 7.5YR4/4 (slightly moist) medium heavy clay; pH 6.5
D36 **Brown subnatric sodosol** **Northcote Principal Profile Form Dr2.32** **This profile is not BSAL as it does not meet fertility criteria.**	Profile situated on slightly undulating, very low relief flat (alluvial /colluvial material from small tributary drainage line), slope less than 3%. Imperfectly drained. Flat low elevation spur is located to the north and also slightly to the north west of the site. Shallow exposures in drainage depressions to the north show gravelly clay B horizon and also a small area of sandstone cobbles. Land is cleared former ironbark woodland, grass understory, now with 100% ground cover of grass, not cultivated. Surface sets hard when dry. A1, 0-19cm. 7.5YR5/4 (dry) sandy clay loam (gritty to coarse sand); very few stones, no concretions, no mottles. pH 6.5. Faint horizontal bedding features. Abundant roots and burrows. Moderate pedality with subangular blocky, rough faced peds, 100-200mm breaking to 50-100mm and 20-50mm. Abrupt boundary. A2, 19-26cm. 7.5YR7/3 (dry), patchily bleached sandy clay loam. Darker material infills root lines and burrows. No stones, no concretions, no mottles. pH 5.5. Moderate pedality, subangular blocky, rough faced, 100-200mm, breaking to 50-100mm and 20-50mm. Abrupt boundary. B1, 26-44cm. 7.5YR4/6 (dry), light medium clay; no stones, no concretions, no mottles. pH 6.5. Weak to moderate pedality, polyhedral, rough faced, 50-100mm. Abundant fine cracks. Clear boundary. B2, 44-80cm and continuing; 5YR 4/6 (slightly moist) sticky medium clay. Occasional faint dull yellow mottle. Very few stones, no concretions. pH 7.0. Weak to moderate pedality, polyhedral, rough faced.

Profile number and soil type	Description
D37 **Brown subnatric sodosol** **Northcote Principal Profile Form Db1.33** **This profile is not BSAL as it does not meet fertility criteria.**	Profile on flat, with low bedrock spur to the north and drainage channel just to the north west. Slope is less than 3%. Cleared woodland with grass understory, no cultivation. 100% groundcover. Imperfectly drained and slowly permeable. Surface is hardset (dry) and cracked. Profile is similar to Site D34, but does not end on bedrock within the pit. A1, 0-19cm. 10YR5/4 (dry) clay loam. Includes thin crusty A0, abundant roots, cracks 2-5mm extend to the surface. Becomes sticky when wet. pH 6.0. No stones, no concretions, no mottles. Moderate pedality, rough faced, subangular blocky. Abrupt but irregular boundary. A2, 19-25cm. 10YR7/3 (dry), bleached, but patchy, mixed with 10YR4/3. Strongly bioturbated, roots and burrows common. pH 6.5. Cracks extend through from surface. Moderate pedality with subangular blocky, rough faced peds. No stones, no concretions, no mottles. Wavy, abrupt and irregular boundary. B1, 25-59cm. 7.5YR4/4 (dry) medium heavy clay. Roots common, especially along ped faces. Moderate pedality, rough faced, subangular blocky. No stones, no concretions, no mottles. pH 8.5. Clear boundary. B2, 59-85cm and continuing. 10YR4/4 (slightly moist) medium heavy clay. Very faint grey mottle. pH 9.0. Moderate pedality, rough faced, sub angular blocky.
C2 **Brown subnatric sodosol, gravelly.** **Northcote Principal Profile Form Dy1.41** **This profile is not BSAL as it does not meet fertility criteria.**	Profile located on mid-slope, very low relief, no rock outcrop. Vegetation is melaleuca and bulloak regrowth, indicative of occasionally impeded drainage. Profile is slightly sodic throughout, and dispersion is visible on exposed profile in embankment. A0, 0-5cm. 10YR5/2 (dry) clay sand, gritty. pH 5.5. Loose consistence, apedal massive, abundant roots. No stones on surface but stones common in the profile, fine gravel (2-6mm from conglomerate and ironstone). Clear, irregular boundary. A2 (A1 has previously been eroded), 5-11cm. 10YR6/2 (dry) very gritty clay sand. Pedal massive, weak, brittle consistence. pH 5.0. Sharp wavy boundary. A3 , 11-17cm. 10YR8/1 (dry) gravelly clay sand. Gravel is angular and common. Moderate consistence. pH 5.5. Sharp wavy boundary. B1, 17-50cm 10YR4/6 medium heavy sandy clay, strongly pedal, with cracks. Faint mottle. pH 6.5. Rock rubble and float is present below 50cm.

Profile number and soil type	Description
C3 **Brown subnatric sodosol** **This profile is not BSAL as it does not meet fertility criteria.**	Profile located on upper slope, with very low local relief. Groundcover approximately 70%, with bare soil visible through grass cover and scattered leaf litter, including bulloak needles. Imperfectly drained. Surface sets hard. Moderate previous sheet wash erosion has removed A1 horizon. This profile has a very low Ca/Mg ratio and is slightly sodic. A2, 0-13cm. 10YR5/2 (dry) sandy loam. Apedal massive, weak, brittle consistence. Few stones. pH 5.0. No cracks, sharp boundary. A3, 13-20cm. 10YR7/2 (bleached) (dry) sandy loam. Moderate consistence, brittle. pH 5.0. No cracks. Gravel and fine gravel abundant, subangular to subrounded, dispersed throughout this unit. Sharp boundary. B1, 20-40cm+. 10YR3/3 (slightly moist) medium heavy clay, with minor fine sand and scattered faint grey/yellow mottle. Stones common, as above. pH 5.5. Moderately sticky. Strongly pedal with subangular blocky and polyhedral peds, 10-20mm and 50-100mm. Very firm consistence.
C6 **Brown subnatric sodosol** **Northcote Principal Profile Form Db1.31** **This profile is not BSAL as it does not meet fertility criteria.**	Profile situated on low angle upper slope in grey gum/ironbark woodland. No melaleuca is present in the understory, so moderately well drained. No rock outcrop. 90% groundcover of bulloak needle and grass. Bulloak needles raft up on the slope during runoff event. Soil sets hard, moderate runoff and imperfectly drained. A1, 0-9cm. !0YR5/2 (dry) fine sandy loam; no stone present in this material or on the surface. Sets hard, but brittle. pH6.0. Roots and burrows common. No mottles. Sharp boundary. A2, 9-12cm. Thin band of partially bleached A2 material, 10YR6/2 (dry) fine sandy loam. Roots and burrows evident. Weak brittle consistence. Few stones, 2mm t 20mm size, from conglomerate and ironstone. Abrupt boundary. B1, 12-40cm+, 10YR3/6 (very slightly moist) medium clay. Strong pedality, subangular blocky and polyhedral. Strong consistence. pH 6.0. Faint mottle is visible, but limited to along root lines. Subsoil is slightly sodic (ESP 6-15%).

3.4.3 Soil fertility

Soil fertility mapping at the regional scale was prepared by OEH as part of the Upper Hunter SRLUP. Soils in the Project Area are predominately mapped as having moderately-low fertility, with a small area of low fertility (on land mapped as being within the Warkworth sands)and moderately-high fertility (on land mapped as being in the Hunter Soil Landscape (refer to **Figure 3.12**).

Soil fertility was tested using laboratory analysis of soil samples from the profiles in the moderately high fertility area in the northwest corner of the Project Area, and from A and B horizon samples collected from typical profiles in previously (relatively) undisturbed parts of the additional disturbance area in the east of the Project Area .

Parameters tested include CEC, ECe, pH, Calcium Magnesium ratio, ESP and total organic carbon. Results are shown in **Appendix A** and a brief summary is provided below (**Table 3.7**).

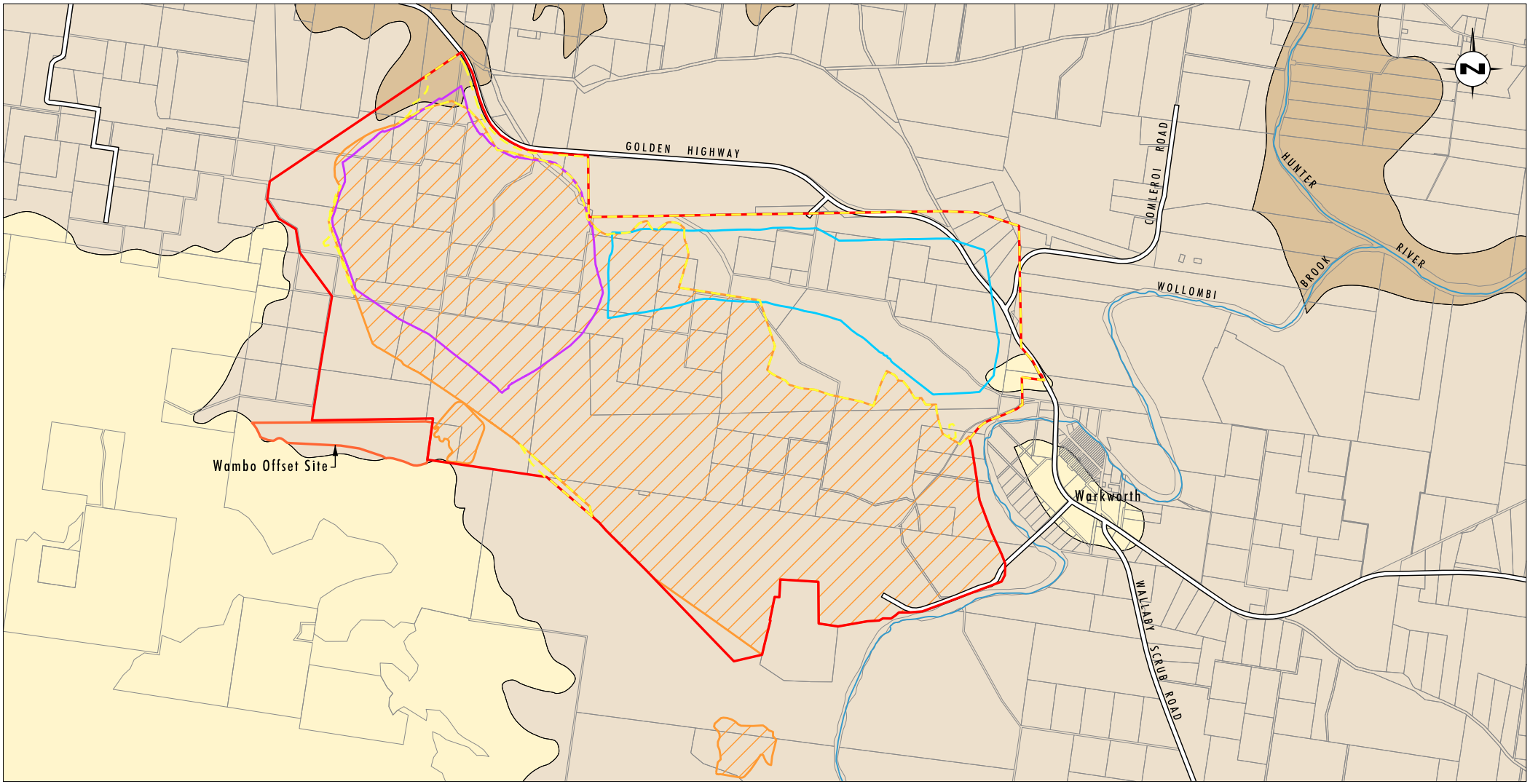
Non saline soils with an ESP above 5 are liable to dispersion in water, but the threshold for BSAL is listed as less than 15. Most soils in the Project Area have ESP values between 5 and 15, with just a few exceeding 15 in the B horizon. These different ESP levels are used in the consideration of land and soil capability in **Section 3.4.4**.

A Ca:Mg ratio of less than 2 (and particularly less than 1) also indicates a tendency to disperse (DPI vegetable soil pak), although the criteria used for BSAL is that soils with a ratio greater than 0.1 would meet the requirements. All profiles in the Project area have Ca:Mg ratio values less than 2 and most values are less than 1, but very few values are less than 0.1.

pH values in water that are outside the range 5.0-8.9 are taken to indicate low fertility. Lower pH values in surface horizons are also indicative of poor acid buffering capacity, and are taken into consideration in **Section 3.4.4**.

ECe values above 4dS/m also indicate soil that has fertility constraints. Most soils in the Project Area are not strongly saline, but elevated salinity does affect the lower B horizon of profiles D14, D18, D23, D24 and D34 (refer to **Figure 2.8**).

All samples that are indicative of fertility constraints are highlighted in blue in **Table 3.7**.



Data Source: LPMA (2009), Office of Environment and Heritage (OEH) SRLUP Mapping 2012

0 1.0 2.0 3.0km
1:60 000

Legend

- Project Area
- Conceptual Additional Disturbance Area
- Approved Wambo Surface Development Area
- Proposed Conceptual United Open Cut Pit
- Proposed Conceptual Wambo Open Cut Realignment
- Wambo Offset Site

Regional Soil Fertility Mapping:

- Low
- Moderately Low
- Moderate High

FIGURE 3.12

Regional Soil Fertility Mapping

File Name (A4): R07/3509_142.dgn
20160511 16.52

Table 3.7 Summary of soil fertility results

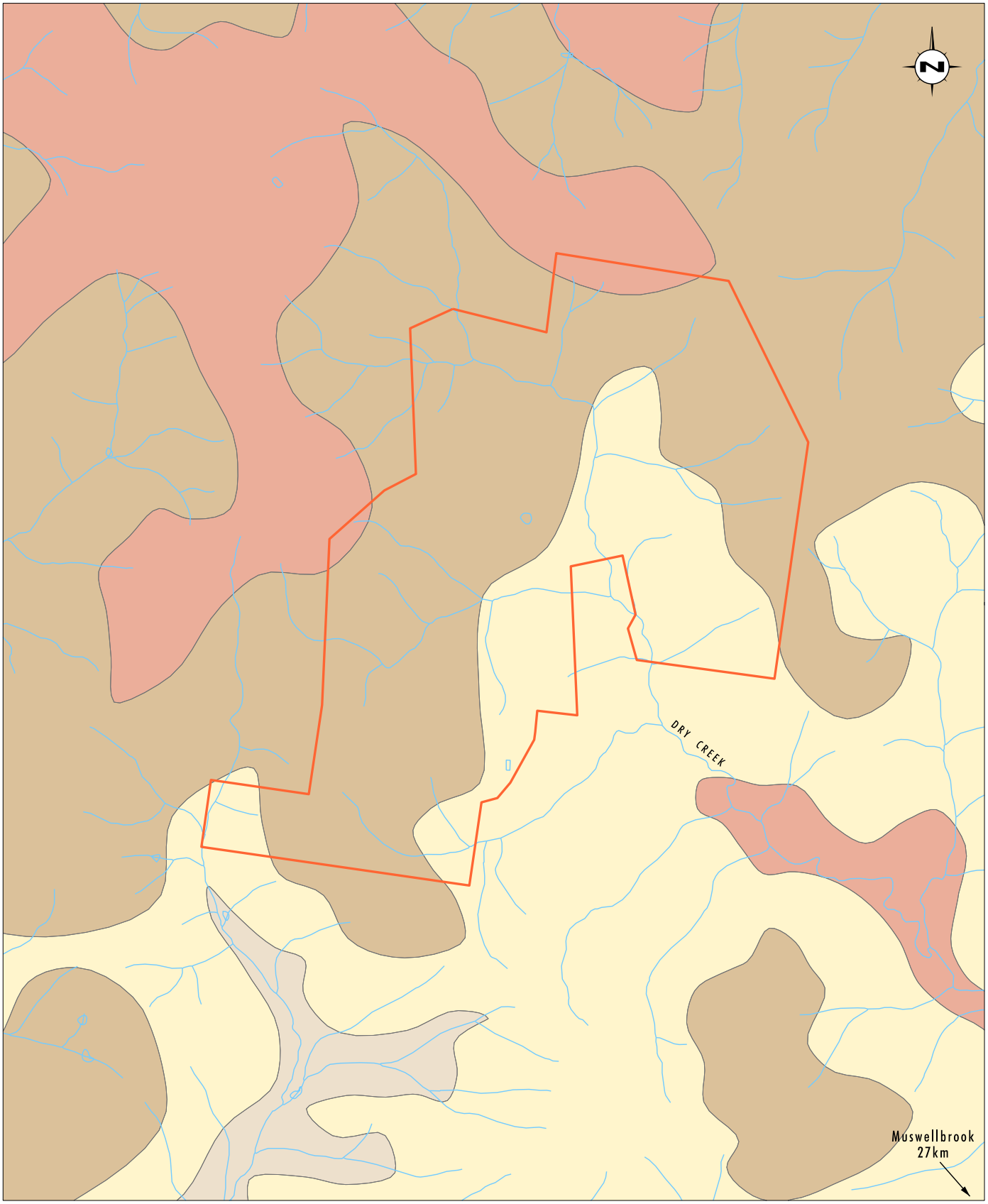
Site	pH (in water)	CEC	ECe	Ca/Mg ratio	ESP
C1, A1	5.3	6.5	0.96	0.64	7.6
C1, A2	5.4	6.5	0.69	0.32	7.6
C1, B	6.0	20.5	1.05	0.12	7.3
C3, A1	5.4	6.2	0.68	0.38	4.8
C3, A2	5.7	4.6	0.19	0.05	8.6
C3, B	5.6	15.4	1.29	0.01	14.3
C4, A2	5.6	7.1	0.19	0.5	2.8
C4, B	6.1	18.6	1.29	0.3	10.2
C6, A	5.9	9.1	0.38	0.36	5.5
C6, B	6.0	17.2	0.97	0.13	9.9
C7, A1	6.1	11.8	0.14	2.1	1.7
C7, B1	7.2	24.7	0.34	1.6	6.5
C7, B2	7.8	24.5	0.67	1.5	8.6
C11, A	5.4	8.7	1.03	0.42	4.6
C11, B	6.3	32.1	3.1	0.22	13.1
12 A1	8.5	30.9	1.05	2.00	1.29
12 B1	8.8	29.2	1.05	1.50	2.40
13 A1	8.7	36.0	2.02	0.61	6.67
13 B1	9.2	32.1	2.77	0.56	9.03
13 B2	9.4	30.6	3.97	0.49	11.44
14 A1	9.0	39.4	4.3	0.79	12.94
14 A2	9.0	37.5	5.68	0.74	14.93
14 B1	8.9	34.5	8.64	0.68	14.78
14 B2	8.9	36.6	9.22	0.68	15.02
15 A1	5.6	9.6	0.25	1.41	4.05
15 A2	5.6	7.4	0.17	0.82	4.05

Site	pH (in water)	CEC	ECe	Ca/Mg ratio	ESP
15 B1	4.8	19.6	0.53	0.37	7.14
15 B2	7.7	19.2	4.35	0.24	12.50
16 A1	5.8	8.4	0.27	1.6	2.38
16 A2	6.3	5.1	0.14	0.93	1.96
16 B1	8.4	19.4	0.37	0.32	3.61
16 B2	9.0	17.7	1.05	0.4	5.65
17 B1	6.4	20.8	0.225	0.9	1.92
17 B2	7.5	25.1	0.3	0.95	2.49
17 C	8.8	31.3	1.65	1.16	5.11
18 A1	6.3	11.4	6.3	1.8	1.75
18 B1	9.1	24.9	3.9	0.76	8.43
18 B2	9.1	32.1	5.03	1.6	11.65
18 C	9.2	31.8	8.25	1.57	17.3
19, A1	5.8	13.2	0.52	1.41	3.79
19, A2	6.4	12.6	0.6	0.78	10.32
19, B1	7.1	25.1	2.03	0.49	23.6
19, B2	8.3	25.1	6.08	0.39	25.1
20, A1	5.5	6.3	0.14	2.0	1.59
20, A2	7.0	15.3	0.97	0.34	12.42
20, B1	7.5	17.3	0.83	0.33	14.45
20, B2	8.7	20.9	2.33	0.22	21.53
21, A1	6.1	14.3	0.15	1.49	2.09
21, B1	8.0	21.1	1.95	0.9	6.64
21, B2	8.5	25.8	3.98	0.75	14.73
22, A2	7.2	8.4	0.95	0.69	2.38
22, B1	6.3	25.0	2.63	0.35	8.80
22, B2	9.0	32.6	5.33	0.72	12.27

Site	pH (in water)	CEC	ECe	Ca/Mg ratio	ESP
23, A1	6.3	8.9	0.09	1.19	1.12
23, B1	7.8	24.7	0.38	0.47	2.02
23, B2	8.8	25.0	6.38	0.80	6.8
23, C	9.1	30.7	8.63	0.39	13.4
33, A1	6.2	13.6	0.17	1.74	1.5
33, A2	6.5	14.3	0.09	1.85	2.1
33, B1	7.1	11.5	0.52	1.12	6.1
34, A1	6.1	12.5	0.38	1.0	4.0
34, B1	7.9	23.6	0.38	0.69	6.8
34, B2	8.9	23.0	4.7	0.66	15.2
35, A1	6.0	9.4	0.26	1.3	4.2
35, B1	7.2	15.4	0.75	0.67	10.3
35, B2	6.7	16.5	1.35	0.63	10.3
36, A1	6.2	13.1	0.28	1.7	1.5
36, A2	5.9	10.9	0.09	1.5	1.8
36, B1	6.5	12.0	0.17	1.1	5.0
36, B2	6.3	15.6	0.82	0.8	7.6
37, A1	6.0	17.1	0.17	1.6	1.7
37, A2	6.9	13.5	0.09	1.9	2.9
37, B1	8.1	18.1	0.45	1.01	8.8
37, B2	8.7	24.1	2.9	0.82	2.7

Soil fertility mapping at the regional scale for the proposed offset sites is presented in **Figure 3.12**, **3.13** and **3.14**.

Information on soil fertility has been used in the assessment of land and soil capability.



Data Source: Office of Environment and Heritage (OEH) SRLUP Mapping 2012

0 0.5 1.0 1.5km
1:25 000

Legend

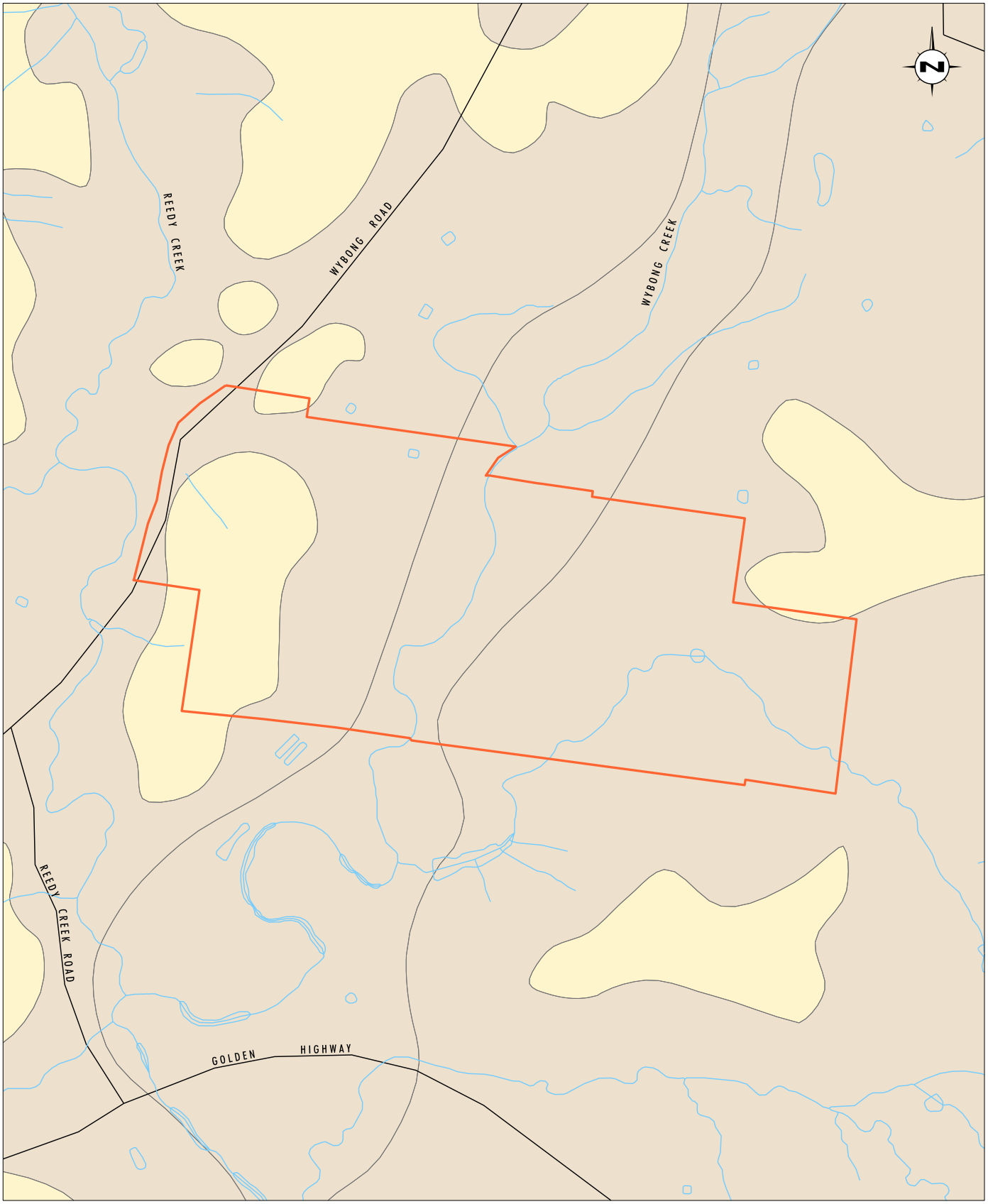
- Highfields Offset Site

Regional Soil Fertility Mapping:

- Low
- Moderately Low
- Moderate High
- High

FIGURE 3.13

Highfields Offset Site
Regional Soil Fertility Mapping



Data Source: Office of Environment and Heritage (OEH) SRLUP Mapping (2012), LPI (2009)

0 0.25 0.5 1.0km

1:20 000

Legend

- Mangrove Offset Site

Regional Soil Fertility Mapping:

- Low
- Moderately Low

FIGURE 3.14

Mangrove Offset Site
Regional Soil Fertility Mapping

3.4.4 Land and soil capability

This section summarises the basis for and general Land and Soil Capability (LSC) of the Project Area, as assessed and mapped by OEH (2012). **Section 3.3** discusses the specific slope, landform and soil characteristics of the Project Area, evaluated at the Project scale. These factors contribute to the actual land and soil capability of the Project Area.

LSC is the ability of the land to sustain a range of land uses and land management practices in the long term without degradation of soil, land, air and water resources (OEH 2012, drawing on Dent and Young 1981, Emery 1986, and Sonter and Lawrie 2007). In particular, the LSC assessment scheme (OEH 2012) is designed to provide regional scale information about land capability as applied to broad scale, dry-land agricultural uses.

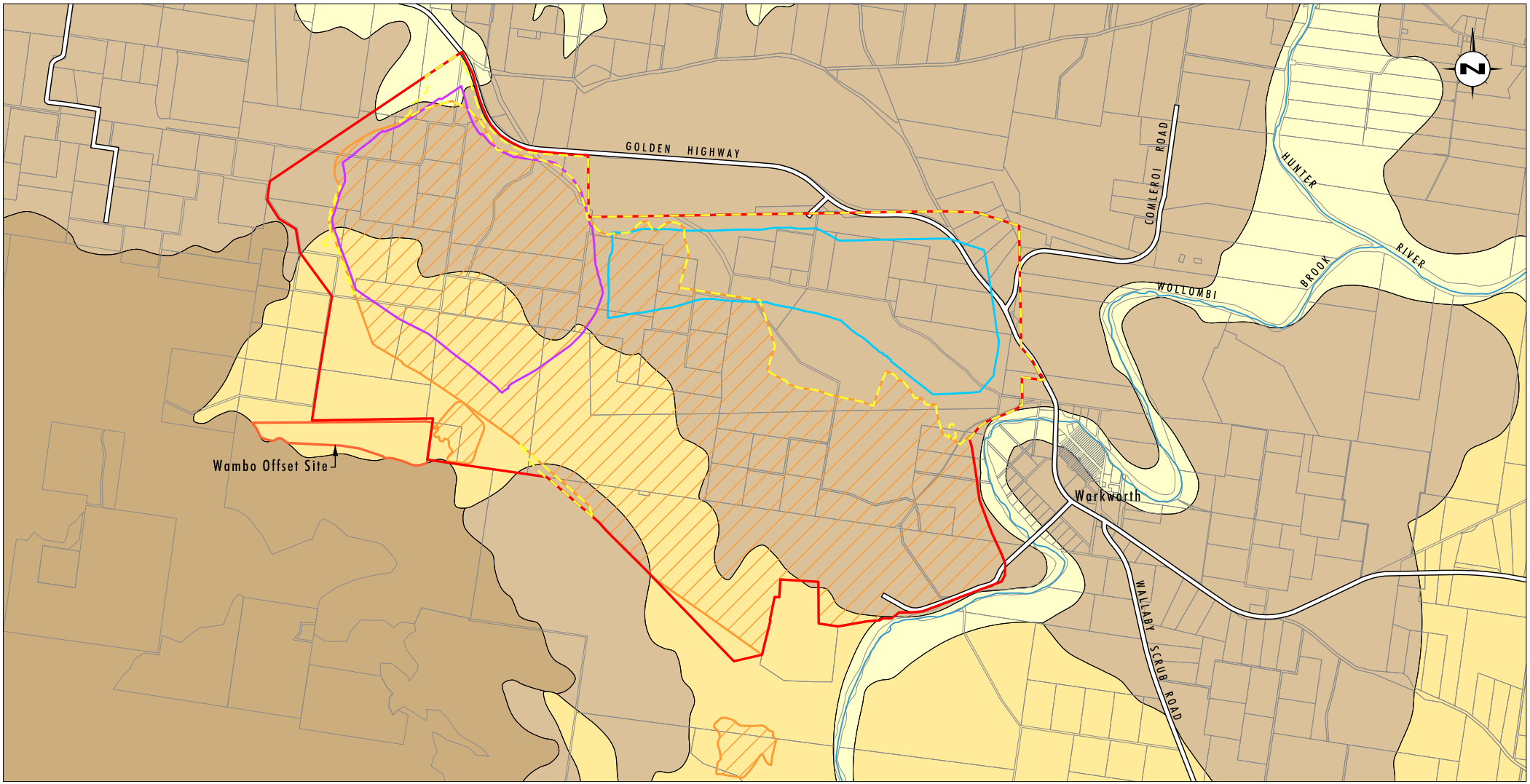
Biophysical characteristics and hazards considered in determining LSC include:

Soil and Landscape Characteristics	Hazards
• Soil type • Slope • Landform position • Acidity • Salinity • Drainage • Rockiness • Climate range and variability	• Water erosion, including sheet, rill and gully erosion • Wind erosion • Soil structure decline • Soil acidification • Salinity • Water logging • Shallow soils and rockiness • Mass movement

The LSC classes identify limitations on the type and intensity of use as a result of the severity of constraints related to the physical attributes of the soil and the extent to which intensive management is required to prevent on and off site degradation under varying land uses. The LSC assessment scheme requires that each tract of similar land is assessed for each of the hazards and ranked from 1 to 8 where Class 1 represents the least hazard and Class 8 the highest hazard. From this, the overall LSC Class is determined by the ranking of the most limiting hazard.

It is important to note that the classification does not necessarily reflect existing land uses; rather, it indicates the potential of the land for different agricultural purposes, while maintaining the quality of natural assets. Many parts of the Hunter region have historically been used beyond their LSC class, resulting in degradation of natural and agricultural resources.

Table 3.8 presents the rationale and definitions for the eight LSC classes currently used in NSW and their presence in the Project Area (including offset areas) based on broad scale (1:250,000 scale) mapping undertaken for the Upper Hunter SRLUP (refer to **Figure 3.15** for the Project Area and **Figures 3.16** and **3.17** for the Highfields and Mangrove offset areas). **Table 3.8** indicates the area of each LSC class that is mapped as being present in the Project Area and/or the potential offset areas.



Data Source: LPMA (2009), OEH (2013)

0 1.0 2.0 3.0km
1:60 000

Legend

- Project Area
- Conceptual Additional Disturbance Area
- Approved Wambo Surface Development Area
- Proposed Conceptual United Open Cut Pit
- Proposed Conceptual Wambo Open Cut Realignment
- Wambo Offset Site

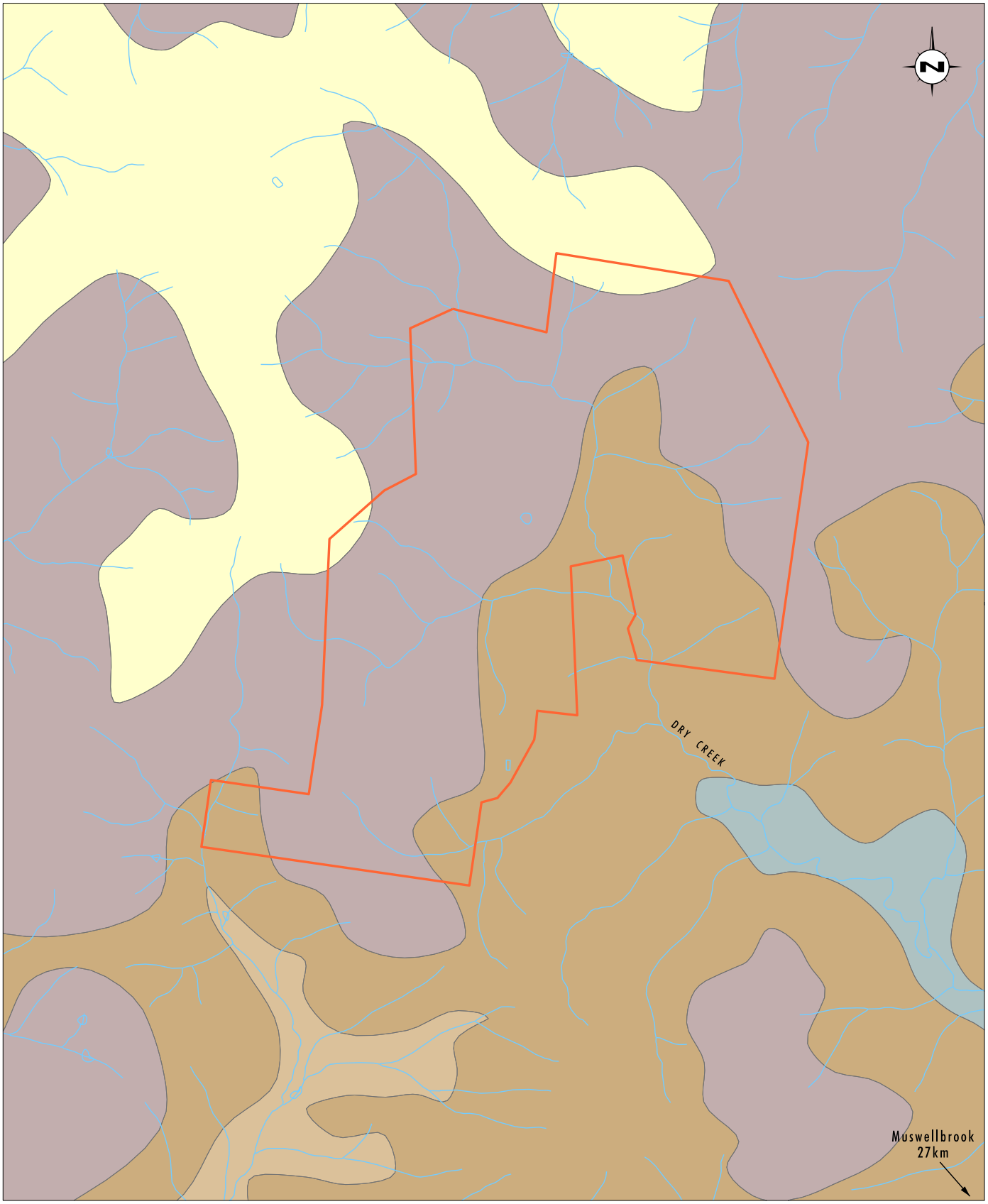
Regional Land and Soil Capability:

- 3 - Moderate Limitations
- 4 - Moderate to Severe Limitations
- 5 - Severe Limitations
- 7 - Extremely Severe Limitations

FIGURE 3.15

Regional Land and Soil Capability

File Name (A4): R07/3509_143.dgn
20160512 13.55



Data Source: Xstrata (2009)

0 0.5 1.0 1.5km

1:25 000

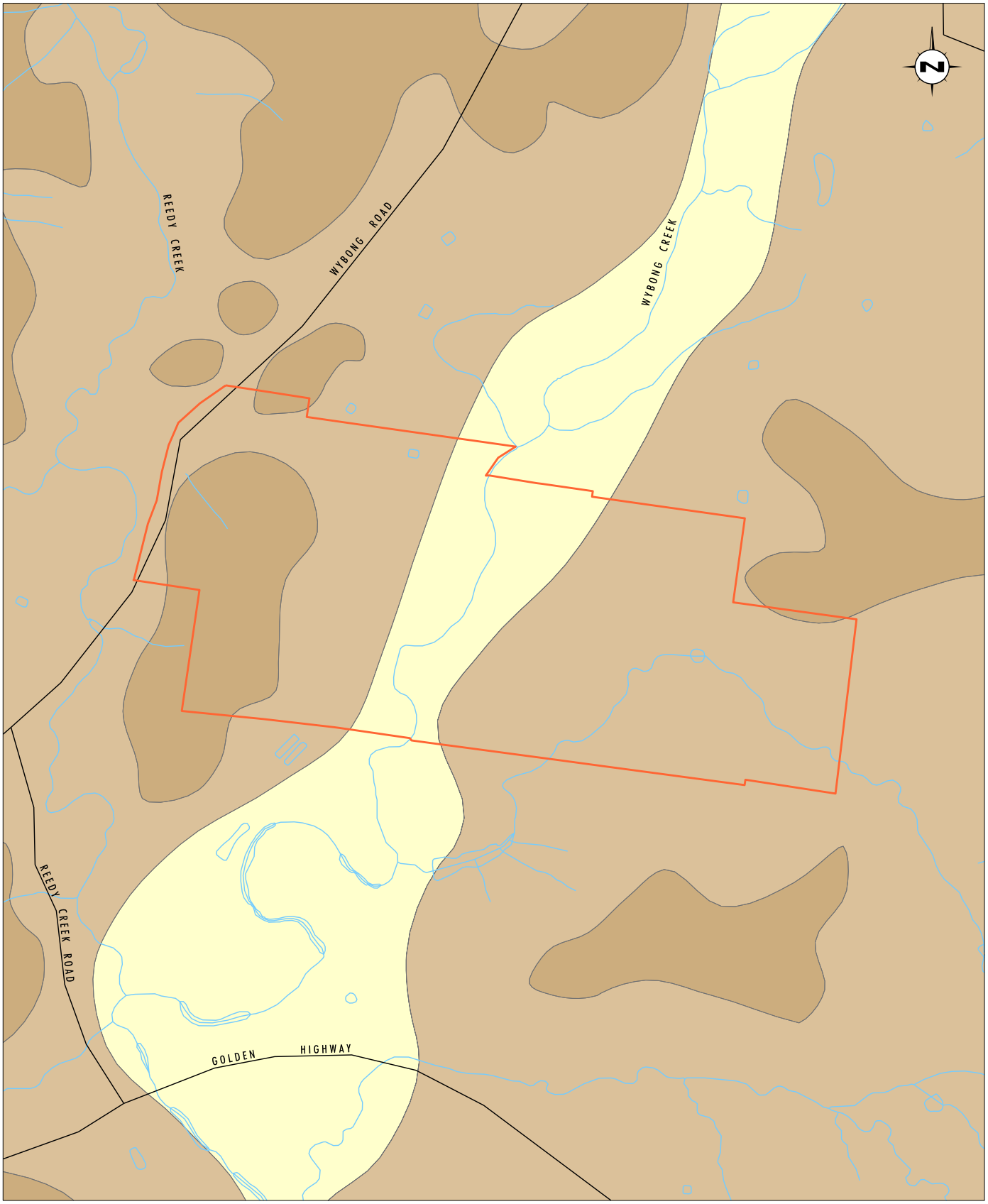
Legend

- Highfields Offset Site
- Regional Land and Soil Capability Mapping:
  - 2 - Slight but Significant Limitations
  - 3 - Moderate Limitations
  - 5 - Severe Limitations
  - 6 - Very Severe Limitations
  - 7 - Extremely Severe Limitations

FIGURE 3.16

Highfields Offset Site
Regional Land and Soil Capability Mapping

File Name (A4): R07/3509_258.dgn
20160511 16.57



Data Source: Office of Environment and Heritage (OEH) SRLUP Mapping (2012), LPI (2009)

0 0.25 0.5 1.0km
1:20 000

Legend

- Mangrove Offset Site

Regional Land and Soil Capability Mapping:

- 3 - Moderate Limitations
- 5 - Severe Limitations
- 7 - Extremely Severe Limitations

FIGURE 3.17

Mangrove Offset Site
Regional Land and Soil Capability Mapping

An analysis of the LSC of the parts of the Additional Disturbance Area that are the focus of this assessment is included in **Table 3.8**. The analysis considers lands mapped as classes 3, 4 5, and 6 at the regional scale and includes the northwest corner of the Project Area (27.9 hectares).

Table 3.8 LSC Classes Locality of the Project Area (based on regional scale mapping by OEH 2012)

LSC Class	General Information	Present in the Project Area (based on regional scale mapping
Land capable of a wide variety of land uses (cropping, grazing, horticulture, forestry, nature conservation)		
1	**Extremely high capability land (very slight to negligible limitations)**: Land has no limitations. No special land management practices required. Land capable of all rural land uses and land management practices.	Not present in the Project Area including the Offset areas
2	**Very high capability land (slight but significant limitations)**: Land has slight limitations. These can be managed by readily available, easily implemented management practices. Land is capable of most land uses and land management practices, including intensive cropping with cultivation.	Not present in the Project Area including the Offset areas
3	**High capability land (moderate limitations)**: Land has moderate limitations and is capable of sustaining high impact land uses, such as cropping with cultivation, using more intensive, readily available and widely accepted management practices. However, careful management of limitations is required for cropping and intensive grazing to avoid land and environmental degradation.	31.7 hectares mapped in the northwest corner of the Project Area, within the additional disturbance area This land is currently used for low intensity cattle grazing. 4.0 hectares within the proposed Highfields offset area. 46.5 hectares within the proposed Mangrove offset area.
Land capable of a variety of land uses (cropping with restricted cultivation, pasture cropping, grazing, some horticulture, forestry, nature conservation)		
4	**Moderate capability land (moderate to severe limitations)**: Land has moderate to high limitations for high impact land uses. Will restrict land management options for regular, high impact land uses such as cropping, high intensity grazing and horticulture. These limitations can only be managed by specialized management practices with a high level of knowledge, expertise, inputs, investment and technology.	893.6 hectares in the Project Area. Note that this land has not been used for agriculture for approximately 20 years. 58.7 hectares in the proposed Wambo offset area.

LSC Class	General Information	Present in the Project Area (based on regional scale mapping
5	**Moderate- low capability land (severe limitations)**: Land has high limitations for high impact uses. Will largely restrict land use to grazing, some horticulture (orchards), forestry and nature conservation. The limitations need to be carefully managed to prevent long term degradation.	2,105.9 hectares in the Project Area, including existing approved mining operations areas. This land has not been used for agriculture for approximately 20 years and was affected by multiple constraints during the period it was used for dryland grazing. 171.9 hectares in the proposed Mangrove offset area.
Land capable for a limited set of land uses (grazing, forestry and nature conservation, some horticulture)		
6	**Low capability land (very severe limitations)**: Land has very high limitations for high impact land uses. Land use restricted to low impact land uses such as grazing, forestry and nature conservation. Careful management of limitations is required to prevent severe land and environment degradation.	None located in the Project Area 242.94 hectares in the proposed Highfields offset area.
Land generally incapable of agricultural land use (selective forestry and nature conservation)		
7	**Very low capability land (extremely severe limitations)**: Land has severe limitations that restrict most land uses and generally cannot be overcome. On site and off site impacts of land management practices can be extremely severe if limitations are not managed. There should be minimal disturbance of native vegetation.	0.27 hectares in the Project Area 128.16 hectares in the proposed Highfields offset area. 40.5 hectares in the proposed Mangrove offset area.
8	**Extremely low capability land (extreme limitations)**: Limitations are so severe that the land is incapable of sustaining any land use apart from nature conservation. There should be no disturbance of native vegetation.	None located in the Project Area

Source: OEH 2012.

Table 3.9 summarises the reasons for allocating various soils in the Project Area to LSC classes. LSC class is set by the most restrictive hazard. Hazards may include water erosion, wind erosion, acidity, salinity, structural decline, water logging, shallow depth and mass movement hazard. Key hazards are summarised in **Figure 3.18**.

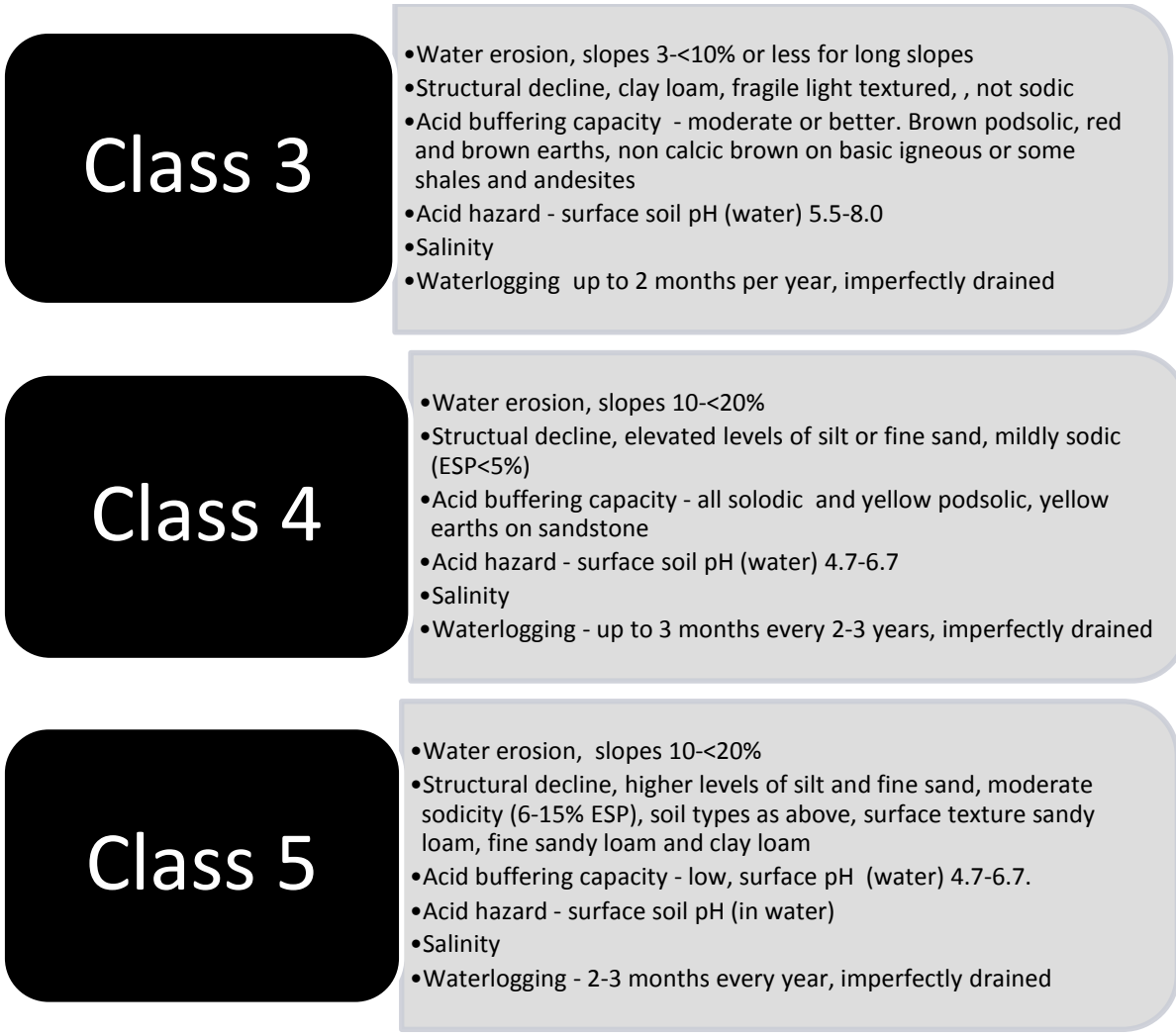


Figure 3.18

Key hazards for LSC classes 3, 4 and 5

Table 3.9 LSC criteria applied to soils in the Additional Disturbance Area within the Project Area

Profile identification	Relevant criteria	LSC class using project scale data
C1	Brown sodosol, Dy1.41, defined as moderately low fertility Low acid buffering capacity, structure decline hazard, acid surface, bleached light textured A. Stony in A2 and below ESP 6-15%, not saline, moderate slope	**Class 5**
C3	Brown sodosol, Dy1.41, defined as moderately low fertility Low acid buffering capacity, structure decline hazard, bleached, light textured brittle A, acid surface ESP >15% in lower B horizon and 5-15% above in B horizon Not saline, moderate slope, severe sheet erosion	**Class 5**

Profile identification	Relevant criteria	LSC class using project scale data
C4	Brown sodosol, Db1.11, defined as moderately low fertility Low acid buffering capacity, light textured A horizon, brittle, subject to structural decline, moderate slope.	**Class 4**
C6	Brown sodosol, Db1.31, defined as moderately low fertility Low acid buffering capacity, light textured, brittle, bleached A horizon, subject to structural decline. Common ironstone gravel. May be waterlogged seasonally (short periods only)	**Class 5**
C7	Brown sodosol, Db2.12, defined as moderately low fertility, on terrace of tributary drainage line and may have been occasionally cropped in past. May be occasionally waterlogged.	**Class 4**
D12	Brown eutrophic chromosol Shallow profile depth, not sodic, not saline, not strongly acid, not affected by waterlogging.	**Class 4**
D13	Brown eutrophic dermosol, on footslope, colluvial transition Shallow profile depth, mildly to moderately sodic, not strongly acid, not saline	**Class 4**
D14	Brown eutrophic dermosol, on footslope, colluvial transition High pH, strongly sodic and saline.	**Class 4**
D15	Red subnatric sodosol, on lower slope Sodic, grading to saline at depth, defined as moderately low fertility, structural decline hazard.	**Class 4**
D16	Brown eutrophic chromosol, on moderate lower slope Shallow profile depth, high pH, erodible	**Class 5**
D17	Brown eutrophic chromosol, on lower slope of spur, 50m from incised tributary drainage line High pH in B2, not saline, ESP in 5-15% range, shallow overall profile depth	**Class 4**
D18	Subnatric sodosol, on lower slope, defined as moderately low fertility. Saline lower B, high pH in lower B, elevated ESP, moderately steep slope, rock outcrop upslope, incised drainage line downslope	**Class 5**

Profile identification	Relevant criteria	LSC class using project scale data
D19	Brown mesonatic sodosol, on valley fill of tributary drainage line. Elevated salinity in lower B, ESP in lower B >15%, risk of structural decline.	**Class 4**
D20	Brown mesonatric sodosol, on valley fill alluvium of tributary drainage line. Defined as moderately low fertility. ESP in lower B >15% and elevated in B1.	**Class 4**
D21	Brown epipedal vertosol, on wash out alluvium ESP is in the 5-15% range throughout the B horizon	**Class 3**
D23	Brown subnatric sodosol, on lower slope Defined as moderately low fertility ECe, pH are elevated in the lower B horizon. ESP is in the range 5-15%, so some sheet erosion hazard.	**Class 4**
D33	Gn3.55 Eutrophic dermosol, in slight depression on drainage flat, in confluence are of alluvial wash out from tributaries. Top part of profile is alluvial material, over pedal clay. Moderately high fertility, low acid buffering capacity, low total CEC	**Class 4**
D34	Dr2.23 Brown mesonatric sodosol, in shallow drainage depression on valley flat, weathered rock at base, may be seasonally waterlogged Low acid buffering capacity	**Class 4**
D35	Db1.31 Brown subnatric sodosol, on very gently grade side slope from low spur, no bedrock visible at base, may be seasonally waterlogged Defined as moderately low fertility, low acid buffering capacity	**Class 4**
D36	Dr2.32 Brown subnatric sodosol, on slightly undulating valley flat, formed on low angle footslope off low spur, weathered rock at base Defined as moderately low fertility, may be seasonally waterlogged, low acid buffering capacity.	**Class 4**
D37	Db1.33 Brown subnatric sodosol, on low gradient /flat lower slope, with bedrock in base of profile Defined as moderately low fertility, may be seasonally waterlogged, low acid buffering capacity.	**Class 4**

3.4.4.1 Soil characteristics in potential offset areas

Detailed soil survey and sampling of the potential offset areas to verify their LSC class has not been undertaken in this assessment. 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 under the Upper Hunter Strategic Assessment Process. The offset strategy will be implemented following the process outlined in the UHSA and the final composition of the offset strategy may evolve as the Project progresses. It is currently proposed that the biodiversity offset strategy will consist of the establishment of proponent-managed offset sites, including the following sites:

- Highfields Offset Site (428 hectares)
- Mangrove Offset Site (259 hectares)
- Wambo Offset Site (56 hectares).

It is also noted that each of the properties has been assessed for agricultural suitability and those areas that are identified as value for ongoing agricultural use have been excluded from the offset areas.

The Regional mapping of LSC classes for the three potential offset sites indicates:

- Highfields Offset Area – LSC classes 3, 6 and 7.
- Mangrove Offset Area – LSC classes 3, 5 and 7 with no BSAL land mapped within 2 kilometres.
- Wambo Offet Area – LSC class 7 with no BSAL land mapped within 2 kilometres.

The Project will not change the agricultural resources of the potential Offset Areas. While these areas are proposed to be managed for biodiversity enhancement and connectivity, the soils and water resources present in the offset areas will not be disturbed.

3.4.5 Strategic Agricultural Land

3.4.5.1 BSAL

Within the Project Area, the strategic mapping undertaken for the Upper Hunter SRLUP (DP&I, 2012a) indicates potentially 31.7 hectares of BSAL in the northwest corner of the Project Area (refer to **Figure 2.1**). This includes 14.7 hectares in the SVC Application Area (refer to **Appendix A**).

Assessment conducted for the SVC Application demonstrates that the extent of BSAL is less than that mapped at the regional scale, when the criteria are applied to soils described and tested at the project scale. The actual area of BSAL in the northwest corner of the Project Area is a maximum of 3 hectares.

Regional mapping also indicates potentially 4 hectares of BSAL within the Highfields Offset Area. A detailed assessment of this BSAL has not been conducted, as the Project is not proposing to disturb this land and soil resource.

3.4.5.2 Verification of BSAL

As discussed in **Section 2.5.4**, the status of soils in the Project Area has been verified in relation to BSAL.

Detailed descriptions of the soil types occurring in or adjacent to the detailed SVC assessment area are included in **Appendix A**. Four different soil types were identified, reflecting complex underlying geomorphology (refer to **Figure 3.7** and **Table 3.10**). This very small area (3.8 hectares) contains Eutrophic Dermosol soils formed on colluvium, with tiny areas of Eutrophic Chromosol, Mesonatric Sodosol and Subnatric Sodosol on the margins. An area of soil that meets the description of Epipedal Vertosol exists on the north western boundary of the Project Area, contiguous with alluvial soils and mapped BSAL outside the Project Area. No Vertosol profiles are present in the detailed assessment are for the SVC application.

Table 3.10 Summary of Soil Types in (and adjacent to) the SVC Application Area, in the north-western corner of the Project Area

ASC Order	ASC Great groups	Landscape context	Fertility (as per Table 6 of the Interim Protocol)
Sodosol **See profiles:** **Subnatric : D15, D18, D23, C30 and C31, D34, D35, D36, D37** **D18** **Mesonatric: D19, D20, C27 and C28**	Brown subnatric and mesonatric, rarely mottled. Strong texture contrast soils, elevated ESP, high pH, elevated ECe; may have rock at less than 750mm.	Most common soil type in the north western part of the Project Area occurs on mid and lower slopes, underlain by sandstone, conglomerate and mudstone.	Moderately Low – defined in Table 6 of Interim Protocol and confirmed with laboratory testing (refer to **Appendix A** and **Table 3.6**)
Chromosol **See profiles D12, D16, D17 and C25 and C32**	Brown Eutrophic Texture contrast soils, with B2 not strongly acid (pH >5.5), CEC>15	Small areas of upper slope or ridge and spur crest (Approximately 0.2 hectares).	May be moderately high in Table 6 of the Interim Protocol Field results indicate low to moderate fertility (**Table 3.6**)
Dermosol, see profiles D13, D14, C29, D33	Eutrophic Gradational profiles, soils with pedal B horizon but the texture contrast is not abrupt or clear	Lower slope, at transition point to valley flat.	Moderately high fertility suggested in Table 6 of the Interim Protocol. Field results suggest fertility constrained by sodicity (**Table 3.6**).

ASC Order	ASC Great groups	Landscape context	Fertility (as per Table 6 of the Interim Protocol)
Vertosol **See Profile D21**	Brown Epipedal Uniform or gradational clay profiles, cracking, with moderate pedality in A horizon	Alluvial soils at interface of tributary valley fills and Hunter alluvium. There is less than 3 hectares of vertosol profile in the Project Area. These soils are occasionally waterlogged.	May be moderately high (in Table 6 of the Interim Protocol)

Additional field survey and laboratory analysis of soil samples was conducted for profiles outside the SVC Application Area but inside the Project Area boundary in the northwest corner of the Project Area. The character of soils in this part of the Project Area is the key information to assess impacts of the Project on valuable agricultural resources.

The field observations and test results, prepared at a scale of 1:10,000, enable an explanation of the complex local scale patterns of low relief terrain variations and soil profile forms in this part of the Project Area.

Based on a detailed verification assessment of land and soils occurring in the northwest corner of the Project Area, including 3.8 hectares where a new subsurface mining lease is required and additional areas within the Additional Disturbance Area, the following can be concluded:

- The terrain in the northwest corner of the Project Area is a transition from the hillslope and tributary valley fill materials that occur in the Jerrys Plains Soil Landscape and the outer margin of the clay soils on the Hunter Soil Landscape.

- The area of BSAL confirmed to be located in the northwest corner of the Project Area is less than the area mapped as BSAL at the regional scale. All soil types across the SVC Assessment area failed to meet the criteria for BSAL based on effective rooting depth to either a chemical (e.g. fertility) or physical barrier (e.g. rock or gravel) at less than 750mm (refer to **Appendix A**).

- The area that meets the BSAL criteria, at a scale of 1:10,000 is shown in **Figure 3.7**. The figure shows contours at 1.0m intervals, to capture minor relief features across the transition area. The BSAL has an area of approximately 3 hectares. This area of likely BSAL is entirely outside areas proposed for open cut mining.

- Where the landscape transition in the northwest corner of the Project Area is from low angle footslope to the outer margin of the floodplain, the transition involves a complex mix of colluvial profiles (Eutrophic Dermosols in this case), and profiles that are still based on bedrock or poorly drained sediments (Subnatric Sodosols), eventually being replaced by profiles that are developed on river alluvium. The shallow profile depth and texture profile of footslope soils, as well as occasional salinity, low fertility and sodicity mean these soils do not meet the BSAL fertility criteria.

- Alluvial fill materials associated with tributary drainage lines (Waterfall Creek) have texture contrast profiles and some gravel lenses present. These soils are deposited from low fertility and saline catchments and do not meet BSAL fertility criteria. These are Mesonatric Sodosols.

- Some soils that were mapped as BSAL at the regional scale are actually shallow texture contrast profiles located on low to very low gradient bedrock spurs (Chromosols). The local relief on these low spurs varies from approximately one metre to three metres above the adjacent alluvial/colluvial fan materials. These soils are not BSAL.

- In addition to the sediments which have been deposited by Waterfall Creek, a number of shallow drainage depressions and remnants of former 'chain of ponds' drainage line morphology traverse the interface between the tributary alluvium/colluvium and the alluvium sourced from the Hunter River. Soil test pits excavated within these shallow depressions indicate profiles that include some weathered gravel units (up to 20% gravel, but may be as little as 5%), likely to be alluvial gravels deposited over a heavy red brown clay B2 horizon. These profiles are not BSAL.

- Epipedal vertosols that meet the BSAL criteria are located at the northern extremity of the Project Area where the alluvial contributions flowing out of the Waterfall Creek tributary catchment have, over a long period, merged with the outer margins of the Hunter floodplain clay soils.

3.4.5.3 Critical Industry Clusters

The strategic mapping undertaken for the Upper Hunter SRLUP (refer to **Figure 2.1**) indicates there are no CICs in the Project Area or within proximity of the Project Area. The nearest area of CIC is a viticulture CIC located in the Bulga area approximately 5 kilometres south of the outer boundary of the Project Area. An equine CIC is mapped northwest of the Project Area; the nearest boundary of the CIC is approximately 7.5 kilometres from the outer boundary of the Project Area.

4.0 Agricultural resources of the locality

This section outlines the climate, water resources, landforms, soils and vegetation of the context of the Project Area.

This section addresses the matters covered under Item 3.1 of the AIS Technical Notes. The resources described are associated with land that is within a 5 km radius of the centre of the Project Area. Within this 5km radius are lands with natural resources that are currently used for agriculture (beef cattle, dairy and a very small area of vineyards), mining and conservation (National Park). These uses are discussed further in **Section 6.0**.

4.1 Climate

Climate measurements including monthly rainfall distribution, evaporation, as well as maximum and minimum temperatures provide a key determinant of the agricultural potential of a district.

The Jerrys Plains Station (BoM Station 61086) has been used to characterise the rainfall and temperature data for the Upper Hunter region and the Project Area. The Scone SCS Station (BoM Station 61089) has been used to characterise the monthly evaporation. These records, presented in **Table 4.1,** have been selected as they are long term (recorded for over 100 years), considered to be representative of the Upper Hunter region and they are consistent with data used in analysis for other components of the EIS.

OEH (Adapt NSW) (2014) provides an overview of the climate of the Upper Hunter region. The information below draws on that overview:

- The climate of the Hunter region generally is subtropical to temperate.

- The upper Hunter experiences distinct seasonal variations in temperature. In summer the average maximum temperature in the Upper Hunter is 30-32 degrees Celsius. Average winter temperatures are 2-8 degrees Celsius. Much of the Hunter Valley experiences 10-20 days each year with a maximum temperature greater than 35 degrees Celsius. The upper Hunter also experiences 20-50 days (depending partly on altitude) winter days with night time temperatures below 2 degrees Celsius.

- Rainfall in the Hunter region is strongly influenced by *el nino* southern oscillation patterns, as well as the topography of the valley and distance from the coast. While average annual rainfall in the region is about 870mm, the upper Hunter is much drier than the coast and has an average annual rainfall of around 600mm. The rainfall of the Upper Hunter is summer dominant with 34 per cent of rainfall occurring in the three months December to February, compared with 20 per cent falling in the three months June to August. Sixty-one per cent of rain falls from October to March inclusive. The monthly evaporation exceeds rainfall in every month except June where evaporation is equal to rainfall.

- The Hunter region is characterised by mid latitude westerly winds and high pressure systems alternating with cold fronts during winter, with winter conditions being drier than summer (HVRF 2005). The prevailing winds in winter are from the northwest direction, with winds in summer predominantly from the southeast. Wind speed is greatest from late winter through the spring, and lighter winds occur in autumn.

- Singleton and the broader region is well known for its historic climate variability and extremes, with major floods, droughts and bushfire events having an impact on the LGA (Singleton Council, nd). OEH 2014 notes that rainfall variability includes:
    - Reduced rainfall and dry conditions in the first half of the 20th century
    - Strong inter-annual variability since the 1950s
    - A long period of below average rainfall in the first decade of the 21st century ('millennium drought')
    - Exceptionally wet conditions in 2010 and 2011.

Indicatively, the climate is currently suitable for a range of agricultural enterprises including permanent and annual horticulture, cropping enterprises and improved perennial and native pastures. The climate would support temperate to sub-tropical plants so long as there is a degree of frost tolerance or dormancy over winter. The growing season length would depend on the crop, however it would be reasonable to expect that temperate species would have suitable conditions for growth from September through to May inclusive and possible over the winter. Sub-tropical species could be expected to have a growing season of October through to March or April.

Permanent horticulture plantings and improved pastures would rely on irrigation to provide consistent productivity in this climate where there can be significant gaps between rainfall events and the evaporation rate is high.

Table 4.1 Mean Climate Statistics at Jerrys Plains and Scone

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Annual
Rainfall (mm)	77.1	73.1	59.7	44.0	40.7	48.1	43.4	36.1	41.7	51.9	61.9	67.5	645.9
Max temp (ºC)	31.8	30.9	28.9	25.3	21.3	18.0	17.4	19.4	22.9	26.3	29.1	31.2	25.2
Min temp (ºC)	17.2	17.1	15.0	11.0	7.4	5.3	3.8	4.4	7.0	10.3	13.2	15.7	10.6
Monthly Evaporation – Scone SCS (mm)	220	174	152	105	68	48	56	84	117	158	183	220	1,606
9am Relative Humidity (%)	67	72	72	72	77	80	78	71	65	59	60	61	70
3pm Relative Humidity (%)	47	50	49	49	52	54	51	45	43	42	42	42	47
9am wind speed (km/h)	9.6	9.0	8.8	8.6	9.0	9.4	10.6	11.0	11.7	10.9	10.5	9.9	9.9
3pm wind speed (km/h)	13.2	13.0	12.4	11.3	11.0	11.5	13.0	14.3	14.7	14.1	14.2	14.2	13.1

Source: BOM, 2012.

4.1.1 Climate variability and climate change

The Upper Hunter region is subject to historic climate variability, both annual and interdecadal, with extreme droughts, bushfires and floods. The western part of Singleton LGA, in which the Project Area is located, experienced a total decrease in average annual water balance of 0.7mm/day over the period 1970 to 2007 (HCCREMS 2009).

Climate change over the coming decades is projected to have a variety of impacts on agricultural resources and related enterprises in the upper Hunter region (DP&I 2013). These include:

- increased incidence of heat stress in beef and dairy cattle, with an additional 5-10 hot days (above 35 degrees) projected by 2040, extending through spring, summer and autumn
- fewer cold nights, which may affect some horticultural production, such as fruit that is dependent on cold winters to produce flower buds
- increased autumn rainfall and decreased spring rainfall over the next 25 years, noting a high level of uncertainty associated with complex rainfall projections. These changes to the seasonality of rainfall may impact on water security for agriculture over the summer period.
- increases in the severity of both drought and flood events, which may also impact on water security for agriculture. Potential indirect impacts of increased flood intensity include delays in transporting cattle to market
- potential for increased incidence of disease and pests in grapes and hay crops, leading to delayed harvests, reduced yield (e.g. with heavy late summer rain) and /or a downgrading of quality
- increased fodder production, with higher rainfall and an extended growing season
- increase in average and severe fire weather, particularly in spring.

DP&I 2013 also note the adaptability of farming enterprises in the Upper Hunter region, evidenced by diversification, good transport routes, existing investment in irrigation infrastructure and good canopy management (for viticulture). DP&I 2013 suggest that with this existing adaptability, climate change is not the highest priority challenge to the future of productive agriculture in the region. Competing land use, both from urban expansion and the mining industry, industry rationalisation and international competition are all important pressures on agriculture.

4.2 Topography

The general topography of the central lowlands of the Hunter Valley comprises rolling low hills, bounding the floodplain and terraces of the Hunter River. The edges of the central lowlands are marked by the boundary between the Permian sedimentary rocks and Triassic sedimentary rocks in the southern mountains.

Approximately 0.5 kilometres to the west of the Project Area lie the foothills of the Wollemi National Park which form the dominant landscape feature of the land surrounding the Project Area (refer to **Figure 1.3**), with steeper slopes and escarpment areas fringing the Hunter Valley floor. Wollemi National Park and the adjacent Yengo National Park provide a large expanse of conservation land stretching south to the west of Sydney.

4.3 Soils

Figure 4.1 illustrates the distribution of soil landscapes in the locality (up to 5km from the edge of the Project Area) as mapped by Kovac and Lawrie (1991) at the regional scale. A discussion of the key conclusion regarding regional scale information for the landscape of the Project Area and surrounding locality is provided in **Section 3.4.1**, with a description of soil landscape characteristics provided in **Table 3.5**.

OEH notes that soil organic carbon is already low in the Hunter region but (based on modelling) may increase in the future. The projected trend in the Hunter region is different to the general decline in soil organic carbon projected for most of the state with climate change (OEH 2015).

4.4 Water Resources

4.4.1.1 Availability in the Locality of the Project Area

The Project is located within the catchment of the Hunter River, just upstream of the confluence of the Hunter River and the Wollombi Brook and downstream of the confluence with the Goulburn River. The Hunter River rises in the Mount Royal Range. The Goulburn River occupies 40% of the total Hunter River catchment, but contributes only 23% of the flow.

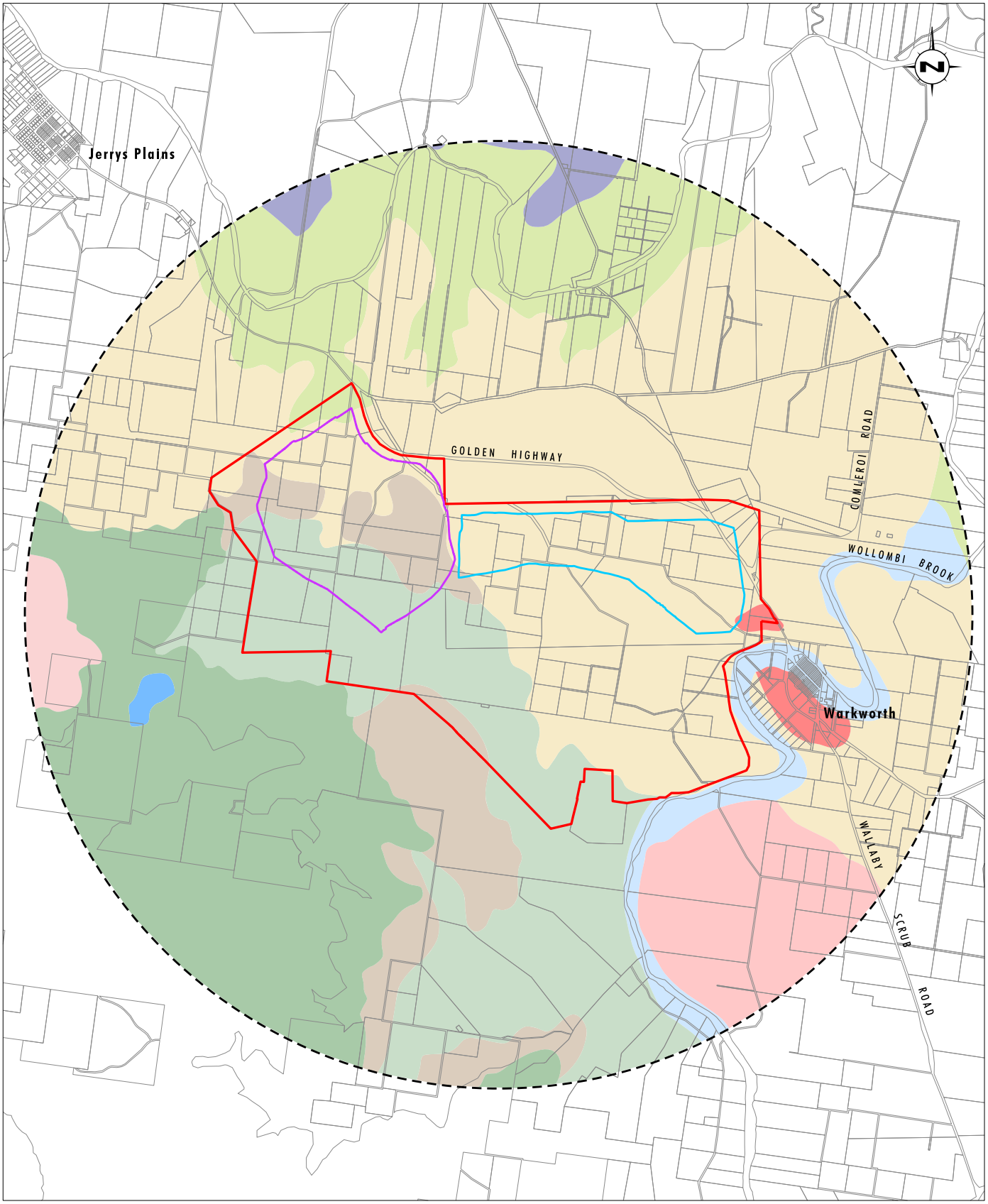
River flows in the Upper Hunter region are highly variable, with extended periods of drought and occasional very high intensity rainfall events leading to catchment wide flooding.

Water resources in this part of the Hunter catchment are managed within the Hunter Regulated River water sharing plan. The Wollombi Brook is not a regulated river. The volume and flow pattern of the Hunter River in this area has been significantly altered by the construction and operation of the Glenbawn Dam. Other important dams are Glennies Creek (further downstream than the Project Area) and Lake Liddell.

4.4.1.2 Water Reliability

The *Interim Protocol for Site Verification and Mapping of Biophysical Strategic Agricultural Land* (OEH and OASFS 2013) state that the whole of the Upper Hunter has access to reliable water supply because the area meets the criteria of having 'rainfall of 350 millimetres or more per annum in 9 out of 10 years of the area is underlain by a groundwater aquifer with a bore yield rate greater than 5 L/s and total dissolved solids of less than 1500 mg/L' (OEH and OASFS 2013).

Jerrys Plains Station (BOM Station 610786) indicates the annual average rainfall is 645.9 millimetres based on records between 1884 and 2014 (refer to **Table 4.1**).



Data Source: LPMA (2009), Office of Environment & Heritage (2005)

0 1.0 2.0 4.0km
1:80 000

Legend

- Project Area
- Proposed Conceptual United Open Cut Pit
- Proposed Conceptual Wambo Open Cut Realignment
- Hunter Soil Landscape
- Benjang Soil Landscape
- Bulga Soil Landscape
- Three Ways Soil Landscape
- Warkworth Soil Landscape
- Ogilvie Soil Landscape
- Branxton Soil Landscape
- Wollombi Soil Landscape
- Jerrys Plains Soil Landscape
- Lees Pinch Soil Landscape
- Roxburgh Soil Landscape
- Liddell Soil Landscape

FIGURE 4.1

Soil Landscape Mapping Units

File Name (A4): R07/3509_141.dgn
20160511 16.59

4.4.2 Vegetation Communities

4.4.2.1 Regional Context

Vegetation mapping of the locality was completed as part of the UHSA, undertaken in accordance with the relevant provisions of the Commonwealth EPBC Act and the NSW EP&A Act. Vegetation communities present in the Project Area and Offset Areas are noted below.

A key feature of the vegetation of the valley floor of the Upper Hunter region is the extent of clearing that has occurred since European settlement. The region has been subject to a long history of vegetation clearing for agricultural purposes (e.g. grazing and cropping) and more recently, open cut coal mining. This has led to the current condition where the woodlands and forested communities in the region have become highly fragmented. Naturally forested areas are primarily confined to the steeper land that has always been considered unsuitable for agriculture. These areas have uses other than agriculture, including forestry, conservation, tourism and military training.

There has been extensive historical land clearing in the region for a variety of land uses, with the areas surrounding the Project Area predominantly composed of remnant patches of woodland and forest communities. Woodland and forest areas in the surrounding landscape include the Wollemi National Park located to the west and southwest.

Further details regarding vegetation in the Project Area and surrounding locality can be found in the UHSA Statement of Consistency Report (Umwelt 2016).

5.0 Agricultural industries and productivity of the Project Area and locality

5.1 Overview of agriculture in the Upper Hunter region

The Project Area is located within the Upper Hunter agricultural region. Land use in the region includes a mix of farming on lands of moderate to good land capability; dense timber, rock or steep land where land capability is in classes 6-8; active mining land and rehabilitated mining land.

The region covers just over 2 million hectares, of which 1,081,841ha is classed as farmed land, used for grazing, crops, fallow and horticulture (DP&I 2013 (Fact Sheet 1)). This is 2% of the farmed area of NSW. Approximately 56% of the agricultural lands of the Upper Hunter region are located within the Upper Hunter Shire. Singleton LGA, in which the Project Area is located, accounts for 13% of the agricultural land in the region and 18% of the estimated value of agricultural production in the region.

Average farm size in the Upper Hunter region is 492 ha, which is 38% of the NSW average. Average farm size in Singleton Shire is 284 ha. The smaller than average farm size reflects both the fragmentation associated with proximity to major urban centres, reliable water supply and the types of agricultural activities such as vineyards, dairy, poultry, horse bloodstock and cattle grazing.

The distribution of agricultural uses in the region is linked to both climate gradients across the region and to variations in soil type. For instance, dairying, equine, grazing and intensive lucerne pasture production are concentrated on alluvial flats with access to irrigation water. The drier climate and volcanic soils of the Upper Hunter Local Government Area are used for broad acre cropping.

5.2 Land Ownership in the Project Locality

Land ownership in the Project Area and surrounding locality is shown on **Figure 5.1**.

In the locality of the Project, the land owners include:

- Mining operations, including:
    - Wambo
    - United
    - Coal and Allied.
- Construction, Forestry, Mining and Energy Union (CFMEU)
- Crown Land, including:
    - Wollemi National Park
    - the bed of the Hunter River
    - Crown reserves

- Private land holdings. Private land holdings are concentrated in five areas:
    - Jerrys Plains village and surrounds
    - Bulga village and surrounds
    - Warkworth village and surrounds
    - Maison Dieu
    - Small parcels of rural land enclosed within Wollemi National Park.

5.3 History of Agricultural Enterprises

Changing agricultural focus and rural settlement patterns are a key characteristic of the history of the area, responding to changes in short to medium term environmental conditions and to changes in economic, social and policy frameworks, often at a scale well beyond the Project. DPI Agriculture 2013 notes that agriculture industry in the region is adapted to changing conditions and the diversity of activity makes it reasonably resilient to diverse change factors.

Notwithstanding historical changes and adaptability, the dominant agricultural land use in the locality is currently cattle grazing. The broader Upper Hunter Region has higher quality soils and a more diverse agricultural sector.

5.3.1 Land Use History of the Region and Locality

European settlers occupied the floor of the Hunter Valley from the early nineteenth century, taking up land as far north as Singleton by October 1821. Early reports described the suitability of the land for pastoral pursuits resulting in the establishment of large scale pastoral holdings. The 1828 census indicated that, on the 191 large (over 1,000 acres) estates occupying the Upper Hunter Valley, cattle grazing was much more common than sheep grazing enterprises. By the mid-nineteenth century European settlement had expanded rapidly, with a total of 372,141 acres taken up in the Hunter Valley between 1822 and 1826.

The settlement pattern across the region reflects early agricultural land uses and features multiple towns and villages which have traditionally functioned as rural or transport service centres. The pattern and demography of rural towns and villages has been gradually changing since the mid-twentieth century, in response to factors such as changes in technology, social conditions, national and international markets and wealth.

Over the last approximately 150 years, a number of agricultural industries have been important and subsequently declined. Since the early nineteenth century, land in the vicinity of the Project Area has been used for sheep and wool, dairying, dryland grazing, horse breeding, and cereal and fodder crops. Changes in land use have responded to changes in environmental, regulatory and economic conditions at the time. A brief history of regional land use, scoping the extent of change over time is presented below.

Historical records indicate cultivation began early in European settlement of the area, with crops including wheat, maize, potatoes, barley and tobacco. Wheat crops grown in the Hunter Valley were prone to the disease ‘rust’, which struck severely in 1857. Disease together with the relatively dry conditions in the Upper Hunter made wheat a precarious crop as a result its production declined. The decline in wheat cultivation saw an increase in barley production, mainly for stock feed but as the dairy industry began to grow, lucerne crops became a more viable option.

Dairy farming became an important land use after sheep/wool production began to wane and by the early twentieth century, dairy farms of up to 500 acres in size were present in the Upper Hunter. The growing importance of the dairying industry in the early twentieth century coincided with the 'development of the mechanical separation of milk and refrigeration causing a re-shaping of the pattern of farming' in the Singleton and Muswellbrook LGAs, due to the increased demand for dairy products in Australia and overseas (Turner 1995:19).

Dairying increased after World War I as soldiers were given small holdings and government assistance to establish small agricultural businesses, such as dairy farms (Heritage Office and DUAP 1996a:49). A gradual decline of the dairying industry began in the second half of the twentieth century, with the number of dairy farms almost halving between 1970 to 1976 from 9,061 to 4,626 (Dunne 2012:75-81). The decline is described as being the result of changing policies, Britain joining the European Economic Community (resulting in Australia losing its main dairy export market), and the reallocation of milk quotas and the eventual deregulation of the industry (following the replacement of the Milk Board with the Dairy Industry Authority).

The development of coal resources began on a limited scale in the early 1900s. Rapid expansion took place in the 1950s with the establishment of large open-cut mines to supply power stations and increasingly to meet export demand. Today, coal mining employs approximately 36% of workers in the Singleton LGA (refer to **Section 5.4.2**).

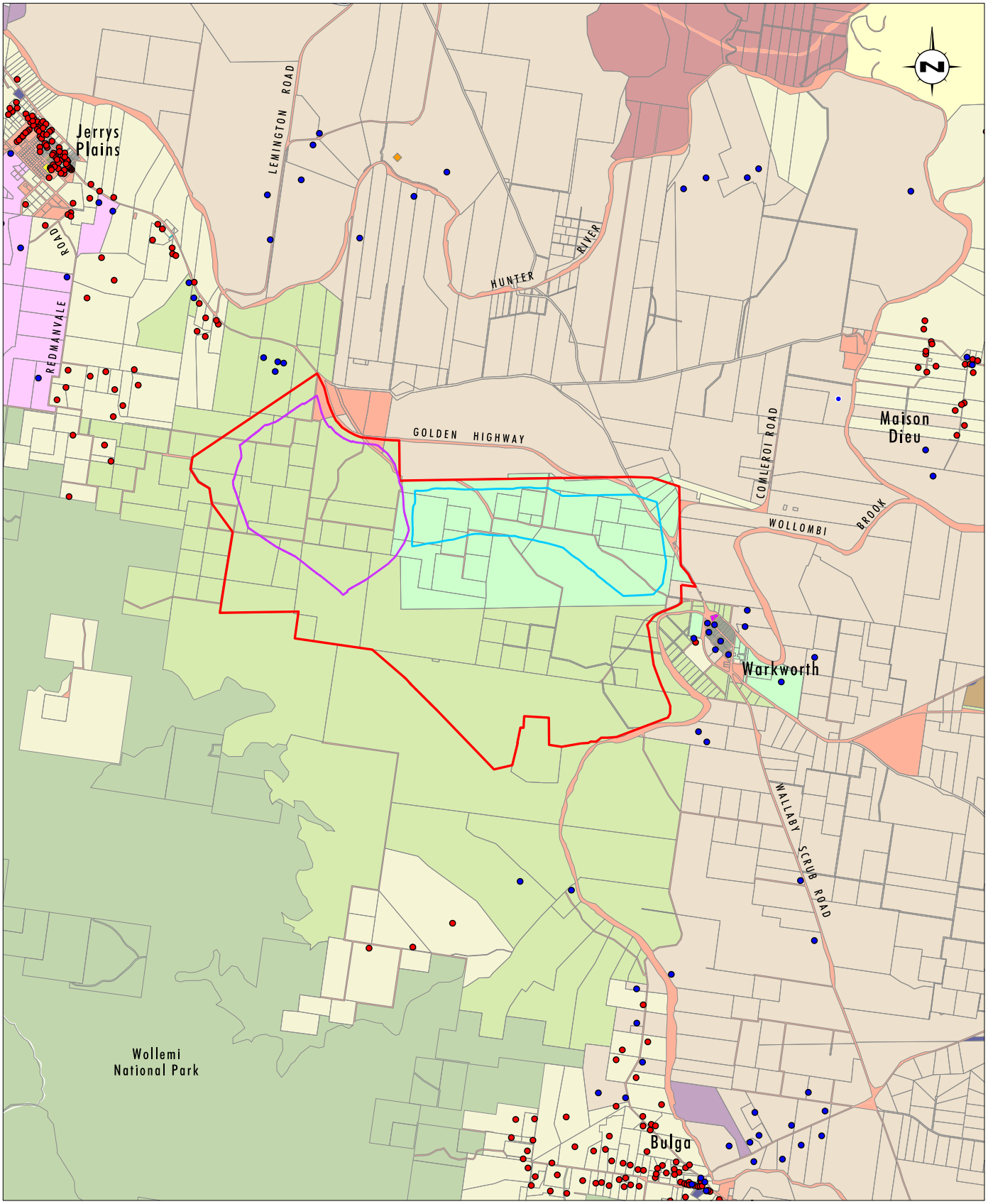
5.3.1.1 United Mine/Wambo Mine Locality

The earliest land taken up in the locality of the Project Area was around the Wambo Mine area on land close to the first road to Windsor and the fertile river flats of Wollombi Brook and the Hunter River, with the earliest granting of land in the area occurring in 1828 and later formed part of James Hale's Wambo Estate in the early-mid 1830s. Hale originally named the property Lemington Grange after the name applied to the parish by Assistant Colonial Surveyor Henry Dangar.

By 1844 Hale was one of the top one hundred landholders in the colony, using his Wambo Estate for both grazing and wheat cultivation. He also ran cattle on the property and is likely to have used Wambo Estate as a halfway point for moving his sheep between Windsor and his large land holdings further north and west. Following Hale's death in 1857, the Wambo Estate was inherited by his stepson William Durham Junior. In 1905 the Wambo Estate was purchased by R. C Allen and Frank McDonald (Collins, 1994: vii) who used it as a horse stud farm and initiated a building program of timber horse boxes, yards and fences (GML 2010:44) prior to subdividing the estate into six lots in 1908.

The majority of the Wambo Estate was sold to Wambo Coal in 1968.

Mine owned land, and active mining operations occupy approximately two thirds of the land within 5km of the Project Area. National Park occupies a further approximately 25% of the land in the vicinity of the Project Area (refer to **Figure 1.3**).



Data Source: LPMA (2009), Department of Natural Resources (2005)

0 1.0 2.0 4.0km

1:90 000

Legend

- Project Area
- Proposed Conceptual United Open Cut Pit
- Proposed Conceptual Wambo Open Cut Realignment
- Mine Owned (Ashton)
- Mine Owned (Bulga)
- Mine Owned (Coal and Allied)
- Mine Owned (Doyles Creek)
- Mine Owned (Glencore)
- Mine Owned (Integra)
- Mine Owned (Peabody)
- Mine Owned (Ravensworth)
- Mine Owned (Wambo)
- AGL Energy
- Ausgrid
- Bulga Community Centre
- Government Authority (Federal, State or Local)
- Department of Education and Communities
- Diocese of Newcastle
- National Parks and Wildlife Service
- Private
- Redbank Energy
- Singleton Council
- Telstra
- Wanaruah Local Aboriginal Land Council
- Private Residence
- Mine Owned Residence

FIGURE 5.1

Land Ownership

5.3.2 Land Use History of the Project Area

The dominance of pastoral grazing in the Project Area from the 1820s to the 1970s is evidenced by the history of native vegetation clearance and construction of pastoral infrastructure such as dams and fences, along with homesteads and other rural structures. In addition, a large portion of the Project Area was formerly used as a Travelling Stock Reserve (TSR); however, by the early twentieth century the land had been sold and by 1932 was predominantly in the hands of the Commonwealth Bank of Australia.

Further details regarding land use history in the Project Area and locality can be found in the *United Wambo Open Cut Coal Mine Project Historical Heritage Assessment* (Umwelt 2016).

A review of aerial photography dating from 1960s, 1970s and 1980s (refer to **Figures 2.2**, **2.3** and **2.4**) indicates the Project Area was generally comprised of cleared grazing land with some scattered trees; illustrating the extent of tree clearing and surface disturbance that had previously been undertaken in the area.

The aerial photos also provide valuable information about the types of agricultural use that were practiced in the area prior to mining and the impacts of those uses on the natural resources of the landscape. Features of note include:

- No cultivation is evident along Redbank Creek, which runs through the United Mine lease area. However, the riparian land along the creek was extensively cleared, and sheet erosion and channel incision are both clearly visible in the 1960s, 1970s and 1980s.

- The floodplain of Wambo Creek was cultivated for fodder crops and dairying in the 1960s, 1970s and early 1980s, but had been largely abandoned by the 1990s.

- The floodplain of Wollombi Brook, to the east of Comleroi Road and the Project Area was cultivated by the 1960s and continuing until recent times. Upstream of the confluence with Redback Creek, only very small patches of floodplain have been cultivated and much of the land adjoining the Wollombi Brook in partially cleared woodland.

- Although most of the area had been cleared for grazing prior to the 1960s, clearing continued in the steep lands in the north west of the Wambo Mine lease area in the 1970s and 1980s and newly cleared areas are affected by erosion. Windrows and attempts at contour drainage banks to restrict sheet erosion are evident. The clearing includes the parcel of Crown land which currently overlaps with the north-west corner of the Project Area. Revegetation of this land did not occur until after 2000.

- Revegetation of the steeper lands in the Wambo Mine lease area occurred after the 1980 and canopy cover had recovered by 1992.

The aerial photos and the history of land uses in the locality and on the Project Area provide clear evidence that high quality agricultural land, suitable for sustainable production without significant investment in natural resource protection, is restricted to the floodplains of the main tributaries of the Hunter River and the Hunter River itself. Although widespread clearing for grazing has occurred in the past, a number of significant constraints are evident from the historical response of the land to clearing and grazing. The highest productivity historical uses of the Project Area suggest Class 4 land at best, with much of the land being classes 6, and 7 agricultural land.

5.4 Current Agricultural Enterprises in the Locality

This section describes the rural land use context of the Singleton LGA in the Upper Hunter region and of the specific Project Locality (i.e. in a 5 kilometre radius from the centre of the Project Area).

Hunter Local Land Services (LLS) (formerly Hunter-Central Rivers Catchment Management Authority (HCRCMA)) reviewed regional land use for the Upper Hunter during the preparation of the *2013 Catchment Action Plan*. The Hunter LLS reviewed the Australian Bureau of Statistics (ABS) land use data release in 2012. For the Upper Hunter, the analysis identified the areas used for diverse rural and industry purposes, as shown in **Table 5.1**.

Table 5.1 Land Use type and value, Upper Hunter Region (HCRCMA 2013)

Upper Hunter Land Use Summary Land Use	AREA (ha)
Conservation Area	43,431
Broad acre cropping	37,863
Grazing	668,477
Horticulture	5,175
Intensive Animal Production	2,861
Mining & Quarrying	55,360
Power Generation	441
River & Drainage System	14,243
Special Category	1,735
Transport & Other Corridors	8,095
Tree & Shrub Cover	124,361
Urban	12,756
Wetland	302

Farms occupy 56% of the area of the Upper Hunter Region, but a much smaller portion of the area of Singleton and Muswellbrook LGAs (DPI 2013). **Table 5.2** provides a summary of the area used for agriculture and non agricultural rural uses for the Upper Hunter region, and for Singleton and Muswellbrook LGAs.

Table 5.2 Agricultural land use in the Upper Hunter (DPI 2013, based on 2006 data for Singleton and 2012 data for Muswellbrook)

Land use	Singleton LGA	Muswellbrook LGA	Upper Hunter region
Total area of farm holdings (ha)	156,484	121,872	1,200,040
Number of farms	551	314	2,438
Farm holdings as % of LGA total area	32%	36%	56%
Grazed/cropped land as% total LGA area	29%	30%	50%
Farmlands not used for agriculture (ha), %	16,923 11%	18,273 15%	118,199 10%
Other land (national park, mining land), ha, %	348,864 71%	236,601 70%	1,074,575 50%
% farm holdings used for crops	4%	7%	4%
% farm holdings used for grazing	85%	78%	86%

Both Singleton and Muswellbrook LGAs have smaller percentages of the total LGA area in agricultural use than the Upper Hunter region as a whole, reflecting the area used for mining and National Park in Singleton and Muswellbrook Shires. However, of agricultural lands, the division between grazing and cropping is very close to the regional average, while Muswellbrook reflects the presence of high quality cropping land along the Hunter River, upstream of the Goulburn River confluence.

DPI (2013b) indicates that, in 2006, the Singleton LGA accounted for approximately 23% of the total number of farms in the Upper Hunter region. This is despite only accounting for approximately 13% of the total area farmed in the Upper Hunter region. This is reflected in the average farm sizes in Singleton LGA, at approximately 284 hectares; where the average farm size in the Upper Hunter region is approximately 492 hectares (DPI, 2013b). The smaller farm sizes are associated with intensive flood plain and terrace agriculture (e.g. historically to support dairying) and historical land tenure such as soldier settlement schemes.

Table 5.3 shows the change in land allocated to the main agricultural uses between the 2006 and 2011 census periods. Overall, the area of land used for agriculture remained stable, with a small reduction (2%) in the number of farms and the total area of farms and a small increase (less than 1%) in the area used for grazing.

Table 5.3 Land Use by Area for Agriculture in the Singleton LGA, 2006 and 2011 data

Land Use by Area	Census Year		Change
	2006	2011	
Total LGA Area (ha)	**488,425**	**488,425**	**No Change**
Total Area of Farm Holdings (ha)	156,484	156,171	-343
Number of Farms	551	536	-15
Farm Holdings as Percentage of LGA Total Area (%)	32	32	No Change
Grazed/Crop Land as Percentage of LGA Total Area (%)	29	29	No Change
Grazing Lands (ha)	132,631	133,686	+1,055

Source: ABS, 2012a and DPI, 2013b

5.4.1 Regional Agricultural Production Statistics

Data collected by ABS (2011) indicates that in the Singleton LGA, agriculture and related uses employ 976 people, or approximately 3% of employment in the LGA. Across the Upper Hunter region generally, agriculture employs 6,310 people, but these statistics include viticultural activity in the Cessnock LGA.

Table 5.4 shows the value of production and employment by agricultural use in the Upper Hunter region (DPI 2013, using 2006 ABS data).

Table 5.4 Value of Agricultural Production, Upper Hunter (DPI 2013)

Agricultural industry	Production value ($million)	Number of farms	Employment	Employment Singleton LGA
Stud horses	$461 (Singleton $81 million)	245	1124	62
Wine grapes	$24	215	481	117
Beef	$212	2158	2420	349
Milk	$117	202	751	210
Poultry (meat and eggs)	$38	37	112	
Hay	$25	490	88	31
Wool and sheep	$21	247	373	11
Broadacre crops	$8	100	44	n/a
Vegetable and mushrooms	$6	22	119	77

Agricultural industry	Production value ($million)	Number of farms	Employment	Employment Singleton LGA
Nurseries, flowers and turf	$4	17	46	n/a
Fruit and nuts (excl grapes)	$4	66	31	n/a
Other agriculture	$4	Not provided	111	31 plus 301 (nfd)

Singleton LGA accounts for approximately 18% of the estimated value of agricultural products (excluding horses) in the Upper Hunter region and 0.4% of the total estimated value of agricultural products in NSW.

DPI (2013b) estimates the value of the equine industry in the Upper Hunter, based on ABS 2006 data. In 2006, there were 932 stud horses in Singleton LGA, with 10,658 in the Upper Hunter region. DPI (2013b) refers to estimates from HTB (2010) that the Hunter overall produces 70% of the stud horses in Australia and 80% to 90% of the export value. HTB (2010) also states that the value of bloodstock on Hunter Valley farms is around $2.5 billion. There are no stud horse enterprises in the Project locality.

5.4.1.1 Ten Year Agricultural Production Data for the Singleton LGA

Table 5.5 shows the amount, in tonnes, of various agricultural products for the Singleton LGA, for the periods 2000-2001 and 2010-2011. **Table 5.6** shows the value of production of these agricultural commodities over the same 10 year period. The trends in Singleton LGA are slightly different to the trends for the Upper Hunter region as a whole, which has remained generally stable.

As shown in **Table 5.6**, in 2010-11 the total gross value of agricultural production in Singleton LGA was approximately $50.7 million (ABS 2012b). This was an increase of approximately $13.6 million and $16.2 million from the total gross value of agricultural production in 2000-01 and 2005-06 respectively.

Livestock slaughtering and milk production have consistently been the biggest contributors to the total value of agricultural production in the Singleton LGA. In 2010-11 the total gross values of livestock slaughtering and milk production accounted for approximately 87% of the total value of agricultural production in Singleton LGA (refer to **Table 5.5**). This was an increase of approximately $17.23 million and $0.38 million from 2005-06 for livestock slaughtering and milk production respectively. It is noteworthy that the gross values of livestock slaughtering and milk production have increased despite a decline in livestock and dairy cattle numbers since 2000-01 (refer to **Tables 5.5** and **5.6**).

In the 10 years between 2000-01 and 2010-11, production of agricultural commodities in Singleton LGA declined; excluding hen egg production, fruit and nut production (refer to **Table 5.5**). None of these products is relevant to the Project Area.

Table 5.5 Production Statistics for the Periods 2000-2001 and 2010-2011* for Singleton LGA#

Agricultural Commodities	2000-2001	2010-2011	Change
Hay and Silage – Total Production (t)1	29,874	30,336	N/A
Broadacre Crops – Total Production (t)3	689	55	-634
Vegetables for human consumption - Total Production (t)4	3,865	950	-2,915
Fruit and Nuts - Total Production (t)5	215	234	19
Grapevines - Total Production (t)6	4,808	3,139	-1,669
Hen egg production for human consumption (dozens)	0	591	591
Total Meat Poultry (no.)	885,292	728,136	-157,156
Dairy cattle - Total (no.)	14,410	7,722	-6,688
Meat cattle - Total (no.)	50,036	49,113	-923
Sheep - Total (no.)	2,066	664	-1,402
Pigs - Total (no.)	191	125	-66
Goats (no.)	Data Not Available	347	Data Not Available
Horses - Stud (no.)	Data Not Available	735	Data Not Available
Horses - Other (no.)	Data Not Available	1,017	Data Not Available
All other livestock (no.)	Data Not Available	2,846	Data Not Available

Source: ABS 2008 and 2012a.

* The ASGC dataset for 2010-11 has been used in order to provide a comparison to the 2000-01 dataset.

Data has been obtained from ABS (2008) and ABS (2012a). This data is based on estimates for a range of commodity items. As such, production numbers are estimates. Furthermore, data categories may not necessarily align between years; it has been noted where data has been perceived to not align.

1 Includes pasture, cereal and other crops cut for hay pasture and cereal cut for silage.

2 The 2000-2001 dataset does not provide data on silage production and as such a comparison/change cannot be drawn.

3 Includes cereal crops for grain or seed; and wheat, oats and barley for grain.

4 Includes carrots, capsicums, cauliflowers, herbs, lettuce, melons, mushrooms, onions, peas, potatoes, pumpkins, sweet corn and tomatoes.

5 Includes citrus fruit, stone fruit, pome fruit, nuts and other orchard fruit.
6 Includes for wine, table and/or other grape production.

Table 5.6 Value of agricultural commodities produced in Singleton LGA

Value of Agricultural Commodities Produced $m	2000-2001		2005-2006		2010-2011	
	Value ($m)	% of total agriculture	Value ($m)	% of total agriculture	Value ($m)	% of total agriculture
Cereal Crops	0.15	0.4	0.12	0.4	0.00	0.0
Other Broadacre Crops	0.04	0.1	0.01	0.0	0.00	0.0
Nurseries & Cut Flowers	0.82	2.2	0.16	0.5	0.20	0.4
Crops for Hay	2.84	7.6	2.07	6.0	3.40	6.7
Vegetables	1.99	5.4	2.11	6.1	1.80	3.6
Citrus Fruit	0.02	0.1	0.10	0.3	0.10	0.2
Grapes (wine and table)	2.05	5.5	3.28	9.5	1.00	2.0
Other Fruit	0.31	0.8	0.10	0.3	0.10	0.2
Nuts	0.00	0.0	0.00	0.0	0.00	0.0
Wool	0.00	0.0	0.06	0.2	0.00	0.0
Milk	11.47	30.9	13.22	38.3	13.60	26.8
Eggs	0.00	0.0	0.00	0.0	0.00	0.0
Livestock Slaughtering	17.41	46.9	13.27	38.5	30.50	60.2
Total Agricultural Commodities	**37.10**	**100**	**34.50**	**100**	**50.70**	**100**

Source: DPI, n.d. and ABS, 2012b.
* Values of agricultural commodities produced in 2010-11 were taken from Value of Agricultural Commodities Produced, Australia, 2010-11 (ABS, 2012b) with rounding to the nearest one-hundred thousand. Therefore, in 2010-11 while some commodities are indicated as having a value $0.0 million, values may have been rounded down.

5.4.2 Agricultural Communities

Singleton is a traditional rural service centre town. However, with increased mining development in the LGA over the last twenty years, the population structure, community functions and employment of the town have changed.

A significant proportion of the total LGA area of Singleton (32%) is dedicated to farm holdings (predominantly grazing and cropping). However, while farm holdings account for a significant proportion of the total LGA area of Singleton, only 3% of the working population are employed in the agricultural industry.

DPI (2013b) notes the shortage of skilled farm workers as one of the challenges faced by most agricultural industries in the Upper Hunter region, which is stated to be due to the availability of alternative employment opportunities. As an example, in 2011, mining accounted for 36% of employment in Singleton LGA (ABS, 2011).

Most districts of Singleton LGA have a relatively young population, with the percentage of young people (0-15 years, 23.7% for the shire as a whole) above the NSW average (20.5%). The highest percentage of young people is in Mitchells Flat, Hunterview and Wattle Ponds, each with 29-30% of the population aged 15 years or younger. Conversely, the percentage of the population aged 65 or older in Singleton LGA (10.4% across the LGA) is generally much lower than the NSW average (14.7%). Pockets of higher concentrations of older people are located in Singleton town, Pokolbin and Putty, but much of the LGA has less than 5% of the population aged 65 or more. These population statistics are not typical of regional and agricultural districts, other than those which have a significant non rural sector which is growing. Examples are regional centres with high education campuses, industrial/mining employment or major tourist attractions.

Singleton Council describes its area as a prosperous rural community, not an agricultural community, recognising the diversity of employment and the current dominance of non agricultural employment drivers. Singleton Council (website, February 2016) provides employment by sector, indicating that of 14,000 people of working age in the LGA, mining employs 5250 people, manufacturing 1065 people, public administration 710, Health care and social assistance 661, Education and training 570, professional and technical services 487, and agriculture (including forestry and fishing) 406.

5.4.3 Supporting Infrastructure for Agriculture

Within the Project Locality, the primary agricultural infrastructure is the road network, which connects rural communities and landholders to markets, services and suppliers. This ranges from Golden Highway to small unsealed roads servicing the agricultural and residential land surrounding the mining operations.

The main agricultural service centre is Singleton, which provides rural supply outlets, agronomic services and a livestock selling centre.

More broadly, supporting infrastructure for the agricultural industries in the Hunter Valley is well established. There are milk processing factories, abattoirs and regional saleyards as well as retailers of agricultural equipment and providers of specialist services such as agronomic advice or management services. A brief overview of regional infrastructure and services for agriculture is provided below:

- Abattoirs located in Singleton, Scone and Kurri Kurri process up to 1,300 head of cattle per day, for both the export and domestic markets. Cattle are sourced from around the eastern seaboard, including into Queensland. Cattle are supplied from both on-property sales and from sale yards. Regional employment is significant with up to approximately 600 full time employees.

- Regional sale yards are located at Scone, Singleton and Maitland. Anecdotally, numbers of cattle sold at Singleton and Maitland have declined by about one third to a half over the past 10 to 15 years. While some of this is linked to the expansion of mining in the region, declining yard numbers are typical across the State as producers use other forums for selling stock.

- Milk processing is undertaken at Hexham.

- Wine grapes are either processed directly on the vineyard or sold on to other wineries in the region including around the Cessnock/Pokolbin district. The grape growing industry is well supported by a vine management industry that undertakes contract pruning, fertilising and spraying.

These specialised ancillary agricultural industries are in turn supported by regional businesses supplying equipment and services.

The region is close to major transport links and population centres including Sydney and Newcastle.

6.0 Assessment of Impacts

This section considers the impacts of the Project on agricultural resources and uses within the specific parts of the Project Area that are relevant to the AIS, as defined in **Section 1.3.** The potential impact of the Project on offset areas is also considered. The impact assessment takes into account the:

- existing land capability and agricultural uses, as outlined and confirmed in **Sections 3.0**, **4.0** and **5.0**
- the area and length of time over which agricultural resources will be impacted by the Project, beyond existing approved disturbance and impact
- proposed final landforms, land and soil capability and land uses (refer to **Section 6.1**)
- likelihood that specific levels of land and soil capability will be achieved post mining.

The impact assessment also considers impacts of the Project on agricultural resources and uses/enterprises in the locality as well as the potential impacts of the Project on agricultural support services) and the amenity, lifestyle and connectedness of rural communities).

Potential impacts on agricultural resources and agricultural enterprise which have been considered in the assessment, include the following:

- Proposed post mining land use and land capability, for areas which will be disturbed by mining. **Section 6.1** outlines the post mining rehabilitation proposal for the Project.
- Direct permanent loss of existing agricultural land and resources including soils, which are within the additional disturbance area and will not be rehabilitated for agricultural use post mining.

  Mining activities can result in changes to land resources that are temporary, long term or permanent. Temporary losses include short term impacts such as construction access tracks or storage areas, which can be readily rehabilitated. Permanent mining impacts on land resources include final voids and significant changes to landform, local drainage and surface and groundwater processes, such that pre-mining land and soil capability cannot be restored.
- Direct temporary loss of existing agricultural land and resources, which are within the additional disturbance area, but will be rehabilitated or restored for agricultural use post mining.

  Land that is disturbed by open cut mining activity is gradually rehabilitated as the extraction area moves forward. Best practice landform reshaping, surface water management and soil rehabilitation has been demonstrated to be able to restore resources suitable for grazing, with careful ongoing management of physical, chemical and biological properties of the soil. With best practice, impacts on the land and soil resources of Class 3 to 5 lands can be considered to be long term, but not permanent. Post mining resources will be different but equivalent to the pre mining resources.
- Permanent change in land use resulting in the loss of land currently used for agriculture because it is within the proposed biodiversity offset area for the Project. The agricultural resources of this land are not changed by the Project, but tenure, access to and use of the land is changed.
- Indirect impacts on agricultural land and enterprises outside the Project Area (in the locality) (loss of value or diversity of potential uses) because of environmental impacts such as noise, dust or water access/water quality, which may affect the feasibility of the land use. In general, where acquisition is required to create a suitable noise or dust buffer around mine operations, the resources and use of the land will not change; but tenure and community structure may be affected.
- Indirect impacts on existing agricultural uses due to changes to access to rural infrastructure, such as sale yards, processing plants or transport.

- Indirect impacts on agricultural land uses in the locality because of changes to management of pests and weeds, or changes to fencing and farm neighbour practices.

- Indirect impacts on nearby rural community caused by changes in employment patterns, land tenure, visual amenity and landscape values.

- Indirect impacts on communities and agricultural resources resulting from changes in land use and resources across the wider Hunter Valley environment.

The likelihood of these potential impacts and their significance are considered in **Section 6.2.3** and **6.3** to establish remaining risks to agricultural resources and enterprises with the proposed management controls in place.

6.1 Post mining rehabilitation and proposed land uses

The Project will involve reforming the land in the Project Area, including landforms, soils and vegetation. The final landforms, soils, vegetation and land capability will be designed and documented as part of the mine closure and rehabilitation strategy. The mine closure and rehabilitation strategy takes into consideration views expressed by community stakeholders during consultation for the EIS, about the potential beneficial uses of the site.

6.1.1 Strategic considerations

Existing strategic land use objectives as well as site opportunities and constraints have been considered in developing the proposed post mining land use proposal. Regional planning considerations include the DRE Synoptic Plan, the Upper Hunter SRLUP (2012), Local Land Services Hunter Region Strategic Plan (2015) and the draft Hunter Regional Plan, as well as the Singleton LEP. The regional strategic plans highlight the value of post mining land uses that reinstate and support regional conservation corridors in the locality of the Project Area, as well as protecting and restoring where appropriate the integrity of high value agricultural lands. The mine closure and rehabilitation strategy requires consideration of:

- Visual amenity, biodiversity and sustainable post closure use.

- Maximising future landscape value by implementing post mining rehabilitation that contributes to biodiversity conservation but also provides the prerequisites for a number of different uses, including agriculture and conservation.

- Encouraging sustainable primary industry production by maintaining and enhancing the natural resource base.

- Encouraging diversity in primary industry enterprises and systems appropriate for the area.

- Minimising the fragmentation and alienation of resource lands.

- Minimising conflict between land uses.

6.1.2 Key features of post mining land use

With this guidance, the proposed post mining landform and land use includes multiple features that are intended to restore landscape structure and function, as well as provide for rural production where feasible.

Key features of the rehabilitation will include:

- An undulating landform, consistent with the dominant features of the existing environment. The landform and soils will be consistent with LSC classes 5, 6 and 7, other than for two areas where restoration to LSC class 4 for grazing is proposed.

- Steeper slopes will be located higher in the subcatchments.

- Drainage lines will have channel and floodplain components.

- Whilst final voids will be part of the landform, they will be carefully designed for stability and to provide flexibility in potential future uses. These include safety berms, benched slopes (with native vegetation) and low wall slopes of 14-19 degrees which will be revegetated with native species; the surface drainage network will divert the majority of surface water away from final voids to avoid runoff capture and retain flows in local catchments. Open lakes will be present in the base of the final voids.

- The rehabilitation of the site will primarily involve the establishment of the Central Hunter Valley Eucalyptus Woodland and Forest CEEC, comprised of Central Hunter Grey Box – Ironbark Woodland in the NSW North Coast and Sydney Basin Bioregions EEC. Suitable riparian species will also be established in drainage lines in the post mining landform. Grassland areas proposed for the site will also utilise where possible native grass species. In terms of land and soil capability, the area returned to native vegetation communities will be equivalent to classes 5, 6 and 7 land. This is consistent with current land and soil capability across the majority of the Project Area and with the increase in some slope gradients which will results from the landform reconstruction process.

- Temporary revegetation (predominantly fast growing grass species) will also be undertaken on unshaped overburden dumps and other disturbed areas that are planned to be inactive for one to two years. Temporary revegetation of these areas will improve both visual amenity and the control of dust emissions.

In relation to agricultural land, the indicative post mining land capability and land use for the Project Area following completion of the Project, will involve:

- agricultural use of approximately 103 hectares of land in the northwest corner of the Project Area. Post mining, the agricultural resources of this area will be rehabilitated to Class 4 agricultural land, suitable for grazing. This is equivalent to the current land and soil capability of the land and its current agricultural use. The agricultural land in the northwest corner of the Project Area is contiguous with class 4 and class 3 land and soil capability resources which extend towards the floodplain of the Hunter River. It is proposed that a mine water dam which will be constructed in this area will be redesigned to make it more appropriate for agricultural land use .

- Agricultural use of 23 hectares on the south western margin of the Project Area, along North Wambo Creek. To achieve agricultural use of this area, the post mining rehabilitation strategy for the existing approved Wambo Mine will be modified. The aim is to create LSC class 4 land along the floodplain of North Wambo Creek.

Rehabilitation to LSC class 4 agricultural land will involve distinct overburden/substrate management, topsoil management and drainage management. United Collieries has a topsoil stockpile handling strategy to maintain the quality of topsoil for subsequent use in rehabilitation. This strategy and the Erosion and Sediment Control Plan, that will be prepared as part of the Water Management Plan for the Project, will be implemented for the Project and includes actions and controls such as the following:

- material characterisation of topsoil and subsoil will be undertaken at an appropriate scale across the site, prior to prestripping activities or the re-handling of topsoil that has been stored on site for a period of two years or more. Representative samples will be taken to characterise the nature of the soil material (e.g. sodicity, acid-generating potential, etc.) to determine the potential limitations to rehabilitation and sustainable plant growth. The results will be used to determine specific ameliorant techniques that may be applied to the soil material in order to overcome potential limitations and enhance vegetation establishment.

- topsoil and subsoil layers will be assessed and managed so that they can be appropriately re-applied in areas to be rehabilitated.

- wherever practicable, topsoil is to be transferred directly from stripping location to areas that have been reshaped for rehabilitation, eliminating the need for storage and re-handling.

- weed growth will be monitored and subsequently controlled if necessary; prior to re-spreading, any weed growth will be scalped from the top of the stockpiles to minimise the transport of weeds into rehabilitated areas.

- Initially post mining soil quality in the main mining disturbance area (United Open Cut and Wambo Open Cut) is expected to be constrained by the pre mining quality of soils (e.g. refer to fertility and structural constraints discussed in **Section 3.0**) and:

    - stoniness, as soils are based on overburden material, with topsoil replaced on areas targeted for higher post mining land and soil capability

    - limited structural integrity, as a formal B horizon will take time to develop

    - shallowness, as the depth of the biomantle component of soil will be limited to re-spread topsoil.

6.1.3 Ongoing review of post mining land use plan

In recognition of the 23 year operational life of the Project, the potential for other sustainable and economically productive post-closure land uses will be investigated as the Project proceeds, to take into account local and regional land uses strategies that may have further evolved towards the end of the mine life. This process will be undertaken as part of the detailed mine closure process and in consultation with relevant stakeholders.

Rehabilitation and closure activities will be implemented progressively throughout the life of mine to maximise opportunities for the development of other potential viable land use options. For instance, there is potential for industrial uses, particularly in consideration of the availability of the rail loop as well as the suitability of infrastructure associated with the workshop, office complex and other surface facilities including lay-down storage areas, stockpiles and water management structures.

An Erosion and Sediment Control Plan will be prepared and implemented for the Project, addressing objectives and methods for soil handling, and post mining rehabilitation. These management plans will be prepared in consultation with and be approved by Department of Trade and Investment – Division of Resources and Energy (DRE).

6.2 Impacts on Agricultural Resources of the Additional Disturbance Area

As discussed in **Section 1.3**, the area of agricultural land (land containing agricultural resources, or used for an agricultural enterprise) that will be directly disturbed by the Project is very small, totalling only approximately 16 hectares.

The agricultural resources of much of the site are:

- already approved for mining (Wambo) and have not been assessed

- previously disturbed or destroyed by mining activity and/or moderately severe soil erosion. These lands formerly were on LCS classes 5, 6 and 7. These lands can no longer be regarded as a viable agricultural resource

- currently carrying dense native vegetation (regrowth), classified as CEEC/EEC in moderate or good condition. These lands have not been used for agriculture since the 1980s and aerial photography from the period of mid twentieth century agriculture demonstrate low land and soil capability, with severe erosion constraints. As they are now densely vegetated, these lands are not considered to be viable agricultural resources, or suitable for broad acre agricultural enterprises.

The agricultural resources of the area of additional disturbance area within the northwest corner of the Project Area (approximately 31.7 hectares), which may be impacted by water management infrastructure associated with the Project, is in the ownership of Wambo Coal.

United Collieries and Wambo Coal own the majority of freehold land within the Project Area other than road reserves, some small parcels of land owned by Coal and Allied, two small parcels of land at the intersection of the Golden Highway and Comleroi Road and some Crown land. United Collieries' land interests in the area are held by the CFMEU on behalf of United Collieries.

It is noted that the Crown land within in the Project Area is subject to an existing approval allowing disturbance under Wambo Coal's development consent.

6.2.1 Potential Impacts on Landforms and Soils of the Additional Disturbance Area

The proposed rehabilitation strategy for the Project indicates the following impacts on landforms and soils:

- LSC Class 5 or 6 land in the Additional Disturbance Area will be returned to a final LSC Class of 5, except for land within the final void, which will be LSC Class 6 or 7. These lands will be returned to native vegetation. This is consistent with the current uses and with regional strategic planning. No BSAL is mapped in this area and none is present.

- LSC Class 3 and 5 (mapped at the regional scale) in the northwest corner of the Project Area, which is currently partly used for beef cattle grazing, will be rehabilitated to Class 4 grazing land. LSC Class 4 is consistent with the actual LSC class of this land which has moderately severe drainage, fertility and erosion hazard constraints.

- Of BSAL (and LSC Class 3 land) mapped in the northwest corner of the Project Area at the regional scale, the actual area meeting BSAL criteria is approximately 3 hectares. This area will be restored as LSC class 4 land (not BSAL), consistent with the rest of the northwest corner area, where disturbance in this area actually occurs.

- LSC Class 4 land along the flats adjacent to North Wambo Creek will be restored to LSC Class 4 land suitable for grazing. Parts of this area have previously been cultivated (in the 1960s, 1970s and 1980s), but this was unlikely to have been a sustainable use for LSC Class 4 land.

The impacts of the Project on agricultural resources are very low, and the Project creates some additional opportunity for sustainable long term agricultural land use.

In terms of impact assessment, the following factors have been considered:

- The total area of additional disturbance of land currently used for agriculture (approximately 16 hectares) is small, but impacts will endure for more than 20 years. The small existing agricultural enterprise within the Project Area is on land owned by Wambo and subject to a short term lease. It is also contiguous with other land holdings which will continue to be utilised for low intensity grazing activities.

- The area which would be returned to an LSC Class lower than at present is less than 10 hectares in the northwest corner of the Project Area (refer to **Figure 3.15**).

- The proposed agricultural use in the northwest corner provides agricultural land that is contiguous with continuing agricultural uses and is therefore consistent with the objective of maintaining spatial continuity of agricultural land.

- The Project proposes to return an additional approximately 23 hectares of land to a potential agricultural (grazing) use, by including land along North Wambo Creek. Post mining, this area could be contiguous with LSC Class 4 land, so it is consistent with the objective of maintaining spatial continuity of agricultural land.

6.2.1.1 Agricultural resources of the locality

The Project will not impact on BSAL within 5km of the Project Area. No CIC land is located within 5 km of the Project Area. The BSAL character of land to the northwest of the Project Area is based on its association with the Hunter River, in terms of terrain, soil type and access to reliable water. The Project will have minimal impact on the ongoing quality of soil in this area of BSAL and minimal impact on water supply for agriculture.

The risk to BSAL off site is very low.

The Project is not predicted to result in any impacts on downstream water users.

The groundwater assessment has identified potential impact on one private bore on an agricultural zoned property to the north of the Project Area. This bore is not currently in a serviceable condition and is not being used. When it was previously operated, it extracted water generally of poor quality and low yielding. The potential for an approximately 6.7 metre drawdown was identified at the bore and United has committed to make good provisions, meaning that should the impact occur and affect the future operability of the bore, and if the landholder desires to recommission the bore, United would work with the landholder to rectify any impact on the bore supply due to the Project. As the bore is not currently being used for agricultural purposes and with the proposed mitigation measures in place, no impacts on resources supporting agricultural production are predicted.

6.2.1.2 Agricultural resources of the potential offset areas

The Project will not change the agricultural resources of the potential offset areas. While these areas are proposed to be managed for biodiversity enhancement and connectivity, the soils and water resources present in the offset areas will not be disturbed.

6.2.2 Impacts on agricultural enterprises

6.2.2.1 Agricultural enterprises in the Project Area

The only agricultural enterprise within the Project Area is a grazing lease over approximately 50 hectares of land in the northwest corner of the Project Area. This land is owned by Wambo Coal. Grazing activities will be discontinued within the Project Area during the operation of the Project. It is proposed that at the completion of mining, this area will be returned to agricultural use, with LSC Class 4 land.

The area will be available for a future grazing lease, consistent with its land and soil capability and its current use. The location of this land adjacent to other moderate to good agricultural land means that post mining, it can augment local agricultural enterprises.

Because of the scale and interim nature of the only current agricultural enterprise, the direct impact of the Project on existing agricultural enterprises is low.

6.2.2.2 Impacts on agricultural enterprises on the potential offset areas

The use of these areas for an agricultural enterprise during the life of the offset requirement will depend on detailed offset planning. This will take place when finalisation of the Biodiversity Offset Strategy is completed. The Biodiversity Offset Strategy may include the identified offset sites or payment into the Upper Hunter Offsets Scheme fund and/or establishment of further offset sites for the residual credits that need to be retired.

6.2.2.3 Management of Pests, Diseases and Invasive Plant Species

Weeds, feral pests and other biosecurity issues have been identified as potential impacts to be managed on biodiversity offsets, rehabilitated mining land and agricultural land owned and managed by United Collieries and Wambo Coal.

The introduction and spread of weeds is always a risk where the movement of personnel, vehicles or water occurs and where the removal or suppression of effective competitive species occurs on a regular and widespread basis. Weeds have the potential to cause significant degradation to neighbouring agricultural land as well as impact negatively on the success of rehabilitation across the Project Area.

Both introduced feral fauna species such as foxes, rabbits, hares, pigs, wild dogs and cats, as well as increasing unmanaged populations of native species such as kangaroos have the potential to impact significantly on both agricultural and non-agricultural land uses on the Project Area and in the locality of the Project Area.

Management strategies for feral animals and noxious weed control are currently detailed in the United Collieries Mine Operations Plan and Wambo Coal Flora and Fauna Management Plan, both of which will be incorporated into a revised and consolidated Landscape Management Plan should the Project be approved.

United Collieries recognise the importance of maintaining contact with surrounding landowners to determine where there are particular weed, pest or fencing issues that need to be addressed. Adequate resources will be directed to monitoring and managing land management impacts as they are identified or arise.

6.2.2.4 Impacts on Agricultural Support Services

There is currently only one small agricultural enterprise operating within the Project Area as discussed in **Section 6.2.2.1**.

The Project will not have any impact on the operation of support services such as sale yards. The Project will result in the realignment of a short section of the Golden Highway. Whilst this will result in temporary inconvenience, it is a low impact on the transport of agricultural produce to sale years or other markets. In the long term, the Project presents negligible risk to agricultural support services or infrastructure.

6.2.2.5 Impacts on Visual Amenity

Open cut mining has been a part of the landscape in this section of the Golden Highway for 30 years. While the Project will intensify the visual impacts of mining operations in the area, the views will be consistent with the surrounding area. Visual amenity impacts will be mitigated at the end of mine life when the emplacement areas are fully rehabilitated and integrated with the surrounding topography and vegetation (refer to Section 6.12 of the EIS).

6.2.2.6 Impact on Agricultural Employment

As only one small leasehold grazing operation exists on the Project Area, the Project will have a negligible impact on agricultural employment.

6.2.3 Uncertainty and Significance of Potential Impacts

6.2.3.1 Significance of Potential Project Impacts

Overall, the Project presents a very low risk to agricultural resources or to agricultural enterprises on site and in the locality:

- risks to BSAL are low
- risks to other on site agricultural resources are low
- risks to the agricultural resources of the potential offset areas are low
- risks to agricultural enterprises on and off site are low
- risks to agricultural support services are low
- impacts and risks to the landscape character of the area are low.

6.2.3.2 Uncertainty

There is a high level of certainty about the relatively low quality of agricultural resources across the Project Area, including within the proposed United Open Cut and the approved Wambo Open Cut.

There is a high level of certainty about the moderately constrained agricultural resources in the northwest corner of the Project Area where detailed investigations have been conducted for this Project.

There is a moderately high level of certainty about the capacity of land to be returned for agricultural purposes to LSC Class 4 after mining, and for all other land to be returned to LSC classes 5 to 7. This level of post mining land capability has been achieved on multiple projects in the Hunter region.

There is a moderately high level of certainty about the capacity of land to be returned to viable ecological communities, based on EECs and CEECs. Examples of the recovery of disturbed land to EEC/CEEC in moderately good condition exist in the Project Area.

6.3 Review of risks to agricultural resources and enterprises

Based on the assessment above, an agricultural risk assessment for the additional disturbance associated with the Project has been conducted. Risks to agricultural resources and enterprises are limited by the extent of previous disturbance, the small area of additional disturbance and the low likelihood of offsite impacts on agricultural resources or enterprises.

The extent of risk associated with Project impacts has been evaluated, taking into account the processes set out in the following guidelines:

- NSW *Interim Protocol for Site Verification and Mapping of Strategic Biophysical Agricultural Land* (OEH and OASFS 2013).

- The previous *Land Use Conflict Risk Assessment* (LUCRA) Guide (DPI 2011), which is aimed at identifying management strategies for potential land use conflicts which could help reduce the level of conflicts/risks effecting existing agricultural enterprises/land uses and proposed new uses.

- *SRLUP Guideline for Agricultural Impact Statements at the Exploration Stage* (DTIRIS 2015). The Guideline provides descriptors for likelihood and consequence to be used in Agricultural Impact Risk Assessment. These have been adopted in this assessment. The guideline distinguishes between short and long term (approximately 20 years) impacts on agricultural resources and also considers the extent to which impacts are irreversible. In relation to agricultural land uses and enterprises, the guideline requires assessment relating to agricultural enterprises to extend to farm productivity, land values and flow on impacts to regional communities.

6.3.1 Summary of risks to agricultural resources and enterprises

Table 6.1 shows the rationale for the agricultural risk assessment for the Project, using consequence descriptors based on those outlined in the Interim Protocol (2013).

The total area of verified BSAL within the Project Area is approximately 3 hectares, and is entirely within the northwest corner of the Project Area. Overall, the analysis indicates that the risk to high quality agricultural resources which would qualify as BSAL is low.

Based on the assessment in **Table 6.1**, the Project presents a low risk to agricultural resources and enterprises. The consequence of the Project is extremely low for agricultural resources and enterprises, but extends over a period of 23 years, with gradual rehabilitation.

Two key measures to continue to refine management and maintain low risk are discussed in **Section 7.0**.

Table 6.1 Consequence descriptors (based on the Interim Protocol)

Consequence description	Implications	Relevance to Project
Level 2 – Major **Significant and/or long term impact to agricultural resources or industries** **Long term management implications** **Serious detrimental impact on the community**	Water and/or soil impacted. Possibly in the long term (e.g. 20 years) Long term displacement or serious impacts on agricultural industries	The area of soil that may be suitable for highly productive agriculture and qualify as BSAL is less than 20 hectares. No part of the Project is located on fertile alluvial soils. Almost all of the Project Area has not been used for agriculture since the 1980s and it is clear that uses prior to that time exceeded the sustainable land and soil capability of the land. Only one small temporary agricultural enterprise (grazing) will be displaced by the Project and it is proposed to return that part of the Project Area to agriculture land with equivalent resources at the conclusion of the Project. Parts of the Project Area which are well forested, with CEEC/EECs and are mapped at the regional scale as Class 5 land. No agricultural uses exist on this land, although it has been used for grazing in the past. The area of Crown land is well forested and not used for agriculture. Off site impacts on agricultural resources and industries will be minimal. **The Project is not consistent with the descriptors for a Major impact**

Consequence description	Implications	Relevance to Project
Level 3 – Moderate **Moderate and/or medium term impact to agricultural resources or industries** **Some ongoing management implications** **Minor damage but over the long term**	Water and/or soil known to be affected probably in the short to medium term (<5years). Management could include significant change of management needed for agricultural enterprises to continue.	In relation to BSAL, the impacts are very minor in terms of area. Other than an area of approximately 3.8 hectares in the northwest corner, BSAL does not occur within the Project Area and the land parcels included in the Project Area are not used for agriculture and are not identified as having or being near quality agricultural soils. The land and soil capability of the Project Area is primarily Class 4 and Class 5, with a small area of Class 3 in the northwest corner. The soils in the Jerrys Plains Soil Landscape are shallow, duplex profiles, poorly drained and subject to both sheet and rill erosion, with gullying of drainage lines. The Project Area is surrounded by other mining sites or conservation lands, other than the connection from the northwest corner to the high quality agricultural lands in the floodplain and terraces of the Hunter River. The risk of conflict with adjoining agricultural lands is low. Off site impacts on agricultural resources and enterprises are expected to be minor to negligible over the life of the Project. **The project is not consistent with the description of moderate impact**
Level 4 – Minor **Minor damage and/or short term impact to agricultural resources or industries** **Can be effectively managed as part of normal operations**	Theoretically could affect the agricultural resource or industry in short term, but no impacts demonstrated Minor erosion, compaction or water quality impacts that can be mitigated (e.g. noise or dust impacts on extensive grazing enterprises for 12 months)	Within the Project Area, there will be minor, but long term impacts on the current soil and water resources. It is proposed to rehabilitate the Project Area to land and soil capability generally equivalent to the current resources and there is demonstrated evidence that this is achievable in the Hunter Valley. While there will be medium to long term impacts during the operation of the Project, they are not permanent. Water resources within the Project Area are intermittent. Post mining, dams will remain on the site, with design adjusted to accommodate the needs of post mining native vegetation (conservation) and agricultural land use. There is a low likelihood of only minor or negligible impacts on agricultural enterprises off site. **The Project Area most closely aligns with these descriptors of consequence.**

7.0 Adaptive management to maintain proposed outcomes for agricultural resources and enterprises

A Rehabilitation Management Plan will be prepared and implemented for the Project which will be reviewed and refined over the life of the Project to ensure that it continues to be consistent with strategic planning for natural resources and land use in the region and that best practice approaches to mine rehabilitation are used for sustainable outcomes. Two activities will inform this ongoing review – ongoing community engagement (**Section 7.1**) and monitoring and reporting (**Section 7.2**)

7.1 Ongoing Community Engagement

Community involvement has been a key element of the Project in order to obtain a comprehensive understanding of the issues and perspectives of neighbouring landholders in proximity to the Project Area. An extensive program of consultation has been ongoing throughout the assessment to inform the Social Impact and Opportunities Assessment (Umwelt 2016) and the broader environmental assessment studies.

United will continue to consult with the local community, including the agricultural community, through a range of mechanisms, including CCC meetings, community newsletters, open days and personal meetings.

The outcomes of these discussions will inform ongoing land management processes for the Project.

The Project will also continue to consult with key regional stakeholders such as Singleton Council, and Local Land Services.

7.2 Monitoring and Reporting the Condition of Agricultural Resources and Industries

It is envisaged that a detailed monitoring program will be prepared as part of the development of the Mine Operations Plan (MOP) and be reported in subsequent annual reports that are submitted to relevant government agencies and made available to the community. Completion criteria, including those relevant to potential grazing uses of parts of the Project Area, will be finalised as part of the detailed mine closure planning process and presented in the Final Closure Plan for approval by the relevant government agencies.

The gradual achievement of these completion criteria will be assessed and discussed in the annual environment report, which will include the identification of any non compliance with the criteria and measures taken to address any such issues. This ongoing monitoring and reporting adds both clarity and certainty to the conditions needed to support preferred post mining land uses, including agriculture.

It is proposed that monitoring that is relevant to agricultural land use within the Project Area and outside the Project Area (where applicable) will include:

- water quality at discharge points (as per EPL licence conditions)
- water quality in creeks downstream of the operation areas, as set out in the Water Management Plan for the Project

- stability of rehabilitated landforms and drainage structures. This monitoring is discussed further in the mine closure and rehabilitation strategy for the Project, outlined in the main text of the EIS

- development of soil profile characteristics on rehabilitated land, including monitoring of organic context, pH, sodicity and fertility. Details of proposed monitoring of post mining landforms and soils are in the mine closure and rehabilitation strategy for the Project

- condition of ground cover (grasses) and other species/habitats in rehabilitated areas. Where there is potential to use parts of the rehabilitated area for grazing at some time in the future, United will also consider monitoring of nutrient value of rehabilitated grassland. Details of proposed biodiversity monitoring are in the UHSA Statement of Consistency for the Project.

Results of monitoring programs will be made available to the community in annual reports and in presentations to the other forums, as appropriate.

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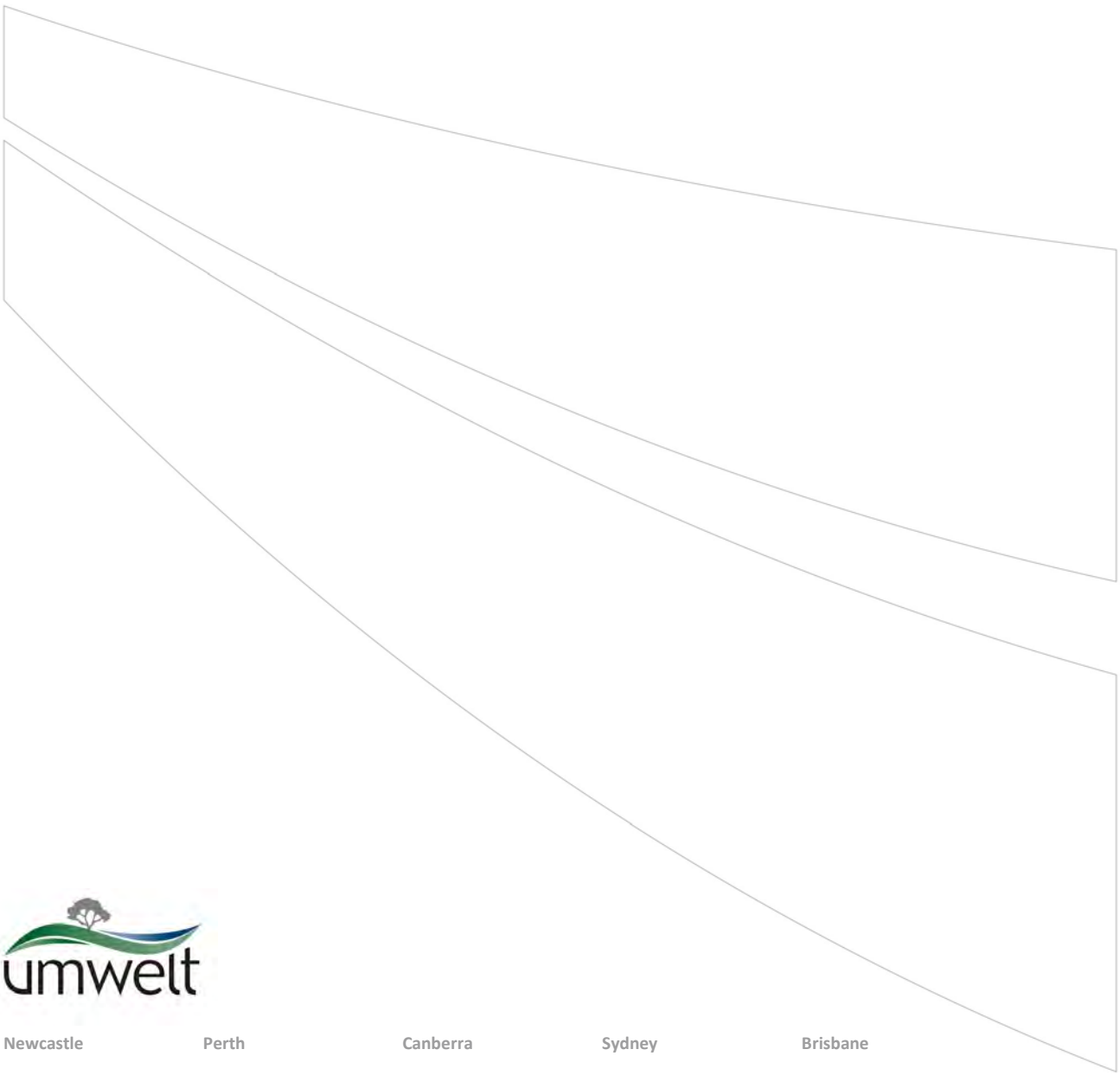

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