BIOSIS
RESEARCH

Camden Gas Project Amended Northern Expansion: Flora and Fauna Assessment

Report for AGL Upstream Investments Pty. Ltd.

October 2012

Natural & Cultural Heritage Consultants 8 Tate Street Wollongong 2500

BIOSIS
RESEARCH

Ballarat:
506 Macarthur Street Ballarat, VIC, 3350
Ph: (03) 5331 7000 Fax: (03) 5331 7033
email: ballarat@biosisresearch.com.au

Brisbane:
72A Wickham Street, Fortitude Valley, QLD, 4006
Ph: (07) 3831 7400 Fax: (07) 3831 7411
email: brisbane@biosisresearch.com.au

Canberra:
Floor 1, Unit 3, 38 Essington Street, Mitchell, ACT, 2911
Ph: (02) 6241 2333 Fax: (02) 6280 8752
email: canberra@biosisresearch.com.au

Melbourne:
38 Bertie Street, Port Melbourne, VIC, 3207
Ph: (03) 9646 9499 Fax: (03) 9646 9242
email: melbourne@biosisresearch.com.au

Sydney:
18-20 Mandible Street, Alexandria, NSW, 2015
Ph: (02) 9690 2777 Fax: (02) 9690 2577
email: sydney@biosisresearch.com.au

Wangaratta:
26a Reid Street, Wangaratta, VIC, 3677
Ph: (03) 5721 9453 Fax: (03) 5721 9454
Email: Wangaratta@biosisresearch.com.au

Wollongong:
8 Tate Street Wollongong, NSW, 2500
Ph: (02) 4229 5222 Fax: (02) 4229 5500
email: wollongong@biosisresearch.com.au

Project no: 13320 (formerly s5251)

Authors:

Brett Morrisey
Sian Wilkins
Matthew Swan
Michael Roberts
Luke Baker
Kylie Reed

Reviewers:

Dr. Kirsten Crosby
Michael Roberts
Nathan Garvey

Mapping:

Robert Suansri
Ashleigh Pritchard

ACKNOWLEDGMENTS

Biosis Research acknowledges the contribution of the following people and organisations in preparing this report:

- Adam Lollback, Natalie Leighton, Aaron Clifton, Siobhan Barry, Tom Lawler, Kevin Rofe and Courtney Collins (AGL)
- Erin Saunders, Duncan Peake, Schandel Jefferys and Alexandra Frolich (AECOM)
- Nathan Garvey, Michael Roberts, Kirsten Crosby (Biosis Research) for review
- Ashleigh Pritchard and Robert Suansri (Biosis Research) for GIS work

ABBREVIATIONS

AGL	AGL Upstream Investments Pty. Ltd.
ASL	Above sea level
CGP	Camden Gas Project
CPSW	Cumberland Plain Shale Woodlands as defined by (DEWHA 2010) and listed under the *Environment Protection and Biodiversity Conservation Act 1999 (Cth)*
CPW	Cumberland Plain Woodland as defined by the NSW Scientific Committee (2009a) and listed under Schedule 1A of the *Threatened Species Conservation Act 1995 (NSW)*
CSM	Coal Seam Methane
DEC	Department of Environment and Conservation
DPI	Department of Primary Industries
DEH	Department of Environment and Heritage
DSEWPaC	Commonwealth Department of Sustainability, Environment, Water, Sustainability, Population and Communities (formerly Department of the Environment, Water, Heritage and the Arts – DEWHA)
EA	Environmental Assessment
EAR	Environmental Assessment Requirements
EP&A Act	*Environmental Planning and Assessment Act 1979 (NSW)*
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999 (Cth)*
GDE	Groundwater Dependent Ecosystem
GGL	Gas Gathering Lines
LGA	Local Government Area
MSW	Moist Shale Woodland
NPWS	NSW National Parks and Wildlife Service (part of OEH)
OEH	Office of Environment and Heritage (formerly NSW Department of Environment, Climate Change and Water, DECCW)
PPL	Petroleum Production Lease
RFEFCF	River-flat Eucalypt Forest on Coastal Floodplains
RPGP	Rosalind Park Gas Plant
ROTAP	Rare or Threatened Australian Plant as listed by Briggs & Leigh (1995)
SCA	Sydney Catchment Authority
SCRFF	Sydney Coastal River-Flat Forest

SEPP	NSW State Environmental Planning Policy
SHW	Shale Hills Woodland
SPW	Shale Plains Woodland
TSC Act	*Threatened Species Conservation Act 1995 (NSW)*
WSL	Well Surface Locations
sp.	Species (singular)
spp.	Species (plural)
ssp.	Subspecies
var.	Variety
Upper Canal	Sydney Upper Canal Water Supply

CONTENTS

TABLES

FIGURES

EXECUTIVE SUMMARY

Biosis Research Pty. Ltd. was commissioned by AECOM Australia Pty. Ltd. (AECOM), on behalf of AGL Upstream Investment Pty. Ltd. (AGL) to conduct a terrestrial flora and fauna assessment for the proposed Camden Gas Project (CGP) Northern Expansion (Northern Expansion Project). The Northern Expansion Project involves the extraction of gas from the Illawarra Coal Measures, within the Southern Coalfield of the Sydney Basin (AECOM 2012).

The project area for the Northern Expansion Project, as amended having regard to the submissions received by AGL during the public exhibition (Amended Project), has been separated into two distinct areas known as the Sub-surface Project Area (within which project works are limited to subsurface drilling activities only) and the Surface Project Area. The Surface Project Area will include the construction and operation of gas wells at up to 11 well surface locations (WSLs), gas gathering lines (GGLs), water lines with central water storage tanks where feasible and access roads. Flora and fauna field surveys were confined to the Subject Site.

The Northern Expansion Project is development to which Part 3A of the *Environmental Planning and Assessment Act 1979 (NSW)* (EP&A Act) applies. Under the (now repealed) clause 6 of Schedule 1 of the *State Environmental Planning Policy (Major Development) 2005* (SEPP 2005), the Northern Expansion Project is, in the opinion of the Minister for Planning, development of a kind that is described in Schedule 1 of SEPP 2005 (that is, development for the purpose of drilling and operation of petroleum wells that is within a specified local government area), and is a project to which Part 3A of the EP&A Act applies. Part 3A of the EP&A Act has been repealed. However, in accordance with Schedule 6A of the EP&A Act, the Northern Expansion Project is a 'transitional Part 3A project', and Part 3A of the EP&A Act continues to apply to in respect of the Northern Expansion Project.

Under the EP&A Act, specified development on specified land may be declared to be State Significant Development (SSD). On 19 October 2012, the project was declared to be SSD by an order of the Minister for Planning and Infrastructure published in the NSW Gazette on 26 October 2012.

By virtue of the operation of clause 6(3)(b), Schedule 6A of the EP&A Act, previous steps taken under Part 3A (including issue of Director-General's requirements and public exhibition of the Environmental Assessment) are now taken to have been completed under Division 4.1, Part 4 of the EP&A Act.

AGL has prepared a Submissions Report to which this report is appended. The Submissions Report addresses the amendments made to the Northern Expansion Project which has reduced the environmental impact of the development. In response to the submissions and having regard to impacts to biodiversity values, AGL made changes to the Northern Expansion Project, including in relation to the route for GGLs and main gas gathering spine, and WSLs. For purposes of this report, the Northern Expansion Project, as amended, will be referred to as the Amended Project. The Amended Project comprises:

- construction and operation of eleven WSLs containing up to six well heads each;
- construction and operation of associated gas gathering lines, including interconnection with the existing CGP network, along with central water storage points where required;
- construction of access roads and ancillary infrastructure, including storage yard(s), where required; and
- subsurface drilling of lateral in-seam well paths within the bounds of the Sub-surface Project Area.

In undertaking the flora and fauna survey and assessments, the Director General's Requirements (DGR) requires AGL to take into account the *Draft Guidelines for Threatened Species Assessment* (DEC and DPI 2005). The flora and fauna assessment subject of this report has been undertaken in accordance with DEC and DPI (2005).

The assessment of the Amended Project, utilised an "envelope" approach to impact assessment, meaning that a wider area or "envelope" is assessed to allow the final infrastructure sites to move within the assessed area, subject to the recommended environmental management measures and consultation with the landowner. This assessment methodology meant that impacts to areas with high biodiversity values could be suitably avoided, mitigated and minimised, either by exclusion from the project, detailed design and ground survey, under boring or by construction method. The envelope assessment included a 200m radius for a WSL and 25 metres either side of GGLs and access roads.

Prior to the field surveys, searches of relevant databases were carried out to determine previous records of the threatened biodiversity in the area and to formulate a list of target species for field surveys and assessments of habitat. Vegetation mapping of the Cumberland Plain by NPWS (2002f) and relevant existing reports were also reviewed.

Flora field surveys focused on the identification of *Threatened Species Conservation Act 1995* (NSW) (TSC Act) and *Environment Protection and Biodiversity Conservation Act 1999* (Cth) (EPBC Act) threatened ecological communities, populations and species or their habitats. Targeted searches for threatened flora species, populations and ecological communities were carried out where suitable habitat was present, in areas where potential impacts resulting from the Amended Project could not be suitably avoided, minimised or mitigated. The fauna survey was undertaken primarily as a habitat based assessment with diurnal surveys including targeted active searches for Cumberland Plain Land Snail (*Meridolum corneovirens*) in areas where potential impacts resulting from the Amended Project could not be suitably avoided, minimised or mitigated. Vegetation over the vast majority of areas surveyed was in a highly disturbed condition as a result of current and previous land uses, such as grazing and other agricultural practices. The general condition of fauna habitats over the majority of the areas surveyed was largely poor and limited by the condition of the vegetation and low spectrum of landscape scale habitats such as waterways.

Three threatened ecological communities (TECs) listed under the EPBC Act and TSC Act occur in the Surface Project Area and Subject Site. The most widespread and abundant of these is Cumberland Plain Woodland (CPW) which is listed as threatened under the TSC Act and under the EPBC Act as Cumberland Plain Shale Woodland (CPSW). Approximately 13.9 ha of this CPSW

(listed under EPBC Act and TSC Act) with an additional 26.45 ha of CPW (listed under TSC Act only), totalling 40.35 ha, is present in various locations within the Subject Site. Some areas of Alluvial Woodland are consistent with the TEC River-flat Eucalypt Forest on Coastal Floodplains (RFEFCF) which is listed under the TSC Act. Approximately 3.46 ha of this TEC is scattered throughout the Subject Site. Distribution of plant communities throughout the Surface Project Area were generally consistent with mapping by NPWS (2002f).

Following initial assessments by Biosis Research in 2009, changes were made to the route for GGLs and main gas gathering spine, and WSLs. These changes were made in response to impacts to biodiversity values, particularly impacts to areas of CPW. The route of the GGLs and main gas gathering spine, access tracks and WSLs were further refined, following additional surveys by Biosis Research in 2011, to avoid and minimise impacts to biodiversity values, particularly CPSW, CPW and RFEFCF. Additional methods to minimise impacts to CPSW, CPW and RFEFCF, such as under-boring and excluding areas of assessment from potential works, were implemented to further reduce impacts to these TECs. These impact minimisation methods have continued to guide adjustments to the route of the GGLs and WSLs in 2012, resulting in further avoidance and minimisation of impacts to CPSW, CPW and RFEFCF.

No threatened flora species or populations listed under the TSC Act or EPBC Act were observed during the field surveys. One threatened fauna species, Cumberland Plain Land Snail listed under the TSC Act, was recorded during the field surveys in vegetation contiguous with the Subject Site. Based on previous records and habitat assessments, several threatened flora and fauna species and one threatened flora population are considered to have a medium to high level of potential to occur in the Surface Project Area.

Potential impacts to the biodiversity values present within the Subject Site, prior to the implementation of impact avoidance, minimisation and mitigation measures, included:

- Impacts to 13.9 ha of CPSW as listed under the EPBC and TSC Acts;
- Impacts to 40.35 ha of CPW as listed under the TSC Act;
- Impacts to 3.46 ha of RFEFCF as listed under the TSC Act;
- Impacts to 12.07 ha of Shrubland; and
- Impacts to known and potential habitat for the Cumberland Plain Land Snail.

With the implementation of impact avoidance, minimisation and mitigation measures, the only residual impact of the Amended Project is the removal of 4.88 ha of Shrubland. The Amended Project would not result in the removal of any CPSW, CPW, RFEFCF, and would not impact on known and potential habitat for the Cumberland Plain Land Snail.

This represents a significant reduction in impacts throughout the life of the Amended Project.

Assessments of significance according to Draft Guidelines for the EP&A Act (DEC & DPI 2005) and Significant Impact Criteria for the EPBC Act (DEWHA 2009) have been carried out for threatened biodiversity either known from or with a medium to high level of potential to occur in the Surface Project Area. In summary, these assessments concluded that the Amended Project is

unlikely to have a significant impact on any threatened species, populations, or ecological communities listed under the EPBC Act or TSC Act, provided that the recommended impact avoidance and mitigation measures listed in this report are implemented. The Amended Project will achieve the environmental outcomes listed in DEC & DPI (2005). While the Amended Project is unlikely to have a significant impact on any matters of national environmental significance outlined in this report, AGL may consider lodging a referral under the EPBC Act on the basis that the Amended Project is "not a controlled action".

Overall, the 'envelope' approach to the Amended Project will significantly reduce potential impacts to native flora and fauna and their habitats within the Surface Project Area through a strategy of impact avoidance, minimisation and mitigation. The majority of the project components are designed and will be constructed such that ecological values throughout the Surface Project Area are maintained.

1.0 INTRODUCTION

AGL Upstream Investments Pty. Ltd. (AGL) is continuing to develop the coal seam methane resource in the local government areas (LGAs) of Camden and Campbelltown, known as the Camden Gas Project (CGP). AGL currently operates 143 wells, low pressure gas gathering lines (GGLs), access roads, the Rosalind Park Gas Plant (RPGP) and a high pressure gas sales pipeline.

In 2010, AGL lodged an application for the Northern Expansion of the Camden Gas Project (Northern Expansion Project) under Part 3A of *the Environmental Planning and Assessment Act* 1979 (NSW) (EP&A Act). Having regard to the submissions receiving during the public exhibition of the environmental assessment (EA) for the Northern Expansion Project, AGL amended the Northern Expansion Project. The Amended Project is further defined in the 2012 submissions report (AECOM 2012).

AGL is seeking planning approval for the Amended Project which comprises:

- construction and operation of eleven well surface locations (WSLs) containing up to six well heads each;
- construction and operation of associated gas gathering lines (GGLs), including interconnection with the existing CGP network, along with central water storage points where required;
- construction of access roads and ancillary infrastructure, including storage yard(s), where required; and
- subsurface drilling of lateral in-seam well paths within the bounds of the Sub-surface Project Area.

The Amended Project is summarised in Section 1.3 below.

Biosis Research Pty. Ltd. (Biosis) has been commissioned by AECOM Australia Pty. Ltd. (AECOM) on behalf of AGL to conduct a terrestrial flora and fauna assessment for the Northern Expansion Project to inform the Environmental Assessment (EA). The assessment has been carried out with reference to threatened biota listed under the provisions of the *Threatened Species Conservation Act* 1995 (NSW) (TSC Act) and the *Environment Protection and Biodiversity Conservation Act* 1999 (Cth) (EPBC Act). Biosis was also commissioned by AECOM on behalf of AGL to undertake further flora and fauna assessments of the Amended Project. In carrying out the flora and fauna survey and assessments, Biosis took into account the *Draft Guidelines for Threatened Species Assessment* (DEC and DPI 2005) as required under the Director-General's Requirements (DGRs).

1.1 Aims

The specific aims of this flora and fauna assessment are to:

- conduct background research, including a literature review and database search for the locality;
- undertake field surveys to provide a reliable assessment of the biodiversity values present within the Surface Project Area (see Section 1.3 below), including the potential for threatened species, populations and ecological communities that are listed under the TSC Act and the EPBC Act to occur within and be impacted by the Amended Project;
- document the potential environmental impacts to the biodiversity values that may result from the Amended Project;
- provide recommendations to avoid, minimise and mitigate the potential environmental impacts of the Amended Project;
- document any residual impacts to the biodiversity values of the Amended Project that cannot be avoided, minimised or mitigated; and,
- undertake impact assessments for threatened species, populations or communities listed under provisions of the TSC and/or EPBC Acts, following the Draft Guidelines (DEC & DPI 2005) and the EPBC Act Significant Impact Guidelines (DEWHA 2009). .

1.2 Definitions

The following key terms are used frequently throughout this report.

- ***The Amended Project*** is the development, activity or action proposed. In this case the Amended Project is the construction and operation of gas wells at up to 11 WSLs; construction and operation of associated GGLs, including interconnection with the existing CGP network, along with central water storage points where required; construction of access roads and ancillary infrastructure including storage yard(s), where required; and subsurface drilling activities of lateral in-seam well paths within the bounds of the Sub-surface Project Area.
- ***Subject Site*** is defined in *Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities - Working Draft* (DEC 2004b) and means the area that may be directly affected by the Amended Project. In this case, the Subject Site is the combination of a 200m radius around all 11 WSL, the network of GGLs, and access tracks (either existing or proposed) including a 25m buffer either side of these linear developments. The Subject Site incorporates any areas where clearing of native or exotic vegetation, earthworks or other activities will result in temporary or permanent disturbance of biotic and abiotic features of the environment within the Surface Project Area. The Subject Site was the focus of this flora and fauna assessment.
- ***Surface Project Area*** is the Subject Site and any additional areas that are likely to be affected by the Amended Project, either directly or indirectly. In this case Surface Project Area is taken to be the combination of the 'Subject Site' defined above and adjoining areas

that are considered potentially impacted by the Amended Project but limited by the area highlighted in Figure 1. In this report, Surface Project Area is the equivalent of Study Area as defined by DEC and DPI (2005). For purposes of this report, the term Surface Project Area has been used to provide consistency with references in the broader Environmental Assessment.

- ***Sub-surface Project Area*** is the area that will be limited to subsurface drilling activities only and extending beyond the Surface Project Area as shown in Figure 1.
- ***Abundance*** means a quantification of the population of the species or community.
- ***Regional*** means the area defined within the applicable IBRA Bioregion (Thackway and Cresswell 1995), i.e., The Sydney Basin Bioregion.
- ***Local population*** is defined in DEC (2004b) as the population of a species within the Surface Project Area.
- ***Locality*** is the area within a 10 kilometre (km) radius of the Surface Project Area.
- ***Threatened biota*** refers to threatened species, populations and ecological communities as listed on the TSC Act and EPBC Act.

1.3 The Amended Project

AGL is currently seeking planning approval for the Amended Project, that is the Northern Expansion of the CGP as amended, having regard to the submissions received during the public exhibition, including impacts on biodiversity. This expansion, known as the Amended Project, includes the construction and operation of 11 WSLs, along with associated infrastructure such as GGLs, roads and drilling. For a full description of the proposal please see AECOM (2012).

The Amended Project includes the areas identified in Figure 1 as the Surface Project Area and the Sub-surface Project Area. It includes the following:

- eleven WSL containing up to 6 well heads each;
- associated GGL, including interconnection with existing gas fields at Menangle Park (located to the south), along with central water storage points where required;
- access roads and ancillary infrastructure, including storage yard(s), where required; and
- subsurface drilling within the boundaries of the Sub-surface Project Area. (Figure 1).

The project activities can be generally divided into the following stages.

- Construction: the activities required to physically develop the drilling of wells and subsurface lateral well paths, GGLs, access roads and supporting infrastructure.

- Production: production and delivery of gas from WSL to the gathering system for connection to the existing gas gathering system at Menangle Park.

- Post Development: operational activities which may be needed to maintain production efficiency. It is anticipated that these activities may include the upgrade of GGLs, re-fracture stimulation (if required) and re-drilling (if required).

- Closure and Final Rehabilitation: decommissioning of the Amended in accordance with statutory requirements and industry best practice.

1.3.1 Assessment Approach

The assessment has been undertaken with a specific focus on the Surface Project Area and the Amended Project has utilised the following approach:

1. an "envelope" approach to impact assessment, meaning that a wider area or "envelope" is assessed to allow the final infrastructure to be located subject to the avoidance, impact minimisation and recommended environmental management measures and consultation with the landowner; and,

2. a worst case approach to the impact assessment such that the highest impact activities are assessed even when these activities are not the most likely, so that the full variety of possible activities at each site are within the assessed parameters and the assessment is conservative.

The 'envelope' approach has provided the opportunity to refine the project to avoid and minimise potential impacts consistent with the DGRs. For the purpose of the EA and this assessment, a 200 m radius for a WSL and 25 m either side of GGLs and access roads has been employed.

1.3.2 Well Surface Locations

The WSLs have been determined following extensive geological exploration and analysis. The final WSLs may be adjusted within the 200m assessment 'envelope' during detailed design based on consideration of the environmental and social constraints including land use (existing and future), topography, subsurface geology, flora and fauna, archaeological constraints and noise impacts. Up to six (6) well heads may be installed in the WSLs (AECOM 2012). An example of operating and rehabilitated WSL are shown in Plates 1 and 2.

	
Plate 1: Operating well surface location	**Plate 2:** Well surface location following construction and rehabilitation

Site preparation and construction works would be generally carried out in accordance with the following sequence.

- Identify biodiversity exclusion zones.
- Installation of silt fences and other environmental controls as required.
- Installation of approved road opening to property where necessary.
- Upgrade or installation of access roads where required.
- Removal of topsoil over access ways and store for initial rehabilitation.
- Truck in hard surface (typically shale) for access road base and drill pad where required.
- Install drain culverts, cattle grids, fencing, gates, bed level crossing and other works as necessary.
- Earthworks as required on a site-specific basis.
- Construct drilling compound (up to 10,000 m^2) and fence the perimeter as required by the existing Environmental Management Systems (EMS), and other requirements.
- Strip topsoil and stockpile, then cut and fill as required for a level drill pad area.
- Dig and line drill pit(s) with polyethylene non-permeable liner (typically up to 25 x 25 m and 2-3 m deep). The drill pit(s) are provided to retain and recycle drilling debris and associated water for the drilling process.
- Create a cut-back, flat operating area where WSLs are located on slopes. This construction generally includes an up-slope diversion drain around the site to manage excessive surface

flow. The surface profile is returned (as near as possible) to the original profile during rehabilitation.

- Rehabilitation of the surplus construction area when construction is complete.

1.3.3 Main Gas Gathering Spine Line, Gas Gathering Lines and Access Tracks

The gas gathering system would be buried to a minimum depth of 750 mm and up to 1,200 mm in some areas, including unsealed and sealed road crossings, and creek and drainage line crossings (Figure 1). Detailed ground survey has been carried out to define the route of the Main Gas Gathering Spine Line and GGLs through areas of conservation or environmental significance such as TECs, other native vegetation, drainage lines and to avoid individual trees. Further detailed engineering and design would be required for crossing other infrastructure, including the Upper Canal, the Distribution Network pipeline and the Eastern Gas pipeline. The route of the gas gathering system and access tracks to construct and maintain this infrastructure has been designed, wherever possible, to utilise previously or currently disturbed land areas and existing access roads. The ancillary water transfer system will be typically co-located in the trenches for the gas gathering system and installed simultaneously (AECOM 2012). Example images of the extent of disturbance during and post construction of GGLs are shown in Plates 3 and 4 below.

Plate 3: Gas gathering line under construction involving the excavation of a narrow trench.

Plate 4: Location of a gas gathering line next to an access track, post-construction showing limited disturbance.

The construction of the GGLs would typically involve the following works.

- Clearing of vegetation, using a small mulching head mounted on small earthmoving equipment, and grading of topsoil in disturbed areas of the pipeline route using earthmoving equipment. For the purpose of this assessment clearing of a maximum width of 10 m, in areas that cannot be avoided, has been assumed.
    - Clearing of vegetation in areas of conservation or environmental significance within a well defined limit of clearing.

  - Following vegetation mulching in these areas, biodiversity exclusion zones would be established, and the GGL routes will be resurveyed with centreline pegged and limits of excavation and construction clearly defined.

- Topsoil will be stripped and stockpiled in the construction footprint separate to the subsoils. Backfilling in these areas will replace the soils in their natural order as far as practical.
- Trenching and under-boring where necessary.
- Lowering-in of pipe strings (including trench preparation and padding).
- Installation of tracer lines (for pipe tracing) as polyethylene (PE) pipe is non conductive.
- Backfilling of soils in their natural order as far as practical and compaction of the trench.
- Rehabilitation of ground along pipeline route.
- Installation of gas line signposts to mark and identify gathering line location.
- Register gas gathering line on 'Dial before you dig'.

The GGLs would typically be buried in sections of approximately 100 m in length at any one time. This would ensure minimal disturbance and reduce impacts on soil erosion and potential run on effects as a result of unanticipated rainfall events or other variables.

1.3.4 Subsurface Drilling

Subsurface drilling activities relate to all wells including vertical, directional or surface to in-seam (SIS). In the instance of directional and SIS wells, drilling deviates from a central point and continues along a subsurface path some distance from its origin through the underlying geology. A distance of up to 2,500m of subsurface drilling from the well surface origin has been considered for the broader EA and this encapsulates the Sub-surface Project Area (AECOM 2012).

1.3.5 Potential Ecological Impacts of the Amended Project

Direct impacts on ecological values and functions that may arise from the Amended Project and will therefore be considered in this assessment for the Surface Project Area, include:

- vegetation clearance;
- the removal or disturbance of potential habitat for threatened flora and fauna; and,
- the fragmentation of potential habitat for threatened flora and fauna.

Indirect impacts on ecological values and functions that may arise from the Amended Project for

the Surface Project Area include:

- the potential for erosion;
- edge effects;
- weed invasion; and,
- elevated noise and light levels associated with increased human activity within or adjacent to sensitive habitat areas.

Sections 4.0 and 4.2 discuss the potential impacts arising from the Amended Project, and proposed measures to avoid and minimise these impacts.

The potential for subsidence and surface impacts as a result of the proposal in the Surface and Sub-surface Project Areas has been assessed by MSEC (2007). The assessment by MSEC (2007) concluded that although it is possible that there could be some shrinkage of the coal seams due to methane gas extraction any subsidence would be negligible. In view of the assessments by MSEC (2007), surface impacts associated with subsidence including on biotic and abiotic landscape features are also likely to be negligible.

1.4 The Surface Project Area

The Surface Project Area spans several suburbs within the Camden and Campbelltown LGAs, east of Camden Valley Way extending from the Mount Annan Botanic Gardens in the south to Denham Court Road in the north. The eastern boundary is formed in part by the South Western Freeway (F5) to the north and south with the central area bound by the residential suburbs of Blairmount through Kearns and extending to Varroville (Figure 1).

The general landscape is primarily semi-rural and agricultural lands with native vegetation extensively cleared over the southern two thirds of the Surface Project Area. Some larger and moderately well connected patches of remnant and regrowth woodland occur over the hills and lower slopes of the northern section (Figure 2).

1.4.1 Geology, Soils and Topography

The geology of the region consists of sandstones and shales from the mid-Triassic. The Surface Project Area is located in the south eastern section of the Cumberland Plain and is formed on the sediments of the Wianamatta Group shales, in particular the Bringelly Shales. They comprise shale, with occasional calcareous claystone, laminate and coal.

This southern area of Cumberland Plain generally comprises gently undulating plains and low rolling hills (Hazelton and Tille 1990). The Surface Project Area is characterised by a central spine of low hills that arcs from the north at Denham Court through to the south at Mount Annan with relief up to approximately 150m ASL.

The region comprises a variety of soil landscapes, with distinct morphological and topological

characteristics. Within the Surface Project Area, the four distinct types of soil landscape are residual, erosional, colluvial and fluvial.

The Blacktown Soil Landscape (residual) covers much of the Surface Project Area, particularly throughout the western half and southeast section. It comprises gently undulating rises without rock outcrops (local relief to 30 m with slopes less than 5% grade). Broad rounded crests and ridges with gently inclined slopes are the dominant topography of this landscape (Hazelton and Tille 1990). The soils consist of loams with strong clay influence over shallow to moderately deep podzols.

The Luddenham Soil Landscape (erosional) is distributed over the central spine of hills and north eastern section of the Surface Project Area. This soil landscape occurs over rolling to steep low hills. Local relief is between 50 and 120m with moderately inclined slopes between 10 and 15% dominant in the topography. Shallow loose and clay loams overlay clay subsoils that vary from strongly pedal medium clays to apedal with sandy influence (Hazelton and Tille 1990).

The Picton soil landscape (colluvial) occurs in two small islands along the central north-south spine of hills. This soil landscape is described as occurring on steep to precipitous hills with local relief varying from 90 to 300m and slope gradients ranging from 20 to 80%. Southerly and south westerly aspects and mass movement are other features of this soil landscape. Surface soils are hard-setting sandy loams grading through sandy clay to stony light clay subsoils.

The South Creek soil landscape (fluvial) is present in the north-eastern sector of the Surface Project Area around the Varroville locality. This soil landscape consists of thin alluvium soils derived from deposits of the Wianamatta Group shale and Hawkesbury Sandstone parent materials. The topography is predominantly flat to gently sloping, active floodplain with occasional terraces or levees providing low relief. Soil structure varies depending on location though the floodplain profile but is summarised as sandy loams to sandy clay loams overlying light to medium clay subsoils (Bannerman and Hazelton, 1990).

There is a high dryland salinity potential and known areas of salinisation across several of these landscapes (DLWC, 2002).

The Surface Project Area incorporates a multitude of small to large constructed dams generally fed by ephemeral drainage lines. Watershed from the southwest of the Surface Project Area is toward South Creek. The northwest sector drains in the direction of Kemps Creek, the northeast drainage is to Bunburry Curran Creek whilst the slopes of the southeast corner drain in the direction of Bow Bowing Creek. The Upper Canal water supply channel bisects the Surface Project Area in a north-south traverse.

1.4.2 Climate

The climate at Campbelltown consists of mild summers with an average maximum of 28.2 degrees Celsius and minimum of 17.5 degrees Celsius in February, and cold, wet winters with an average minimum of 4.9 degrees Celsius and a maximum of 17.3 degrees Celsius in July (Bureau of Meteorology 2009b). The mean annual rainfall is 715 millimetres (Bureau of Meteorology 2009a).

1.5 Planning Approvals

The Northern Expansion Project is development to which Part 3A of the *Environmental Planning and Assessment Act 1979 (NSW)* (EP&A Act) applies. Under the (now repealed) clause 6 of Schedule 1 of the *State Environmental Planning Policy (Major Development) 2005* (SEPP 2005), the Northern Expansion Project is, in the opinion of the Minister for Planning, development of a kind that is described in Schedule 1 of SEPP 2005 (that is, development for the purpose of drilling and operation of petroleum wells that is within a specified local government area), and is a project to which Part 3A of the EP&A Act applies. Part 3A of the EP&A has been repealed. However, in accordance with Schedule 6A of the EP&A Act, the Northern Expansion Project is a 'transitional Part 3A project', and Part 3A of the EP&A Act continues to apply to and in respect of the Northern Expansion Project.

Under the EP&A Act, specified development on specified land may be declared to be State significant development (SSD). On 19 October 2012, the project was declared to be SSD by an order of the Minister for Planning and Infrastructure published in the NSW Gazette on 26 October 2012.

Under clause 6(3)(B) of Schedule 6A of the EP&A Act, previous steps taken under Part 3A (including issue of DGRs and public exhibition of the environmental assessment) are taken to have been completed under Division 4.1, Part 4 of the EP&A Act. AGL has prepared a Submissions Report to which this report is appended. The Submissions Report also addresses the amendments made to the Northern Expansion Project (now called the Amended Project) which has reduced the environmental impacts of the development as a result of the issues raised in the submissions.

2.0 METHODS

2.1 Taxonomy

The plant taxonomy used in this report follows Harden (1992, 1993, 2000, 2002) and subsequent advice from the National Herbarium of NSW. In the body of this report plants are referred to by their scientific names only. Common names, where available, have been included in the species inventory of the Appendices.

Names of vertebrates follow the Census of Australian Vertebrate Species (CAVS) maintained by Department of Sustainability, Environment, Water, Sustainability, Population and Communities (DSEWPaC). In the body of this report vertebrates are referred to by both their common and scientific names when first mentioned. Subsequent references to these species cite the common name only. Common and scientific names are included in the Appendices.

2.2 Legislation

Federal and State Acts and policies that have been considered in this report with regard to terrestrial flora and fauna are listed below:

- EPBC Act;
- NSW TSC Act;
- EP&A Act; and
- SEPP 44 – Koala Habitat.

2.3 Literature and Database Review

A list of documents used to prepare this report is located in the References. Records of threatened species and populations were obtained from the OEH Atlas of NSW Wildlife within a 10 km radius of the Surface Project Area and from the Birds Australia Database.

Potential occurrences of threatened species, populations and communities listed on the EPBC Act were obtained from the DSEWPaC Protected Matters Search Tool within a 10km radius of the Surface Project Area.

Initial database searches for threatened species were conducted prior to field assessments in June 2009. These were updated in June 2012, with additional records and species assessed in this report.

2.4 Field Survey

To provide a reliable and comprehensive assessment of the biodiversity values of the 3,898 ha Surface Project Area, including the potential for threatened species, populations and ecological communities to occur, an iterative approach to field surveys was undertaken whereby the Subject Site was stratified according to the presence of biodiversity values, and the potential to avoid or

minimise impacts. All areas of the Subject Site have been assessed, according to the following procedure:

- Biosis staff have assessed all areas of the Subject Site, including all WSL, GGLs and access tracks, using the assessment envelopes outlined in Sections 1.2 and 1.3.1;
- These surveys and assessments focused on areas likely to support significant biodiversity values, including native vegetation and/or fauna habitat. Areas subject to significant amounts of past disturbance (e.g. urban environments, grazed pasture, areas of exotic vegetation) were only preliminarily assessed;
- Where significant biodiversity values were identified within the assessment area, input was sought from AGL field and planning staff, accompanying Biosis staff, on opportunities to avoid and minimise impacts through micrositing of project infrastructure. The focus was to avoid and then minimise impacts;
- Where impacts were suitably avoided or minimised detailed assessment was deemed not required;
- Where residual impacts were likely to occur, detailed assessment was undertaken.

Field survey effort focused on the locations within the Surface Project Area that have the highest potential for threatened biota or their habitats to occur and that would likely be directly or indirectly affected by the Amended Project. This assessment methodology has ensured that the entire Subject Site has been assessed, and detailed assessment of areas subject to potential impact has been undertaken.

Spanning autumn to spring, the majority of flora and fauna field surveys were conducted over eight days between May and September 2009. Following design changes and publication of diagnostic criteria for Cumberland Plain Shale Woodlands (CPSW) listed under the EPBC Act, further flora and fauna surveys were carried out during June and July 2011, and June 2012. In addition to targeted searches for threatened flora and fauna species detailed vegetation surveys were carried out to assess the presence and distribution of TECs according to revised identification guidelines (DEWHA 2010). Flora and fauna survey effort is summarised in Table 1.

Table 1: Flora and fauna survey effort in the Subject Site

Date	Approximate person hours
26th May 2009	14
12th June 2009	14
15th June 2009	7
6th August 2009	7
7th August 2009	7
26th August 2009	7
24th September 2009	7

Date	Approximate person hours
30th September 2009	7
20th June 2011	18
21st June 2011	14
14th July 2011	9
21st June 2012	19
26th June 2012	14
Total	**144**

The location of all survey effort was marked or tracked by GPS and this is shown in Figure 8.

The general condition of the Subject Site was assessed and observations of flora and fauna species and plant communities were made (as detailed below). During the site visits the weather ranged from cool and cloudy with intermittent light to medium showers to sunny during the cooler months. Weather conditions during autumn and spring surveys varied from overcast and cool to clear, sunny and warm.

2.5 Flora

Flora surveys of Subject Site included the following activities:

- A photograph that represented the vegetation most likely to be affected by the Amended Project for a particular component of the Amended Project, such as a section of GGL, was taken.
- The identification and mapping of plant communities based on previous broad-scale mapping of the Cumberland Plain and accompanying descriptions by NPWS (2002d) or the structural definitions of Specht & Specht (1999). Vegetation mapping by (NPWS 2002f) has been amended in some locations by Biosis following field surveys.
- Determination of the presence or absence of a TSC Act TECs CPW and RFEFCF according to the criteria of Final Determinations prepared by the NSW Scientific Committee (2009a and 2004).
- Determination of the presence or absence of the EPBC Act TEC CPSW according to the criteria described by (DEWHA 2010).
- Assessment of threatened flora species habitat based on preferred habitat features or specific habitat features.
- Targeted searches for threatened plant species according to the "random meander" method (Cropper 1993b) in areas of suitable habitat likely to be impacted by the Amended Project.

- Compiling a dominant flora species inventory by incidental observation, random meanders, quadrats and transects.
- Assessment of vegetation condition (Section 2.5.1) and land use history.

A plant species inventory was compiled and is included in Appendix 1.

2.5.1 Vegetation Condition Assessment

Condition for the majority of vegetation was assessed according to the degree to which it resembles a relatively natural, undisturbed vegetation community. Vegetation was assessed as being in Good, Moderate or Poor condition or Disturbed according to the following criteria.

- **Species composition** (species richness, degree of weed invasion).
- **Vegetation structure** (representation of each of the original layers of vegetation).
- **Resilience** (this is the capacity of a site for natural regeneration and as further defined by (McDonald 1996). Resilience is primarily linked to the degree to which the natural soil profile of the area has been disturbed and previous and current landuse).

The categories of vegetation condition are as follows:

Good: containing a high number of indigenous species; no weeds present or weed invasion restricted to edges; vegetation community supports structurally characteristic layers of vegetation; vegetation layers (ground, shrub, canopy etc.) are intact, or if modified, natural soil profile remains intact.

Moderate: containing a moderate number of indigenous species; moderate level of weed invasion; weeds occurring in isolated patches or scattered throughout; one or more of original layers of vegetation are modified; vegetation layers (ground, shrub, canopy etc.) are largely intact, or if modified, natural soil profile remains intact; able to be regenerated to Good condition with minimal level of management.

Poor: containing a low number of indigenous species; high level of weed invasion; weeds occurring in dense patches or scattered throughout; one or more of the original layers of vegetation are highly modified; one or more original vegetation layers (ground, shrub, canopy etc.) are modified or missing, but natural soil profile intact; able to be regenerated to Moderate or Good condition with substantial management.

Disturbed: highly modified landscape containing few or no indigenous species; exotic species dominant; original native vegetation layers removed; natural soil profile disturbed; unable to be regenerated to natural condition; requires a high input of resources to achieve restoration goals.

Assessment of the condition the TSC Act TEC CPW referenced the relevant clauses of the Final Determination (NSW Scientific Committee 2009a) for the community. Assessment of the presence

of the TSC Act TEC RFEFCF referenced the relevant clauses of the Final Determination (NSW Scientific Committee 2004) for the community. Similarly, assessments to determine the presence or absence of the EPBC Act listed CPSW considered the vegetation condition criteria described by DEWHA (2010) and the Federal Threatened Species Scientific Committee (2009).

2.6 Fauna

The fauna survey was undertaken primarily as a habitat based assessment. In addition to habitat assessments diurnal surveys involved:

- direct incidental visual and aural observation for bird and frog calls;
- opportunistic searches for Cumberland Plain Land Snail *Meridolum corneovirens* (CPLS) in areas of suitable habitat likely to be impacted by the Amended Project.; and
- noting of fauna habitat resources such as water bodies and locating hollow bearing trees by GPS.

A fauna species inventory was compiled and is included in Appendix 3.

2.6.1 Fauna Habitat Assessment

As noted, the site assessment was primarily a habitat assessment. Apart from opportunistic targeted searches for CPLS, active searching or trapping for animal species was not undertaken during this assessment as the majority of impacts to significant biodiversity values have been avoided and targeted surveys for threatened species were deemed to be not required.

The habitat assessment noted the presence of one or more of the following features:

- vegetation cover;
- leaf litter, fallen timber, rubbish and other debris:
- size range and abundance of tree hollows;
- rock outcrops, overhangs or crevices;
- freestanding water bodies, ephemeral drainage or seepage areas;
- disturbances including weed invasion, clearing, rubbish dumping or fire;
- connectivity to off site habitats; and,
- surrounding habitat.

The following three categories were used to evaluate habitat value.

Good: ground flora containing a high number of indigenous species; vegetation community structure, ground, log and litter layer intact and undisturbed; a high level of breeding, nesting, feeding and roosting resources available; a high richness and diversity of native fauna species.

Moderate: ground flora containing a moderate number of indigenous species; vegetation community structure, ground log and litter layer moderately intact and undisturbed; a moderate level of breeding, nesting, feeding and roosting resources available; a moderate richness and diversity of native fauna species.

Poor: ground flora containing a low number of indigenous species, vegetation community structure, ground log and litter layer disturbed and modified; a low level of breeding, nesting, feeding and roosting resources available; a low richness and diversity of native fauna species.

Other habitat features, such as the value of the Surface Project Area as a habitat corridor, the presence of remnant communities and the structure of ecological vegetation communities, were also used to assess habitat quality.

2.7 Groundwater Dependent Ecosystems

An assessment of Groundwater Dependent Ecosystems (GDEs) has been undertaken. This assessment included:

- Review of *Risk Assessment Guidelines for Groundwater Dependent Ecosystems* (NOW 2012);
- Review of the *Atlas of Groundwater Dependent Ecosystems* (BoM 2012);
- Review of the *Groundwater Management Plan for the Camden Gas Project* (AGL 2012)
- Review of the *Peer Review of the Groundwater Management Plan for the Camden Gas Project – Interim Report* (PB 2012a); and,
- Review of *Update on the Camden North Phase 2 Groundwater Program – Denham Court* (PB 2012b).

There are several groundwater systems located beneath the Sub-surface project area. Only the very shallow groundwater systems are thought to have any connected (dependent) ecosystems. There are no GDEs known for the deeper groundwater systems below the Hawkesbury Sandstone (PB, 2011).

The reliance of vegetation communities within the Sub-surface Project Area on groundwater was assessed to determine the potential for impacts to result to any GDEs using all available information sources.

2.8 Limitations

Field surveys were conducted over eight days from autumn to spring 2009, three days in winter 2011 and two days in winter 2012. Flora and fauna field surveys were based on the recommendations of Draft Guidelines (DEC & DPI 2005). Flora and fauna field surveys have also considered:

- the nature and design of the Amended Project, as described in Section 1.3, to focus the field survey effort within the Subject Site, in view of the size of the Surface Project Area;
- the types and complexity of flora and fauna habitats that are likely to be directly and indirectly affected by the Amended Project; and
- the relatively homogeneous wider disturbed landscape of the Locality.

This study was, by design, primarily a habitat based assessment. The field survey does not include trapping, spotlighting and call playback techniques for a more complete spectrum of terrestrial fauna that may occur within the Surface Project Area, as this was deemed not necessary based on measures to avoid, minimise and mitigate impacts and the fact that residual impacts are considered unlikely to result in a significant impact to any species, populations or communities.

Following habitat based assessment an aquatic assessment was deemed not to be required. Aquatic habitat within the Subject Site is limited in extent and quality, and is considered unlikely to support threatened species, populations or communities. Further, measures to avoid, minimise, mitigate and offset impacts arising from the Amended Project further reduced the need for an aquatic assessment.

Detailed assessment of the entire Surface Project Area was not undertaken, as outlined above. As such the full spectrum of flora and fauna species and ecological processes likely to occur in the Surface Project Area and Subject Site cannot be fully quantified or described in this report. These limitations have been addressed by identifying potential habitats for threatened flora and fauna species, populations and ecological communities, assessing the potential for these species to occur within the Surface Project Area based on previous records, the type and condition of habitats present, the land use throughout the Surface Project Area and the landscape context, and implementation of measures to avoid, minimise and mitigate impacts. Through this process the vast majority of impacts to significant biodiversity values have been avoided and residual impacts are unlikely to be significant.

This assessment has relied on a previous regional vegetation survey and mapping project and as such the limitations of the surveys by Tozer (Tozer 2003) and NPWS (NPWS 2002d) apply to some extent to this survey and assessment.

This assessment has relied on threatened species data provided for this project by the OEH and publicly available data from DSEWPaC. The limitations of the collection, processing, management and distribution of the data sourced from these parties are relevant to the current assessment.

In relation to the amount of field survey effort and its timing, a reasonable sample of the spectrum of flora and fauna, their habitats and assessment of the ecological processes that are likely to occur in the Surface Project Area and Subject Site have been made.

The desktop and field survey effort and methods have compiled adequate information to provide a robust and reliable assessment of the potential for threatened species, populations and ecological communities or their habitats to occur in the Surface Project Area. The impact assessment has considered the ecologically sustainable design principles of the Amended Project as they relate to the threatened biodiversity or its habitat known to occur or with potential to occur in the Surface Project Area. In addition to considering the conservation of important threatened biodiversity previously recorded in the Surface Project Area at the design phase, adequate mitigation measures have been recommended for quantifiable impacts. Where there is uncertainty about the likelihood of additional impacts to threatened biodiversity or its habitat, then further impact assessment will need to be undertaken.

3.0 RESULTS

A broad description of the plant communities (Section 3.1), flora species (Section 3.2), fauna habitats (Section 3.3) and fauna species (Section 3.4) is provided below. This is followed by detailed descriptions of biodiversity values present at each WSL (Section 3.5) and GGLs and access tracks (Section 3.7).

Potential impacts on flora and fauna values of the Surface Project Area are described in Section 4.0 with recommendations to avoid, minimise and mitigate these potential impacts provided in Section 4.2.

3.1 Plant Communities

The native vegetation of the region has been mapped by NPWS (2002d) at a scale of 1:25,000 and mapped by Tozer *et al*. (Tozer 2006) at a scale of 1:100,000. After examination of both vegetation maps, it was decided to base plant community descriptions and vegetation calculations of the Surface Project Area on the NPWS (2002d) mapping. NPWS (2002d) mapping was refined and modified during field surveys. As a result of the field surveys vegetation mapped as Alluvial Woodland at some locations and outside the Subject Site is considered to be more floristically aligned with SHW. Accordingly these areas of Alluvial Woodland mapped by NPWS (2002f) are assessed as a being CPW and vegetation mapping has been modified. The extent of other vegetation communities was also refined.

Five native plant communities (Shale Hills Woodland, Shale Plains Woodland, Alluvial Woodland, Moist Shale Woodland and Western Sydney Dry Rainforest) have been mapped as occurring in the Surface Project Area (Figure 2). These communities are described in Sections 3.1.1 to 3.1.4 below.

Two additional vegetation communities not mapped by NPWS, Shrubland and Closed Grassland, have been described by this assessment. Shrubland communities are present within the Subject Site and elsewhere throughout the Surface Project Area. Closed Grassland is the most widespread plant community over both the Subject Site and Surface Project Area. These communities are described in Sections 3.1.5 to 3.1.6 below.

Five of these communities (Shale Hills Woodland, Shale Plains Woodland, Alluvial Woodland, Shrubland and Closed Grassland) have been mapped as occurring within the Subject Site (Figures 6).

Three of the communities occurring within the Subject Site equate to TECs listed under the EPBC Act and / or TSC Act as described in Section 3.1.7.

3.1.1 Cumberland Plain Woodland – Shale Hills Woodland and Shale Plains Woodland

Shale Hills Woodland (SHW) is described by NPWS (2002d) as a woodland occurring almost exclusively on soils derived from Wianamatta Shale at higher elevations and on steeper slopes than Shale Plains Woodland (SPW). SHW most often occurs in undulating country with a relatively high degree of ruggedness. Dominant canopy species include *Eucalyptus moluccana* and

Eucalyptus tereticornis with *Eucalyptus crebra* occurring less frequently. A small tree stratum is often present, supporting *Acacia implexa* with a variety of the commonly occurring *Eucalyptus* species. The shrub stratum is typically dominated by *Bursaria spinosa*, with *Acacia falcata, Breynia oblongifolia, Indigophera australis* and *Dodonea viscosa* ssp. *cuneata* occurring less frequently. The ground stratum is variable in cover, often supporting good cover of native grass and herb species such as *Dichondra repens, Brunoniella australis, Aristida ramosa, Desmodium varians, Microlaena stipoides* var. *stipoides, Themeda australis* and *Cheilanthes sieberi* spp. *sieberi*.

Shale Plains Woodland (SPW) is described by NPWS (2002d) as predominantly occurring on soils derived from Wianamatta Shale, but also on Holocene alluvium in well drained areas that are infrequently inundated. SPW is dominated by *Eucalyptus moluccana* and *Eucalyptus tereticornis* with *Eucalyptus crebra, Eucalyptus eugenioides* and *Corymbia maculata* occurring less frequently. These species often also form a separate small tree stratum, occasionally including other species such as *Exocarpus cupressiformis, Acacia parramattensis* subsp. *parramattensis* and *Acacia decurrens*. A shrub stratum dominated by *Bursaria spinosa* is usually present. Common ground stratum species include *Dichondra repens, Aristida vagans, Microlaena stipoides* var. *stipoides, Themeda australis, Brunoniella australis, Desmodium varians, Opercularia diphylla, Wahlenbergia gracilis* and *Dichelachne micrantha*.

All areas of SHW and SPW mapped in Figures 6 are considered representative of CPW as listed under the TSC Act and / or CPSW as listed under the EPBC Act (see Section 3.1.7 below). As these vegetation communities represent CPW they are hereafter grouped under this TEC and referred to as CPW. CPW is also classed as a High Priority Endangered Ecological Community (but not a High Priority Groundwater Dependent Ecosystem (GDE) in the *Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources 2011*. In the more recent *Risk Assessment Guidelines for Groundwater Dependent Ecosystems* (Office of Water (2012)), CPW is listed with a high probability of being a GDE.

CPW is the most widespread and abundant native plant community in the Surface Project Area. The total estimate of CPW within the Surface Project Area is 868 ha. Of this, approximately 13.9 ha of CPSW (listed under EPBC Act and TSC Act) and an additional 26.45 ha of CPW (listed under TSC Act only), totalling 40.35 ha, is present in various locations within the Subject Site.

CPW within the Subject Site is variable in condition. Areas of CPW assessed as in Good condition support remnant or well established canopy of native trees, recruiting trees in the mid and understorey, full or partially intact understorey dominated by native shrub species and groundcover stratum at dominated by native grasses and herbs. Weed per cent cover is low through all major structural units. Areas of CPW in Good condition tend to occur on crests, ridges and upper slopes and as larger patches of the community with lower area to volume ratios. Areas of CPW assessed as in moderate condition share a similar suite of condition criteria to areas assessed in Good condition. The understorey and groundcover stratums however have a higher per cent cover of invasive weed species including the woody weeds *Olea europaea* ssp. *cuspidata* and *Lycium ferocissimum* African Boxthorn and exotic perennial grasses and herbs such as *Eragrostis*

curvula, *Paspalum dilatatum* and *Plantago lanceolata*. CPW in moderate condition is generally smaller in patch size and lower in the landscape compared with patches in Good condition. Moderate to Good condition CPW within the Subject Site is included as either TSC Act or both TSC Act and EPBC Act CPW. The Subject Site also includes patches of heavily disturbed vegetation but which are still considered to meet the criteria of the NSW Scientific Committee Final Determination (2009a) for TSC Act listed CPW.

3.1.2 Alluvial Woodland

Alluvial Woodland is described by NPWS (2002d) as occurring exclusively along, or in close proximity to minor watercourses draining soils derived from Wianamatta Shale. It is the most common community found on soils of recent alluvial deposition. The most common canopy species include *Eucalyptus amplifolia* and *Eucalyptus tereticornis*, with *Angophora floribunda* occurring slightly less frequently. A stratum of small trees is often present, frequently including *Acacia parramattensis* subsp. *parramattensis*, and less frequently *Casuarina glauca*, and sometimes *Angophora floribunda* and *Melaleuca linariifolia*. A shrub stratum is usually evident, but is often sparse and invariably dominated by *Bursaria spinosa*. The dense ground cover is dominated by grasses such as *Oplismenus aemulus, Microlaena stipoides* var. *stipoides, Entolasia marginata* and *Echinopogon ovatus.* Herb species are also common, including *Solanum prinophyllum, Pratia purpurascens* and *Commelina cyanea*.

Alluvial Woodland within the assessed areas is considered representative of RFEFCF which is listed as an EEC under the TSC Act (see Section 3.1.7 below). As this vegetation community is representative of RFEFCF it is hereafter referred to as RFEFCF.

RFEFCF is the second most widespread native plant community in the Surface Project Area. The total estimate of RFEFCF within the Surface Project Area is 42.24 ha. Of this approximately 3.46 ha of RFEFCF is estimated to occur in the Subject Site.

RFEFCF is present within the Subject Site on the VV03 WSL access track and GGL. This stand of RFEFCF is characterised by a canopy of native tree species including *Angophora subvelutina* and *Eucalyptus tereticornis*, a midstorey of *Melaleuca styphelioides* and understorey dominated by woody weeds with scattered native shrubs such as *Bursaria spinosa* present. The groundcover stratum is highly modified and is dominated by exotic perennial pasture grasses and herbs such as *Pennisetum clandestinum* and *Trifolium repens*. RFEFCF in the Subject Site is in Poor condition.

3.1.3 Moist Shale Woodland

Moist Shale Woodland (MSW) is described by NPWS (2002d) as being restricted to rugged areas at higher elevations in the southern half of the Cumberland Plain. This community appears to represent the endpoint of the gradient in increasing elevation, rainfall and ruggedness from the central Cumberland Plain to the Razorback range at Picton. Dominant canopy species include *Eucalyptus tereticornis* and. *Eucalyptus moluccana*, with *Eucalyptus crebra* and *Corymbia maculata* occurring more occasionally. A small tree stratum consisting of the same species is often evident, and this may occasionally include species such as *Acacia implexa* or *Acacia*

parramattensis subsp. parramattensis. A relatively sparse shrub stratum dominated by mesophyllic species such as *Breynia oblongifolia, Clerodendrum tomentosum, Sigesbeckia orientalis* subsp. *orientalis, Bursaria spinosa and Olearia viscidula* is usually present. The ground stratum is variable in cover and contains species such as *Desmodium varians, Cyperus gracilis, Galium propinquum, Cayratia clematidea, Glycine clandestina, Brunoniella australis, Desmodium brachypodum, Dichondra repens, Microlaena stipoides* var *stipoides* and *Solanum prinophyllum*.

MSW is listed as an EEC under the TSC Act (see Section 3.1.7 below).

Figure 2 shows the distribution of vegetation communities according to mapping by NPWS (2002d). Based on this mapping, an estimated 33.04 ha of Moist Shale Woodland is present in the Surface Project Area. No Moist Shale Woodland is present in the Subject Site.

3.1.4 Western Sydney Dry Rainforest

Western Sydney Dry Rainforest (WSDR) is described by NPWS (2002d) as having a highly restricted distribution, occurring on sheltered lower slopes and gullies on steeply sloping, rugged topography. It is often found at higher elevations in areas receiving relatively high rainfall. Dominant species include a mixture of species including *Melaleuca styphelioides, Acacia implexa, Alectryon subcinereus* and less frequently *Streblus brunonianus*. Mesic species are predominant in the shrub stratum, such as *Pittosporum revolutum, Breynia oblongifolia, Clerodendrum tomentosum, Notelea longifolia* f. *longifolia* and *Sigesbeckia orientalis* subsp. *orientalis*. The ground stratum consists primarily of a mixture of fern and herb species, with relatively few grass species present. Dominant species include *Adiantum aethiopicum, Pellaea falcata* var. *falcata, Asplenium flabellifolium, Dichondra repens, Microlaena stipoides* var. *stipoides, Oplismenus imbecillis, Plectranthus parvifolius, Desmodium varians, Galium propinquum* and *Stellaria flaccida*. Vine species are also common, including *Cayratia clematidea, Eustrephus latifolius, Geitonoplesium cymosum, Pandorea pandorana, Aphanopetalum resinosum* and *Stephania japonica* var. *discolor*.

WSDR is listed as an EEC under the TSC Act (see Section 3.1.7 below).

Figure 2 shows the distribution of vegetation communities according to mapping by NPWS (2002d). Based on this mapping, an estimated 4.52 ha of Western Sydney Dry Rainforest is present in the Surface Project Area. No Western Sydney Dry Rainforest is present in the Subject Site.

3.1.5 Shrubland

Shrubland occurs throughout the Surface Project Area and has established as patches dominated by regenerated native species, stands of woody weeds or a mixture of native and exotic species. Stands dominated by natives are commonly a mix of *Acacia decurrens, Acacia falcata, Acacia parramattensis* and *Bursaria spinosa* ssp. *spinosa* with occasional occurrences of *Cassinia uncata*, *Daviesia ulicifolia* and *Dillwynia sieberi*. Some stands are characterised by a monoculture of *Bursaria spinosa* ssp. *spinosa*. Shrublands dominated by native shrubs often have a good cover of

native grasses and herbs or support a mosaic of native and exotic groundcovers. Common native groundcovers include *Aristida ramosa*, *A.vagans*, *Asperula conferta*, *Brunoniella australis*, *Cheilanthes sieberi* ssp. *sieberi*, *Cyperus gracilis*, *Glycine microphylla*, *Microlaena stipoides* var. *stipoides* and *Themeda australis*. Common exotic grasses and annual or perennial herbs are *Anagallis arvensis*, *Axonopus fissifolius*, *Briza subaristata*, *Paspalum dilatatum*, *Phalaris aquatic* and *Taraxacum officinale*.

Shrublands dominated by exotic species include stands of sparse to dense cover of *Olea europaea* ssp. *cuspidata* with *Lantana camara*, *Lycium ferocissimum* and *Pyracantha angustifolia* also common to occasional. Occasional native shrubs are also present and include *Acacia* spp., *Bursaria spinosa* ssp. *spinosa* and *Ozothamnus diosmifolius*. The groundcover of Shrublands is dominated by woody weeds, and is usually in poor condition as it supports a high per cent of introduced grasses and herbs such as *Axonopus fissifolius*, *Cirsium vulgare*, *Gamochaeta americana*, *Pennisetum clandestinum*, *Sida rhombifolia* and *Stellaria media*. Native grasses and herbs are also present including the species cited above and *Cynodon dactylon*, *Einadia hastata* and *Wahlenbergia stricta* ssp. *stricta*.

Approximately 19.77 ha of this community is mapped in the Surface Project Area. This includes approximately 12.07 ha in the Subject Site. The majority of Shrubland is assessed to be in Poor condition with some areas of the community adjoining native plant communities assessed as Poor to Moderate.

3.1.6 Closed Grassland

This plant community has established as a result of past and current agricultural land use in the Surface Project Area and wider Cumberland Plain. The most common form of this community type is dominated by exotic grasses and annual and perennial weeds with sparse cover of native grasses and herbs mixed through the exotic flora. Exotic grasses include pasture species such as *Axonopus fissifolius*, *Briza subaristata*, *Chloris gayana*, *Paspalum dilatatum* and *Pennisetum clandestinum*, with colonising weeds such as *Cirsium vulgare*, *Gamochaeta americana*, *Hypochaeris radicata*, *Modiola caroliniana*, *Sida rhombifolia*, *Trifolium repens* and *Verbena bonariensis* common and abundant. Native grasses and perennial herbs that commonly occur in this community include *Aristida ramosa*, *Austrodanthonia tenuior*, *Bothriochloa macra*, *Cynodon dactylon*, *Dichondra repens*, *Glycine microphylla*, *Sporobolus crebra* and *Themeda australis*.

A second form of the Closed Grassland community dominated by native grasses and herbs is also present throughout the Surface Project Area and in places on the Subject Site. Species composition in small to large patches of native dominated Closed Grassland were generally characterised by *Aristida* spp. or *Themeda australis* as the dominant grass accompanied by one or two subdominant grasses such as *Austrodanthonia tenuior*, *Bothriochloa macra*, *Chloris truncata*, *Microlaena stipoides* var. *stipoides* or *Sporobolus creber*. Common native herbs in this form of Closed Grassland included *Brunoniella australis*, *Centella asiatica*, *Cyperus gracilis*, *Dichondra repens*, *Hypericum gramineum*, *Geranium solanderi* var. *solanderi* and *Glycine microphylla*. Generally this subunit occurs along access tracks that are fenced off from grazed paddocks, along fencelines or under and around patches off or isolated individual trees and shrubs.

Isolated patches or individual occurrences of native and exotic trees and shrubs are scattered throughout the Closed Grassland community. Commonly occurring native and exotic trees and shrubs are *Acacia decurrens, Acacia parramattensis, Bursaria spinosa, Eucalyptus moluccana, Eucalyptus tereticornis, Lycium ferocissimum, Olea europaea* ssp. *cuspidata, Pinus radiata* and *Schinus areira*.

Closed Grassland is the most widespread and abundant vegetation community within the Surface Project Area and Subject Site.

3.1.7 Threatened Ecological Communities

The native plant communities discussed above in Section 3.3.1 to 3.3.5 include TECs listed under the TSC Act and EPBC Act. Five TECs (CPW, CPSW, RFEFCF, MSW and WSDR) are mapped by NPWS (2002d) within the Surface Project Area. Three of these TECs (CPW, CPSW and RFEFCF) occur within the Subject Site and are discussed further below.

CPW, incorporating the SHW and SPW sub-units, is listed as a Critically Endangered Ecological Community (CEEC) on the TSC Act and EPBC Act. CPW, as listed under the TSC Act, can include areas dominated by exotic species, provided the overstorey is consistent with the NSW Scientific Committee Final Determination (2009a) these areas have been considered CPW. The community, as listed under the EPBC Act, has higher cover thresholds for overstorey cover and native understorey cover, and larger patch size requirements (DEWHA 2010). Thus although an area may meet the requirements for CPW under the TSC Act, these areas may not meet thresholds to be considered CPSW under the EPBC Act.

Alluvial Woodland was previously incorporated into the former Sydney Coastal River-Flat Forest (SCRFF) EEC. SCRFF is now included in and replaced by the EEC RFEFCF and parts of the Alluvial Woodland community are included in RFEFCF (NSW Scientific Committee 2004).

Table 4 shows the relationship of plant communities within the Surface Project Area to TECs under the relevant legislation. The distribution of the communities listed in Table 4 in the Surface Project Area is according to the vegetation mapping of the Cumberland Plain (NPWS 2002e) and as modified following field surveys by Biosis.

Table 2: Critically Endangered and Endangered Ecological Communities in the Surface Project Area

Plant Community	EEC under TSC Act	CEEC under TSC Act	CEEC under EPBC Act
Shale Hills Woodland	N/A	Cumberland Plain Woodland	Cumberland Plain Shale Woodland
Shale Plains Woodland	N/A	Cumberland Plain Woodland	Cumberland Plain Shale Woodland
Alluvial Woodland	River-flat Eucalypt Forest on coastal floodplains of the NSW North Coast, Sydney Basin and South East Corner Bioregions.	N/A	N/A
Moist Shale Woodland	Moist Shale Woodland in the Sydney Basin Bioregion.	N/A	N/A

Western Sydney Dry Rainforest	Western Sydney Dry Rainforest in the Sydney Basin Bioregion.	N/A	N/A

3.2 Flora

A total of 147 plant species were recorded in the Subject Site, including 85 locally occurring native species, one non-locally occurring native species and 61 exotic species. Of the 61 exotic species nine are listed as Noxious under Order 20 of the *Noxious Weeds Act 1993* for the Camden and Campbelltown LGAs. One additional weed species is listed only for Campbelltown LGA.

A list of plant species recorded in the Subject Site is provided in Appendix 1.

3.2.1 Threatened Flora Species

Thirty-one threatened flora species and one threatened flora population listed under the TSC Act and / or EPBC Act have been either previously recorded or have potential habitat within 10km of the Surface Project Area (Table 3). Previous records for 27 threatened plants derived from OEH Atlas of NSW Wildlife data are illustrated in Figure 3.

No threatened flora species were recorded within the Subject Site during the current surveys. However, based on habitat assessments during the field surveys and other criteria, there is a medium to high likelihood of occurrence for six threatened flora species previously recorded in the locality (Table 3), including:

- *Acacia pubescens;*
- *Cynanchum elegans;*
- *Pimelea spicata;*
- *Pomaderris brunnea;*
- *Thesium australe*; and,
- *Marsdenia viridiflora* ssp. *viridiflora* (endangered population).

Four of these species are reasonably conspicuous due to their habit and other identifying characteristics. Two species are cryptic.

Assessments according to Draft Guidelines (DEC & DPI 2005) and EPBC Significant Impact criteria (DEWHA 2009) have been undertaken and are presented in Appendix 4 and 5 and summarised in Table 8.

Table 3: Threatened flora species previously recorded within 10km of the Surface Project Area and likelihood of occurrence.

Species	Status			Habitat	Likelihood of Occurrence
	EPBC Act[1]	TSC Act[2]	ROTAP[3]		
Acacia bynoeana Bynoe's Wattle	V	E1	3V	*Acacia bynoeana* is found in central eastern NSW, in the following catchment regions – Hawkesbury/Nepean, Hunter/Central Rivers, Southern Rivers, and Sydney Metropolitan. More specifically it is found from the Hunter District (Morisset) south to the Southern Highlands and west to the Blue Mountains. It has recently been found in the Colymea and Parma Creek areas west of Nowra (DEC 2005a). It seems to prefer open, sometimes slightly disturbed sites such as trail margins, edges of roadside spoil mounds and recently burnt patches (DEC 2005a). It grows in sandy clay soils often containing ironstone gravels (Fairley 2004). Main vegetation types include heath or dry sclerophyll forest on sandy soils (DEC 2005a). Associated overstorey species include *Corymbia gummifera*, *Corymbia maculata*, *Eucalyptus parramattensis*, *Banksia serrata* and *Angophora bakeri* (DEC, 2005). Flowering period is mainly summer	**Low**. Subject Site does not support preferred soils, vegetation types or species of known association. Previously recorded to the south-east in vegetation of the Georges River corridor.
Acacia pubescens Downy Wattle	V	V	3Va	*Acacia pubescens* is found in Sydney Metropolitan, and Hawkesbury/Nepean Catchment Management Region, with concentrated populations around the Bankstown-Fairfield-Rookwood area and the Pitt Town area, with outliers occurring at Barden Ridge, Oakdale and Mountain Lagoon (NPWS 2003). It occurs on alluviums, shales and at the intergrade between shales and sandstones. The soils are characteristically gravelly soils, often with ironstone. The species occurs in open woodland and forest, in a variety of plant communities, including Cooks River/ Castlereagh Ironbark Forest, Shale/ Gravel Transition Forest and Cumberland Plain Woodland. Flowers from August to October. The pods mature in October to December (NPWS 2003).	**Medium**. Although the species is not recorded in the Subject Site there is a high incidence of records for the locality. Most records are to the north of the Subject Site including on Upper Canal near Austral.

[1] Listed on the EPBC Act as Critically Endangered (Z), Endangered (E), Vulnerable (V)

[2] Listed on the TSC Act as Endangered (E1), Extinct (E4), Endangered Population (EP), Vulnerable (V)

[3] ROTAP conservation ratings – see Appendix 2

Species	Status			Habitat	Likelihood of Occurrence
	EPBC Act[1]	TSC Act[2]	ROTAP[3]		
Caladenia tessellata Tessellated Spider Orchid	V	E1	3V	*Caladenia tessellata* is found in the following Catchment Management Regions Sydney Metropolitan, Southern Rivers, Hawkesbury/Nepean, and Hunter/Central Rivers. Currently known from three disjunct areas: Braidwood on southern tablelands, Ulladulla on the south coast and three populations in Wyong area on the Central Coast (DEC 2005c). It is generally found in grassy, dry sclerophyll forests/woodland, particularly those associated with clay loam, or sandy soils. However, there is one population at Braidwood in lowland on stony soil (DEC 2005c). This species only grows in very dense shrubbery in coastal areas (Bishop 1996) . Flowers appear between September and November, but generally late September or early October in extant southern populations (DEC 2005c).	**Low**. Subject Site does not support preferred soils or vegetation types of known association.
Callistemon linearifolius	-	V	2Ri	Occurs chiefly from Georges River to the Hawkesbury River where it grows in dry sclerophyll forest (Harden 2002), open forest, scrubland (Fairley and Moore 2000) or woodland on sandstone. Found in damp places, usually in gullies (Robinson 1994). Flowers in Spring.	**Low**. Subject Site does not support preferred soils or vegetation types. Previously recorded to the south-east in vegetation of the Georges River corridor.
Cryptostylis hunteriana Leafless Tongue Orchid	V	V	3V	This species typically grows in swamp-heath on sandy soils chiefly in coastal districts (Harden 1993) but has also been recorded on steep bare hillsides (Bishop 1996). Within the Central Coast bioregion, this species has been recorded within Coastal Plains Smooth-barked Apple Woodland and Coastal Plains Scribbly Gum Woodland (Bell 2001). This species does not appear to have well defined habitat preferences and is known from a range of communities, including swamp-heath and woodland. The larger populations typically occur in woodland dominated by *Eucalyptus sclerophylla, E. sieberi, Corymbia gummifera* and *Allocasuarina littoralis*; appears to prefer open areas in the understorey of this community and is often found in association with the *Cryptostylis subulata* (DEC 2005d). It occurs in the following Catchment Management Regions Hawkesbury/Nepean, Hunter/Central Rivers, Northern Rivers and Southern Rivers.	**Low**. Subject Site does not support preferred soils or vegetation types
Cynanchum elegans White-flowered Wax Plant	E	E1	3Ei	Restricted to eastern NSW where it is distributed from Brunswick Heads on the north coast to Gerroa in the Illawarra region. The species has been recorded as far west as Merriwa in the upper Hunter River valley. Catchment Management Regions include Hawkesbury/Nepean , Hunter/Central Rivers, Northern Rivers, Southern Rivers and Sydney Metropolitan (DEC 2005~). *Cynanchum elegans* usually occurs on the edge of dry rainforest vegetation. Other associated vegetation types include littoral rainforest; *Leptospermum laevigatum, Banksia integrifolia subsp. integrifolia; Eucalyptus tereticornis* open forest and woodland; *Eucalyptus maculata* open forest and woodland; and *Melaleuca armillaris* scrub to open scrub (DEC 2005~). Flowering occurs between August and May, with a peak in November. Flower abundance on individual plants varies from sparse to prolific (DEC 2005~).	**High**. Previously recorded in the northern part of area of the Surface Project Area. Large remnant stands of CPW dominated by *Eucalyptus tereticornis* provide good habitat.

Species	Status			Habitat	Likelihood of Occurrence
	EPBC Act[1]	TSC Act[2]	ROTAP[3]		
Dillwynia tenuifolia	V	V1	2Vi	The core distribution is the Cumberland Plain from Windsor to Penrith east to Deans Park. Other populations in western Sydney are recorded from Voyager Point and Kemps Creek, Luddenham and South Maroota. Disjunct localities include: the Bulga Mountains, Kurrajong Heights and Woodford (DEC 2005f) . In western Sydney, may be locally abundant particularly within scrubby/dry heath areas within Castlereagh Ironbark Forest and Shale Gravel Transition Forest on tertiary alluvium or laterised clays. May also be common in transitional areas where these communities adjoin Castlereagh Scribbly Gum Woodland (DEC 2005f). *Eucalyptus fibrosa* is likely to be a dominant canopy species. *Eucalyptus globoidea, E. longifolia, E. parramattensis, E. sclerophylla* and *E. sideroxylon* may also be present or codominant (NPWS 2002a). Flowering occurs sporadically from August to March depending on environmental conditions. Surveys should initially concentrate in open areas within woodland/open forest, particularly targeting areas possessing laterised gravels, or low rises which have a well developed or regenerating low shrub layer (NPWS 2002a).	**Low**. Subject Site does not support preferred soils or vegetation types
Diuris aequalis Buttercup Doubletail	V	E1	3V	*Diuris aequalis* has been recorded in Kanangra-Boyd National Park, Gurnang State Forest, towards Wombeyan Caves, the Taralga - Goulburn area, and the ranges between Braidwood, Tarago and Bungendore. Catchment Management Regions include: Hawkesbury/Nepean, Lachlan, Murrumbidgee, Southern Rivers and Sydney Metropolitan (DEC 2005g). Recorded in forest, low open woodland with grassy understorey and secondary grassland on the higher parts of the Southern and Central Tablelands (especially on the Great Dividing Range) (DEC 2005g). It favours gravelly clay-loam, often on gentle slopes (Bishop 1996). Like most Diuris species, the flowers mimic native pea flowers to attract pollinators; in this case the model is a small-flowered wedge-pea (Gompholobium sp.), with which it always grows. Flowering occurs between mid-October and mid-November in the southern part of its range, and between mid-November and early December in the populations north of the Abercrombie River (DEC 2005g).	**Low**. Subject Site does not support preferred vegetation types
Diuris lanceolata Snake Orchid	E	-	-	Grows in moist grassy areas, among shrubs in sclerophyll forest and heath; coast and tablelands (Harden 1993). The species is highly localised (Jones, 2006).	**Low**. Subject Site does not support preferred vegetation types
Eucalyptus benthamii Nepean River Gum	V	V	2Vi	Known from two main locations: Bents Basin and Kedumba Valley. A few scattered individuals are recorded from other sites on the sandy alluvial flats of the Kedumba/Cox/Nepean River system. Occurs only in wet open forest on sandy alluvial soils along valley floors at an elevation of 140-750 m. The soils are shallow to moderately deep and are well drained alluvial sands and gravels along stream channels, small terraces and alluvial flats (NPWS 2000b). Restricted but locally abundant (Harden 1991). ROTAP; 2Vi	**Low**. Subject Site does not support preferred soil or vegetation types

Species	Status			Habitat	Likelihood of Occurrence
	EPBC Act[1]	TSC Act[2]	ROTAP[3]		
Eucalyptus scoparia Wallangarra White Gum	V	E1	2Vi	Occurs in Queensland and recently found in NSW on the northern tablelands where it grows on well drained granitic hilltops, slopes and outcrops, often as scattered trees in open forest and woodland (NSW Scientific Committee 2002).	**Low**. This record is beyond the species natural range and distribution. The record is most likely of a planted specimen.
Genoplesium baueri Bauer's Midge Orchid	-	V	3R	This terrestrial orchid species grows in open sclerophyll forest or moss gardens on sandstone. Typically the habitat is a drier heathy forest (Harden 1993) (Bishop 1996). The species has been recorded from locations between Nowra and Pittwater and may occur as far north as Port Stephens. About half the records were made before 1960 with most of the older records being from Sydney suburbs including Asquith, Cowan, Gladesville, Longueville and Wahroonga. No collections have been made from those sites in recent years. Flowers Dec. - Mar (DEC 2005i).	**Low**. Subject Site does not support preferred habitat resources. Previously recorded to the east near Campbelltown.
Grevillea juniperina ssp.. *juniperina*	-	V	-	Its distribution is centred on an area bounded by Blacktown, Erskine Park, Londonderry and Windsor with outlier populations at Kemps Creek and Pitt Town (NPWS 2002b). It is found on clay soils in open forest on the Cumberland Plain (Robinson 1994). Grows in moist sites, usually near creek on acidic soils (Harden 1991).	**Low**. This is a conspicuous species and nearest record is to the north in a low lying area of Kemps Creek.
Grevillea parviflora ssp.. *parviflora* Small-flower Grevillea	V	V	-	Located in Hawkesbury/Nepean, Hunter/Central Rivers and Sydney Metropolitan Catchment. Sporadically distributed throughout the Sydney Basin with the main occurrence centred in Picton, Appin, Wedderburn and Bargo. Northern populations are found in the Lower Hunter Valley. To the west of Sydney, small populations occur at Kemps Creek & Voyager Point (DEC 2005l). *Grevillea parviflora* ssp.. *parviflora* grows on sandy clay loam soils, often with ironstone gravels. Soils are mostly derived from Tertiary sands or alluvium and from the Mittagong Formation with alternating bands of shale and fine-grained sandstones (NPWS 2002c). *Grevillea parviflora* subsp. *parviflora* is found on crests, upper slopes or flat plains in both low-lying areas and on higher topography. The plant prefers open habitat conditions with the largest populations in open woodland and along exposed roadside areas (NPWS 2002c). *G. parviflora* subsp. *parviflora* has been recorded in a range of vegetation types from heath and shrubby woodland to open forest. Canopy species vary greatly with community type but generally are species that favour soils with a strong lateritic influence including *Eucalyptus fibrosa*, *E. parramattensis*, *Angophora bakeri* and *Eucalyptus sclerophylla* (NPWS 2002c).. Flowering has been recorded between July to December as well as April-May (NPWS 2002c).	**Low**. Subject Site does not support preferred soils or vegetation types. Previously recorded to the south-east in vegetation of the Georges River corridor and north at Kemps Creek.
Gyrostemon thesioides	-	E1	2K	Within NSW, has only ever been recorded at three sites, to the west and south of Sydney, near the Colo, Georges and Nepean Rivers. The most recent sighting was of a single male plant near the Colo River within Wollemi National Park. The species has not been recorded from the Nepean and Georges Rivers for 90 and 30 years respectively, despite searches. Also occurs also in Western Australia, South Australia, Victoria and Tasmania. Grows on hillsides and riverbanks and may be restricted to fine sandy soils (DEC 2005m).	**Low**. Most recent records from locality are between 30 and 90 years ago.
Lepidium	E	E1	3Ei	Associated with introduced weedy species that tend to populated areas that receive little maintenance	**Low**. The single known

Species	Status			Habitat	Likelihood of Occurrence
	EPBC Act[1]	TSC Act[2]	ROTAP[3]		
hyssopifolium Basalt Peppercress				and are generally allowed to lie as derelict pasture. Original habitat is eucalypt woodland with grassy groundcover, low open Casuarina woodland with a grassy ground cover and tussock grassland (Cropper 1993a).	population of the species does not occur in the locality.
Leucopogon exolasius Woronora Beard-heath	V	V	2V	Occurs in Hawkesbury/Nepean and Sydney Metropolitan Catchment (DEC 2005€), restricted to the Woronora and Grose Rivers (Harden 1991). The plant occurs in woodland on sandy alluvium and rocky sandstone hillsides near creeks, and on low nutrient soils (Powell 2007). Flowering occurs in August and September (Harden 1991). Associated species include *Eucalyptus piperita* and *E. sieber*i and the shrubs *Pultenaea flexilis, Leptospermum trinervium* and *Dillwynia retorta* (Powell 2007).	**Low**. Subject Site does not support preferred soils or vegetation types. Previously recorded to the south-east in vegetation of the Georges River corridor.
Leucopogon fletcheri ssp.. fletcheri	-	E1	2R	Found in woodland (Harden 1992) on clayey lateritic soils between the Wianamatta Shale and Hawkesbury Sandstone, generally on flat to gently sloping ridges and spurs (NSW Scientific Committee 1999). Flowers August to September. Restricted to north-western Sydney between St Albans in the north and Annangrove in the south, within the local government areas of Hawkesbury, Baulkham Hills and Blue Mountains (DEC 2005p).	**Low**. Subject Site does not support preferred soils or vegetation types. Previously recorded to the south-east in vegetation of the Georges River corridor.
Marsdenia viridiflora ssp.. viridiflora Native Pear	-	EP	-	This species has a wide distribution in sub coastal and southern Queensland but has been recorded rarely in NSW and from a disjunct occurrence near Sydney where it occurs as very scattered plants in areas of remnant vegetation (NSW Scientific Committee 2003). Grows in woodland and scrub (Harden 1992) and is typically found in Sydney Turpentine Ironbark Forest (NSW Scientific Committee 2003). Grows in vine thickets and open shale woodland. Recent records are from Prospect, Bankstown, Smithfield, Cabramatta Creek and St Marys. Previously known north from Razorback Range (DEC 2005q).	**Medium**. CPW of the Surface Project Area supports preferred soils and vegetation type.
Melaleuca deanei Dean's Melaleuca	V	V	3R	*Melaleuca deanei* occurs in Catchment Management Regions Hawkesbury/Nepean, Southern Rivers, and Sydney Metropolitan. Distinctly it occurs in the Ku-ring-gai/Berowra and Holsworthy/Wedderburn areas. There are also more isolated occurrences at Springwood (in the Blue Mountains), Wollemi National Park, Yalwal (west of Nowra) and Central Coast (Hawkesbury River) areas (DEC 2005r). The species grows in wet heath on sandstone (Harden 1991) and Dry Sclerophyll Forests. Flowers appear in summer but seed production appears to be small and consequently the species exhibits a limited capacity to regenerate (DEC 2005r).	**Low**. Subject Site does not support preferred soils or vegetation types. Previously recorded to the south-east in vegetation of the Georges River corridor.

Species	Status			Habitat	Likelihood of Occurrence
	EPBC Act[1]	TSC Act[2]	ROTAP[3]		
Persoonia bargoensis Bargo Geebung	V	E1	2V	Found in the Sydney Metropolitan and Hawkesbury/Nepean Catchment Authority Regions. Restricted to a small area south-west of Sydney on the western edge of the Woronora Plateau. Its entire range falls between Picton, Douglas Park, Yanderra, Cataract River and Thirlmere (DEC 2005s). *P. bargoensis* grows in woodland to dry sclerophyll forest on sandstone and clayey laterite on heavier, well drained, loamy, gravelly soils of the Hawkesbury Sandstone and Wianamatta Shale (NPWS 2000c). More specifically, *P.bargoensis* seems to prefer the interfaces between shale-derived soils such as the Blacktown Soil Landscape, the complex soils of the Mittagong Formation (Lucas Heights Soil Landscape), and the underlying sandstone (Hawkesbury and Gymea Soil Landscapes). Some of the vegetation in which *P. bargoensis* occurs can be recognised as the endangered Shale/Sandstone Transition Forest (NPWS 2000c). This species seems to benefit from the reduced competition and increased light available on disturbance margins including roadsides (DEC 2005s). Flowering occurs mainly in summer but can extend into autumn (NPWS 2000c).	**Low**. Subject Site does not support preferred soils or vegetation types.
Persoonia nutans Nodding Geebung	E	E1	2Ei	Occurs in Hawkesbury/Nepean and Sydney Metropolitan Catchment. Restricted to the Cumberland Plain between Richmond in the north and Macquarie Fields in the south. Core distribution occurs within the Penrith LGA, and to a lesser extent, Hawkesbury LGA. Small populations also occur in the Liverpool, Campbelltown, Bankstown and Blacktown LGA's (DEC 2005t). Confined to Aeolian and alluvial sediments and occurs in a range of sclerophyll forest and woodland vegetation communities with the majority of individuals occurring within Agnes Banks Woodland or Castlereagh Scribbly Gum Woodland (DEC 2005t). *P. nutans* also occurs on Shale/Gravel Transition Forest and Cooks River Castlereagh Ironbark Forest (DEC 2005h). In Castlereagh Scribbly Gum Woodlands it is found in open woodland with dominant overstorey species being *Angophora bakeri*, *Eucalyptus sclerophylla* and *Melaleuca decora*. The Agnes Banks Woodlands have a similar array of tree species, with the addition of *Banksia serrata* and *Banksia aemula* (DEC 2005h). *Persoonia nutans* is found on the Agnes Banks and Berkshire Park soil landscapes. Drainage appears to influence the distribution of *P. nutans* as the species is more common on the deeper sands at Agnes Banks. At other locations on the Cumberland Plain it occurs on low rises as opposed to swales or other low lying areas (DEC 2005h).	**Low**. Subject Site does not support preferred soils or vegetation types Previously recorded to the east in vegetation of the Georges River corridor and to the north in low areas around Kemps Creek.

Species	Status			Habitat	Likelihood of Occurrence
	EPBC Act[1]	TSC Act[2]	ROTAP[3]		
Pimelea spicata Spiked Rice-flower	E	E1	3Ei	Once widespread on the Cumberland Plain, *Pimelea spicata* occurs in two disjunct areas, the Cumberland Plain and the Illawarra. Catchment areas are Hawkesbury/Nepean, Southern Rivers, and Sydney Metropolitan Catchment (NPWS 2000d). In western Sydney, P. spicata occurs on an undulating topography of substrates derived from Wianamatta Shale in areas supporting, or that previously supported, the Cumberland Plain Woodland Vegetation Community (NPWS 2004). Associated species include: *Eucalyptus moluccana, E. tereticornis, E.crebra, Bursaria spinosa*, and *Themeda australis* (NPWS 2004). In the Illawarra region, *P. spicata* is found in open woodland and also in coastal grassland communities with emergent shrubs. Dominant species within the woodland habitat include *Eucalyptus tereticornis, E. eugenioides, Themeda australis*, and *Lomandra longifolia*. In the coastal Illawarra it occurs commonly in Coast Banksia open woodland with a more well developed shrub and grass understorey (NPWS 2004). Pimelea spicata flowers sporadically throughout the year, with flowering likely to depend upon climatic conditions, particularly rainfall. Flowering times recorded for P. spicata vary. Rye (1990) noted flowering period as May - January; Benson and McDougall (2001) noted peak flowering period as March/ April (NPWS 2000d).	**High**. Previously recorded in Surface Project Area with CPW providing preferred habitat.
Pomaderris brunnea Rufous Pomaderris	V	V	2V	*Pomaderris brunnea* is found in a very limited area around the Nepean and Hawkesbury Rivers, including the Bargo area. Occurs in the Central West, Hawkesbury/Nepean, Hunter/Central Rivers Catchments. Occurs on clay & alluvial soils (Fairley and Moore 1995). In the Hawkesbury/Nepean region, the species is known to be associated with Dry sclerophyll forests (Cumberland, Upper Riverina, Sydney Coastal, Sydney Hinterland, Sydney Sand Flats), Coastal Floodplain Wetlands and Coastal Valley Grassy Woodlands (DEC 2005u). Flowers appear in September and October.	**Medium**. Although records for the species in the locality are clustered to the south along Nepean River CPW of the Subject Site supports preferred soils and vegetation type.
Pterostylis nigricans Dark Greenhood	-	V	3V	The Dark Greenhood occurs in north-east NSW north from Evans Head, and in Queensland. Grows in coastal heathland with Heath Banksia (Banksia ericifolia), and lower-growing heath with lichen-encrusted and relatively undisturbed soil surfaces, on sandy soils (DEC 2005w).	**Low**. Subject Site does not support preferred soils or vegetation types Previously recorded to the north near Edmonson Park.

Species	Status			Habitat	Likelihood of Occurrence
	EPBC Act[1]	TSC Act[2]	ROTAP[3]		
Pterostylis saxicola Sydney Plains Greenhood	E	E1	2E	Restricted to western Sydney between Freemans Reach in the north and Picton in the south (Hawkesbury/Nepean and Sydney Metropolitan Catchment) (DEC 2005 •). Most commonly found growing in small pockets of shallow soil in depressions on sandstone rock shelves above cliff lines. The vegetation communities above the shelves where Pterostylis saxicola occurs are sclerophyll forest or woodland on shale/sandstone transition soils or shale soils (DEC 2005 •). All species of Pterostylis are deciduous and die back to fleshy, rounded underground tuberoids. The time of emergence and withering has not been recorded for this species, however flowering occurs from October to December and may vary due to climatic conditions. The above ground parts of the plant whither and die following seed dispersal and the plant persists as a tuberoid until the next year (DEC 2005 •).	**Low**. Subject Site does not support preferred soils, specific habitat features or vegetation types Previously recorded to the east in vegetation of the Georges River.
Pultenaea aristata Prickly Bush-pea	V	V	2V	Restricted to the Woronora Plateau, a small area between Helensburgh, south of Sydney, and Mt Keira above Wollongong. The species occurs in either dry sclerophyll woodland or wet heath on sandstone. Flowering has been recorded in winter and spring (DEC 2005x).	**Low.** Subject Site does not support preferred soils or vegetation types.
Pultenaea parviflora	V	E1	2E	*Pultenaea parviflora* is endemic to the Cumberland Plain, with a core distribution from Windsor to Penrith and east to Dean Park. Outlier populations are recorded from Kemps Creek and Wilberforce. *P. parviflora* may be locally abundant, particularly within scrubby/dry heath areas within Castlereagh Ironbark Forest and Shale Gravel Transition Forest on tertiary alluvium or laterised clays and in transitional areas where these communities adjoin Castlereagh Scribbly Gum Woodland (NPWS 2002g). Often found in association with other threatened species such as *Dillwynia tenuifolia*, *Dodonaea falcat*a, *Grevillea juniperina*, *Micromyrtus minutiflora*, *Persoonia nutans* and *Styphelia laeta*. Flowering may occur between August and November depending on environmental conditions (DEC 2005y).	**Low.** Subject Site does not support preferred soils, or vegetation types Previously recorded to the north at Kemps Creek.
Pultenaea pedunculata Matted Bush-pea	-	E1	-	Restricted to the Cumberland Plain and near Merimbula where it grows in dry sclerophyll forest and disturbed sites (Harden 2002). In western Sydney it occurs in three locations: within industrial and residential areas at Villawood and Prestons, and north-west of Appin between the Nepean River and Devines Tunnel No. 2(NPWS 2002h). Associated with Hawkesbury/Nepean, Southern Rivers and Sydney Metropolitan Catchment areas. It occurs in clay or sandy clay soils (Blacktown soil landscape) on Wianamatta shale, close to localised patches of Tertiary alluvium (Liverpool) or the shale/sandstone influence (west of Appin) (DEC 2005z). At all sites there is a lateritic influence in the soil with characteristic ironstone gravels present (DEC 2005z). This species is known to occur in remnants of Cooks River Clay Plain Scrub Forest (James *et al.* 1999).	**Low**. Subject Site does not support preferred soils. Previously recorded to the north at Prestons and south near Menangle.

Species	Status			Habitat	Likelihood of Occurrence
	EPBC Act[1]	TSC Act[2]	ROTAP[3]		
Syzygium paniculatum Magenta Lilly Pilly	V	V	3Ri	Subtropical and littoral rainforest on sandy soils or stabilised dunes near the sea (Harden 1991). Found only in NSW, in a narrow, linear coastal strip from Bulahdelah to Conjola State Forest. On the south coast the Magenta Lilly Pilly occurs on grey soils over sandstone, restricted mainly to remnant stands of littoral (coastal) rainforest. On the central coast Magenta Lilly Pilly occurs on gravels, sands, silts and clays in riverside gallery rainforests and remnant littoral rainforest communities (DEC 2005|). The species occurs in the following Catchment Management Authority Regions - Hunter/Central Rivers, Hawkesbury/Nepean, Sydney Metropolitan, and Southern Rivers.	**Low**. Subject Site does not support preferred soils or vegetation types.
Thesium australe Austral Toad-flax	V	V	3Vi	Found in very small to large populations scattered across eastern NSW, along the coast, and from the Northern to Southern Tablelands. *Thesium australe* is a root parasite that takes water and some nutrient from other plants, especially Kangaroo Grass (DEC 2005}). It is often found in damp sites in association with *Themeda australis*, but also found on other grass species at inland sites (G. Leonard pers. obs.). Occurs on clay soils in grassy woodlands or coastal headlands (James *et al.* 1999).	**Medium**. Although there is only one record to the south of the Surface Project Area at Camden Park *Themeda australis* is widely distributed and abundant throughout the Subject Site.
Thelymitra sp. Kangaloon	Z	-	-	*Thelymitra* sp. Kangaloon is a terrestrial orchid endemic to New South Wales, and is known from three locations near Robertson in the Southern Highlands. The swamp habitat in which the species occurs has an extent of occurrence of 300 km2 and an area of occupancy of 10 km2. The three swamps are Butlers Swamp, Stockyard Swamp and Wildes Meadow Swamp, and are all located above what is known as the Kangaloon aquifer. It flowers in late October and early November. The species grows amongst tall sedges and rushes in seasonally swampy sedgeland on grey silty clay loam at 600-700 m above sea level (Threatened Species Scientific Committee 2008).	**Low**. Subject Site does not support preferred soils, specific habitat features or vegetation types.

3.3 Fauna Habitats

The main fauna habitats within the Surface Project Area consist largely of partially structured regrowth woodland and well structured remnant woodland that correspond to the CPW outlined in Section 3.1. Other landscape scale fauna habitats present in the Surface Project Area are small to large constructed waterbodies and ephemeral drainage lines. The Subject Site incorporates these broad habitats primarily as portions of larger areas of habitat extending beyond the Subject Site. Finer scale habitat features include, hollow bearing trees, leaf litter, fallen logs, damp areas, soaks, buildings and agricultural debris which may occur within the main woodland habitat unit or as isolated occurrences in extensively cleared areas. Animal species may utilise some of these features wholly or partly, in conjunction with one another, or may depend entirely on one specific habitat type. These habitat features and species associations are discussed further below.

3.3.1 Woodlands

Woodlands correspond with CPW, RFEFCF, MSW and WSDR as outlined in Section 3.1 and mapped in Figures 6. Remnant and regrowth woodlands provide a wide range of foraging and sheltering habitat for vertebrate fauna. Myrtaceous trees dominate the upper canopy in these areas and supply direct (foliage, nectar, exudates) and indirect food (arthropods) for a range of vertebrates through all seasons. Species such as *Eucalyptus tereticornis* and *Eucalyptus moluccana* may provide foraging and feeding resources for common fauna such Grey Butcherbird *Cracticus torquatus,* Black-faced Cuckoo-shrike *Coracina novaehollandiae,* Yellow-faced Honeyeater *Lichenostomus chrysops,* Noisy Miner *Manorina melanocephala,* White-striped Freetail-bat *Tadarida australis* and Little Forest Bat *Vespadelus vulturnus* and threatened fauna such as Speckled Warbler *Chthonicola sagittata*, *Climacteris picumnus victoriae,* Swift Parrot *Lathamus discolour,* Hooded Robin (south-eastern form) *Melanodryas cucullata cucullata,* Eastern False Pipistrelle *Falsistrellus tasmaniensis* and Grey-headed Flying-fox *Pteropus poliocephalus.*

Thirty-six hollow-bearing trees (including stags, mature and/or senescent trees) were recorded within the Subject Site and were commonly observed in the wider Surface Project Area. Small to large hollows provide nesting and roosting habitat for a range of birds, microbats and arboreal mammal species. Common non threatened fauna that would utilise this resource include Laughing Kookaburra *Dacelo novaeguineae,* Galah *Eolophus roseicapillus,* Common Ringtail Possum *Pseudocheirus peregrinus* and Eastern Broad-nosed Bat *Scotorepens orion*. Locally recorded threatened species requiring tree-hollows as breeding resources include the Gang-gang Cockatoo *Callocephalon fimbriatum* and Greater Broad-nosed Bat *Scoteanax rueppellii*.

Woodland habitat within the Subject Site varies from Poor condition in small isolated patches which have suffered from weed invasion, edge effects and historical land clearing and Moderate to Good condition in larger patches that have a natural structure and broad range of foraging, sheltering, nesting and roosting resources.

3.3.2 Shrubland

Shrubland corresponds with the vegetation community of the same name, as outlined in Section 3.1 and mapped in Figures 6. Shrubland provides foraging and sheltering habitat for limited range of vertebrate fauna. Dense to sparse thickets dominated by native shrubs such as *Acacia* spp. and *Bursaria spinosa* ssp. *spinosa* are a source of food resources such as foliage, nectar, pollen and associated food including invertebrates which are likely to be favoured by small to medium sized bird species such as Brown Thornbill *Acanthiza pusilla*, White-browed Scrubwren *Sericornis frontalis*, Grey Fantail *Rhipidura albiscapa*, Eastern Yellow Robin *Eopsaltria australis* and Silvereye *Zosterops lateralis*. Good cover of native or mixed native and exotic grasses in the better quality Shrublands are likely to attract seed eating species such as Red-browed Finch *Neochmia temporalis* and Stubble Quail *Coturnix pectoralis*.

Shrublands dominated by native or exotic shrub and groundcover species may provide some foraging and sheltering habitat for common to abundant reptiles including Dark-flecked Garden Sunskink *Lampropholis delicata*, Red-bellied Black Snake *Pseudechis porphyriacus* and Eastern Brown Snake *Pseudonaja textilis*. In view of the condition of the broader landscape in which the Shrubland habitat occurs it is likely to utilised by a very narrow range of mammals including native and introduced species such as European Rabbit *Oryctolagus cuniculus* and *Pseudocheirus peregrinus* Common Ringtail Possum with microchriopteran bats such as Gould's Wattled Bat *Chalinolobus gouldii* and Chocolate Wattled Bat *Chalinolobus morio* potentially extending forging to these areas from more suitable adjoin Woodland habitats.

3.3.3 Cleared Areas

Cleared areas correspond with Closed Grassland as outlined in Section 3.1 and mapped in Figures 6. The majority of the Surface Project Area has been previously cleared or disturbed for agriculture and peri-urban development. Despite these activities some native species still occur within disturbed vegetation and microhabitat components of these areas. Generally these areas would provide few habitat opportunities for native fauna. Species more likely to inhabit these areas include introduced and domestic animals and native species tolerant of disturbance or favouring edge/ecotone habitat.

Cleared areas are considered to be in Poor condition, with the ground flora containing a low number of indigenous species; fragmented vegetation communities; ground, log and litter layer highly disturbed; and few resources available for native fauna.

3.3.4 Waterbodies (Farm Dams, Drainage lines and Upper Canal)

Dams are scattered throughout the Surface Project Area including several larger ones. Generally these waterbodies fit into of the following two categories.

- Dams that provide a range of aquatic and semi-aquatic fauna habitat resources and features including shallow to deep water, good cover of fringing terrestrial and macrophyte vegetation, floating attached vegetation and with a low level of disturbance.

- Dams that are regularly disturbed and used for agriculture practices such as livestock watering or water extraction. These waterbodies support a much narrower range of fauna habitat resources and features such as fringing vegetation and good water quality.

Less disturbed dams with a good range of habitat features, provide foraging, watering, sheltering and nesting habitat for a suite of native fauna that may include threatened species. Native fauna that may utilise this habitat type are likely to include Eastern Dwarf Tree Frog *Litoria fallax*, Common Eastern Froglet *Crinia signifera*, Sacred Kingfisher *Todiramphus sanctus*, Grey Teal *Anas gracilis*, Dusky Woodswallow *Artamus cyanopterus*, Eastern Rosella *Platycercus adscitus eximius*, Red-rumped Parrot *Psephotus haematonotus*, Dusky Moorhen *Gallinula tenebrosa*, Gould's Wattled Bat *Chalinolobus gouldii*, Eastern Water Dragon *Physignathus lesueurii*, Eastern Snake-necked Turtle *Chelodina longicollis*, Red-bellied Black Snake *Pseudechis porphyriacus*.

Dams in a disturbed condition, with a narrower range of fauna habitat features and resources also provide foraging, watering and some sheltering habitat, but for more mobile and disturbance tolerant native fauna such as, Brown-striped Frog *Limnodynastes peronii*, Pacific Black Duck *Anas superciliosa*, Dusky Woodswallow *Artamus cyanopterus* and White-faced Heron *Egretta novaehollandiae*.

Drainage lines in the Surface Project Area are mainly ephemeral and cleared of native vegetation with very few locations supporting regular flow or chains of ponds with standing water. The predominant habitat feature of these drainage lines is the provision of movement corridors, mainly through areas of partially or fully structured native vegetation or dense cover of exotic vegetation. Small to medium sized native birds and microchiropteran bat species are the fauna that are most likely to utilise these corridors on a regular basis.

The water flow of Upper Canal is unlikely to provide many fauna habitat resources. However, the habitat resources offered may be supplemented by patches of CPSW and CPW that are scattered along the length of the channel. When considered in conjunction with mosaics of isolated patches of other native vegetation stands in the Surface Project Area, the Upper Canal may provide stepping stone habitats within part of a broader movement corridor.

3.4 Fauna

A total of 61 fauna species were recorded in the Subject Site, including 54 locally occurring native species and seven introduced species (Table 4)

Table 4: Breakdown of Fauna Recorded in the Subject Site

	Native	Introduced
Birds	49	3
Mammals	0	4
Frogs	3	0
Reptiles	2	0

A list of fauna species recorded in the Subject Site is provided in Appendix 3.

All native fauna recorded in the field surveys are considered common and abundant within their range and distribution in NSW, the locality and broader Sydney Basin Bioregion.

3.4.1 Threatened Fauna Species

Fifty-eight threatened or migratory fauna species listed under the TSC Act and / or EPBC Act have either been previously recorded within or have potential habitat within 10km of the Surface Project Area (Table 5). Previous records for 51 threatened fauna species derived from the OEH Atlas of NSW Wildlife are illustrated in Figure 4.

No threatened fauna species were recorded within the Subject Site during the current surveys. One threatened fauna species (CPLS, listed as endangered under the TSC Act) was recorded outside the Subject Site during the most recent surveys adjacent to the CU22 GGL. This fauna assessment was undertaken primarily as a habitat based assessment. As outlined in Section 2.6.1, apart from opportunistic targeted searches for CPLS, active searching or trapping for animal species was not undertaken during this assessment as the majority of impacts to significant biodiversity values have been avoided and targeted surveys for threatened species were deemed to be not required.

Based on habitat assessments during the field surveys and the likelihood of occurrence criteria (Appendix 6) there is a medium to high likelihood of occurrence for:

- seven threatened bird species - Little Eagle *Hieraaetus morphnoides*, Bush Stone-curlew *Burhinus grallarius*, Speckled Warbler *Chthonicola sagittata*, Diamond Firetail *Stagonopleura guttata*, Hooded Robin *Melanodryas cucullata cucullata*, Little Lorikeet *Glossopsitta pusilla* and Swift Parrot *Lathamus discolour*;

- six threatened bat species - Eastern Freetail-bat *Mormopterus norfolkensis*, Grey-headed Flying-fox *Pteropus poliocephalus*, Eastern False Pipistrelle *Falsistrellus tasmaniensis*, Eastern Bentwing Bat *Miniopterus schreibersii oceanensis*, Large-footed Myotis *Myotis macropus* (adversus) and Greater Broad-nosed Bat *Scoteanax rueppellii*; and

- the threatened invertebrate, CPLS.

One EPBC Act migratory species Cattle Egret *Ardea ibis* was recorded in the field surveys and an additional four migratory bird species are considered to have a medium likelihood to occur in the Subject Site based on suitable habitat and other criteria.

Assessments according to Draft Guidelines (DEC & DPI 2005) and EPBC Significant Impact criteria (DEWHA 2009) have been undertaken and are presented in Appendix 4 and 5 and summarised in Table 8.

Table 5: Threatened and migratory fauna species previously recorded within 10km of the Surface Project Area and likelihood of occurrence.

Species	Status		Habitat	Likelihood of occurrence
	EPBC Act[4]	TSC Act[5]		
Amphibians				
Green and Golden Bell Frog *Litoria aurea*	V	E1	Most existing locations for the species occur as small, coastal, or near coastal populations, with records occurring between south of Grafton and northern VIC (NSW Government 2009). The species is found in marshes, dams and stream sides, particularly those containing bullrushes or spike rushes. Preferred habitat contains water bodies that are unshaded, are free of predatory fish, have a grassy area nearby and have diurnal sheltering sites nearby such as vegetation or rocks (NPWS 1999d; White and Pyke 1996), although the species has also been recorded from highly disturbed areas including disused industrial sites, brick pits, landfill areas and cleared land. Breeding usually occurs in summer. Tadpoles, which take approximately 6 weeks to develop, feed on algae and other vegetative matter. Adults eat insects as well as other frogs, including juveniles of their own species (DEC 2005k).	**Low**. Suitable habitat not present, unlikely to occur.
Littlejohn's Tree Frog *Litoria littlejohni*	V	V	Occurs in wet and dry sclerophyll forests associated with sandstone outcrops between 280 and 1000 m on the eastern slopes of the Great Dividing Range (Barker *et al.* 1995). Prefers rock flowing streams, but individuals have also been collected from semi-permanent dams with some emergent vegetation (Barker *et al.* 1995). Forages both in the tree canopy and on the ground, and has been observed sheltering under rocks on high exposed ridges during summer. It is not known from coastal habitats.	**Low**. Suitable habitat not present, unlikely to occur.
Giant Burrowing Frog *Heleioporus australiacus*	V	V	Prefers hanging swamps on sandstone shelves adjacent to perennial non-flooding creeks (Daly 1996; Recsei 1996). Can also occur within shale outcrops within sandstone formations. Known from wet and dry forests and montane woodland in the southern part range (Daly 1996). Individuals can be found around sandy creek banks or foraging along ridge-tops during or directly after heavy rain. Males often call from burrows located in sandy banks next to water (Barker *et al.* 1995). Spends the majority of its time in non-breeding habitat 20-250m from breeding sites (Penman *et al.* 2008).	**Low**. Suitable habitat not present, unlikely to occur.
Stuttering Frog *Mixophyes balbus*	V	E1	This species is usually associated with mountain streams, wet mountain forests and rainforests (Barker *et al.* 1995). It rarely moves very far from the banks of permanent forest streams, although it will forage on nearby forest floors. Eggs are deposited in leaf litter on the banks of streams and are washed into the water during heavy rains (Barker *et al.* 1995).	**Low**. Suitable habitat not present, unlikely to occur.
Southern Barred Frog *Mixophyes iteratus*	E	E1	Occurs along coast and ranges from south-eastern Queensland to the Hawkesbury River in NSW. Found in rainforests, moist eucalypt forest and nearby dry eucalypt forest, at elevations below 1000 m, often hiding in leaf litter near permanent fast-flowing streams. Females lay eggs onto moist creek banks or rocks above water level, from where tadpoles drop into the water when hatched. When not breeding the frogs disperse hundreds of metres away from streams (DEC 2005j).	**Low**. Suitable habitat not present, unlikely to occur.

[4] Listed on the EPBC Act as Critically Endangered (Z), Endangered (E), Vulnerable (V); Migratory (M)

[5] Listed on the TSC Act as Endangered (E1), Extinct (E4), Endangered Population (EP), or Vulnerable (V)

Species	Status		Habitat	Likelihood of occurrence
	EPBC Act[4]	TSC Act[5]		
Red-crowned Toadlet *Pseudophryne australis*		V	Occurs on wetter ridge tops and upper slopes of sandstone formations on which the predominant vegetation is dry open forests and heaths. This species typically breeds within small ephemeral creeks characterised by a series of shallow pools that feed into larger semi-perennial streams (Thumm and Mahony 1997). Breeds all year round (Thumm and Mahoney 2002).	**Low**. Suitable habitat not present, unlikely to occur.
Birds				
White-bellied Sea Eagle *Haliaeetus leucogaster*	M		A migratory species that is generally sedentary in Australia, although immature birds and some adults are dispersive (Marchant and Higgins 1993). Found in terrestrial and coastal wetlands; favouring deep freshwater swamps, lakes and reservoirs; shallow coastal lagoons and saltmarshes. It hunts over open terrestrial habitats. Feeds on birds, reptiles, fish, mammals, crustaceans and carrion. Roosts and makes nest in trees (Marchant and Higgins 1993).	**Low**. Species may occasionally fly over Subject Site.
Little Eagle *Hieraaetus morphnoides*		V	The Little Eagle is most abundant in lightly timbered areas with open areas nearby providing an abundance of prey species (NSW Scientific Committee 2009c). It has often been recorded foraging in grasslands, crops, treeless dune fields, and recently logged areas. The Little Eagle nests in tall living trees within farmland, woodland and forests (Marchant and Higgins 1993).	**Medium.** Suitable habitat present and recent records are present surrounding Subject Site
Square-tailed Kite *Lophoictinia isura*		V	Typically inhabits coastal forested and wooded lands of tropical and temperate Australia (Marchant and Higgins 1993). In NSW it is often associated with ridge and gully forests dominated by Eucalyptus longifolia, Corymbia maculata, E. elata, or E. smithii (NPWS 1999g). Individuals appear to occupy large hunting ranges of more than 100 km2. They require large living trees for breeding, particularly near water with surrounding woodland /forest close by for foraging habitat. Nest sites are generally located along or near watercourses, in a tree fork or on large horizontal limbs (Marchant and Higgins 1993).	**Low**. Species may occasionally fly over Not considered to be core breeding or foraging habitat.
Spotted Harrier *Circus assimilis*		V	The Spotted Harrier is found throughout Australia but rarely in densely forested and wooded habitat of the escarpment and coast (NSW Scientific Committee 2010). Preferred habitat consists of open and wooded country with grassland nearby for hunting. Habitat types include open grasslands, acacia and mallee remnants, spinifex, open shrublands, saltbush, very open woodlands, crops and similar low vegetation (NSW Scientific Committee 2010). The Spotted Harrier is more common in drier inland areas, nomadic part migratory and dispersive, with movements linked to the abundance of prey species. Nesting occurs in open or remnant woodland and unlike other harriers, the Spotted Harrier nests in trees (Marchant and Higgins 1993).	**Low**. Species may occasionally fly over Not considered to be core breeding or foraging habitat.
Blue-billed Duck *Oxyura australis*		V	Almost wholly aquatic, preferring deep water in large, permanent wetlands with an abundant aquatic flora (Marchant and Higgins 1990).	**Low**. No suitable habitat present within the Subject Site.
Freckled Duck *Stictonetta naevosa*		V	The freckled duck breeds in permanent fresh swamps that are heavily vegetated. Found in fresh or salty permanent open lakes, especially during drought. Often seen in groups on fallen trees and sand spits (Simpson and Day 1996).	**Low**. No suitable habitat present within the Subject Site.
Fork-tailed Swift *Apus pacificus*	M		Almost exclusively aerial (foraging and roosting). Breed in Asia (Higgins 1999).	**Low**. Species may occasionally fly over Subject Site.

Species	Status		Habitat	Likelihood of occurrence
	EPBC Act[4]	TSC Act[5]		
White-throated Needletail *Hirundapus caudacutus*	M		An aerial species found in feeding concentrations over cities, hilltops and timbered ranges. Breed in Asia (Pizzey and Knight 1997).	**Low.** Species may occasionally fly over Subject Site.
Great Egret *Ardea alba*	M		Terrestrial wetlands, estuarine and littoral habitats and moist grasslands. Inland, prefer permanent waterbodies on floodplains; shallows of deep permanent lakes (either open or vegetated), semi-permanent swamps with tall emergent vegetation and herb dominated seasonal swamps with abundant aquatic flora. Also regularly use saline habitats including mangrove forests, estuarine mudflats, saltmarshes, bare saltpans, shallows of salt lakes, salt fields and offshore reefs. Breeding requires wetlands with fringing trees in which to build nests including mangrove forest, freshwater lakes or swamps and rivers (Marchant and Higgins 1990).	**Low**. Species may occasionally fly over Subject Site.
Cattle Egret *Ardea ibis*	M		Occurs in tropical and temperate grasslands, wooded lands and terrestrial wetlands (Marchant and Higgins 1990).	**High**. Species observed during field surveys.
Bush Stone-curlew *Burhinus grallarius*		E1	Lightly timbered open forest and woodland, or partly cleared farmland with remnants of woodland, with a ground cover of short sparse grass and few or no shrubs where fallen branches and leaf litter are present (Marchant and Higgins 1993).	**Medium**. Suitable habitat present and recent records are present surrounding Subject Site.
Gang-gang Cockatoo *Callocephalon fimbriatum*		V	In summer, occupies tall montane forests and woodlands, particularly in heavily timbered and mature wet sclerophyll forests (Higgins 1999). Also occur in subalpine Snow Gum woodland and occasionally in temperate or regenerating forest (Forshaw and Cooper 1981). In winter, occurs at lower altitudes in drier, more open eucalypt forests and woodlands, particularly in box-ironbark assemblages, or in dry forest in coastal areas (Shields and Crome 1992). It requires tree hollows in which to breed (Gibbons and Lindenmayer 1997).	**Low**. Not considered to be core foraging or breeding habitat.
Glossy Black-cockatoo *Calyptorhynchus lathami*		V	Inhabits forest with low nutrients, characteristically with key Allocasuarina species. Tends to prefer drier forest types (NPWS 1999c). Often confined to remnant patches in hills and gullies. Breed in hollows stumps or limbs, either living or dead (Higgins 1999).	**Low.** Not considered to be core breeding habitat.
Black-necked Stork *Ephippiorhynchus asiaticus*		E1	Found in swamps, mangroves and mudflats. Can also occur in dry floodplains and irrigated lands and occasionally forages in open grassy woodland. Nests in live or dead trees usually near water (Pizzey and Knight 1997).	**Low**. No suitable habitat present within the Subject Site.
Brown Treecreeper *Climacteris picumnus victoriae*		V	Lives in eucalypt woodlands, especially areas of relatively flat open woodland typically lacking a dense shrub layer, with short grass or bare ground and with fallen logs or dead trees present (Traill and Duncan 2000).	**Low**. Not considered to be core foraging or breeding habitat

Species	Status		Habitat	Likelihood of occurrence
	EPBC Act[4]	TSC Act[5]		
Black-faced Monarch *Monarcha melanopsis*	M		A migratory species found during the breeding season in damp gullies in temperate rainforests. Disperses after breeding into more open woodland (Pizzey and Knight 1997).	**Medium.** Some nearby records outside Subject Site.
Satin Flycatcher *Myiagra cyanoleuca*	M		Migratory species that occurs in coastal forests, woodlands and scrubs during migration. Breeds in heavily vegetated gullies (Pizzey and Knight 1997).	**Medium**. Some nearby records outside Surface Project Area.
Rufous Fantail *Rhipidura rufifrons*	M		Migratory species that prefers dense, moist undergrowth of tropical rainforests and scrubs. During migration it can stray into gardens and more open areas (Pizzey and Knight 1997).	**Low**. No suitable habitat. Some nearby records outside Surface Project Area, likely to be vagrants.
Regent Honeyeater *Anthochaera phrygia*	E	E1	A semi-nomadic species occurring in temperate eucalypt woodlands and open forests. Most records are from box-ironbark eucalypt forest associations and wet lowland coastal forests (NPWS 1999e; Pizzey and Knight 1997). Key eucalypt species include Mugga Ironbark, Yellow Box, Blakely's Red Gum, White Box and Swamp Mahogany. Also utilises : *E. microcarpa, E. punctata, E. polyanthemos, E. mollucana, Corymbia robusta, E. crebra, E. caleyi, C. maculata, E.mckieana, E. macrorhyncha, E. laevopinea,* and *Angophora floribunda*. Nectar and fruit from the mistletoes *Amyema miquelii, A. pendula, A. cambagei* are also eaten during the breeding season (DEC 2005{). Regent Honeyeaters usually nest in horizontal branches or forks in tall mature eucalypts and Sheoaks. Also nest in mistletoe haustoria. An open cup-shaped nest is constructed of bark, grass, twigs and wool by the female (DEC 2005{).	**Low**. Not considered to be core foraging or breeding habitat.
White-fronted Chat *Epthianura albifrons*		V	The White-fronted Chat occupies foothills and lowlands below 1000 m above sea level. In NSW it occurs mostly in the southern half of the state, occurring in damp open habitats along the coast, and near waterways in the western part of the state. The White-fronted Chat is found in damp open habitats, particularly wetlands containing saltmarsh areas that are bordered by open grasslands or lightly timbered lands. Along the coastline, they are found in estuarine and marshy grounds with vegetation less than 1 m tall. The species is also observed in open grasslands and sometimes in low shrubs bordering wetland areas. Inland, the species is often observed in open grassy plains, saltlakes and saltpans that are along the margins of rivers and waterways. In Victoria White-fronted Chats have been observed breeding from late July through to early March. Nests are built in low vegetation and in the Sydney region nests have also been observed in low isolated mangroves. An Endangered Population occurs in the Sydney Metropolitan CMA area, at Newington Nature Reserve near Homebush and at Towra Point Nature Reserve.	**Low.** Not considered to be core foraging or breeding habitat, unlikely to occur

Species	Status		Habitat	Likelihood of occurrence
	EPBC Act[4]	TSC Act[5]		
Melithreptus gularis gularis		V	Found mostly in open forests and woodlands dominated by box and ironbark eucalypts (Higgins *et al.* 2001). It is rarely recorded east of the Great Dividing Range (Higgins *et al.* 2001).	**Low**. Not considered to be core foraging or breeding habitat, unlikely to occur
Black-chinned Honeyeater *Merops ornatus*	M		Usually occurs in open or lightly timbered areas, often near water. Nest in embankments, including banks of creeks and rivers, in sand dunes, in quarries and in roadside cuttings. Breeding occurs from November to January. It has complex migratory movements in Australia. NSW populations migrate north for winter (Higgins 1999).	**Low**. Not considered to be core foraging or breeding habitat. Unlikely to be present.
Speckled Warbler *Chthonicola sagittata*		V	This species occurs in eucalypt and cypress woodlands on the hills and tablelands of the Great Dividing Range. They prefer woodlands with a grassy understorey, often on ridges or gullies (Blakers *et al.* 1984; NSW Scientific Committee 2008a). The species is sedentary, living in pairs or trios and nests on the ground in grass tussocks, dense litter and fallen branches. They forage on the ground and in the understorey for arthropods and seeds (Blakers *et al.* 1984; NSW Scientific Committee 2008a). Home ranges vary from 6-12 hectares (NSW Scientific Committee 2008a).	**Medium**. Some records near the Surface Project Area.
Diamond Firetail *Stagonopleura guttata*		V	Found in a range of habitat types including open eucalypt forest, mallee and acacia scrubs (Pizzey and Knight 1997). Often occur in vegetation along watercourses (Higgins *et al.* 2006).	**Medium**. Suitable habitat present and nearby records present near the Surface Project Area.
Scarlet Robin *Petroica boodang*		V	During the breeding season the Scarlet Robin is found in eucalypt forests and temperate woodlands, often on ridges and slopes. During autumn and winter it moves to more open and cleared areas. It has dispersive or locally migratory seasonal movements. The Scarlet Robin forages amongst logs and woody debris for insects which make up the majority of its diet (NSW Scientific Committee 2009d). The nest is an open cup of plant fibres and cobwebs, sited in the fork of a tree (often a dead branch in a live tree, or in a dead tree or shrub) which is usually more than 2 m above the ground (NSW Scientific Committee 2009d). It is conspicuous in open and suburban habitats (NSW Scientific Committee 2009d).	**Low.** Not considered to be preferable foraging or breeding habitat, may occur seasonally in autumn and winter.
Flame Robin *Petroica phoenicea*		V	Flame Robins are found in a broad coastal band from southern Queensland to just west of the South Australian border (Australian Museum 2009). The species is also found in Tasmania. The preferred habitat in summer includes moist eucalyptus forests and open woodlands, whilst in winter prefers open woodlands and farmlands (NSW Scientific Committee 2009b). It is considered migratory. The Flame Robin breeds from about August to January (NSW Scientific Committee 2009b).	**Low.** Not considered to be preferable foraging or breeding habitat, may occur seasonally in autumn and winter.
Hooded Robin *Melanodryas cucullata cucullata*		V	This species lives in a wide range of temperate woodland habitats, and a range of woodlands and shrublands in semi-arid areas (Traill and Duncan 2000).	**Medium**. Suitable habitat present and records present near the Surface Project Area.
Little Lorikeet *Glossopsitta*		V	Distributed in forests and woodlands from the coast to the western slopes of the Great Dividing Range in NSW, extending westwards to the vicinity of Albury, Parkes, Dubbo and Narrabri. Mostly occur in	**Medium**. Suitable habitat present and

Species	Status		Habitat	Likelihood of occurrence
	EPBC Act[4]	TSC Act[5]		
pusilla			dry, open eucalypt forests and woodlands. They feed primarily on nectar and pollen in the tree canopy. Nest hollows are located at heights of between 2 m and 15 m, mostly in living, smooth-barked eucalypts. Most breeding records come from the western slopes (NSW Scientific Committee 2008b).	records present near the Surface Project Area.
Swift Parrot *Lathamus discolor*	E	E1	The Swift Parrot occurs in woodlands and forests of NSW from May to August, where it feeds on eucalypt nectar, pollen and associated insects (Forshaw and Cooper 1981). The Swift Parrot is dependent on flowering resources across a wide range of habitats in its wintering grounds in NSW (Shields and Crome 1992). This species is migratory, breeding in Tasmania and also nomadic, moving about in response to changing food availability (Pizzey and Knight 1997).	**Medium**. Suitable foraging habitat present and records present near the Surface Project Area.
Australian Painted Snipe *Rostratula australis*	VM	E1	Usually found in shallow inland wetlands including farm dams, lakes, rice crops, swamps and waterlogged grassland. They prefer freshwater wetlands, ephemeral or permanent, although they have been recorded in brackish waters (Marchant and Higgins 1993).	**Low**. Not considered to be core foraging or breeding habitat. Unlikely to be present.
Latham's Snipe *Gallinago hardwickii*	M		Typically found on wet soft ground or shallow water with good cover of tussocks. Often found in wet paddocks, seepage areas below dams (Pizzey and Knight 1997).	**Medium**. Nearby records and may use some habitats within Subject Site.
Common Greenshank *Tringa nebularia*	M		Widely distributed throughout a range of inland wetlands and sheltered coastal habitats. Occurs in habitats with varying salinity (Higgins and Davies 1996).	**Low.** Not considered to be core foraging or breeding habitat. Unlikely to be present.
Barking Owl *Ninox connivens*		V	Generally found in open forests, woodlands, swamp woodlands and dense scrub. Can also be found in the foothills and timber along watercourses in otherwise open country (Pizzey and Knight 1997). Territories range from 30 to 200 ha (DEC 2005b).	**Low.** Not considered to be core foraging or breeding habitat.
Powerful Owl *Ninox strenua*		V	Occupies wet and dry eucalypt forests and rainforests. Can occupy both un-logged and lightly logged forests as well as undisturbed forests where it usually roosts on the limbs of dense trees in gully areas (Debus and Chafer 1994b; Debus and Chafer 1994a). Large mature trees with hollows at least 0.5 m deep are required for nesting (Garnett 1992). Tree hollows are particularly important for the Powerful Owl because a large proportion of the diet is made up of hollow-dependent arboreal marsupials (Gibbons and Lindenmayer 1997). Nest trees for this species are usually emergent with a diameter at breast height of at least 100 cm (Gibbons and Lindenmayer 1997). Has a large home range of between 450 and 1450 hectares (DEC 2005v).	**Low**. Not considered to be core foraging or breeding habitat.
Cumberland Plain Land Snail *Meridolum corneovirens*		E1	Most likely restricted to Cumberland Plain, Castlereagh Woodlands and boundaries between River-flat Forest and Cumberland Plain Woodland. It is normally found beneath logs, debris and amongst accumulated leaf and bark particularly at the base of trees. May also use soil cracks for refuge and is capable of burying up to 10 cm into the soil profile (NPWS 1999b).	**High**. Previously recorded from a number of locations within the Surface Project Area.
Mammals				
Mammals				

Species	Status		Habitat	Likelihood of occurrence
	EPBC Act[4]	TSC Act[5]		
Eastern Pygmy-possum *Cercartetus nanus*		V	Inhabits rainforest through to sclerophyll forest and tree heath. Banksias and myrtaceous shrubs and trees are a favoured food source. Will often nest in tree hollows, but can also construct its own nest (Turner and Ward 1995). Because of its small size it is able to utilise a range of hollow sizes including very small hollows (Gibbons and Lindenmayer 1997). Individuals will use a number of different hollows and an individual has been recorded using up to 9 nest sites within a 0.5ha area over a 5 month period (Ward 1990).	**Low**. Not considered to be core foraging or breeding habitat. Unlikely to be present.
Spotted-tailed Quoll *Dasyurus maculatus maculatus*	E	V	Occurs along the east coast of Australia and the Great Dividing Range (Belcher *et al.* 2008). Uses a range of habitats including sclerophyll forests and woodlands, coastal heathlands and rainforests (Dickman and Read 1992). Occasional sightings have been made in open country, grazing lands, rocky outcrops and other treeless areas (NPWS 1999k). Habitat requirements include suitable den sites, including hollow logs, rock crevices and caves, an abundance of food and an area of intact vegetation in which to forage (Edgar and Belcher 1995) . 70% of the diet is medium-sized mammals, and also feeds on invertebrates, reptiles and birds. Individuals require large areas of relatively intact vegetation through which to forage (NPWS 1999f). The home range of a female is between 180 – 1000 ha, while males have larger home ranges of between 2000 – 5000 ha. Breeding occurs from May to August (Belcher *et al.* 2008).	**Low**. Not considered to be core foraging or breeding habitat. Unlikely to be present.
Yellow-bellied Sheathtail Bat *Saccolaimus flaviventris*		V	Found throughout NSW. They have been reported from southern Australia between January and April. Reported from a wide range of habitats throughout eastern and northern Australia, including wet and dry sclerophyll forest, open woodland, acacia shrubland, mallee, grasslands and desert. They roost in tree hollows in colonies of up to 30 (but more usually two to six) and have also been observed roosting in animal burrows, abandoned Sugar Glider nests, cracks in dry clay, hanging from buildings and under slabs of rock. It is high-flying, making it difficult to detect. It forages above the canopy of eucalypt forests, but comes lower to the ground in mallee or open country (Churchill 2008; Richards 2008)	**Low**. Not considered to be core foraging or breeding habitat.
Brush-tailed Rock Wallaby *Petrogale penicillata*	V	E1	Occurs along the Great Dividing Range south to the Shoalhaven, and also occurs in the Warrumbungles and Mt Kaputar. Habitats range from rainforest to open woodland. It is found in areas with numerous ledges, caves and crevices, particularly where these have a northerly aspect. Individuals defend a specific rock shelter, emerging in the evening to forage on grasses and forbs, as well as browse in drier months. Home sizes range from 2-30 ha (Eldridge and Close 1995).	**Low**. Not considered to be core foraging or breeding habitat.
Eastern Freetail-bat *Mormopterus norfolkensis*		V	Distribution extends east of the Great Dividing Range from southern Queensland to south of Sydney. Most records are from dry eucalypt forests and woodland. Individuals tend to forage in natural and artificial openings in forests, although it has also been caught foraging low over a rocky river within rainforest and wet sclerophyll forest habitats. The species generally roosts in hollow spouts of large mature eucalypts (including paddock trees), although individuals have been recorded roosting in the roof of a hut, in wall cavities, and under metal caps of telegraph poles. Foraging generally occurs within a few kilometres of roosting sites (Churchill 2008; Hoye *et al.* 2008).	**High**. Previously recorded within the Surface Project Area.

Species	Status		Habitat	Likelihood of occurrence
	EPBC Act[4]	TSC Act[5]		
Southern Brown Bandicoot (eastern) *Isoodon obesulus obesulus*	E	E1	Prefers sandy soils with scrubby vegetation and/or areas with low ground cover that are burn from time to time (Braithwaite 1995). A mosaic of post fire vegetation is important for this species (Maxwell *et al.* 1996).	**Low**. Not considered to be core foraging or breeding habitat.
Squirrel Glider *Petaurus norfolcensis*		V	Sparsely distributed along the east coast and immediate inland areas as far west as Coonabarabran (DEC 1999) in the northern part of the state and as far west as Tocumwal along the southern border of the state (NSW Government 2009) . Generally occurs in dry sclerophyll forests and woodlands but is absent from dense coastal ranges in the southern part of its range. Require abundant hollow bearing trees and a mix of eucalypts, banksias and acacias (Van der Ree and Suckling 2008). Within a suitable vegetation community at least one species should flower heavily in winter and one species of eucalypt should be smooth barked (Menkhorst *et al.* 1988). They live in family groups of 2-10 individuals and maintain home ranges of 0.65 and 10.5 hectares, varying according to habitat quality and food resource availability (Quin 1995; Goldingay and Jackson 2004).	**Low**. Not considered to be core foraging or breeding habitat.
Koala *Phascolarctos cinereus*		V	In NSW the Koala mainly occurs on the central and north coasts with some populations in the western region (DEC 2005o). Koalas feed almost exclusively on eucalypt foliage, and their preferences vary regionally (Martin *et al.* 2008). Primary feed trees include Eucalyptus robusta, E. tereticornis, E. punctata, E. haemostoma and E. signata (DoP 1995). They are solitary with varying home ranges. In high quality habitat home ranges may be 1-2 ha and overlap, while in semi-arid country they are usually discrete and around 100ha (Martin *et al.* 2008).	**Low**. Numerous records to the east of the Surface Project Area in more intact woodland. Not considered to be core foraging habitat.
Long-nosed Potoroo *Potorous tridactylus*	V	V	Occurs from Queensland to Victoria, normally within 50km of the coast (Claridge *et al.* 2007). Inhabits coastal heath and wet and dry sclerophyll forests. Generally found in areas with rainfall greater than 760 mm. Requires relatively thick ground cover where the soil is light and sandy. Known to eat fungi, arthropods, fleshy fruit, seeds and plant tissue. It is solitary and sedentary, buts tends to aggregate in small groups. It has two breeding seasons, one in late winter-early spring and the other in late summer. (Johnston 2008). This species appears to benefit from a lack of recent disturbance (Claridge *et al.* 2007).	**Low**. Not considered to be core foraging or breeding habitat.
Grey-headed Flying-fox *Pteropus poliocephalus*	V	V	Occurs along the NSW coast, extending further inland in the north. This species is a canopy-feeding frugivore and nectarivore of rainforests, open forests, woodlands, melaleuca swamps and banksia woodlands. Roosts in large colonies (camps), commonly in dense riparian vegetation. Bats commute daily to foraging areas, usually within 15 km of the day roost (Tidemann 1995) although some individuals may travel up to 70 km (Augee and Ford 1999).	**High.** Records of this species are within the Surface Project Area.

Species	Status		Habitat	Likelihood of occurrence
	EPBC Act[4]	TSC Act[5]		
Large-eared Pied Bat *Chalinolobus dwyeri*	V	V	Occurs from the Queensland border to Ulladulla, with largest numbers from the sandstone escarpment country in the Sydney Basin and Hunter Valley (van dyck and Strahan 2008). Primarily found in dry sclerophyll forests and woodlands, but also found in rainforest fringes and subalpine woodlands (Churchill 2008; Hoye and Schulz 2008). Forages on small, flying insects below the forest canopy. Roosts in colonies of between three and 80 in caves, Fairy Martin nests and mines, and beneath rock overhangs, but usually less than 10 individuals. Likely that it hibernates during the cooler months (Churchill 2008). The only known existing maternity roost is in a sandstone cave near Coonabarabran (Pennay 2008).	**Low.** Not considered to be core foraging or breeding habitat.
Eastern False Pipistrelle *Falsistrellus tasmaniensis*		V	Distribution extending east of the Great Dividing Range throughout the coastal regions of NSW, from the Queensland border to the Victorian border. Prefers wet sclerophyll and coastal mallee, preferring wet forests with a dense understorey but being found in open forests at lower altitudes (Churchill 2008). Roosts in tree hollows and sometimes in buildings and caves, in colonies of between 3 and 80. Often change roosts every night. Has a large foraging range, up to 136 ha (Churchill 2008; Law *et al.* 2008). Records show movements of up to 12 km between roosting and foraging sites (Menkhorst and Lumsden 1995).	**High.** Previously recorded within the Surface Project Area and may use the habitat types present on occasion.
Eastern Bentwing Bat *Miniopterus schreibersii oceanensis*		V	Occurs from Victoria to Queensland, on both sides of the Great Dividing Range. Forms large maternity roosts (up to 100,000 individuals) in caves and mines in spring and summer. Individuals may fly several hundred kilometres to their wintering sites, where they roost in caves, culverts, buildings, and bridges. They occur in a broad range of habitats including rainforest, wet and dry sclerophyll forest, paperbark forest and open grasslands. Has a fast, direct flight and forages for flying insects (particularly moths) above the tree canopy and along waterways (Churchill 2008; Hoye and Hall 2008).	**High** Previously recorded within the Surface Project Area and may use the habitat types present on occasion for foraging only.
Large-footed Myotis *Myotis macropus (adversus)*		V	Scattered, mainly coastal distribution extending to South Australia along the Murray River. Roosts in caves, mines or tunnels, under bridges, in buildings, tree hollows, and even in dense foliage. Colonies occur close to water bodies, ranging from rainforest streams to large lakes and reservoirs. They catch aquatic insects and small fish with their large hind claws, and also catch flying insects (Richards *et al.* 2008).	**High**. Previously recorded within the Surface Project Area and may use foraging and roosting habitats on occasion.
Greater Broad-nosed Bat *Scoteanax rueppellii*		V	Occurs along the Great Dividing Range, up to 1200m, and in coastal areas. Occurs in woodland and rainforest, but prefers open habitats or natural or human-made openings in wetter forests. Often hunts along creeks or river corridors. Flies slowly and directly at a height of 30m or so to catch beetles and other large, flying insects. Also known to eat other bats and spiders. Roosts in hollow tree trunks and branches (Churchill 2008; Richards *et al.* 2008).	**High**. Previously recorded within the Surface Project Area and may use foraging and roosting habitats on occasion.
Reptiles				
Broad-headed Snake *Hoplocephalus bungaroides*	V	E1	Mainly occurs in association with communities occurring on Triassic sandstone within the Sydney Basin. Typically found among exposed sandstone outcrops with vegetation types ranging from woodland to heath. Within these habitats they generally use rock crevices and exfoliating rock during the cooler months and tree hollows during summer (Webb 1996; Webb and Shine 1998).	**Low**. Not considered to be core foraging or breeding habitat.

Species	Status		Habitat	Likelihood of occurrence
	EPBC Act[4]	TSC Act[5]		
Rosenberg's Goanna *Varanus rosenbergi*		V	This species is a Hawkesbury/Narrabeen sandstone outcrop specialist (Wellington and Wells 1985). Occurs in coastal heaths, humid woodlands and both wet and dry sclerophyll forests (Cogger 1992).	**Low**. Not considered to be core foraging or breeding habitat.

3.5 Groundwater Dependent Ecosystems

GDEs are defined as *'Ecosystems which have their species composition and natural ecological processes wholly or partially determined by groundwater'* (NOW 2012).

GDEs are dependent upon groundwater to varying degrees, from non-dependent to facultative to entirely dependent. Non-dependent ecosystems occur mostly in recharge areas and have no connection with groundwater. Facultative GDEs require groundwater in some areas and not others. Entirely dependent GDEs are restricted to areas of groundwater discharge or within aquifers (NOW 2012). Groundwater occurs in many different aquifers and groundwater systems from near-surface perched and unconfined aquifers (that maybe connected to GDEs) to deep confined aquifers and water bearing zones (that are rarely connected to GDEs). When discussing GDEs and any groundwater dependence, it is important to identify the aquifer or groundwater system from which that water is likely to be derived. At any one location, not all groundwater systems will be supporting an ecosystem that may have been determined to be a GDE or have a high potential of being a GDE.

The depth to the groundwater table is a key determinant of groundwater dependency, with groundwater dependency decreasing to minimal levels in areas where the groundwater table is greater than 10m (NOW 2012, Vol. 2 p.A5-21). The geology and groundwater flow characteristics are also important attributes to assess groundwater dependency. In the Northern Expansion Area, the shallowest groundwater system occurs within the Wianamatta Shales where perched water in the weathered bedrock and shallow unconfined aquifers in the shale are sometimes present. Locally these shallow systems may support ecosystems such as CPW during drought cycles, however conceptual groundwater flow models (PB, 2011) conclude there is no known connectivity with deeper (coal seam) water being zones and hence ecosystems in this area are extremely unlikely to have any groundwater dependency on these deeper systems.

As a part of the Groundwater Management Plan (AGL 2012) AGL has established three groundwater monitoring bores within the Sub-surface Project Area (one Wianamatta Shale locations and two Hawkesbury Sandstone locations). Initial data from these bores indicates that the maximum water table height recorded to date is between 32.5 m AHD and -8.0 m AHD or 40 m and 81 m below surface level (PB 2012b). The Nepean River in the south-western section of the Sub-surface Project Area sits at approximately 66 m AHD while the Georges River in the south-eastern section of the Sub-surface Project area is located at 58 m AHD. Therefore it is unlikely that vegetation communities within the Sub-surface Project Area are in hydraulic connection with these regional aquifers.

CPW is listed as a high probability GDE by NOW (2012) and is mapped as a GDE on the Atlas of Groundwater Dependant Ecosystems (BoM 2012). However no justification for the listing of CPW as a GDE is given. Based on flora assessments undertaken it is likely that the CPW present within the study area occasionally relies on shallow perched groundwater within the weathered rock profile. There is no hydraulic connectivity between shallow perched groundwater and groundwater found in the deep coal seam water bearing zones (PB, 2011) so it is most unlikely that CPW, as

well as other vegetation communities present within the Sub-surface Project Area have any reliance on deeper, regional groundwater systems.

The perched groundwater system does not occur everywhere in the landscape and is probably more pronounced in lower topographic areas where there are thicker weathered zones, and occasional colluvial/alluvial sediments present. Groundwater is replenished by rainfall and in some areas is ephemeral. This perched groundwater system is not considered at risk of impact as a result of dewatering associated with the Preferred Project.

Therefore we infer that the Sub-surface Project Area does not support any GDE's that are hydraulically connected with groundwater from deeper groundwater systems (including the coal seams that are targeted by this project).

3.6 Well Surface Locations

Details of the location, and flora and fauna values of the 11 WSLs are provided below in Table 6.

Table 6: Flora and fauna values of Well Surface Locations

Well Surface Locations			
Description	**Flora**	**Fauna**	**Plates – detail located in Description column for each WSL**
CU29 **Plate 5:** CU29 proposed WSL situated in open cleared paddock	WSL CU29 is dominated by closed grassland with a stand of *Bursaria spinosa* Shrubland on the slopes to the north of the alluvial flat and a small stand of RFEFCF to the south on the drainage line. Vegetation condition is assessed as Disturbed. No threatened flora species were recorded in the 200 m assessment envelope and due to the current and previous disturbances there is low likelihood for threatened flora.	WSL CU29 is dominated by cleared areas with areas of woodland, drainage lines and a waterbody consisting of a constructed dam. Fauna habitats are highly modified and assessed as Poor. Although some highly mobile threatened fauna such as birds and microchiropteran bats may forage over the survey area and adjacent areas there is a low likelihood for any threatened fauna.	
CU26 **Plate 6:** CU26 WSL location proposed in areas of open cleared paddock, facing north east.	WSL CU26 is dominated by a closed grassland with two stands of shrubland dominated by *Bursaria spinosa* in the west and an area of RFEFCF in the east. Vegetation condition is assessed as Disturbed. No threatened flora species were recorded in the 200 m assessment envelope and due to the current and previous disturbances there is low likelihood for threatened flora.	WSL CU26 is dominated by cleared areas with small stands of woodland. Fauna habitats are highly modified and assessed as Poor. Although some highly mobile threatened fauna such as birds and microchiropteran bats may forage over the survey and adjacent areas there is low likelihood for any threatened fauna.	

Well Surface Locations			
Description	**Flora**	**Fauna**	**Plates – detail located in Description column for each WSL**
CU22 **Plate 7:** Location of CU22 is proposed for the open cleared areas.	WSL CU22 consist largely of closed grassland with some scattered occurrences of *Bursaria spinosa*. Within the 200m assessment envelope there are two small stands of CPW (TSC Act). Two patches of Shrubland dominated by *Bursaria spinosa* are present in the south and south east of the WSL. An additional two patches of Shrubland dominated by *Olea europea* ssp *cuspidata* are located in the eastern sector of the survey envelope. CPW is in a moderate condition whilst the remaining plant communities are assessed as Disturbed to Poor. No threatened flora species were recorded in the 200m assessment envelope and due to the current and previous disturbances there is low likelihood for threatened flora.	WSL CU22 consist of a mix of cleared areas and woodland. A waterbody also provides fauna habitat. Fauna habitats are highly modified and mainly assessed as Poor with the larger patch of CPW in a Moderate condition. Although some highly mobile threatened fauna such as birds and microchiropteran bats may forage over the WSL and adjacent areas there is low likelihood for any threatened fauna species.	
CU31 **Plate 8:** CU31 WSL proposed in middle of close grassland at this WSL, facing north to CPSW.	WSL CU31 consists of a mix of closed grassland in disturbed areas, as well as CPW (TSC Act). Vegetation in the northeast and southern sectors of the WSL is characterised by *Eucalyptus tereticornis* with patches of *Bursaria spinosa* and mixed groundcover of native and exotic grasses and herbs. The patch in the northeast sector forms part of a larger patch of CPW extending beyond the Subject Site. CPW is in a Moderate condition. No threatened flora species were recorded in the 200m assessment envelope, and due to the current and previous disturbances there is low potential habitat for threatened flora in the areas of closed grassland.	WSL CU31 consists of a mix of cleared areas and woodland habitat. Fauna habitats in the CPW are in a Moderate condition. Areas of CPW provide potential habitat for CPLS, as well as roosting and nesting habitat for highly mobile threatened fauna species such as birds and microchiropteran bats.	

Well Surface Locations			
Description	**Flora**	**Fauna**	**Plates – detail located in Description column for each WSL**
CU14 **Plate 9:** CU14 WSL proposed in middle of open cleared paddock at this WSL, facing north.	WSL CU14 consists of closed grassland dominated by a mixture of exotic and native grasses and herbs such as *Themeda australis*, *Aristida ramosa*, *Paspalum dilatatum*, *Romulea rosea* and *Plantago lanceolata*. Vegetation condition is assessed as Disturbed. No threatened species or EEC's were recorded in the 200m assessment envelope, and due to the current and previous disturbances there is low likelihood for threatened flora.	Fauna habitat in WSL CU14 consists of cleared area. Fauna habitats are highly modified in the WSL and assessed as Poor. There is negligible likelihood for any threatened fauna.	
CU10 **Plate 10:** Location of CU10 WSL proposed in middle of open cleared paddock at this WSL, facing north.	WSL CU10 consists largely of closed grassland with a small patch of CPW (TSC Act) in the northern sector of the WSL. CPW includes a stand of *Eucalyptus tereticornis* with an understorey of *Olea europea* ssp. *cuspidate*.CPW within the WSL forms part of a larger patch extending north. In view of the previous and current landuse vegetation over the majority of the WSL is assessed as Disturbed. CPW within the WSL is in a moderate condition. No threatened species were recorded in the 200m assessment envelope and there is a low likelihood for threatened flora.	WSL CU10 consists largely of cleared areas with a small patch of woodland habitat in the northern sector. This area of woodland is connected to woodland habitat outside of the Subject Site. The majority of fauna habitat is highly simplified and assessed as Poor. Areas of woodland habitat area assessed as moderate condition due to their connectivity. Areas of CPW provide potential habitat for the CPLS, and roosting and nesting habitat for highly mobile threatened fauna species such as birds and microchiropteran bats. Negligible likelihood of threatened fauna in other areas.	

Well Surface Locations			
Description	**Flora**	**Fauna**	**Plates – detail located in Description column for each WSL**
CU06 **Plate 11:** CU06 WSL proposed in open cleared paddock in centre of photo, facing west.	WSL CU06 contains a mix of closed grassland, Shrubland and CPW (EPBC & TSC Act). CPW in the eastern sector of CU06 is contiguous with a larger stand of the community extending beyond the Subject Site. The canopy is dominated by *Eucalyptus tereticornis* and *Eucalyptus moluccana* with regrowth canopy species in the midstorey and *Melaleuca styphelioides* present in the gully. The groundcover is in variable condition ranging from good on the upper slopes to poor in the gully. There is a patch of shrubland dominated by *Bursaria spinosa* with mixed native and exotic groundcovers in the western area. CPW is in a Moderate to Good condition. Shrubland is in Poor condition. Closed grassland is in a Disturbed condition. No threatened flora species were recorded in the 200m assessment envelope and due to the current and previous disturbances including continuing grazing there is low likelihood for threatened flora.	Fauna habitats found at CU06 include woodland and cleared areas. Fauna habitats in this area provide a high level of connectivity. Woodland habitat is assessed as being in Moderate condition. All other areas are considered in Poor condition. Areas of CPW provide potential habitat for CPLS, and roosting and nesting habitat for highly mobile threatened fauna species such as birds and microchiropteran bats. Cleared areas have negligible likelihood of threatened fauna.	

Well Surface Locations			
Description	**Flora**	**Fauna**	**Plates – detail located in Description column for each WSL**
CU02 **Plate 12:** Location of CU02 WSL proposed in open cleared paddock at this WSL, facing north east.	WSL CU02 consist of a grazed paddock dominated by exotic pasture grasses and herbaceous weeds, with a few scattered trees of *Eucalyptus tereticornis* in decline. Vegetation is assessed as Disturbed. Additionally no threatened species or EECs were recorded and there is no potential habitat for threatened flora.	Fauna habitats are highly simplified in the WSL and assessed as Poor. Some of the scattered *Eucalyptus tereticornis* in decline within the 200m assessment area support small to medium sized hollows that may provide, nesting and roosting habitat for birds and microchiropteran bats. Although some highly mobile threatened fauna such as birds and microchiropteran bats may forage over the survey and adjacent areas there is negligible likelihood for any threatened fauna species.	
RA09 **Plate 13:** RA09 WSL proposed on gentle slope of open cleared paddock, facing north east.	WSL RA09 consist of a mix oc CPW (EPBC & TSC Act), CPW (TSC Act) and Shrubland. Vegetation in the central and northern sectors of the WSL is primarily grazed paddock cleared of native vegetation. There is a patch of shrubland dominated by *Bursaria spinosa* ssp *spinosa* in the northern sector. CPW is mapped within the western, southern and eastern areas of the 200m assessment envelope. This forms part of a larger area of CPW extending outside the Subject Site. CPW is in Moderate to Good condition. Shrubland is in Poor condition. Other vegetation is assessed as Disturbed. Due to the current and previous disturbances there is a low likelihood for threatened flora within the open grassland of the WSL. Areas of CPW provide potential habitat for threatened flora species.	Fauna habitat within WSL RA09 consist of woodland, cleared areas and two constructed waterbodies. Areas of woodland form part of larger area of connected habitat within the Local area.. Woodland habitat is assessed as Good condition. Other areas are assessed as Poor condition. Areas of CPW provide potential habitat for the CPLS, and roosting and nesting habitat for highly mobile threatened fauna species such as birds and microchiropteran bats. Cleared areas have a negligible likelihood for threatened fauna species.	

Well Surface Locations			
Description	**Flora**	**Fauna**	**Plates – detail located in Description column for each WSL**
RA03 **Plate 14:** Location of RA03 WSL proposed in open cleared paddock at this WSL, facing north east.	Vegetation at WSL RA03 consist of a grazed paddock dominated by exotic pasture grasses and herbaceous weeds. There is small stand and scattered occurrences of mature *Eucalyptus tereticornis* and *Eucalyptus moluccana*. In view of the previous and current landuse vegetation in the WSL is assessed as Disturbed. No threatened species or EECs were recorded and there is no likelihood for threatened flora.	Fauna habitats at WSL RA03 include cleared areas and a large waterbody. Fauna habitat is assessed as Poor condition. Although some highly mobile threatened fauna such as birds and microchiropteran bats may forage over the 200m assessment envelope and adjacent areas there is low likelihood for any threatened fauna species.	
VV03 **Plate 15:** Location of VV03 WSL proposed in area of cleared paddock, facing south east.	WSL VV03 consists of CPW (EPBC & TSC Act), CPW (TSC Act), RFEFCF, Shrubland and Closed Grassland. Areas of CPW in the northeast are in Moderate to Good condition and considered representative of CPW (EPBC & TSC Act). An area of CPW in the southern sector is in Poor condition and is considered representative of CPW (TSC Act). RFEFCF, representative of RFEFCF, occurs in the southwest sector, and is assessed as Poor to Moderate condition due to a disturbed understorey.. CPW provides potential habitat for threatened flora species. Other areas have negligible likelihood of threatened flora species.	WSL VV03 consist largely of cleared areas with small patches of woodland habitat and a small waterbody in the southeast sector. Fauna habitats are assessed as Poor condition. Areas of CPW provide potential habitat for the CPLS, and roosting and nesting habitat for highly mobile threatened fauna species such as birds and microchiropteran bats. Cleared areas have a negligible likelihood for threatened fauna species.	

3.7 Main Gas Gathering Spine, Gas Gathering Lines and Access Tracks

Details of the Main Gas Gathering Spine, GGLs and access tracks that were surveyed, their location and flora and fauna values are detailed below in Table 7.

Table 7: Main Spine Line GGL, other associated GGLs and access tracks.

Main Spine Line Gas Gathering Line			
Description	**Flora**	**Fauna**	**Plate**
MSL GGL - CPW **Plate 16:** Small stand of CPW along the western side of the Upper Canal easement, near St. Andrews Road, facing north.	CPW occurs along the Main Gas Gathering Spine as scattered patches, with the majority of the patches occurring on the western side of Upper Canal. CPW in these areas varies in condition from Good to Poor. Areas considered to be in Good condition support a high species diversity and relatively natural structure, despite being regrowth. Areas considered to be in Moderate condition support a less diverse array of native species and have a sparse understorey. Areas considered to be in a Poor condition have an altered structure, generally supporting a relatively diverse native understorey with no tree canopy. These patches represent the EEC CPW. No threatened flora species were observed however the CPW over the length of the Upper Canal supports potential habitat for several species previously recorded in the Surface Project Area.	Patches of CPW along the Main Gas Gathering Spine vary in condition in terms of fauna habitat. Where these patches consist of largely intact vegetation and high connectivity they are assessed as Moderate to Good condition. Some of the more isolated patches contain fewer resources for native fauna and are in a Poor condition. Canopy, nectar and flowering resources were reasonably scarce given the age of most of the trees however there was abundant mistletoe which provides foraging resources to a number of common or threatened woodland birds. Multiple hollow bearing trees were identified within these patches of CPW. The ground layer in many areas provides potential habitat for the CPLS, with abundant fungi, leaf litter and detritus. Hollows provide potential roosting and nesting habitat for threatened bird and bat species.	
MSL GGL - Cleared areas **Plate 17:** Cleared, western side of Upper Canal easement, adjacent to existing access roads, facing south.	The majority of the area along the Upper Canal water supply channel is mostly cleared of native vegetation, supporting mown and slashed exotic grasses and herbaceous species. Scattered regrowth native vegetation occurs in this area, supporting species such as *Acacia parramattensis*, *A. decurrens* and *Allocasuarina littoralis*. Areas also support a dense shrub layer of the exotic *Olea europea* subsp. *cuspidata*. These areas are generally considered to be in a Disturbed condition No EECs or threatened plants were recorded in the cleared areas along the Upper Canal. There is a low likelihood for threatened floa species.	Fauna habitats in the cleared areas along the Spine Line are highly modified and Poor in quality. They provide negligible value to fauna. There is a low likelihood for threatened fauna species	

GGLs CU06, CU 14 to CU10 & Access Tracks			
Description	**Flora**	**Fauna**	**Plate**
CPW **Plate 18:** Access track through CPW off Saddle Close	A small and isolated patch of CPW (TSC & EPBC Act) occurs next to the existing access track to CU06, immediately off Saddle Close. This vegetation is in a Good condition. CPW provides potential habitat for a number of threatened flora species that have been recorded within the Surface Project Area.	This woodland habitat may provide sheltering, roosting and foraging habitat for a suite of fauna such as arboreal mammals, birds, and bats. It is considered to be in Moderate condition due to a lack of connectivity. Although some highly mobile threatened fauna such as birds and microchiropteran bats may forage in and over this stand of CPW and adjacent areas, there is a low likelihood of threatened fauna species.	
Cleared and disturbed **Plate 19:** Open cleared paddocks occur along entire GGL alignment close to fenceline, facing north east.	The majority of the GGL's and access tracks to the WSLs consist of grazed paddocks or along existing access tracks through the paddocks. In view of the previous and current landuse vegetation in the main construction footprint is assessed as Disturbed. There is a low likelihood for threatened flora species..	Cleared areas provide negligible value to fauna, other than for common and opportunistic species. These fauna habitat are in Poor condition. There is a negligible likelihood for threatened fauna.	

GGLs CU02 to Main Gas Gathering Spine Access Track			
Description	**Flora**	**Fauna**	**Plate**
RFEFCF **Plate 20:** RFEFCF adjacent to GGL from CU02 to the Main Spine	Two small and isolated patches of RFEFCF occur in the assessment envelopes at the eastern end of the GGL. These areas have been subject to grazing and pasture improvement with the groundcover stratum highly disturbed. Vegetation condition of the RFEFCF is assessed as Poor to Moderate. No threatened species were recorded and there is a low likelihood for threatened flora species to occur in these areas.	These small stands of woodland may provide sheltering, roosting and foraging habitat for non threatened native birds, bats and amphibians. Some highly mobile threatened fauna such as birds and microchiropteran bats may also forage in and over these stands of RFEFCF. Fauna habitats are highly modified and assessed as Poor. There is a low likelihood of threatened fauna species occurring.	
Shrubland **Plate 21:** Shrubland of GGL from CU02 to the Main Spine	A small patch of Shrubland occurs on the western end of the GGL adjacent to South Creek. This area has been subject to vegetation clearing and grazing with vegetation condition assessed as being Poor. No threatened species were recorded and there is a low likelihood for threatened flora species to occur in the Shrubland.	This small stand of derived native vegetation may provide sheltering and foraging habitat for non threatened native birds, reptiles and amphibians. Fauna habitats are highly modified and assessed as Poor in the Shrubland. There is a low likelihood of threatened fauna species occurring.	

GGLs CU02 to Main Gas Gathering Spine Access Track			
Description	**Flora**	**Fauna**	**Plate**
Cleared and Disturbed **Plate 22:** Closed grassland of GGL from CU02 toward the Main Spine	The majority of the GGLs and Access Tracks for these WSLs consist of grazed paddocks supporting a closed grassland. Scattered individuals of *Eucalyptus tereticornis* and *Eucalyptus moluccana* are present adjacent to this alignment. In view of the previous and current landuse the vegetation of the GGL assessed as Disturbed. No threatened species were recorded and there is a low likelihood for threatened flora species to occur in the Shrubland.	Cleared areas provide negligible value to fauna, other than for common and opportunistic species. These fauna habitat are in Poor condition. There is a negligible likelihood for threatened fauna.	

GGLs CU22 and CU31 to Main Gas Gathering Spine & Access Tracks			
Description	**Flora**	**Fauna**	**Plate**
CPW **Plate 23:** CPSW east of CU22 to CU31 access track.	The access track to CU22 passes through a small and isolated patch of CPW (TSC Act), while there is a large patch of CPW (TSC Act) to the east of the CU22 to CU31 access track, extending beyond the Subject Site, consisting of remnant and regrowth canopy and understorey of mixed native and exotic shrubs. CPW is generally in Poor to Moderate condition. CPW provides potential habitat for a number of threatened flora species that have been recorded within the Surface Project Area.	The stands of woodland adjacent to the access track in the exiting easement and CU31 GGL may provide sheltering, roosting and foraging habitat for a suite of fauna such as arboreal mammals, birds, and bats. Fauna habitats are generally in a Moderate condition and provide connectivity. Areas of CPW provide potential habitat for the CPLS, and roosting and nesting habitat for highly mobile threatened fauna species such as birds and microchiropteran bats.	
Shrubland **Plate 24:** Shrubland of GGL from CU22 to the Main Spine	A small patch of Shrubland occurs to the south of the CU22 WSL GGL. This area has been subject to vegetation clearing and grazing with vegetation condition assessed as being Poor. No threatened species were recorded and there is a low likelihood for threatened flora species to occur in the Shrubland.	This small stand of derived native vegetation may provide sheltering and foraging habitat for non threatened native birds, reptiles and amphibians. Some highly mobile threatened fauna such as birds and microchiropteran bats may extend foraging in and over the Shrubland from nearby stands of CPSW and CPW. Fauna habitats are highly modified and assessed as Poor in the Shrubland. There is a low likelihood for threatened fauna species.	

GGLs CU22 and CU31 to Main Gas Gathering Spine & Access Tracks			
Description	**Flora**	**Fauna**	**Plate**
Cleared and Disturbed **Plate 25:** Closed grassland of GGL from CU22 toward the Main Spine	The access tracks to CU22 and on to CU31 will be confined to the existing service tracks for the Eastern pipeline with adjacent vegetation assessed as closed grassland. The majority of the CU22 and CU31 GGLs will also be through highly disturbed closed grassland. In view of the previous and current landuse the vegetation is assessed as Disturbed There is a low likelihood for threatened flora species.	Cleared areas provide negligible value to fauna, other than for common and opportunistic species. These fauna habitat are in Poor condition. There is a negligible likelihood for threatened fauna.	

CU26 and CU29 GGL & Access Track			
Description	**Flora**	**Fauna**	**Plate**
CPW **Plate 24:** CPW located on CU29 GGL.	The southern end of the access track for CU26 and CU29 supports a patch of CPW (TSC Act). Another patch of CPW (TSC Act) occurs along the GGL for CU29, while another small and isolated patch occurs along the GGL for CU26. Condition is assessed as Poor to Moderate. Based on the condition there is a low likelihood for threatened flora species.	These woodland areas provide forasging, nesting and roosting habitat for avifauna and microchiropteran bats. Condition is assessed a Moderate. Although some highly mobile threatened fauna such as birds and microchiropteran bats may forage over the survey and adjacent areas there is a low likelihood for any threatened fauna species to occur.	
Shrubland **Plate 22:** Shrubland on the north of the dam that will be disturbed for the proposed GGL.	The CU29 GGL passes through a Shrubland into the WSL. Condition of the Shrubland community is Poor. There is a low likelihood of occurrence for threatened flora species.	Fauna habitats of the Shrubland are simplified and are assessed as Poor. Although some highly mobile threatened fauna such as birds and microchiropteran bats may forage over the survey and adjacent areas there is a low likelihood for any threatened fauna species within the GGL construction footprint.	

CU26 and CU29 GGL & Access Track			
Description	**Flora**	**Fauna**	**Plate**
Cleared and disturbed **Plate 23:** Gentle slopes along the open cleared GGL alignments, facing east.	The main impact area is a grazed paddock. The closed grassland is dominated by a mixture of exotic and native grasses and herbs such as *Aristida ramosa, Themeda australis, Paspalum dilatatum, Setaria gracilis,* and *Verbena bonariensis*. In view of the previous and current landuse vegetation in the main construction footprint is assessed as Disturbed. Additionally no threatened species or EECs are recorded and there is no potential habitat for threatened flora.	Cleared areas provide negligible value to fauna, other than for common and opportunistic species. These fauna habitat are in Poor condition. There is a negligible likelihood for threatened fauna.	

VV03 GGL & Access Tracks			
Description	**Flora**	**Fauna**	**Plate**
CPW **Plate 26:** CPW adjacent to existing farm vehicle track on GGL, facing north.	A small isolated patch of CPW (TSC Act) occurs within the VV03 GGL immediately adjacent to the MSL. Another small and isaolted patch occurs along the GGL, within the WSL assessment area. All areas of CPW are assessed as Poor condition. Based on the condition there is a low likelihood for threatened flora species.	Woodland habitat provides roosting, nesting and foraging habitat for avifauna and microchiropteran bats. Although some highly mobile threatened fauna such as birds and microchiropteran bats may forage over the survey and adjacent areas there is a low likelihood for any threatened fauna species in this patch.	

VV03 GGL & Access Tracks			
Description	**Flora**	**Fauna**	**Plate**
RFEFCF **Plate 27:** RFEFCF on VV03 access and part GGL.	The access track and GGL, close to the VV03 WSL, pass through a stand of RFEFCF. RFEFCF is highly modified and is assessed as being in Poor Condition. There a low likelihood for threatened flora species to occur in the RFEFCF.	This woodland habitat provides limited value to fauna with many key components not present. Fauna habitats are simplified and are assessed as Poor to Moderate condition. Although areas of woodland habitat in this area provide sheltering and foraging habitat for waterbirds, amphibians and reptiles, there is a low likelihood of occurrence for threatened fauna species.	
Cleared and disturbed **Plate 28:** Closed grassland between Raby Rd and the WSL.	The majority of the GGL between the WSL and Raby Rd passes through closed grassland characterised by exotic pasture grasses and herbaceous weeds. In view of the previous and current landuse vegetation in the main construction footprint is assessed as Disturbed. There is a low likelihood for threatened flora species to occur in these disturbed environments.	Cleared areas provide negligible value to fauna, other than for common and opportunistic species. These fauna habitat are in Poor condition. There is a negligible likelihood for threatened fauna.	

RA09 GGL to MSL GGL and Access Track			
Description	**Flora**	**Fauna**	**Plate**
CPW **Plate 30:** Open cleared existing track where GGL is proposed, facing east.	A patch of CPW (TSC Act) occurs in the central section of the GGL and access track, partially within the RA09 WSL. This patch is assessed as being in a Moderate condition with native species well represented in all stratums. This patch if CPW provides habitat for threatened flora species previously recorded in the Surface Project Area.	This area of woodland provides foraging, nesting and roosting habitat for a variety of avifauna species as well as common ground-dwelling fauna, This patch has some level of connectivity to the larger area of Woodland to the west. Fauna habitat in this patch of Woodland is assessed as Moderate. Although some highly mobile threatened fauna such as birds and microchiropteran bats may forage over the survey and adjacent areas there low likelihood of occurrence for other threatened fauna species in this patch based on lack of suitable habitat features.	
Cleared and disturbed **Plate 31:** Existing disturbed track along which GGL is proposed, facing north east	The GGL will mainly be constructed through a managed pasture. In view of the previous and current landuse vegetation in the cleared areas of the construction footprint is assessed as Disturbed. No threatened species or EECs are recorded and there is no potential habitat for threatened flora.	Cleared areas provide negligible value to fauna, other than for common and opportunistic species. These fauna habitat are in Poor condition. There is a negligible likelihood for threatened fauna.	

GGL RA03 to RA09 & Access			
Description	**Flora**	**Fauna**	**Plate**
CPW and Cleared and disturbed **Plate 32:** Open cleared paddocks across which GGL runs.	The GGL between RA03 and RA09 passes along Campbelltown Road, within the road verge. Vegetation along the GGL consists largely of grazed paddocks or disturbed road edges dominated by exotic grasses and herbaceous weeds. There is one small patch of CPW (TSC Act) along Campbelltown Rd just south of the RA09 GGL. Vegetation in cleared areas is assessed as being in a Disturbed condition. The small patch of CPW is in a Poor condition. No threatened flora species were recorded and there is no potential habitat for threatened flora.	Fauna habitats are highly simplified and are assessed as Poor condition. Although some highly mobile threatened fauna such as birds and microchiropteran bats may forage over the survey and adjacent areas there is a low likelihood for any threatened fauna species within the GGL and access tracks.	

GGL RA09 to Main Gas Gathering Spine			
Description	**Flora**	**Fauna**	**Plate**
CPW and Cleared and disturbed **Plate 33:** Open cleared paddocks across which GGL runs.	The GGL between RA09 and the MSL passes along Denham Court Road within the road verge. Vegetation along the GGL includes managed road reserves dominated by exotic grasses and herbs, scattered woody weeds and several patches of CPW along Denham Court Rd. Vegetation of the open managed road verges is assessed as being in a Disturbed condition. Patches of CPW in the GGL assessment area included CPW in Good condition (EPBC & TSC Act) and with stands of trees in Poor condition (TSC Act). No threatened flora species were recorded and there is low likelihood for threatened flora.	Although woodland habitat occurs within the assessment envelope it is largely restricted to private property adjacent to the road reserve. Woodland habitats provide habitat for a range of species, and there is a high level of connectivity in these areas. Cleared areas provide negligible value to fauna, other than for common and opportunistic species. Woodland habitat is assessed as being in Good condition, while stands of trees and cleared areas are assessed as Poor condition. Areas of CPW provide potential habitat for the CPLS, and roosting and nesting habitat for highly mobile threatened fauna species such as birds and microchiropteran bats. Other areas provide negligible likelihood for threatened fauna species.	

GGL & Access tracks, Mount Annan –Endeavour Energy Easement			
Description	**Flora**	**Fauna**	**Plate**
CPW **Plate 34:** Existing track within Endeavour Energy easement, CPW to right of track.,	Several patches of CPW (TSC Act) are present within the GGL and access track envelope. A small patch of CPW (EPBC & TSC Act) occurs at the southern end of this GGL and Access Track. Condition varies from Moderate to Good. No threatened flora species were observed however the CPW supports potential habitat for several species previously recorded in the Surface Project Area.	These areas of woodland are likely to provide habitat for ground dwelling and arboreal fauna, avifauna and microchiropteran bats. Hollow bearing trees are present in several locations of the GGL alignment. Fauna habitat in these patches of Woodland is assessed as Moderate Areas of CPW provide potential habitat for the CPLS, and roosting and nesting habitat for highly mobile threatened fauna species such as birds and microchiropteran bats.	
Cleared and disturbed **Plate 35:** Existing disturbed track within Endeavour Energy easement, facing south	Closed grasslands are present throughout the GGL and these are assessed as in a Disturbed condition. No threatened flora species or EECs are recorded in the cleared areas and there is very little potential habitat for threatened flora.	Cleared areas provide negligible value to fauna, other than for common and opportunistic species. These fauna habitat are in Poor condition. There is a negligible likelihood for threatened fauna.	

4.0 POTENTIAL IMPACTS, MITIGATION AND RESIDUAL IMPACTS

4.1 Potential Impacts

Section 4.1describes the potential impacts of the project before impact avoidance, minimisation and mitigation measures were considered for the project.

4.1.1 Well Surface Locations

The main disturbance at most WSLs will be earthworks undertaken for the drilling and establishment of wells and cut and fill for finished levels to construct the wells and associated infrastructure. All WSLs will be situated in cleared and disturbed areas of the 200 m assessment envelopes, and areas containing significant biodiversity values will be excluded from proposed works, thus avoiding impacts on TSC Act and EPBC Act TECs (CPW, CPSW and RFEFCF) and potential habitat for other threatened biodiversity. These cleared and disturbed areas support Closed Grasslands dominated by exotic pasture grasses and annual and perennial weeds. Although native grasses and herbs are present, these areas are managed primarily for agriculture, have a low resilience and are highly unlikely to return to a partially or fully structured native plant community without sustained and significant resources.

The area of disturbance for the establishment of a drilling compound is estimated at up to 1 ha within the approximate 12.5 ha of a WSL. This would result in the temporary disturbance of up to 11.5 ha of Closed Grasslands at the WSLs across the Surface Project Area.

Following the rehabilitation of the drilling compound and operation of a WSL (Plates 1 and 2) the total loss of vegetation at a WSL will be approximately 360 m^2.

By avoiding the need for removal of most native vegetation and undertaking micrositing of GGLs to avoid the need for removal of trees it is expected that impacts to the majority of native flora and fauna, including birds, bats and the CPLS, can be avoided.

Without the implementation of impact avoidance, minimisation and mitigation measures, the Amended Project would impact on 3960 m^2 (0.4 ha) of Closed Grassland which is approximately 0.01% of the vegetation within the Surface Project Area that is not mapped as a native plant community by NPWS (2002e).

As will be discussed in sections 4.2 and 4.3 below, with the implementation of measures, the construction and operation of the proposed WSLs is unlikely to have a significant impact on the native flora and fauna of the Surface Project Area including TSC and EPBC Act listed species provided the recommendations in Section 4.2 are implemented.

4.1.2 Main Gas Gathering Spine, Gas Gathering Lines and Access Tracks

Construction and establishment of these linear infrastructures will involve earthworks within narrow construction footprints. In addition to the trenches there will be some disturbance for machinery and vehicle access (Plates 3 and 4). Design of the Main Gas Gathering Spine, GGL

network and access tracks has considered alignments through disturbed areas wherever possible and under boring areas of high conservation significance. Upgrading or establishment of access tracks has followed the same principle and access for construction works or maintenance during operation will, for the most part, be restricted to existing tracks.

Avoidance of significant flora and fauna habitats, such as regrowth and remnant Woodlands and other features such as water bodies and hollow bearing or other trees, has been a continuous process through inception phases, field surveys and culminating in the current design. The bulk of the Main Gas Gathering Spine and GGL network will be through disturbed areas that have been substantially cleared of native vegetation and are under agricultural management practices.

Approximately 283 ha of vegetation occurs in the assessment envelopes of the Main Gas Gathering Spine, GGL network and access tracks (Figure 2) with an estimated 227 ha of Closed Grassland dominating the landscape. The area of disturbance for the Main Gas Gathering Spine and GGLs will vary throughout the Subject Site within a corridor of a maximum of 10m width including trenches, soil stockpile areas, vehicle and plant operational areas (see Plate 3 example). Approximately 0.87 ha of native vegetation will be underbored.

By avoiding the need for removal of most native vegetation and undertaking micrositing of GGLs to avoid the need for removal of trees it is expected that impacts to the majority of native flora and fauna, including birds, bats and the CPLS, can be avoided.

As such, over the approximately 15,000 m^2 area of the Main Gas Gathering Spine, GGLs and access tracks, 13.75 ha of vegetation (including 0.48 ha of Shrubland and 13.27 ha of Closed Grassland) will be temporarily affected by the Amended Project. Despite the application of sustainability principles in the design and planning phase, including avoidance and exclusion measures for threatened biodiversity and its potential habitat, some area of native vegetation and potential fauna habitats will be impacted (Figures 6a to 6q).

A suite of additional avoidance and impact minimise measures will be implemented during construction (Section 4.2; Figures 7a to 7q) that will result in a negligible level of impact to general and threatened biodiversity and habitats. There is unlikely to be any long term net loss of native or derived plant communities as a result of the construction and operation of these components of the Amended Project.

4.1.3 Summary of Potential Impacts

A guiding element of the project design for surface infrastructure and focus of the field surveys in relation to impact assessment has been the ‘envelope’ approach. Assessments carried out on potential impacts associated with the construction of the WSLs, Main Gas Gathering Spine, GGLs and access tracks have taken a similar approach. Specifically, assessments have considered a 200 m area around WSLs and 25 m area either side of the centreline for linear infrastructure components (GGLs and access tracks), in which the final alignments will also consider managing the area of disturbance during construction and access around constraints.

This strategic approach considers a matrix of constraining factors including management of natural heritage such as flora and fauna habitats and the presence of threatened biodiversity and has provided the opportunity to refine the project to avoid and minimise potential impacts consistent with the 'General Requirements' of the DGRs.

A summary of the potential impacts that are associated with the project, with relevance to each of the project components, is presented in Table 8 below.

Table 8: Summary of potential impacts at key locations within the Subject Site.

PROJECT COMPONENT	***VEGETATION COMMUNITIES & ASSOCIATED HABITAT WITHIN ASSESSMENT 'ENVELOPES'***
Main Gas Gathering Spine Line GGL	There will be a minimal amount of clearing of native vegetation for the construction of the Main Gas Gathering Spine. Additional measures to avoid and minimise impacts are outlined in Section 4.2. Impacts to habitat for fauna, including birds, bats and the CPLS, are expected to be negligible. Construction of the Main Gas Gathering Spine through cleared areas is unlikely to have a significant impact on native flora and fauna or their habitats.
RA03 WSL	No clearing of native vegetation communities will occur in the WSL. No impacts to habitat for fauna, including birds, bats and the CPLS, are expected to occur. Construction of the WSL and associated infrastructure is unlikely to impact upon the native flora and fauna or their habitats at the site.
GGL RA03 to RA09 & Access Tracks	Avoid all trees along proposed GGL and access tracks by altering alignments. No impacts to habitat for fauna, including birds, bats and the CPLS, are expected to occur. No clearing of native vegetation required for the GGL and access.
RA09 WSL	No clearing of native vegetation communities will occur for the construction of the WSL infrastructure in the Amended Project. No impacts to habitat for fauna, including birds, bats and the CPLS, are expected to occur. Construction of the WSL and associated infrastructure in the Disturbed vegetation at the WSL is likely to have little or no impact on native flora and fauna or their habitats.
GGL RA09 and Access Track	Avoid small patch of CPW identified along access track to RA09. No clearing of native vegetation required for the GGL and access track. No impacts to habitat for fauna, including birds, bats and the CPLS, are expected to occur.
VV03 WSL	No clearing of native vegetation communities will occur for the construction of the WSL infrastructure in the Amended Project. No impacts to habitat for fauna, including birds, bats and the CPLS, are expected to occur. Construction of the WSL and associated infrastructure in the Disturbed vegetation at the WSL is likely to have little or no impact on the native flora and fauna or their habitats of the site.
VV03 GGL and Access Track	Avoid all trees along proposed section of access track and GGLs through the RFEFCF. No clearing of native vegetation required for the GGL or access track over Disturbed landscapes on private property or Raby Road to Main Spine. No impacts to habitat for fauna, including birds, bats and the CPLS, are expected to occur.

PROJECT COMPONENT	*VEGETATION COMMUNITIES & ASSOCIATED HABITAT WITHIN ASSESSMENT 'ENVELOPES'*
CU31 WSL	No clearing of native vegetation communities will occur for the construction of the WSL infrastructure at this location. No impacts to habitat for fauna, including birds, bats and the CPLS, are expected to occur. Construction of the WSL and associated infrastructure is likely to have little or no impact on the native flora and fauna or their habitats of the site.
GGL CU31 & Access Track	No clearing of native vegetation will occur for the GGL or access track. No impacts to habitat for fauna, including birds, bats and the CPLS, are expected to occur.
CU22 WSL	No clearing of native vegetation communities will occur for the construction of the WSL infrastructure. No impacts to habitat for fauna, including birds, bats and the CPLS, are expected to occur. Construction of the WSL and associated infrastructure is likely to have little or no impact on the native flora and fauna or their habitats of the site.
GGL CU22 & Access Track	No clearing of native vegetation will occur for the GGL or access track. No impacts to habitat for fauna, including birds, bats and the CPLS, are expected to occur.
CU26	No clearing of native vegetation communities will occur for the construction of the WSL infrastructure. No impacts to habitat for fauna, including birds, bats and the CPLS, are expected to occur. Construction of the WSL and associated infrastructure is likely to have little or no impact on the native flora and fauna or their habitats of the site
GGL CU26 & Access Track	There will be minor disturbance to CPW on the GGL. Impacts to habitat for fauna, including birds, bats and the CPLS, are expected to be negligible.
CU29 WSL	No clearing of native vegetation communities will occur for the construction of the WSL infrastructure at this location. No impacts to habitat for fauna, including birds, bats and the CPLS, are expected to occur. Construction of the WSL and associated infrastructure is likely to have little or no impact on the native flora and fauna or their habitats of the site.
GGL CU29 & Access Track	No clearing of native vegetation will occur for the GGL or access track. No impacts to habitat for fauna, including birds, bats and the CPLS, are expected to occur.
CU02 WSL	No clearing of native vegetation communities will not occur in the WSL. No impacts to habitat for fauna, including birds, bats and the CPLS, are expected to occur. Construction of the WSL and associated infrastructure is likely to have little or no impact on the native flora and fauna or their habitats of the site.
GGL CU02 & Access Tracks	No clearing of native vegetation will occur for this GGL and access roads. No impacts to habitat for fauna, including birds, bats and the CPLS, are expected to occur.
CU06 WSL	No clearing of native vegetation communities will occur in the WSL. No impacts to habitat for fauna, including birds, bats and the CPLS, are expected to occur. Construction of the WSL and associated infrastructure is likely to have little or no impact on the native flora and fauna or their habitats of the site.

PROJECT COMPONENT	*VEGETATION COMMUNITIES & ASSOCIATED HABITAT WITHIN ASSESSMENT 'ENVELOPES'*
GGL CU06 & Access Tracks	No clearing of native vegetation will occur for these GGLs and access roads. No impacts to habitat for fauna, including birds, bats and the CPLS, are expected to occur.
CU10 WSL	No clearing of native vegetation communities will occur at CU10. No impacts to habitat for fauna, including birds, bats and the CPLS, are expected to occur. Construction of the WSL and associated infrastructure is likely to have little or no impact on the native flora and fauna or their habitats of the site.
CU14 WSL	No clearing of native vegetation communities will occur for the construction of the WSL infrastructure at this location. No impacts to habitat for fauna, including birds, bats and the CPLS, are expected to occur. Construction of the WSL and associated infrastructure is likely to have little or no impact on the native flora and fauna or their habitats of the site.
GGLs CU10 & CU14 & access	No clearing of native vegetation required for GGL site and access road. No impacts to habitat for fauna, including birds, bats and the CPLS, are expected to occur. Use existing tracks to reduce impacts to identified vegetation.
Mount Annan GGL Main Gas Gathering Spine Line	No clearing of native vegetation required for GGL and access road as the existing Endeavour Energy easement and access will be utilised. No impacts to habitat for fauna, including birds, bats and the CPLS, are expected to occur. There will be no impact on the native flora and fauna or their habitats along the already cleared easement.

4.2 Recommendations and Mitigation Measures

The following general recommendations arising from this report aim to minimise or mitigate potential impacts on biodiversity at key locations of the proposed development.

- No work should be undertaken in areas identified as 'Avoid by Exclusion' in Figures 7a to 7q. Should works be required further flora and fauna impact assessment is required.
- Areas identified as 'Avoid by Exclusion' should be fenced prior to commencement of works, and "Significant Biodiversity – no access" signage posted.
- In other locations where native plant communities will or may be disturbed, temporary exclusion fencing should be installed around vegetation that is to be retained with no access to occur in the fenced areas. Signs should be placed on the fencing that identifies these areas as "no access zones".
- Micro-siting of GGLs and access tracks to avoid native trees and other habitat features such as waterbodies, where possible.

- Trees with hollows should be retained and protected. Earthworks in the vicinity of retained trees should conform to the Australian Standard *Protection of trees on development sites, AS 4970 – 2009* (Standards Australia 2009).

- Where practicable, existing farm vehicle tracks will typically be used as access roads for the construction and maintenance of GGLs and WSL.

- Any trimming of branches along existing access tracks to accommodate heavy plant or large vehicles should be carried out by a qualified Arborist. Should large branches with hollows be required to be removed, a suitably qualified ecologist should be on site during clearing to ensure no resident fauna are harmed. Cleared branches should be placed in adjoining vegetation, as they will provide habitat for fauna.

- If areas of suitable habitat identified in Section 3.5 and 3.7cannot be avoided, pre-clearing fauna surveys should be carried out targeting CPLS. CPLS need to be relocated into nearby areas that will not be disturbed.

- A local wildlife rescue organisation is to be contacted should any vertebrate fauna be injured during construction.

- If disturbance to areas of CPW is proposed, surface soils to 100 mm depth should be scalped and stockpiled separately. Following bulk earthworks, such as levelling and back filling, the stockpiled surface soil should be spread back over areas that will not be disturbed in the future as part of the operation of the development. Stockpiled topsoil should be respread as soon as possible to prevent loss of the native seed bank as a result of composting.

- Excess subsoil remaining as a result of displacement from the Main Gas Gathering Spine and GGLs is to be removed from site, in consultation and with the approval of the SCA. Alternatively this excess soil should be removed following backfilling of trenches and disposed of at a registered waste facility.

- Sediment and erosion control measures need to be installed and maintained during construction particularly in areas where there are sensitive receiving environments such as native vegetation and waterways. Sediment and erosion controls should stay in place until construction footprints and associated disturbed areas are stabilized.

- To prevent the dispersal of weed seed or soil born pathogens into regrowth or remnant native vegetation hygiene protocols should be implemented for vehicles, heavy plant and machinery used for earthworks. This equipment should be washed down prior to entering a site.

- Vehicles and heavy plant movements and parking should be restricted to designated access and storage/parking areas during and post construction at the WSLs.

- Site supervisors should be provided with the Biodiversity Exclusion and Impact Minimisation maps (Figures 7a to 7q).

- The project manager and site supervisors should consult with suitably qualified ecologist should flora and fauna issues arise during the construction phase.

- A list of recommended native plant species for any revegetation works carried out in rehabilitation works is provided in Appendix 7.

These general mitigation measures should be incorporated into the existing Environmental Management System (EMS) for the CGP.

The main measures to reduce impacts to specific biodiversity values identified in this report has been to avoid impacts wherever possible and minimise impacts any further impacts. Through an iterative design, and following discussions with the wider project team, the measures outlined below have been implemented across the project area to avoid and minimise impacts to the greatest extent possible.

Avoid By Design

AGL has undertaken a review of the location of the Main Gas Gathering Spine, GGLs, WSLs and associated access tracks based on information provide by Biosis. This review resulted in a significant redesign of the location of these assets to avoid and minimise impacts to threatened biodiversity through siting of infrastructure outside of areas identified as supporting threatened biodiversity or their potential habitat. Where residual impacts could have occurred micro siting of infrastructure, such as locating access tracks and GGLs along access tracks and in disturbed areas, was undertaken.

This redesign resulted in a significant reduction of potential impacts to threatened biodiversity.

Avoid By Exclusion

Areas mapped as "Avoid by Exclusion" in Figures 7a to 7q will not be disturbed as part of the Amended Project. Although these areas are included in the 'assessment envelopes' they have been excluded from the works area due to the presence of or potential for threatened species, populations or communities or their habitat.

Minimise By Detailed Ground Survey And Construction Method

Multiple sections of the Main Gas Gathering Spine have been surveyed in detail to avoid and minimise impacts to threatened species, populations or communities or their habitat and other general habitat features including individual trees, areas of better quality Shrubland and drainage lines. Some of these areas identified in Figures 7a to 7q have been marked with surveyors' pegs to guide vegetation clearing and construction works. Further impact minimisation measures outlined below in Minimise by construction methods may be applied in these areas.

Minimise By Under Bore

Where impacts could not be avoided, disturbance to native vegetation, particularly TECs, will be minimised in several locations along the Main Gas Gathering Spine Line by using directional drilling techniques to under bore and install the pipeline. Underboring will be undertaken at depth of greater than 1 m, thus avoiding the main root zone for sclerophyllous trees.

Minimise By Construction Methods

Areas mapped as Minimise by Construction Method in Figures 7a to 7q will include a number of measures to minimise potential impacts including:

- minor adjustment of infrastructure alignments to remain in cleared and disturbed areas of the Main Gas Gathering Spine Line, GGLs and Access Tracks;
- minor adjustment of pipeline alignments to avoid drip lines of tree canopies throughout the Subject Site;.
- limiting vehicle access to existing tracks with new tracks confined to cleared and disturbed areas; and,
- close supervision of vegetation clearing and construction contractors by AGL Project Managers.

Further detail on the construction methods for major components of the Amended Project is provided in Sections 1.3.2 to 1.3.4.

Impact avoidance and mitigation measures specific to each project component are outlined in Table 9. These measures should be implemented in addition to the general measures outlined above.

Table 9: Summary of Recommendations for Flora and Fauna within each component envelope.

PROJECT COMPONENT	***VEGETATION COMMUNITY & HABITAT IN 'ENVELOPE'***	***SITE SPECIFIC RECOMMENDATIONS***
Main Gas Gathering Spine Line GGL	Open cleared areas Closed Grassland CPW	Avoid and minimise disturbing vegetation within areas mapped as supporting CPW. If impacts to CPW cannot be avoided additional assessment may be required and pre-clearing fauna surveys should be carried out in regrowth or remnant Woodland targeting CPLS. Avoid impacts to patches of native trees and shrubs where possible. Construct GGL within existing cleared areas wherever possible.
RA03 WSL	Open cleared areas Closed Grassland	None.
GGL RA09 & RA03 & Access Track	Open cleared areas Closed Grassland CPW	Minimise impacts to CPW by construction method. If impacts to CPW cannot be minimised additional assessment may be required and pre-clearing fauna surveys should be carried out in regrowth or remnant Woodland targeting CPLS.

PROJECT COMPONENT	***VEGETATION COMMUNITY & HABITAT IN 'ENVELOPE'***	***SITE SPECIFIC RECOMMENDATIONS***
RA09 WSL	Open cleared areas Closed Grassland CWP western, eastern and southern margins of envelope	The CPW mapped in the WSL has been excluded from the works area. All native trees should be retained in cleared areas.
RA09 GGL to MSL GGL and Access Track	Open cleared areas and roads CPW – small patch along access track	Avoid and minimise impacts to CPW through the exclusion of areas where possible and minimising impacts using construction method. If impacts to CPW cannot be avoided additional assessment may be required and pre-clearing fauna surveys should be carried out in regrowth or remnant Woodland targeting CPLS.
VV03 WSL	Open cleared areas Closed Grassland CPSW located in north east, with small patch of CPW and RFEFCF in the south east areas of WSL envelope	The CPW mapped in the WSL has been excluded from the works area. All native trees should be retained in cleared areas. Minimise impacts to other vegetation communities by construction method.
GGL VV03 & Access Track	Open cleared areas Closed Grassland RFEFCF	Impacts to areas of RFEFCF should be minimised through the use of underboring. Impacts to other areas should be minimised by construction method, and limited to disturbance of the groundcover stratum. Surface soils to 100mm depth should be scalped and stockpiled and replaced as the surface soil for the final finished level.
CU31 WSL & GGL	Open cleared areas Closed Grassland CPSW CPW	The CPW mapped in the WSL has been excluded from the works area. All native trees should be retained in cleared areas
CU31 to CU22 Access track	Open cleared areas Closed Grassland CPSW CPW	The CPW adjacent to the access track will not be disturbed. Impacts to CPW at the northern extent of the access track should minimised by detailed ground survey and construction method, by keeping impacts to within the currently disturbed track.
CU22 WSL & GGL	Open cleared areas Closed Grassland Shrubland CPW	The CPW mapped in the WSL has been excluded from the works area.
CU26	Open cleared areas Closed Grassland Native and introduced grasses	The stands of *Bursaria spinosa* in the WSL should be avoided where possible.
CU 26 GGL & Access Track	Open cleared areas Closed Grassland	Impacts to areas of CPW should be minimised by detailed ground survey and construction method. The GGL alignment should avoid any habitat trees either dead or alive.

PROJECT COMPONENT	***VEGETATION COMMUNITY & HABITAT IN 'ENVELOPE'***	***SITE SPECIFIC RECOMMENDATIONS***
CU29 GGL & Access track	Cleared open areas Closed Grasslands CPW along margins of the GGL	Impacts to CPW along margins of the GGL route will be minimised by detailed ground survey and construction method. Impacts to CPW at the southern end of the access track will be minimised by detailed ground survey and construction method. Impacts to areas of Shrubland will be minimised by construction method
CU29 WSL	Cleared areas Closed Grasslands RFEFCF	The small stand of RFEFCF in the south east section of the WSL has been excluded from the works area.
CU02 WSL	Open cleared areas Closed Grasslands	Avoid impacts to living and dead native trees in the WSL where possible.
CU02 GGL & Access Track	Opened cleared areas and roads Closed Grasslands Shrublands RFEFCF	Impacts to areas of RFEFCF and Shrubland will be minimised by minimised by detailed ground survey and construction method.
CU06 WSL	Open cleared areas Closed Grasslands Shrubland CPSW	The CPW mapped in the WSL has been excluded from the works area.
CU06 GGL and Access Track	Open cleared areas Closed Grasslands CPW CPSW	The CPW mapped adjacent to the Saddle Close has been excluded from the works area.
CU10 WSL	Open cleared areas Native grasses MSW	The CPW mapped in the WSL has been excluded from the works area.
CU14 WSL	Open cleared areas Native grasses	None.
GGLs CU10 & CU14 & access tracks	Open cleared areas Exotic grasses SWH	None.
GGL between Main Gas Gathering Spine Line GGL & MP05	Open cleared easement Exotic grasses	Minimise impacts to areas of CPW and Shrubland through detailed ground survey and construction method.

4.3 Residual Impacts

Table 10 compares:

- the potential impacts of the project before impact avoidance, minimisation and mitigation measures were considered for the project; and
- the residual impacts of the Amended Project following the implementation of mitigation measures outlined in Section 4.2.

Table 10: Comparison of potential and residual impacts to native vegetation (all figures in hectares)

	Alluvial Woodland (RFEFCF)	Cumberland Plain Woodland (TSC Act & EPBC Act)	Cumberland Plain Woodland (TSC Act)	Shrubland	Moist Shale Woodland	Western Sydney Dry Rainforest	Grand Total
Surface Project Area	**42.24**	**868.41**		**19.77**	**33.04**	**4.52**	**967.98**
Access Track Corridor (inc. assessment envelope)	**0.92**	**0.12**	**1.57**	**0.16**	**0.00**	**0.00**	**2.77**
Avoid By Exclusion	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Minimise By Detailed Ground Survey and Construction Method	0.00	0.12	1.57	0.00	0.00	0.00	1.69
Minimise By Underbore	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Minimised By Construction Method	0.92	0.00	0.00	0.00	0.00	0.00	0.92
Residual Impacts	0.00	0.00	0.00	0.16	0.00	0.00	0.16
Gas Gathering Line corridor (inc. assessment envelope)	**0.85**	**1.51**	**4.69**	**1.26**	**0.00**	**0.00**	**8.30**
Avoid By Exclusion	0.02	0.00	1.24	0.00	0.00	0.00	1.26
Minimise By Detailed Ground Survey and Construction Method	0.41	0.00	0.34	0.33	0.00	0.00	1.08
Minimise By Underbore	0.41	0.00	0.00	0.00	0.00	0.00	0.41
Minimised By Construction Method	0.00	1.51	3.11	0.65	0.00	0.00	5.27
Residual Impacts	0.00	0.00	0.00	0.28	0.00	0.00	0.28
Main Spine Line Corridor (inc. assessment envelope)	**0.67**	**2.09**	**14.72**	**4.40**	0.00	0.00	21.88
Avoid By Exclusion	0.00	0.20	0.09	0.00	0.00	0.00	0.28
Minimise By Detailed Ground Survey and Construction Method	0.67	1.30	14.16	4.36	0.00	0.00	20.48
Minimise By Underbore	0.00	0.00	0.46	0.00	0.00	0.00	0.46
Minimised By Construction Method	0.00	0.59	0.01	0.00	0.00	0.00	0.60
Residual Impacts	0.00	0.00	0.00	0.04	0.00	0.00	0.04
Well Assessment Area (inc. assessment envelope)	**1.03**	**10.18**	**5.47**	**6.25**	0.00	0.00	22.93
Avoid By Exclusion	0.70	10.05	4.52	0.27	0.00	0.00	15.54
Minimise By Detailed Ground Survey and Construction Method	0.00	0.14	0.54	0.36	0.00	0.00	1.04
Minimise By Underbore	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Minimised By Construction Method	0.33	0.00	0.40	1.22	0.00	0.00	1.94
Residual Impacts	0.00	0.00	0.00	4.41	0.00	0.00	4.41
Grand Total (Subject Site only)	3.46	13.90	26.45	12.07	0.00	0.00	55.88
Avoid By Exclusion	0.73	10.24	5.85	0.27	0.00	0.00	17.09

	Alluvial Woodland (RFEFCF)	Cumberland Plain Woodland (TSC Act & EPBC Act)	Cumberland Plain Woodland (TSC Act)	Shrubland	Moist Shale Woodland	Western Sydney Dry Rainforest	Grand Total
Minimise By Detailed Ground Survey and Construction Method	1.07	1.55	16.61	5.05	0.00	0.00	24.29
Minimise By Underbore	0.41	0.00	0.46	0.00	0.00	0.00	0.87
Minimised By Construction Method	1.25	2.10	3.52	1.87	0.00	0.00	8.74
Residual Impacts	0.00	0.00	0.00	4.88	0.00	0.00	4.88

The only residual impact of the Amended Project, after the implementation of impact avoidance, minimisation and mitigation measures is the removal of 4.88 has of Shrubland. There will be no removal of CPSW, CPW or RFEFCF.

The residual impacts to the biodiversity values of the Subject Site associated with the Amended Project are therefore considered negligible, with no impact to TECs or significant habitat for threatened species likely to occur. This includes avoidance of impacts to 13.9 ha of CPSW (TSC & EPBC Act), 40.35 ha of CPW (TSC Act) and 3.46 ha of RFEFCF. It also includes avoidance of impacts to 7.19 ha of Shrubland.

Avoidance of impacts to native vegetation, and microalignment to avoid the need for removal of trees, has resulted in negligible impacts to fauna species recorded or considered likely to occur within the Amended Project area, including the CPLS.

5.0 IMPACT ASSESSMENTS

The impacts of the Amended Project on threatened biota listed under the TSC Act have been assessed in Section 5.1 in accordance with the *Draft Guidelines for Threatened Species Assessment* (DEC & DPI 2005) and are presented in Appendix 4. Impacts on threatened biota listed under the EPBC Act have been assessed in Section 5.2 in accordance with the *Matters of National Environmental Significance: Significant Impact Guidelines 1.1* (DEWHA 2009) and are presented in Appendix 5.

Where threatened biota **is recorded** within the Surface Project Area an assessment of significance is required. When threatened biota **is not recorded** during a survey, the presence of potential habitat for this species is used to determine the need to undertake an assessment of significance. Where there is no potential habitat in the Surface Project Area for threatened biota, there is unlikely to be any impact on these species and therefore these species are not required to be considered further.

Impact assessments outlined below are based on residual impacts outlined in Section 4.3 once the impact avoidance, minimisation and mitigation measures outlined in Section 4.2 have been implemented.

5.1 Draft Guidelines for Threatened Species Assessment (EP&A Act)

5.1.1 Threatened Ecological Communities

Four TECs listed under the TSC Act have been mapped in the Surface Project Area by NPWS (2002d). One CEEC, CPW, and one EEC, RFEFCF have been recorded in field surveys at several locations in the current investigation. The potential impacts of the Amended Project on these threatened ecological communities are considered in Appendix 4.

5.1.2 Flora

Although not a limiting factor, regrowth and remnant stands of CPW and CPSW provide the most optimal habitat for the five threatened flora species and single threatened flora population with a medium to high likelihood of occurrence in the Subject Site. In addition to preferred habitat such as vegetation community, plant species associations and soil types, this assessment has considered the distribution and number of observations of previous records (Figure 3) to determine a list of threatened flora species that have been considered in relation to potential impacts associated with the Amended Project (Table 8). The threatened flora species that have been assessed according to the Draft Guidelines are *Acacia pubescens, Cynanchum elegans, Pimelea spicata, Pomaderris brunnea* and *Thesium australe*. One threatened population known from the Locality has a medium to high potential to occur in the Subject Site and Subject Site. Appendix 4 provides the assessments for the five threatened flora species and flora population in full.

5.1.3 Fauna

Apart from an observation of CPLS in the Surface Project Area outside the Subject Site, no other threatened fauna were recorded during the current survey. However, where there is potential habitat (foraging or breeding resources) for a threatened species in the Subject Site, consideration has been given to the potential for these species to occur in the Subject Site and the potential impact of the Amended Project on these species (Table 3; Appendix 4).

The Amended Project may significantly impact threatened species by causing any of the following situations to arise:

- death or injury of individuals;
- loss or disturbance of limiting foraging resources; and
- loss or disturbance of limiting breeding resources.

Limiting resources are specialised habitat components that species are dependent on for their ongoing survival. Such limiting resources are predominantly associated with specialised breeding habitats (such as tree hollows or suitable nest/maternity roost sites) that occur at low densities, with high levels of competition from a range of species. However for some species, limiting resources include specialised foraging habitats that have a restricted distribution (such as Koalas feeding only on specific tree species).

Based on database records, the field assessments of habitats and other considerations (see Appendix 6) it is considered that there is a medium to high likelihood for seven threatened bird species, six threatened bat species and CPLS to occur in the Subject Site and potentially use the habitats of the Subject Site (Table 6). Accordingly impact assessments have been prepared for these TSC Act-listed species in Appendix 4.

The remaining 31 TSC Act-listed threatened species are considered to have a low likelihood of occurrence in the Surface Project Area and on the Subject Site and have not been considered further.

5.1.4 Conclusions of the Impact Assessments

The impact assessments (Appendix 4) concluded that the Amended Project is likely to have a negligible impact on threatened species, populations and communities, as listed under the TSC Act, provided the avoidance measures and recommended mitigation measures are adhered to.

5.1.5 Key Thresholds

The Draft Guidelines (DEC & DPI 2005) set out a number of key thresholds which need to be addressed to justify the impacts of the Amended Project on threatened species, populations or ecological communities. The key thresholds are:

- whether or not the proposal, including actions to avoid or mitigate impacts or compensate to prevent unavoidable impacts, will maintain or improve biodiversity values;
- whether or not the proposal is likely to reduce the long-term viability of a local population of the species, population or ecological community;
- whether or not the proposal is likely to accelerate the extinction of the species, population or ecological community or place it at risk of extinction; and,
- whether or not the proposal will adversely affect critical habitat.

Based on the impact assessments following the Draft Guidelines (DEC & DPI 2005) (Appendix 4), the Amended Project is unlikely to reduce the long-term viability of, accelerate the extinction of and/or adversely affect critical habitat for threatened species and/or populations within the Subject Site provided the actions to avoid impacts and the recommendations of Section 4.2 in this report are followed.

The design of the current Amended Project has been guided by an over-arching principle to avoid any area either known or likely to support threatened biodiversity (such as CPW) or potential habitats. Commitment to continued efforts to minimise potential impacts to threatened biodiversity and its habitat, as described in Section 4.1.4 above and implementation of mitigation measures, described in Section 5 following is unlikely to result residual impacts from the proposed works.

Construction and operation of the project in cleared and disturbed areas will not significantly impact on or further degrade the biodiversity values of this landscape type in the Subject Site. Overall biodiversity values will be maintained throughout the Surface Project Area in cleared and disturbed areas including on the Subject Site.

Table 11: Assessment of Key Thresholds

Threatened Biota	Whether or not the Amended Project, including actions to avoid or mitigate impacts or compensate to prevent unavoidable impacts, will maintain or improve biodiversity values.	Will the Amended Project reduce the long-term viability of a local population of the species, population or EEC?	Will the Amended Project accelerate the extinction of the species, population or EEC or place it at risk of extinction?	Will the Amended Project adversely affect critical habitat?
Threatened Ecological Communities				
Cumberland Plain Woodland	Likely to maintain biodiversity values	Unlikely	Unlikely	No
River Flat Eucalypt Forest on Coastal Floodplains	Likely to maintain biodiversity values	Unlikely	Unlikely	No
Threatened Flora				
Acacia pubescens	Likely to maintain biodiversity values	Unlikely	Unlikely	No
Cynanchum elegans	Likely to maintain biodiversity values	Unlikely	Unlikely	No
Marsdenia viridiflora ssp. *viridiflora*	Likely to maintain biodiversity values	Unlikely	Unlikely	No
Pimelea spicata	Likely to maintain biodiversity values	Unlikely	Unlikely	No
Pomaderris brunnea	Likely to maintain biodiversity values	Unlikely	Unlikely	No
Thesium australe	Likely to maintain biodiversity values	Unlikely	Unlikely	No
Threatened Fauna				
Cumberland Land Snail	Likely to maintain biodiversity values	Unlikely	Unlikely	No
Grey-headed Flying Fox	Likely to maintain biodiversity values	Unlikely	Unlikely	No
Microchiropteran Bats (Eastern Freetail-bat, Eastern False Pipistrelle Eastern Bentwing Bat Large-footed Myotis and Greater Broad-nosed Bat)	Likely to maintain biodiversity values	Unlikely	Unlikely	No
Threatened woodland birds - Little Eagle, Diamond Firetail, Hooded Robin, Speckled Warbler, Little Lorikeet and the Swift Parrot	Likely to maintain biodiversity values	Unlikely	Unlikely	No
Bush Stone-curlew	Likely to maintain biodiversity values	Unlikely	Unlikely	No

5.2 Commonwealth Significant Impact Criteria (EPBC Act)

Under the EPBC Act, a person who proposes to take an action that will have, or is likely to have, a significant impact on a matter of national environmental significance must refer that action to the Federal Minister for the Environment for a decision on whether assessment and approval is required under the EPBC Act.

The Significant Impact Criteria set out in the *Matters of National Environmental Significant: Significant Impact Guidelines 1.1* (DEWHA 2009) are used to assess the likelihood of a significant impact of an action (in this case the Amended Project). Following the application of these criteria, a 'significant impact' can be considered as an impact which is important, notable, or of consequence, having regard to its context or intensity. Whether or not an action is likely to have a significant impact depends upon the sensitivity, value, and quality of the environment which is impacted, and upon the intensity, duration, magnitude and geographic extent of the impacts (DEWHA 2009).

EPBC Act assessments addressing the Significant Impact Criteria are presented in Appendix 5. The assessments have considered the residual impacts outlined in Section 4.3 following implementation of mitigation measures outlined in Section 4.2.

5.2.1 Critically Endangered Ecological Communities (CEEC)

The CEEC CPW listed under the TSC Act has been mapped in the Surface Project Area by NPWS (2002d). This mapping has been modified in places throughout the Subject Site and adjoining areas following field surveys by Biosis with reference to the clauses of the NSW Scientific Committee (2009a) Final Determination for the community and thresholds outlined in DEWHA (2010). In summary CPW listed under the TSC Act and which is consistent with the criteria described by (DEWHA 2010) is considered to form CPSW listed as a CEEC under the EPBC Act. CPSW has been mapped on the Subject Site and in some adjoining areas following detailed site surveys. Although the presence and absence of the community has not been verified for the entire Surface Project Area it is identified in several locations including multiple WSLs, some GGLs and the Main Gas Gathering Spine during the current investigation (Figures 6a to 6q). The potential impacts of the Amended Project on the EPBC Act listed CPSW have been considered in Appendix 5.

5.2.2 Flora

Of the 24 EPBC Act threatened flora species previously recorded within 10km of the Surface Project Area five species, *Acacia pubescens, Cynanchum elegans, Pimelea spicata, Pomaderris brunnea* and *Thesium australe*, are considered to have a medium to high likelihood to occur in the Surface Project Area and potentially on the Subject Site. Accordingly, the impact of the Amended Project on these species is summarised in Section 5 and has been considered in Appendix 5.

5.2.3 Fauna

Twenty six threatened fauna species and migratory species were recorded as having the potential to occur within 10km of the Surface Project Area (DSEWPAC online database). Of these, five threatened species are considered to have a medium to high potential to occur in the Subject Site. One migratory species was recorded in the field surveys and a further three migratory species potentially utilise the habitats of the Subject Site.

Assessments of the Significance Impact Criteria have been prepared for these species in Appendix 5. Potential habitat for the remaining 30 threatened species does not occur within the Subject Site or is not limiting (as defined in Section 4.1.3) and therefore Assessments of Significance are not required for these species.

5.2.4 Conclusions of the Significant Impact Criteria

Having regard to the Significant Impact Criteria Assessments under the EPBC Act (Appendix 5), the assessment undertaken for the Amended Project indicates that the Amended Project is not likely to have a significant impact on threatened species and ecological communities or their habitats, as listed on the EPBC Act, provided the impact avoidance and minimisation actions highlighted above and recommended mitigation measures in Section 4.2 are implemented.

Accordingly, a referral to the DSEWPaC is not required on the basis that the Amended Project is not likely to have a significant impact on a matter of national environmental significance. Despite this, AGL may consider lodging a referral on the basis that the Amended Project is not a controlled action to confirm that approval under the EPBC Act is not required.

6.0 CONCLUSIONS

This report outlines the results of flora and fauna assessments undertaken for the Amended Project.

Three TECs, that is CPW, CPSW and RFEFCF, were recorded within the Subject Site.

No threatened flora or fauna species were recorded within the Subject Site. One threatened fauna species, the CPLS, was recorded immediately adjacent to the Subject Site. There is a medium to high likelihood for five threatened flora species and 13 threatened fauna species to occur within the Subject Site.

Potential impacts to the biodiversity values identified include:

- Impacts to 13.9 ha of CPSW as listed under the EPBC and TSC Acts;
- Impacts to 40.35 ha of CPW as listed under the TSC Act;
- Impacts to 3.46 ha of RFEFCF as listed under the TSC Act;
- Impacts to 12.07 ha of Shrubland; and
- Impacts to known and potential habitat for the Cumberland Plain Land Snail.

As discussed throughout this report, the design and assessment methodology of the Amended Project have been guided by an over-arching principle to avoid and minimise impacts to any area either known or likely to support threatened biodiversity (such as CPW). Measures to avoid and minimise impacts to the identified biodiversity values have resulted in a negligible impact to threatened species, populations and communities, with only minor removal of modified or common vegetation communities, such as Shrubland or Closed Grassland, with minor habitat value for fauna required. With the implementation of these measures, the only residual impacts of the Amended Project is the removal of 4.88 ha of Shrubland. The Amended Project will not result in the removal of any CPSW, CPW, RFEFCF, and will not impact on potential habitat for the Cumberland Plain Land Snail.

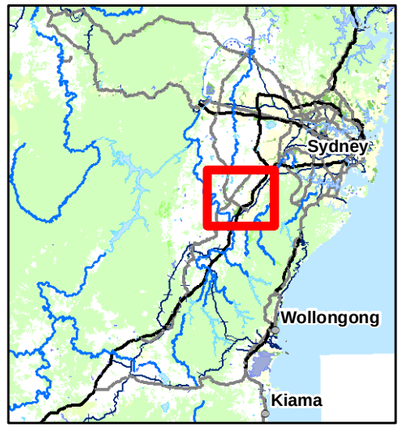
Impact assessments following the Draft Guidelines (DEC & DPI 2005) were carried out for threatened biota listed under the TSC Act, occurring or with potential habitat in the Subject Site. These assessments identified that the project is unlikely to significantly affect the lifecycles or the long term survival of any of the assessed species. The Amended Project will:

- maintain or improve biodiversity;
- not reduce the long term viability of any threatened species, population or community;
- not accelerate the extinction of a threatened species, population or community; or,
- adversely effect critical habitat.

The Amended Project meets key thresholds outlined in the Draft Guidelines DEC & DPI (2005).

Impact assessments following the *Significant Impact Guidelines* under the EPBC Act (DEWHA 2009) were carried out for threatened biota listed under the EPBC, occurring or with potential habitat in the Surface Project Area. These assessments identified that the Amended Project is unlikely to result in a significant impact to CPW, five threatened flora species or five threatened fauna species outlined in Section 3.0. A referral to the DSEWPaC is not required on the basis that the Amended Project is not likely to have a significant impact on a matter of national environmental significance. Despite this, AGL may consider lodging a referral on the basis that the Amended Project is not a controlled action to confirm that approval under the EPBC Act is not required.

FIGURES



Legend

Well Locations
- Well Surface Location
- Well Assessment Area

Gas Gathering Lines
- Gas Gathering Line
- Main Gas Gathering Spine

Access Tracks
- Access Track

Survey Area
- Surface Project Area
- Subsurface Project Area

Figure 1: Overview of Surface and Subsurface Project Areas, showing Well Surface Locations, Main Spine Line and Gas Gathering Lines

0 0.65 1.3 1.95 2.6 3.25

Kilometers

Scale: 1:65,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

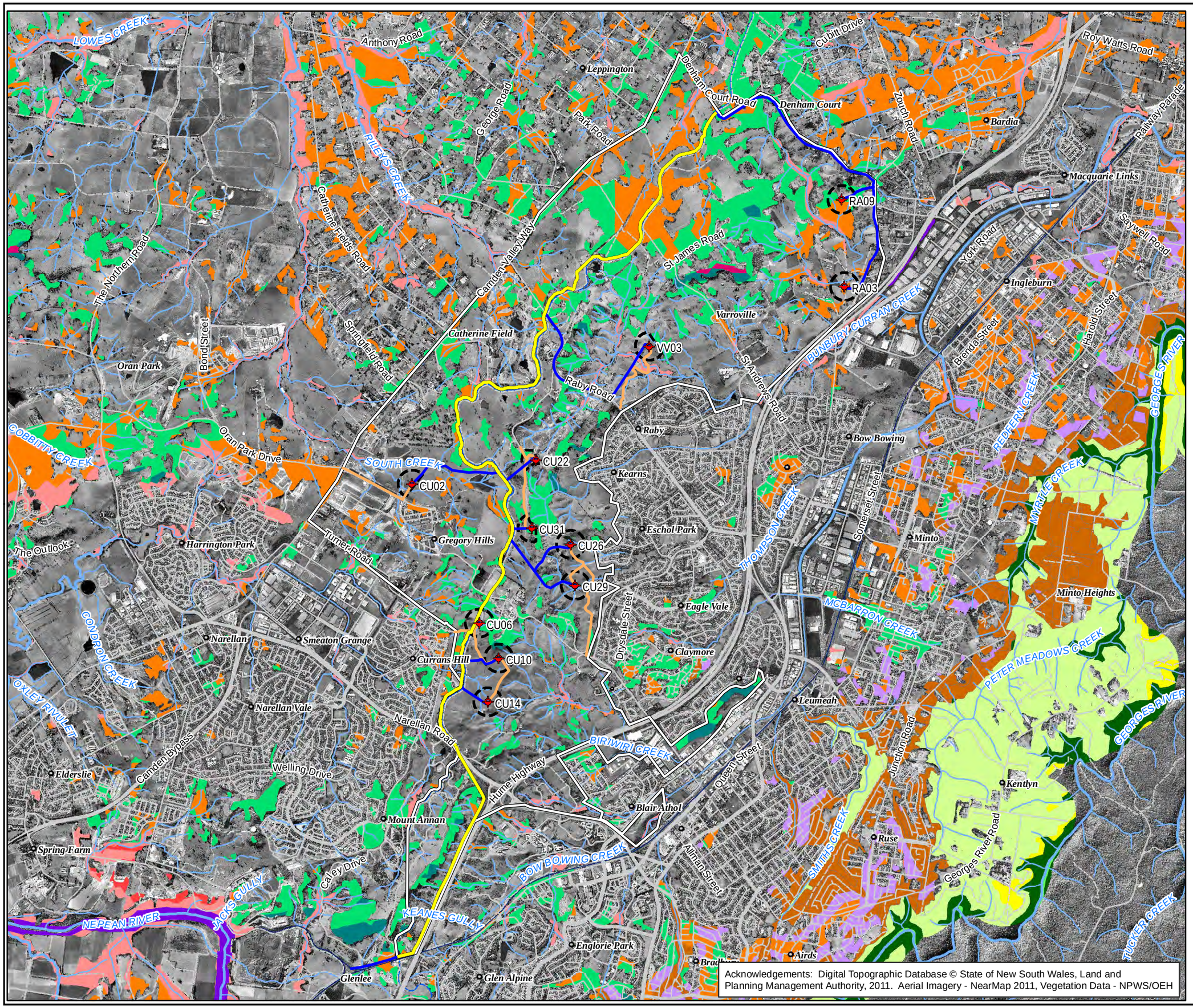
Biosis Research Pty. Ltd.
8 Tate Street
Wollongong
NEW SOUTH WALES
2500

Offices also in: Sydney, Canberra, Ballarat, Melbourne, Wangaratta

N

Date: 05 September 2012, File number: 13320
Checked by: BWM, Drawn by: ANP
Location:P:\13300s\13320\Mapping\Variation Mapping June 2012\V4 Report Figures_FINAL\13320 F1 V4_Overview_20120830.mxd

Acknowledgements: Digital Topographic Database © State of New South Wales, Land and Planning Management Authority, 2011. Aerial Imagery - NearMap 2011



Legend

Vegetation Communities
- Alluvial Woodland
- Cooks River Castlereagh Ironbark Forest
- Elderslie Banksia Scrub Forest
- Moist Shale Woodland
- Riparian Forest
- Riparian Scrub
- Sandstone Ridgetop Woodland
- Shale Hills Woodland
- Shale Plains Woodland
- Shale Sandstone Transition Forest (High Sandstone Influence)
- Shale Sandstone Transition Forest (Low Sandstone Influence)
- Shale/Gravel Transition Forest
- Turpentine-Ironbark Margin Forest
- Upper Georges River Sandstone Woodland
- Western Sandstone Gully Forest
- Western Sydney Dry Rainforest
- Woodland Heath Complex

Well Locations
- Well Surface Location
- Well Assessment

Gas Gathering Lines
- Gas Gathering Line
- Main Gas Gathering Spine

Access Tracks
- Access Track

Survey
- Surface Project Area

Figure 2: Overview of Cumberland Plain Vegetation communities (NPWS 2002) within the vicinity of the Surface Project Area

0 0.5 1 1.5 2 2.5

Kilometers

Scale: 1:50,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

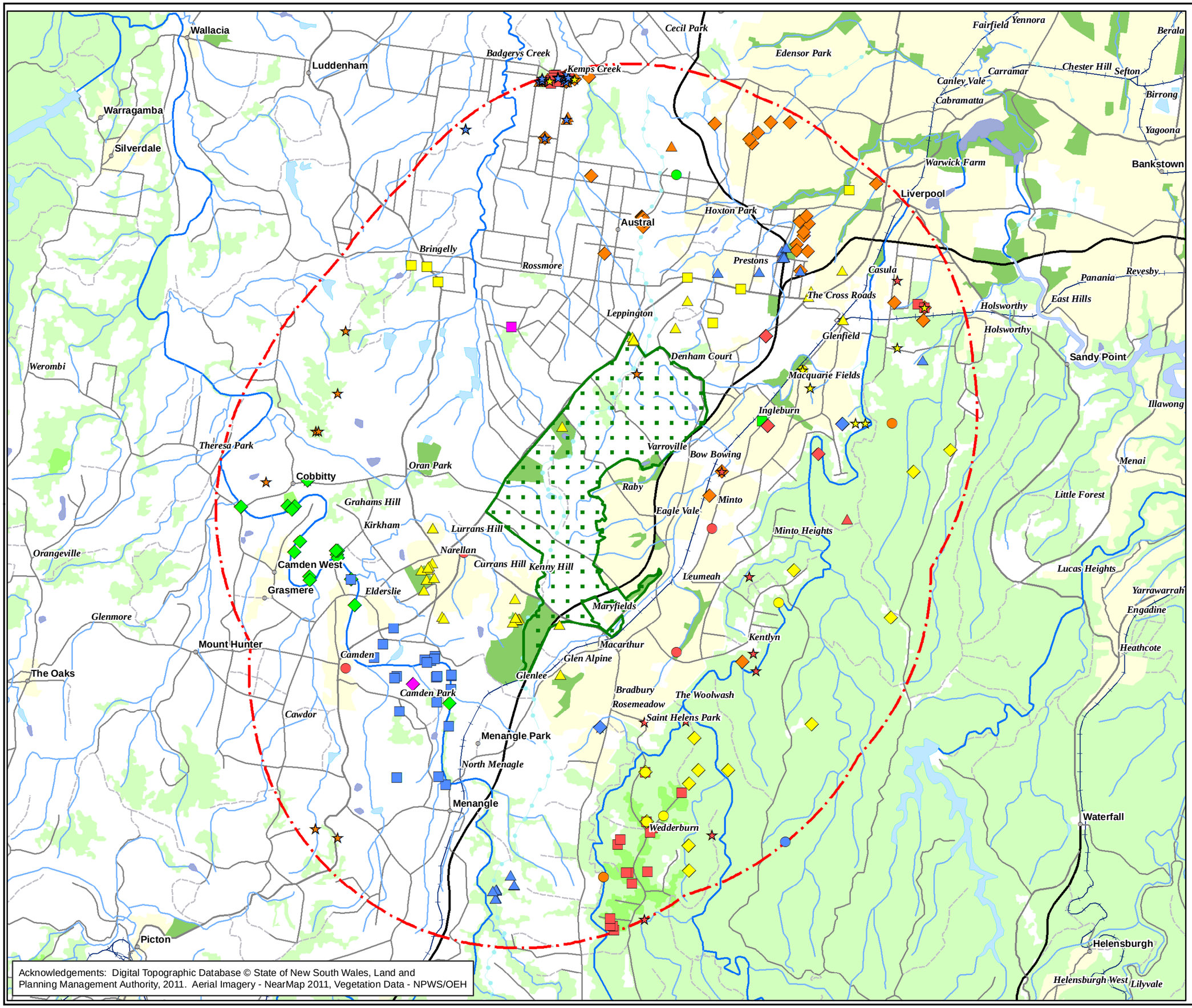
Biosis Research Pty. Ltd.
8 Tate Street
Wollongong
NEW SOUTH WALES
2500

Offices also in: Sydney, Canberra, Ballarat, Melbourne, Wangaratta

N

Acknowledgements: Digital Topographic Database © State of New South Wales, Land and Planning Management Authority, 2011. Aerial Imagery - NearMap 2011, Vegetation Data - NPWS/OEH

Date: 30 August 2012, File number: 13320
Checked by: BWM, Drawn by: ANP
Location:P:\13320\s13320\Mapping\Validation Mapping June 2012\V4 Report Figures_FINAL\13320 F2 V4_Cumb Vegetation, 20120830.mxd



Acknowledgements: Digital Topographic Database © State of New South Wales, Land and Planning Management Authority, 2011. Aerial Imagery - NearMap 2011, Vegetation Data - NPWS/OEH

Legend

Threatened Flora

- Acacia bynoeana
- Acacia pubescens
- Callistemon linearifolius
- Cynanchum elegans
- Dillwynia tenuifolia
- Diuris lanceolata
- Eucalyptus benthamii
- Eucalyptus scoparia
- Genoplesium baueri
- Grevillea juniperina subsp. juniperina
- Grevillea parviflora subsp. parviflora
- Gyrostemon thesioides
- Lepidium hyssopifolium
- Leucopogon exolasius
- Leucopogon fletcheri subsp. fletcheri
- Marsdenia viridiflora subsp. viridiflora
- Melaleuca deanei
- Persoonia hirsuta
- Persoonia nutans
- Pimelea spicata
- Pomaderris brunnea
- Pterostylis saxicola
- Pultenaea aristata
- Pultenaea parviflora
- Pultenaea pedunculata
- Syzygium paniculatum
- Thesium australe

Survey Area

- Surface Project Area
- 10km Seach Area

Figure 3: Threatened flora, listed on the TSC and EPBC Act, recorded within 10km of the Project Area.

0 1 2 3 4 5

Kilometers

Scale: 1:130,000 @ A3

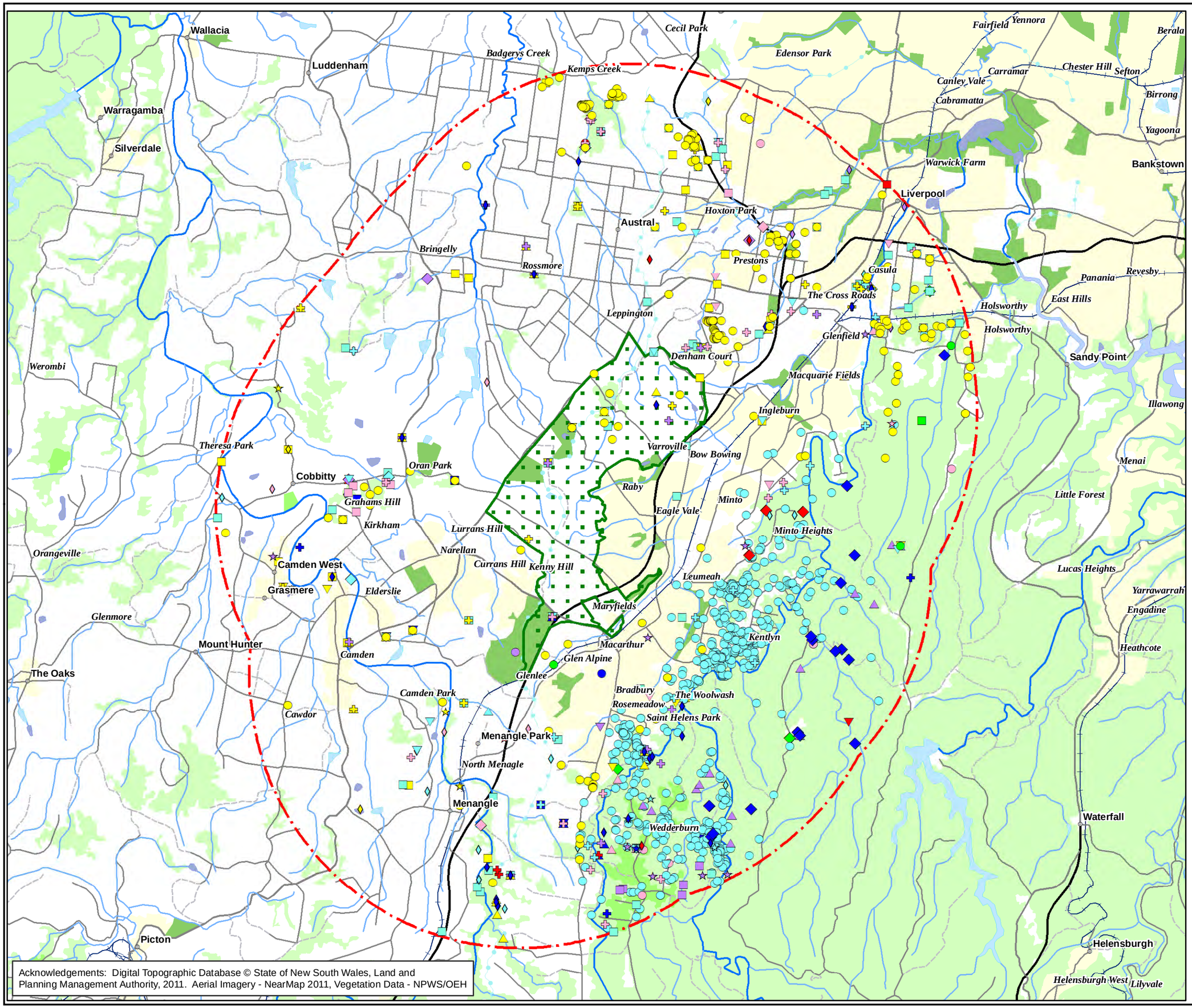
Coordinate System: GDA 1994 MGA Zone 56

Biosis Research Pty. Ltd.
8 Tate Street
Wollongong
NEW SOUTH WALES
2500

Offices also in: Sydney, Canberra, Ballarat, Melbourne, Wangaratta

N

Date: 30 August 2012, File number: 13320
Checked by: BWM, Drawn by: ANP
Location:P:\13300s\13320\Mapping\Variation Mapping June 2012\V4 Report Figures_FINAL\13320 F3 V4_Thr Flora_21208...



Acknowledgements: Digital Topographic Database © State of New South Wales, Land and Planning Management Authority, 2011. Aerial Imagery - NearMap 2011, Vegetation Data - NPWS/OEH

Legend

Threatened and Migratory Fauna

- Barking Owl
- Black-chinned Honeyeater (eastern subspecies)
- Black-faced Monarch
- Black-necked Stork
- Blue-billed Duck
- Broad-headed Snake
- Brown Treecreeper (eastern subspecies)
- Bush Stone-curlew
- Cattle Egret
- Common Greenshank
- Cumberland Plain Land Snail
- Diamond Firetail
- Eastern Bentwing-bat
- Eastern False Pipistrelle
- Eastern Freetail-bat
- Eastern Great Egret
- Eastern Pygmy-possum
- Flame Robin
- Freckled Duck
- Gang-gang Cockatoo
- Giant Burrowing Frog
- Glossy Black-Cockatoo
- Greater Broad-nosed Bat
- Green and Golden Bell Frog
- Grey-headed Flying-fox
- Hooded Robin (south-eastern form)
- Koala
- Large-eared Pied Bat
- Latham's Snipe
- Little Eagle
- Little Lorikeet
- Powerful Owl
- Rainbow Bee-eater
- Red-crowned Toadlet
- Regent Honeyeater
- Rosenberg's Goanna
- Rufous Fantail
- Satin Flycatcher
- Scarlet Robin
- Southern Myotis
- Speckled Warbler
- Spotted Harrier
- Spotted-tailed Quoll
- Square-tailed Kite
- Squirrel Glider
- Swift Parrot
- Varied Sittella
- White-bellied Sea-Eagle
- White-fronted Chat
- White-throated Needletail
- Yellow-bellied Sheathtail-bat

Survey Area

- Surface Project Area
- 10km Seach Area

Figure 4: Threatened fauna, listed on the TSC and EPBC Act, recorded within 10km of the Project Area.

0 1 2 3 4 5

Kilometers

Scale: 1:130,000 @ A3

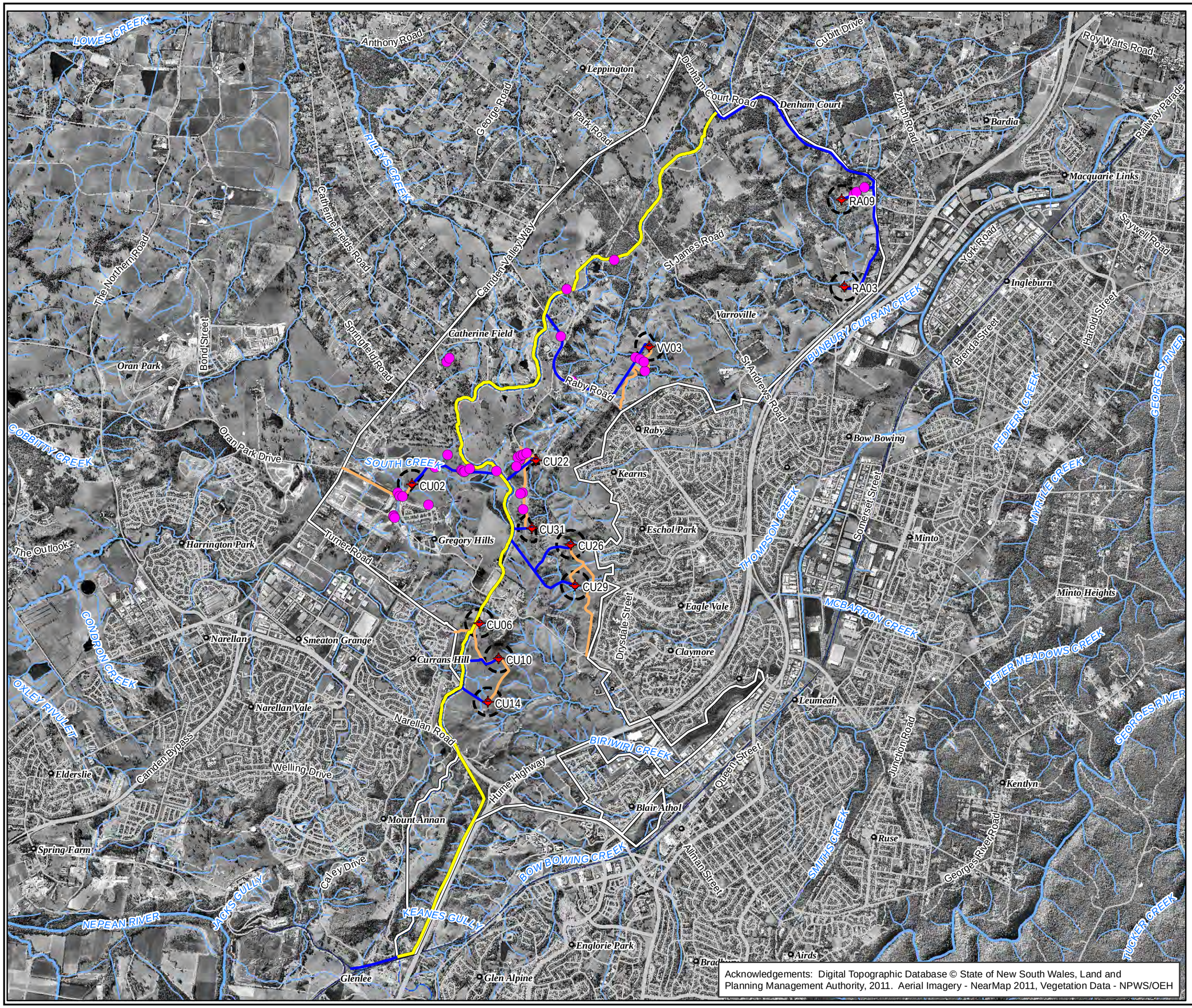
Coordinate System: GDA 1994 MGA Zone 56

Biosis Research Pty. Ltd.
8 Tate Street
Wollongong
NEW SOUTH WALES
2500

Offices also in: Sydney, Canberra, Ballarat, Melbourne, Wangaratta

N

Date: 30 August 2012, File number: 13320
Checked by: BWM, Drawn by: ANP
Location:P:\13300s\13320\Mapping\Variation Mapping June 2012\V4 Report Figures_FINAL\13320 F4 V4_Thr Fauna_10120830.mxd



Legend

Significant Sites
- Hollow Bearing Tree

Well Locations
- Well Surface Location
- Well Assessment Area

Gas Gathering Lines
- Gas Gathering Line
- Main Gas Gathering Spine

Access Tracks
- Access Track

Survey Area
- Surface Project Area

Acknowledgements: Digital Topographic Database © State of New South Wales, Land and Planning Management Authority, 2011. Aerial Imagery - NearMap 2011, Vegetation Data - NPWS/OEH

Figure 5: Hollow Bearing Trees in the Surface Project Area.

0 0.5 1 1.5 2 2.5

Kilometers

Scale: 1:50,000 @ A3

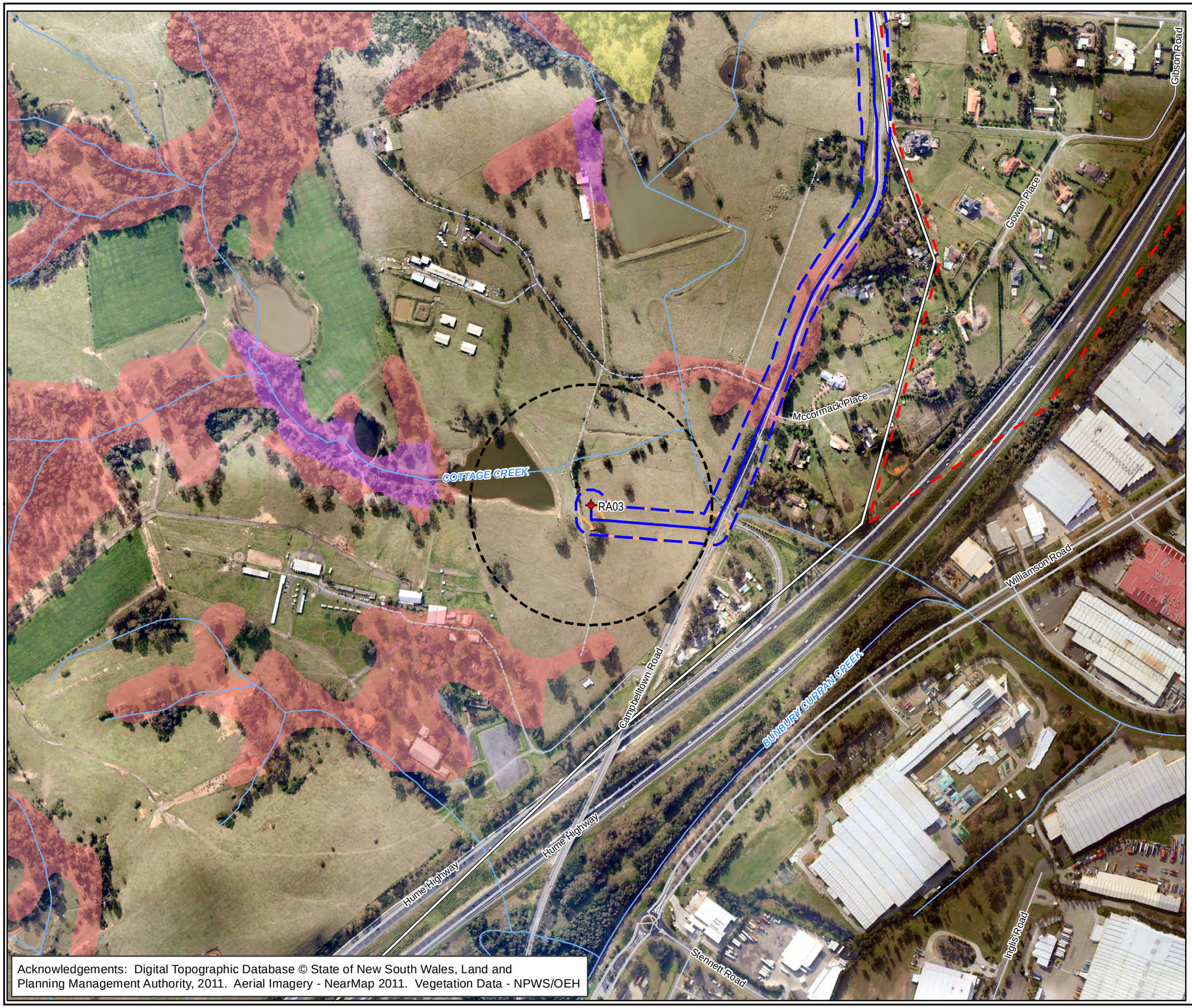
Coordinate System: GDA 1994 MGA Zone 56

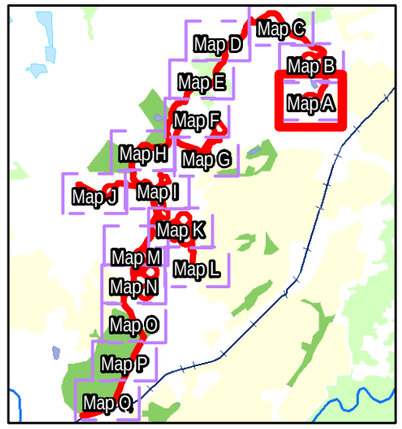
Biosis Research Pty. Ltd.
8 Tate Street
Wollongong
NEW SOUTH WALES
2500

Offices also in: Sydney, Canberra, Ballarat, Melbourne, Wangaratta

N

Date: 30 August 2012, File number: 13320
Checked by: BWM, Drawn by: ANP
Location:P:\13320\s\13320\Mapping\Variation Mapping June 2012\V4 Report Figures_FINAL\13320 FS V4_Hollow Bearing Trees_20120830.mxd





Legend

Vegetation Communities
- Cumberland Plain Woodland (TSC Act & EPBC Act)
- Cumberland Plain Woodland (TSC Act)
- Alluvial Woodland (RFEFCF)
- Moist Shale Woodland
- Shrubland

Well Locations
- Well Surface Location
- Well Assessment Area

Gas Gathering Lines
- Gas Gathering Line
- Gas Gathering Line Envelope
- Main Gas Gathering Spine
- Main Gas Gathering Spine Envelope

Access Tracks
- Access Track
- Access Track Envelope

Survey Area
- Surface Project Area
- Subsurface Project Area

Figure 6A: Vegetation Mapping of the Subject Site including Cumberland Plain Woodland (TSC Act), Cumberland Plain Woodland (EPBC & TSC Act) and River Flat Eucalypt Forest on Coastal Floodplain Threatened Ecological Communities

0 50 100 150 200 250

Meters

Scale: 1:5,800 @ A3

Coordinate System: GDA 1994 MGA Zone 56

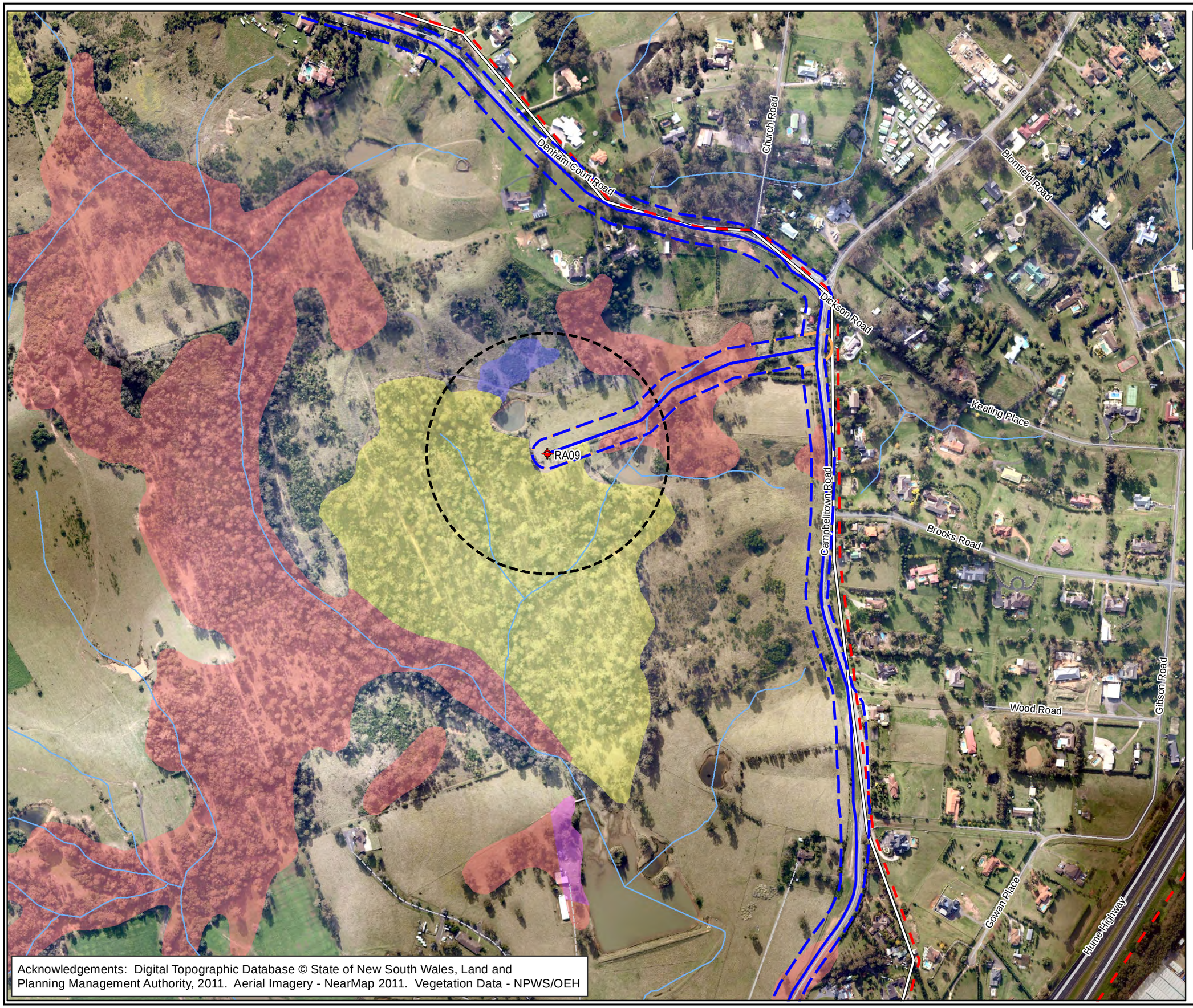
Biosis Research Pty. Ltd.
8 Tate Street
Wollongong
NEW SOUTH WALES
2500

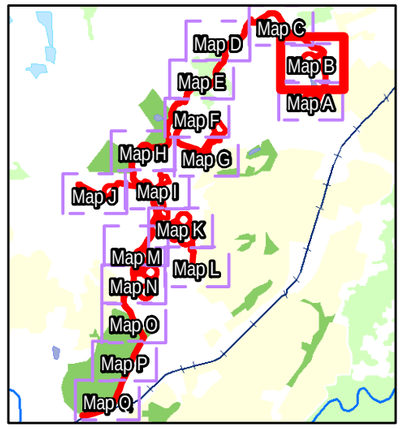
Offices also in: Sydney, Canberra, Ballarat, Melbourne, Wangaratta

N

Date: 06 September 2012, File number: 13320
Checked by: BWM, Drawn by: ANP
Location:P:\13320\GIS\13320\Mapping\Validation Mapping June 2012\V4 Report Figures_FINAL\13320 F6 V4_Vegetation_20120830.mxd

Acknowledgements: Digital Topographic Database © State of New South Wales, Land and Planning Management Authority, 2011. Aerial Imagery - NearMap 2011. Vegetation Data - NPWS/OEH





Legend

Vegetation Communities
- Cumberland Plain Woodland (TSC Act & EPBC Act)
- Cumberland Plain Woodland (TSC Act)
- Alluvial Woodland (RFEFCF)
- Moist Shale Woodland
- Shrubland

Well Locations
- Well Surface Location
- Well Assessment Area

Gas Gathering Lines
- Gas Gathering Line
- Gas Gathering Line Envelope
- Main Gas Gathering Spine
- Main Gas Gathering Spine Envelope

Access Tracks
- Access Track
- Access Track Envelope

Survey Area
- Surface Project Area
- Subsurface Project Area

Figure 6B: Vegetation Mapping of the Subject Site including Cumberland Plain Woodland (TSC Act), Cumberland Plain Woodland (EPBC & TSC Act) and River Flat Eucalypt Forest on Coastal Floodplain Threatened Ecological Communities

0 50 100 150 200 250

Meters
Scale: 1:5,800 @ A3
Coordinate System: GDA 1994 MGA Zone 56

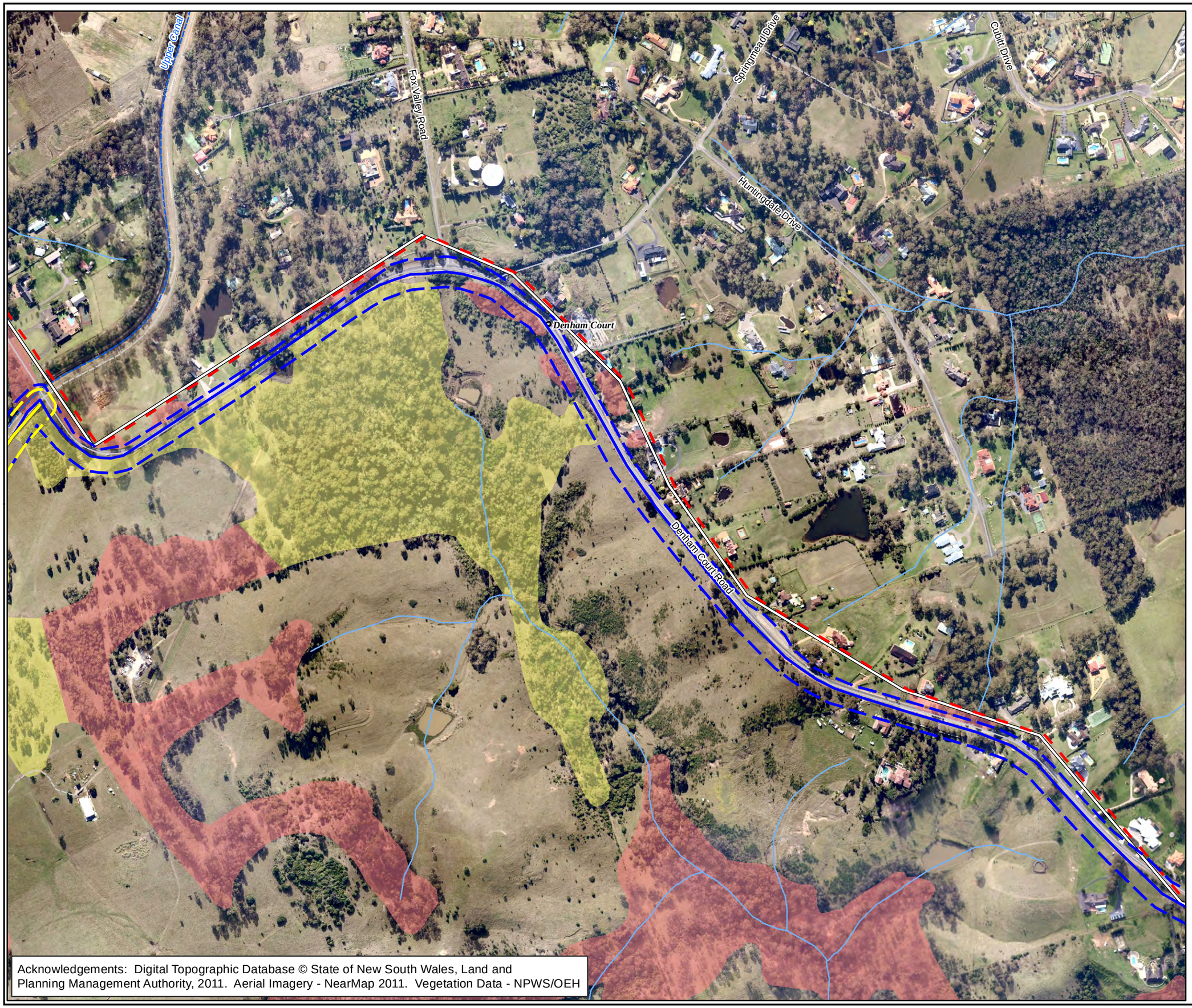
Biosis Research Pty. Ltd.
8 Tate Street
Wollongong
NEW SOUTH WALES
2500

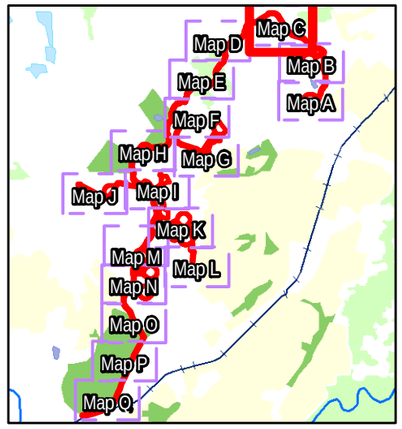
Offices also in: Sydney, Canberra, Ballarat, Melbourne, Wangaratta

N

Date: 06 September 2012, File number: 13320
Checked by: BWM, Drawn by: ANP
Location:P:\13320\d13320\Mapping\Vegetation Mapping June 2012\V4 Report Figures_FINAL\13320 F6 V4_Vegetation_20120830.mxd

Acknowledgements: Digital Topographic Database © State of New South Wales, Land and Planning Management Authority, 2011. Aerial Imagery - NearMap 2011. Vegetation Data - NPWS/OEH





Legend

Vegetation Communities
- Cumberland Plain Woodland (TSC Act & EPBC Act)
- Cumberland Plain Woodland (TSC Act)
- Alluvial Woodland (RFEFCF)
- Moist Shale Woodland
- Shrubland

Well Locations
- Well Surface Location
- Well Assessment Area

Gas Gathering Lines
- Gas Gathering Line
- Gas Gathering Line Envelope
- Main Gas Gathering Spine
- Main Gas Gathering Spine Envelope

Access Tracks
- Access Track
- Access Track Envelope

Survey Area
- Surface Project Area
- Subsurface Project Area

Figure 6C: Vegetation Mapping of the Subject Site including Cumberland Plain Woodland (TSC Act), Cumberland Plain Woodland (EPBC & TSC Act) and River Flat Eucalypt Forest on Coastal Floodplain Threatened Ecological Communities

0 50 100 150 200 250

Meters
Scale: 1:5,800 @ A3
Coordinate System: GDA 1994 MGA Zone 56

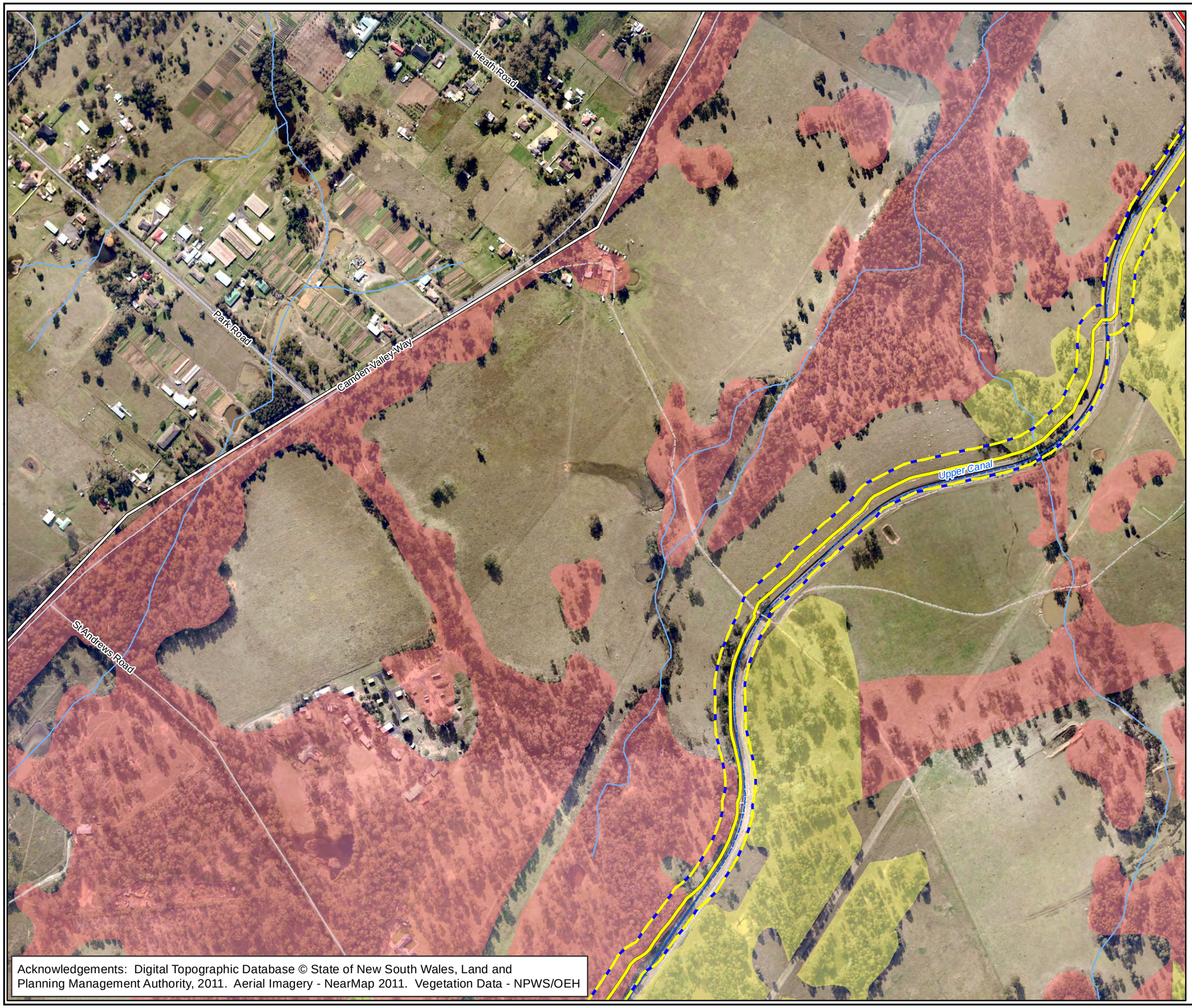
Biosis Research Pty. Ltd.
8 Tate Street
Wollongong
NEW SOUTH WALES
2500

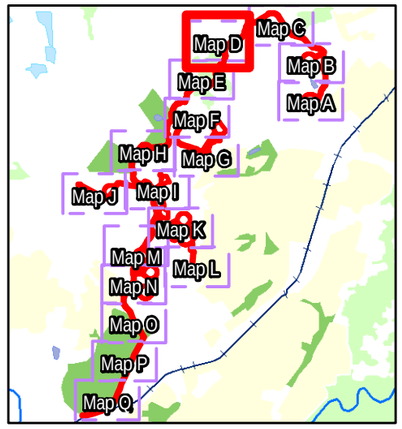
Offices also in: Sydney, Canberra, Ballarat, Melbourne, Wangaratta

N

Date: 06 September 2012, File number: 13320
Checked by: BWM, Drawn by: ANP
Location:P:\13320\GIS\13320\Mapping\Vegetation Mapping June 2012\V4 Report Figures_FINAL\13320 F6 V4_Vegetation_20120830.mxd

Acknowledgements: Digital Topographic Database © State of New South Wales, Land and Planning Management Authority, 2011. Aerial Imagery - NearMap 2011. Vegetation Data - NPWS/OEH





Legend

Vegetation Communities
- Cumberland Plain Woodland (TSC Act & EPBC Act)
- Cumberland Plain Woodland (TSC Act)
- Alluvial Woodland (RFEFCF)
- Moist Shale Woodland
- Shrubland

Well Locations
- Well Surface Location
- Well Assessment Area

Gas Gathering Lines
- Gas Gathering Line
- Gas Gathering Line Envelope
- Main Gas Gathering Spine
- Main Gas Gathering Spine Envelope

Access Tracks
- Access Track
- Access Track Envelope

Survey Area
- Surface Project Area
- Subsurface Project Area

Figure 6D: Vegetation Mapping of the Subject Site including Cumberland Plain Woodland (TSC Act), Cumberland Plain Woodland (EPBC & TSC Act) and River Flat Eucalypt Forest on Coastal Floodplain Threatened Ecological Communities

0 50 100 150 200 250

Meters
Scale: 1:5,800 @ A3
Coordinate System: GDA 1994 MGA Zone 56

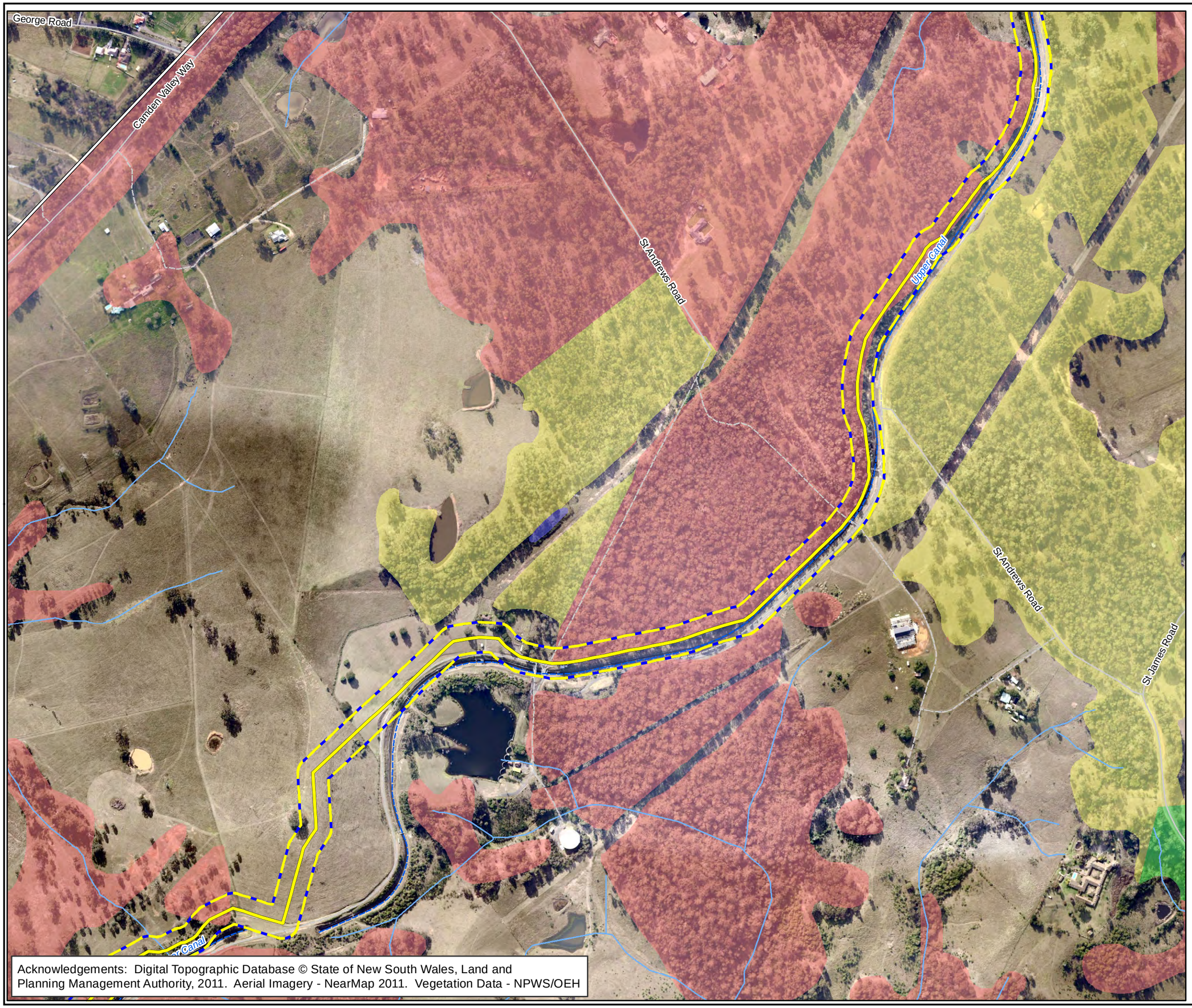
Biosis Research Pty. Ltd.
8 Tate Street
Wollongong
NEW SOUTH WALES
2500

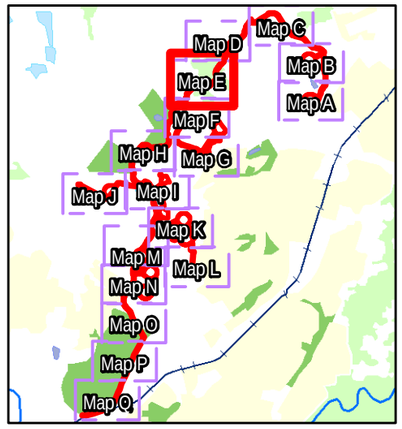
Offices also in: Sydney, Canberra, Ballarat, Melbourne, Wangaratta

N

Date: 06 September 2012, File number: 13320
Checked by: BWM, Drawn by: ANP
Location:P:\13320\s13320\Mapping\Vegetation Mapping June 2012\V4 Report Figures_FINAL\13320 F6 V4_ Vegetation_20120830.mxd

Acknowledgements: Digital Topographic Database © State of New South Wales, Land and Planning Management Authority, 2011. Aerial Imagery - NearMap 2011. Vegetation Data - NPWS/OEH





Legend

Vegetation Communities
- Cumberland Plain Woodland (TSC Act & EPBC Act)
- Cumberland Plain Woodland (TSC Act)
- Alluvial Woodland (RFEFCF)
- Moist Shale Woodland
- Shrubland

Well Locations
- Well Surface Location
- Well Assessment Area

Gas Gathering Lines
- Gas Gathering Line
- Gas Gathering Line Envelope
- Main Gas Gathering Spine
- Main Gas Gathering Spine Envelope

Access Tracks
- Access Track
- Access Track Envelope

Survey Area
- Surface Project Area
- Subsurface Project Area

Figure 6E: Vegetation Mapping of the Subject Site including Cumberland Plain Woodland (TSC Act), Cumberland Plain Woodland (EPBC & TSC Act) and River Flat Eucalypt Forest on Coastal Floodplain Threatened Ecological Communities

0 50 100 150 200 250

Meters
Scale: 1:5,800 @ A3
Coordinate System: GDA 1994 MGA Zone 56

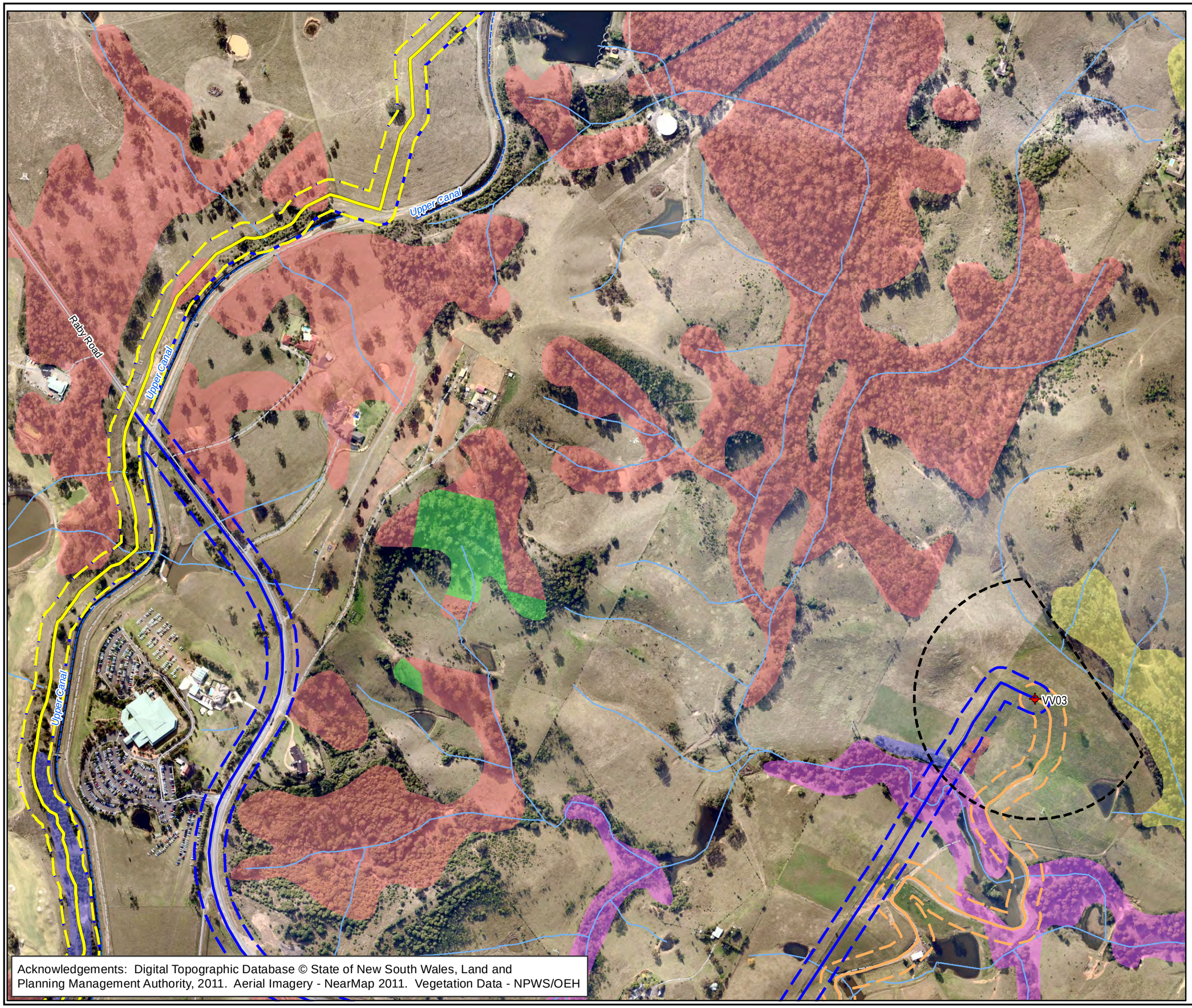
Biosis Research Pty. Ltd.
8 Tate Street
Wollongong
NEW SOUTH WALES
2500

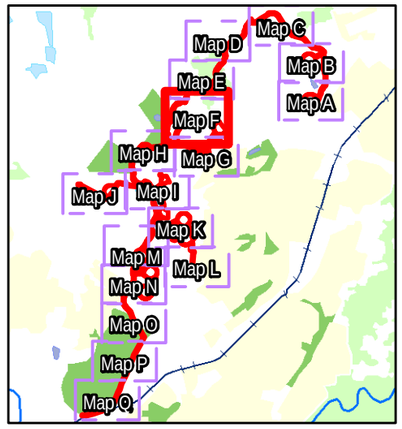
Offices also in: Sydney, Canberra, Ballarat, Melbourne, Wangaratta

N

Date: 06 September 2012, File number: 13320
Checked by: BWM, Drawn by: ANP
Location:P:\13320\d13320\Mapping\Validation Mapping June 2012\V4 Report Figures_FINAL\13320 F6 V4_Vegetation_20120830.mxd

Acknowledgements: Digital Topographic Database © State of New South Wales, Land and Planning Management Authority, 2011. Aerial Imagery - NearMap 2011. Vegetation Data - NPWS/OEH





Legend

Vegetation Communities
- Cumberland Plain Woodland (TSC Act & EPBC Act)
- Cumberland Plain Woodland (TSC Act)
- Alluvial Woodland (RFEFCF)
- Moist Shale Woodland
- Shrubland

Well Locations
- Well Surface Location
- Well Assessment Area

Gas Gathering Lines
- Gas Gathering Line
- Gas Gathering Line Envelope
- Main Gas Gathering Spine
- Main Gas Gathering Spine Envelope

Access Tracks
- Access Track
- Access Track Envelope

Survey Area
- Surface Project Area
- Subsurface Project Area

Figure 6F: Vegetation Mapping of the Subject Site including Cumberland Plain Woodland (TSC Act), Cumberland Plain Woodland (EPBC & TSC Act) and River Flat Eucalypt Forest on Coastal Floodplain Threatened Ecological Communities

0 50 100 150 200 250

Meters
Scale: 1:5,800 @ A3
Coordinate System: GDA 1994 MGA Zone 56

Biosis Research Pty. Ltd.
8 Tate Street
Wollongong
NEW SOUTH WALES
2500

Offices also in: Sydney, Canberra, Ballarat, Melbourne, Wangaratta

N

Date: 06 September 2012, File number: 13320
Checked by: BWM, Drawn by: ANP
Location:P:\13320\d13320\Mapping\Validation Mapping June 2012\V4 Report Figures_FINAL\13320 F6 V4_Vegetation_20120830.mxd

Acknowledgements: Digital Topographic Database © State of New South Wales, Land and Planning Management Authority, 2011. Aerial Imagery - NearMap 2011. Vegetation Data - NPWS/OEH

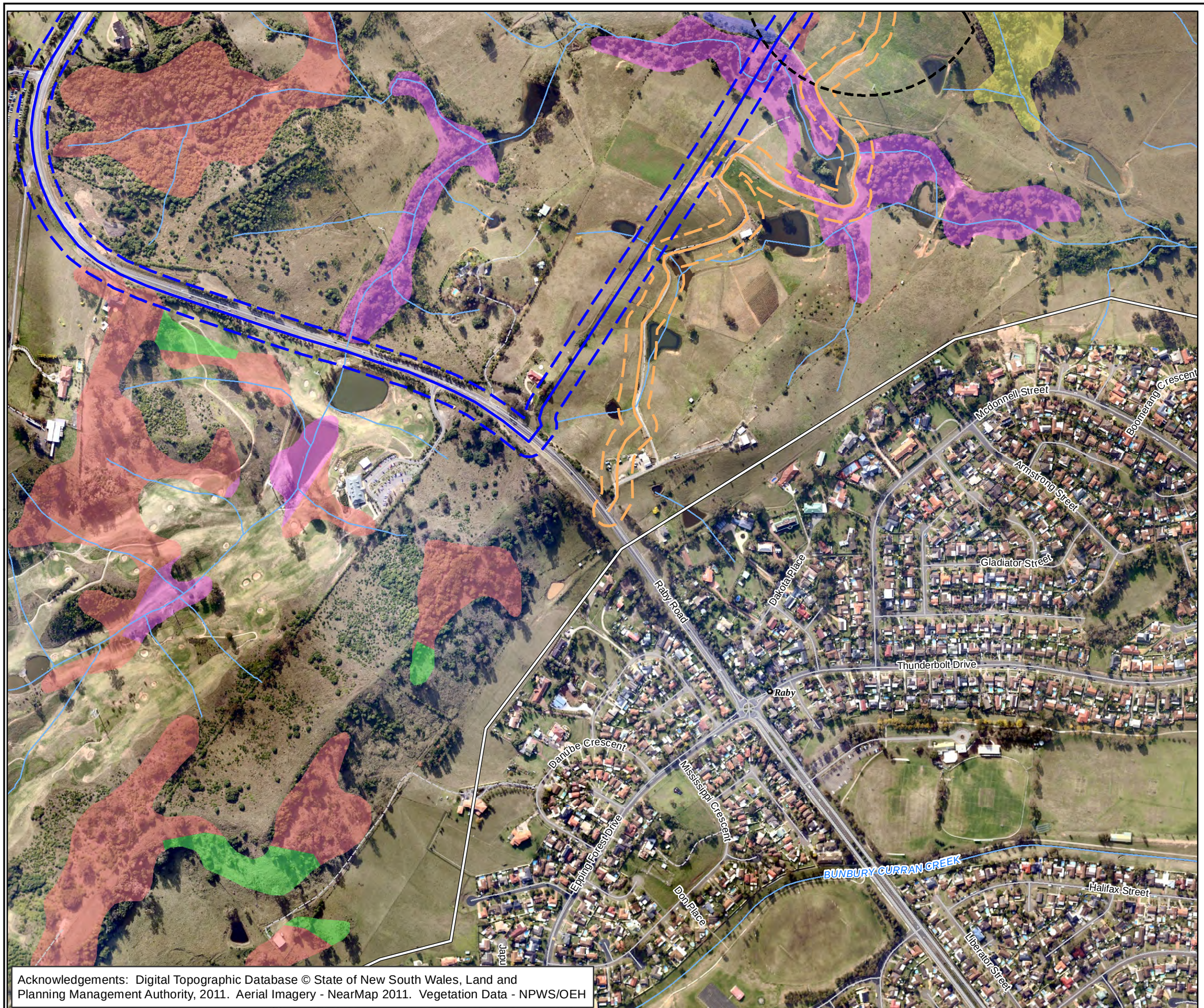
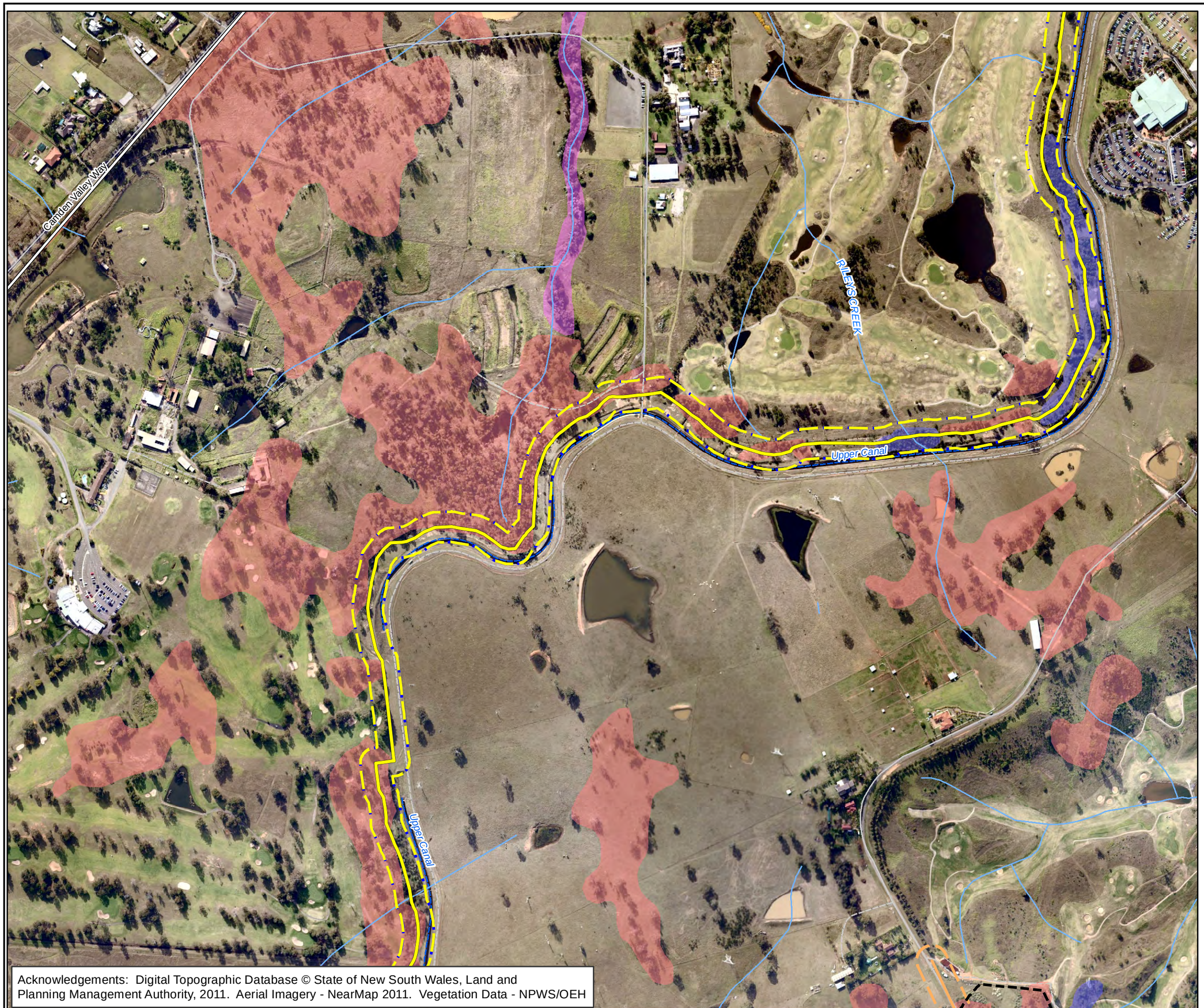


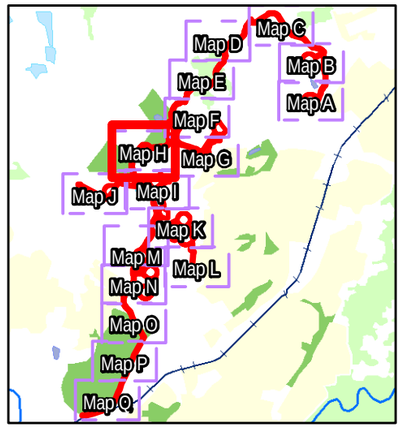
Figure 6G: Vegetation Mapping of the Subject Site including Cumberland Plain Woodland (TSC Act), Cumberland Plain Woodland (EPBC & TSC Act) and River Flat Eucalypt Forest on Coastal Floodplain Threatened Ecological Communities

Acknowledgements: Digital Topographic Database © State of New South Wales, Land and Planning Management Authority, 2011. Aerial Imagery - NearMap 2011. Vegetation Data - NPWS/OEH

Biosis Research Pty. Ltd.
8 Tate Street
Wollongong
NEW SOUTH WALES
2500
Offices also in: Sydney, Canberra, Ballarat, Melbourne, Wangaratta

Date: 06 September 2012, File number: 13320
Checked by: BWM, Drawn by: ANP
Location:P:\13320\s13320\Mapping\Vegetation Mapping June 2012\V4 Report Figures_FINAL\13320 F6 V4_Vegetation_20120830.mxd





Legend

Vegetation Communities
- Cumberland Plain Woodland (TSC Act & EPBC Act)
- Cumberland Plain Woodland (TSC Act)
- Alluvial Woodland (RFEFCF)
- Moist Shale Woodland
- Shrubland

Well Locations
- Well Surface Location
- Well Assessment Area

Gas Gathering Lines
- Gas Gathering Line
- Gas Gathering Line Envelope
- Main Gas Gathering Spine
- Main Gas Gathering Spine Envelope

Access Tracks
- Access Track
- Access Track Envelope

Survey Area
- Surface Project Area
- Subsurface Project Area

Figure 6H: Vegetation Mapping of the Subject Site including Cumberland Plain Woodland (TSC Act), Cumberland Plain Woodland (EPBC & TSC Act) and River Flat Eucalypt Forest on Coastal Floodplain Threatened Ecological Communities

0 50 100 150 200 250

Meters
Scale: 1:5,800 @ A3
Coordinate System: GDA 1994 MGA Zone 56

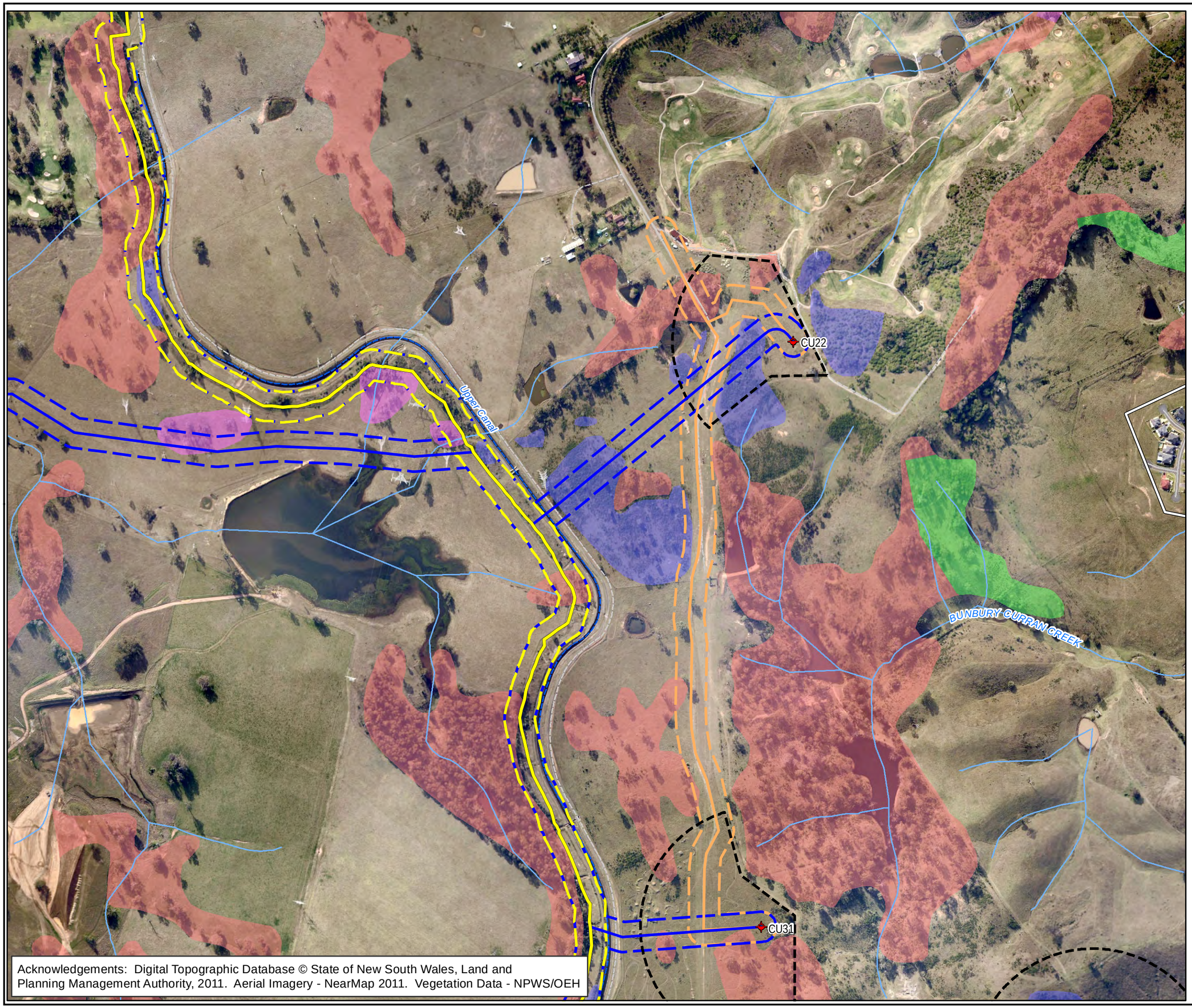
Biosis Research Pty. Ltd.
8 Tate Street
Wollongong
NEW SOUTH WALES
2500

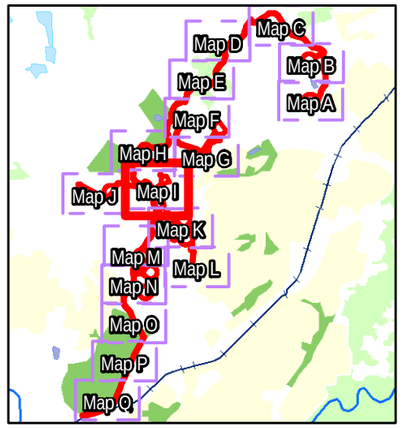
Offices also in: Sydney, Canberra, Ballarat, Melbourne, Wangaratta

N

Date: 06 September 2012, File number: 13320
Checked by: BWM, Drawn by: ANP
Location:P:\13300s\13320\Mapping\Vegetation Mapping June 2012\V4 Report Figures_FINAL\13320 F6 V4_Vegetation_20120830.mxd

Acknowledgements: Digital Topographic Database © State of New South Wales, Land and Planning Management Authority, 2011. Aerial Imagery - NearMap 2011. Vegetation Data - NPWS/OEH





Legend

Vegetation Communities
- Cumberland Plain Woodland (TSC Act & EPBC Act)
- Cumberland Plain Woodland (TSC Act)
- Alluvial Woodland (RFEFCF)
- Moist Shale Woodland
- Shrubland

Well Locations
- Well Surface Location
- Well Assessment Area

Gas Gathering Lines
- Gas Gathering Line
- Gas Gathering Line Envelope
- Main Gas Gathering Spine
- Main Gas Gathering Spine Envelope

Access Tracks
- Access Track
- Access Track Envelope

Survey Area
- Surface Project Area
- Subsurface Project Area

Figure 6I: Vegetation Mapping of the Subject Site including Cumberland Plain Woodland (TSC Act), Cumberland Plain Woodland (EPBC & TSC Act) and River Flat Eucalypt Forest on Coastal Floodplain Threatened Ecological Communities

0 50 100 150 200 250

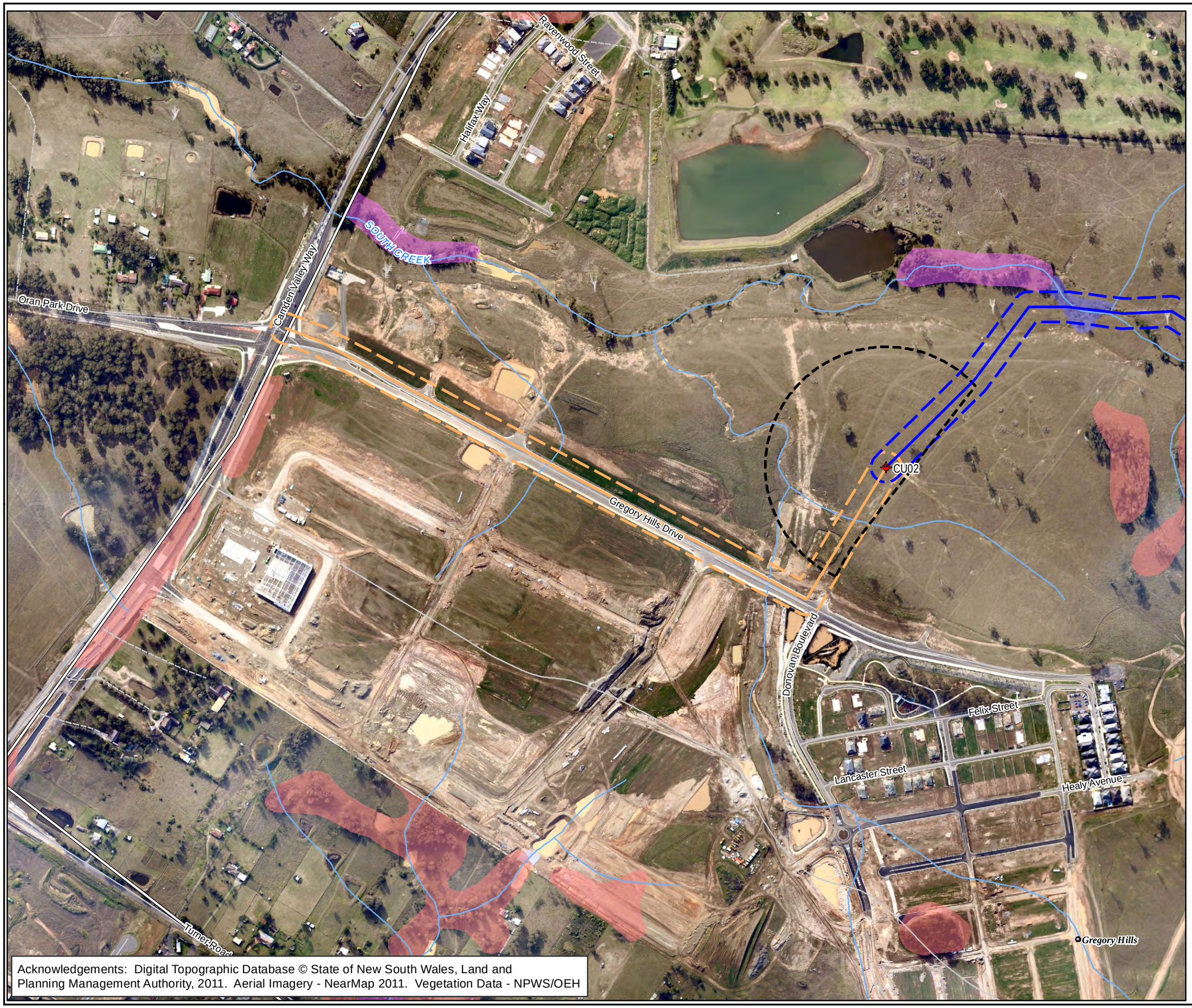
Meters
Scale: 1:5,800 @ A3
Coordinate System: GDA 1994 MGA Zone 56

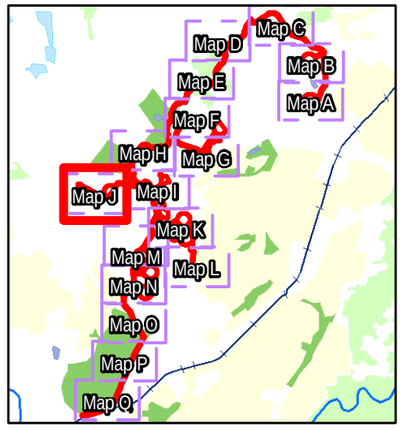
Acknowledgements: Digital Topographic Database © State of New South Wales, Land and Planning Management Authority, 2011. Aerial Imagery - NearMap 2011. Vegetation Data - NPWS/OEH

Biosis Research Pty. Ltd.
8 Tate Street
Wollongong
NEW SOUTH WALES
2500
Offices also in: Sydney, Canberra, Ballarat, Melbourne, Wangaratta

N

Date: 06 September 2012, File number: 13320
Checked by: BWM, Drawn by: ANP
Location:P:\13320\d13320\Mapping\Validation Mapping June 2012\V4 Report Figures_FINAL\13320 F6 V4_Vegetation_20120830.mxd





Legend

Vegetation Communities
- Cumberland Plain Woodland (TSC Act & EPBC Act)
- Cumberland Plain Woodland (TSC Act)
- Alluvial Woodland (RFEFCF)
- Moist Shale Woodland
- Shrubland

Well Locations
- Well Surface Location
- Well Assessment Area

Gas Gathering Lines
- Gas Gathering Line
- Gas Gathering Line Envelope
- Main Gas Gathering Spine
- Main Gas Gathering Spine Envelope

Access Tracks
- Access Track
- Access Track Envelope

Survey Area
- Surface Project Area
- Subsurface Project Area

Figure 6J: Vegetation Mapping of the Subject Site including Cumberland Plain Woodland (TSC Act), Cumberland Plain Woodland (EPBC & TSC Act) and River Flat Eucalypt Forest on Coastal Floodplain Threatened Ecological Communities

0 50 100 150 200 250

Meters
Scale: 1:5,800 @ A3
Coordinate System: GDA 1994 MGA Zone 56

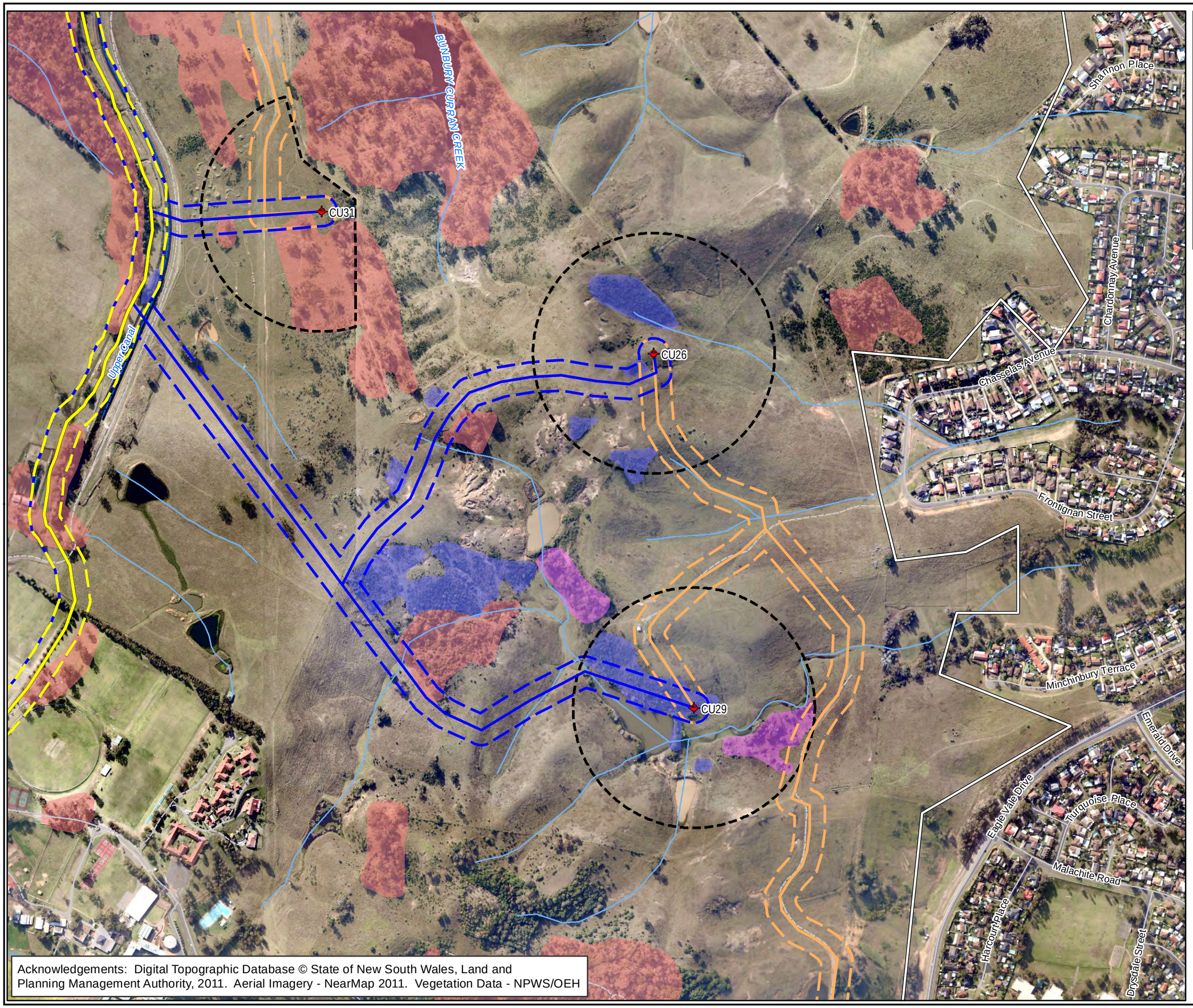
Biosis Research Pty. Ltd.
8 Tate Street
Wollongong
NEW SOUTH WALES
2500

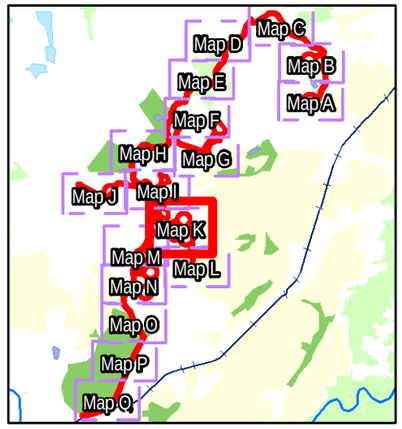
Offices also in: Sydney, Canberra, Ballarat, Melbourne, Wangaratta

N

Acknowledgements: Digital Topographic Database © State of New South Wales, Land and Planning Management Authority, 2011. Aerial Imagery - NearMap 2011. Vegetation Data - NPWS/OEH

Date: 06 September 2012, File number: 13320
Checked by: BWM, Drawn by: ANP
Location:P:\13320\GIS\13320\Mapping\Vegetation Mapping June 2012\V4 Report Figures_FINAL\13320 F6 V4_Vegetation_20120830.mxd





Legend

Vegetation Communities
- Cumberland Plain Woodland (TSC Act & EPBC Act)
- Cumberland Plain Woodland (TSC Act)
- Alluvial Woodland (RFEFCF)
- Moist Shale Woodland
- Shrubland

Well Locations
- Well Surface Location
- Well Assessment Area

Gas Gathering Lines
- Gas Gathering Line
- Gas Gathering Line Envelope
- Main Gas Gathering Spine
- Main Gas Gathering Spine Envelope

Access Tracks
- Access Track
- Access Track Envelope

Survey Area
- Surface Project Area
- Subsurface Project Area

Figure 6K: Vegetation Mapping of the Subject Site including Cumberland Plain Woodland (TSC Act), Cumberland Plain Woodland (EPBC & TSC Act) and River Flat Eucalypt Forest on Coastal Floodplain Threatened Ecological Communities

0 50 100 150 200 250

Meters

Scale: 1:5,800 @ A3

Coordinate System: GDA 1994 MGA Zone 56

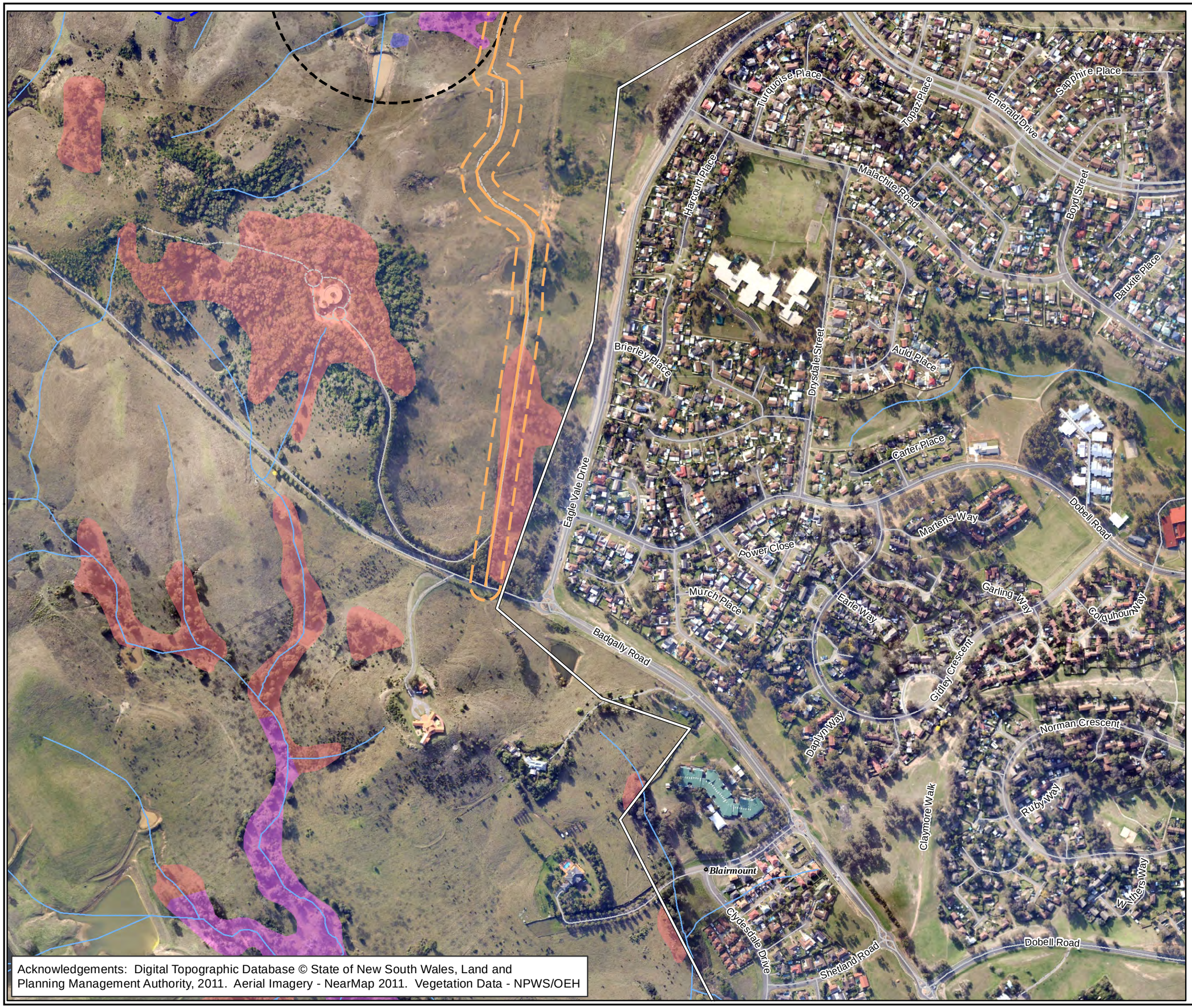
Biosis Research Pty. Ltd.
8 Tate Street
Wollongong
NEW SOUTH WALES
2500

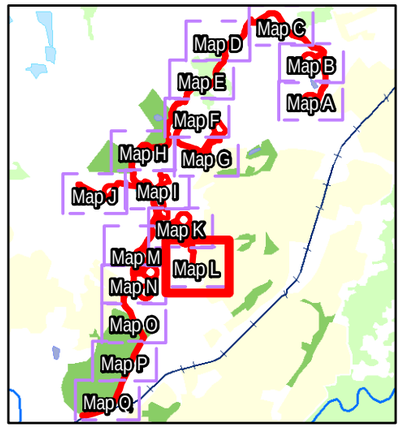
Offices also in: Sydney, Canberra, Ballarat, Melbourne, Wangaratta

N

Date: 06 September 2012, File number: 13320
Checked by: BWM, Drawn by: ANP
Location:P:\13320\GIS\13320Mapping\Validation Mapping June 2012\V4 Report Figures_FINAL\13320 F6 V4_Vegetation_20120830.mxd

Acknowledgements: Digital Topographic Database © State of New South Wales, Land and Planning Management Authority, 2011. Aerial Imagery - NearMap 2011. Vegetation Data - NPWS/OEH





Legend

Vegetation Communities
- Cumberland Plain Woodland (TSC Act & EPBC Act)
- Cumberland Plain Woodland (TSC Act)
- Alluvial Woodland (RFEFCF)
- Moist Shale Woodland
- Shrubland

Well Locations
- Well Surface Location
- Well Assessment Area

Gas Gathering Lines
- Gas Gathering Line
- Gas Gathering Line Envelope
- Main Gas Gathering Spine
- Main Gas Gathering Spine Envelope

Access Tracks
- Access Track
- Access Track Envelope

Survey Area
- Surface Project Area
- Subsurface Project Area

Figure 6L: Vegetation Mapping of the Subject Site including Cumberland Plain Woodland (TSC Act), Cumberland Plain Woodland (EPBC & TSC Act) and River Flat Eucalypt Forest on Coastal Floodplain Threatened Ecological Communities

0 50 100 150 200 250

Meters

Scale: 1:5,800 @ A3

Coordinate System: GDA 1994 MGA Zone 56

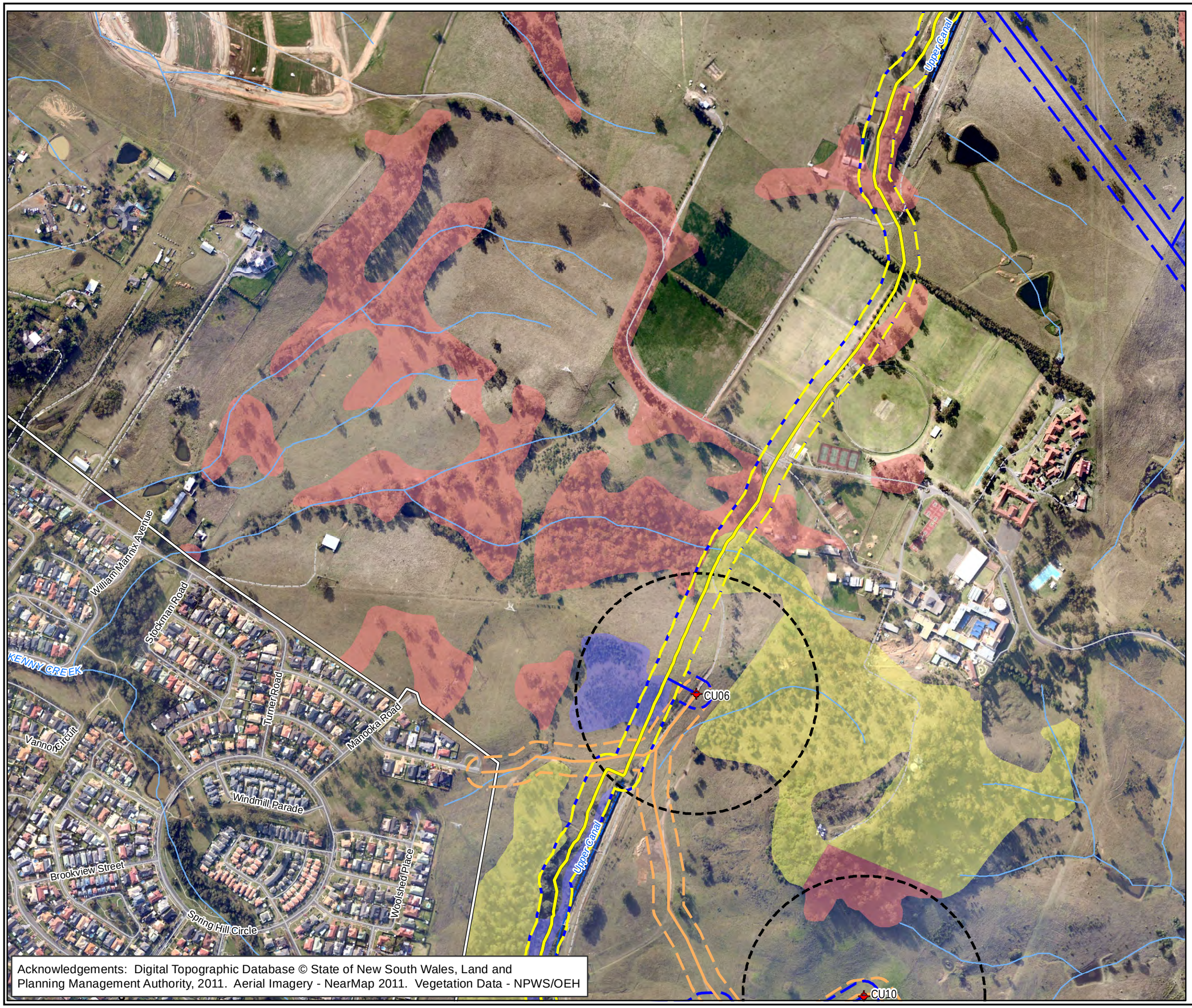
Biosis Research Pty. Ltd.
8 Tate Street
Wollongong
NEW SOUTH WALES
2500

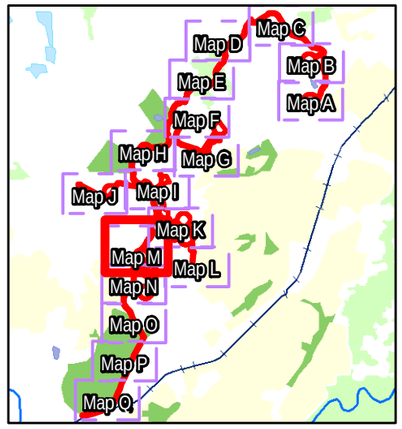
Offices also in: Sydney, Canberra, Ballarat, Melbourne, Wangaratta

N

Acknowledgements: Digital Topographic Database © State of New South Wales, Land and Planning Management Authority, 2011. Aerial Imagery - NearMap 2011. Vegetation Data - NPWS/OEH

Date: 06 September 2012, File number: 13320
Checked by: BWM, Drawn by: ANP
Location:P:\13320\GIS\3320MappingVariation Mapping June 2012\V4 Report Figures_FINAL\13320 F6 V4_Vegetation_20120830.mxd





Legend

Vegetation Communities
- Cumberland Plain Woodland (TSC Act & EPBC Act)
- Cumberland Plain Woodland (TSC Act)
- Alluvial Woodland (RFEFCF)
- Moist Shale Woodland
- Shrubland

Well Locations
- Well Surface Location
- Well Assessment Area

Gas Gathering Lines
- Gas Gathering Line
- Gas Gathering Line Envelope
- Main Gas Gathering Spine
- Main Gas Gathering Spine Envelope

Access Tracks
- Access Track
- Access Track Envelope

Survey Area
- Surface Project Area
- Subsurface Project Area

Figure 6M: Vegetation Mapping of the Subject Site including Cumberland Plain Woodland (TSC Act), Cumberland Plain Woodland (EPBC & TSC Act) and River Flat Eucalypt Forest on Coastal Floodplain Threatened Ecological Communities

0 50 100 150 200 250

Meters
Scale: 1:5,800 @ A3
Coordinate System: GDA 1994 MGA Zone 56

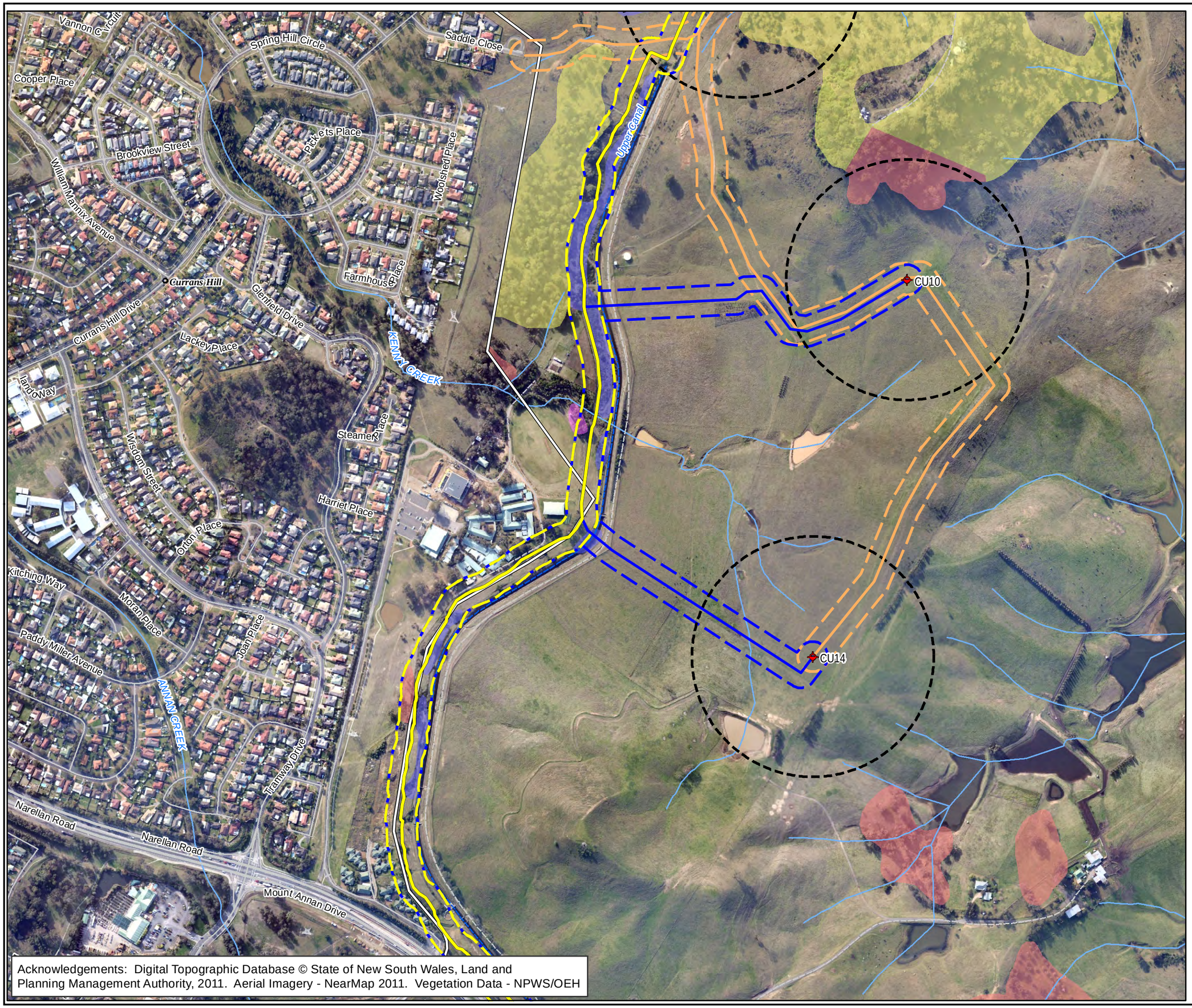
Biosis Research Pty. Ltd.
8 Tate Street
Wollongong
NEW SOUTH WALES
2500

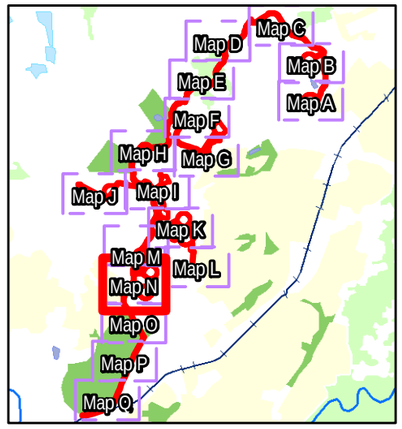
Offices also in: Sydney, Canberra, Ballarat, Melbourne, Wangaratta

N

Acknowledgements: Digital Topographic Database © State of New South Wales, Land and Planning Management Authority, 2011. Aerial Imagery - NearMap 2011. Vegetation Data - NPWS/OEH

Date: 06 September 2012, File number: 13320
Checked by: BWM, Drawn by: ANP
Location:P:\13320sl\13320\Mapping\Vegetation Mapping June 2012\V4 Report Figures_FINAL\13320 F6 V4_Vegetation_20120830.mxd





Legend

Vegetation Communities
- Cumberland Plain Woodland (TSC Act & EPBC Act)
- Cumberland Plain Woodland (TSC Act)
- Alluvial Woodland (RFEFCF)
- Moist Shale Woodland
- Shrubland

Well Locations
- Well Surface Location
- Well Assessment Area

Gas Gathering Lines
- Gas Gathering Line
- Gas Gathering Line Envelope
- Main Gas Gathering Spine
- Main Gas Gathering Spine Envelope

Access Tracks
- Access Track
- Access Track Envelope

Survey Area
- Surface Project Area
- Subsurface Project Area

Figure 6N: Vegetation Mapping of the Subject Site including Cumberland Plain Woodland (TSC Act), Cumberland Plain Woodland (EPBC & TSC Act) and River Flat Eucalypt Forest on Coastal Floodplain Threatened Ecological Communities

0 50 100 150 200 250

Meters
Scale: 1:5,800 @ A3
Coordinate System: GDA 1994 MGA Zone 56

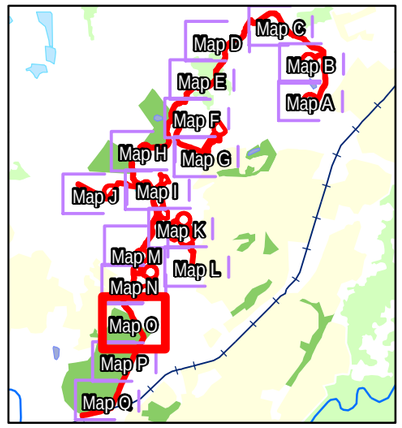
Biosis Research Pty. Ltd.
8 Tate Street
Wollongong
NEW SOUTH WALES
2500

Offices also in: Sydney, Canberra, Ballarat, Melbourne, Wangaratta

N

Date: 06 September 2012, File number: 13320
Checked by: BWM, Drawn by: ANP
Location:P:\13320\GIS\13320 Mapping\Vegetation Mapping June 2012\V4 Report Figures_FINAL\13320 F6 V4_Vegetation_20120830.mxd

Acknowledgements: Digital Topographic Database © State of New South Wales, Land and Planning Management Authority, 2011. Aerial Imagery - NearMap 2011. Vegetation Data - NPWS/OEH



Legend

Vegetation Communities
- Cumberland Plain Woodland (TSC Act & EPBC Act)
- Cumberland Plain Woodland (TSC Act)
- Alluvial Woodland (RFEFCF)
- Moist Shale Woodland
- Shrubland

Well Locations
- Well Surface Location
- Well Assessment Area

Gas Gathering Lines
- Gas Gathering Line
- Gas Gathering Line Envelope
- Main Gas Gathering Spine
- Main Gas Gathering Spine Envelope

Access Tracks
- Access Track
- Access Track Envelope

Survey Area
- Surface Project Area
- Subsurface Project Area

Figure 6O: Vegetation Mapping of the Subject Site including Cumberland Plain Woodland (TSC Act), Cumberland Plain Woodland (EPBC & TSC Act) and River Flat Eucalypt Forest on Coastal Floodplain Threatened Ecological Communities

0 50 100 150 200 250

Meters

Scale: 1:5,800 @ A3

Coordinate System: GDA 1994 MGA Zone 56

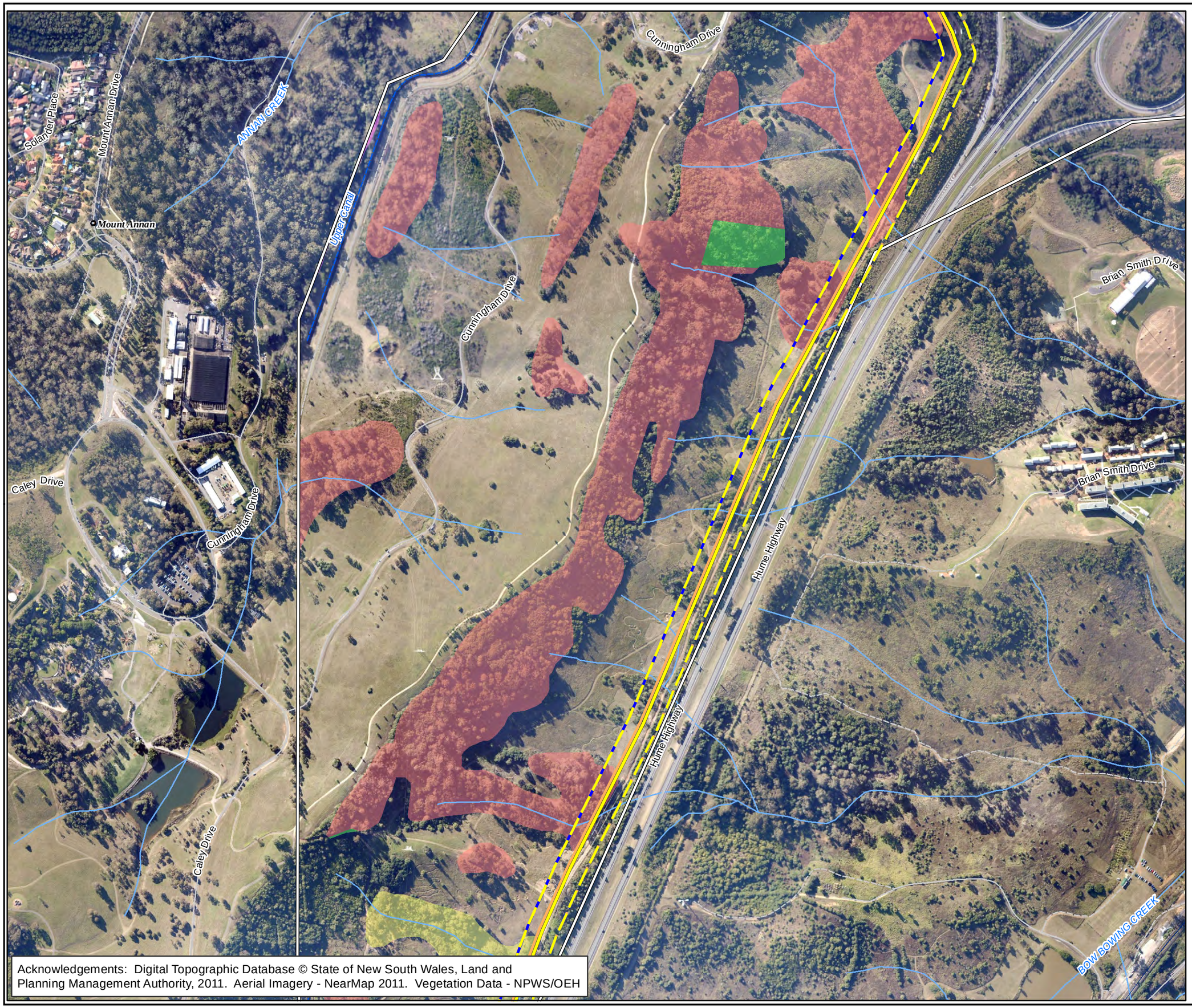
Acknowledgements: Digital Topographic Database © State of New South Wales, Land and Planning Management Authority, 2011. Aerial Imagery - NearMap 2011. Vegetation Data - NPWS/OEH

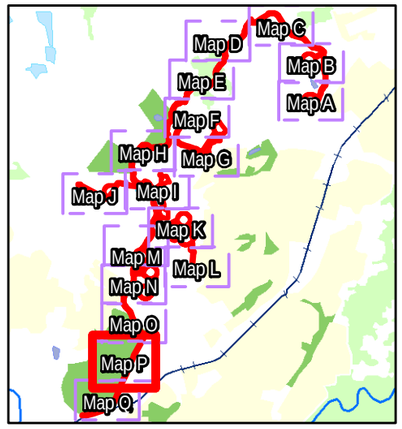
Biosis Research Pty. Ltd.
8 Tate Street
Wollongong
NEW SOUTH WALES
2500

Offices also in: Sydney, Canberra, Ballarat, Melbourne, Wangaratta

N

Date: 26 October 2012, File number: 13320
Checked by: BWM, Drawn by: ANP
Location:P:\13300\13320\Mapping\Vegetation Mapping June 2012\V4 Report Figures_FINAL\13320 F6 V4_Vegetation_20120830.mxd





Legend

Vegetation Communities
- Cumberland Plain Woodland (TSC Act & EPBC Act)
- Cumberland Plain Woodland (TSC Act)
- Alluvial Woodland (RFEFCF)
- Moist Shale Woodland
- Shrubland

Well Locations
- Well Surface Location
- Well Assessment Area

Gas Gathering Lines
- Gas Gathering Line
- Gas Gathering Line Envelope
- Main Gas Gathering Spine
- Main Gas Gathering Spine Envelope

Access Tracks
- Access Track
- Access Track Envelope

Survey Area
- Surface Project Area
- Subsurface Project Area

Figure 6P: Vegetation Mapping of the Subject Site including Cumberland Plain Woodland (TSC Act), Cumberland Plain Woodland (EPBC & TSC Act) and River Flat Eucalypt Forest on Coastal Floodplain Threatened Ecological Communities

0 50 100 150 200 250

Meters
Scale: 1:5,800 @ A3
Coordinate System: GDA 1994 MGA Zone 56

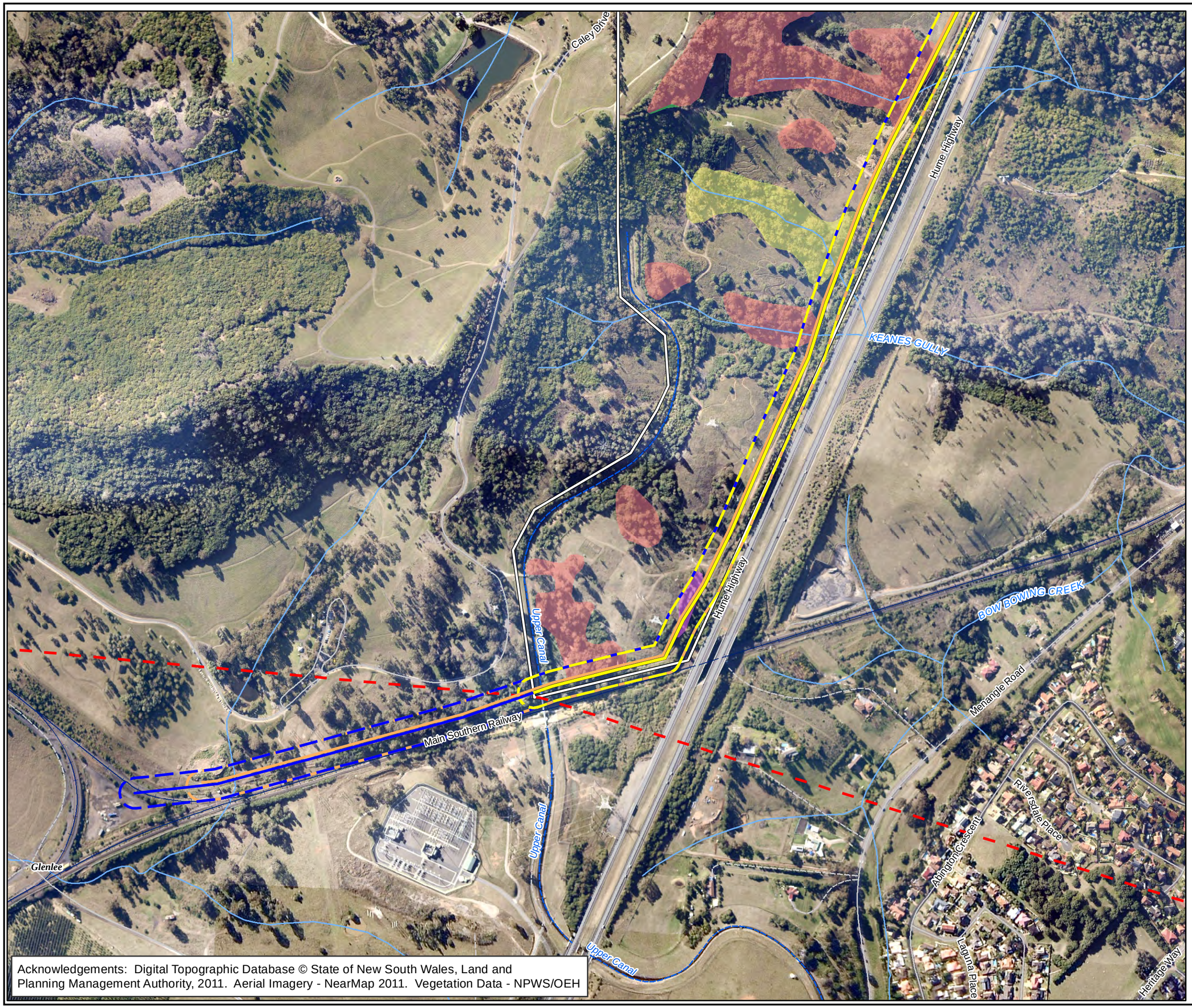
Biosis Research Pty. Ltd.
8 Tate Street
Wollongong
NEW SOUTH WALES
2500

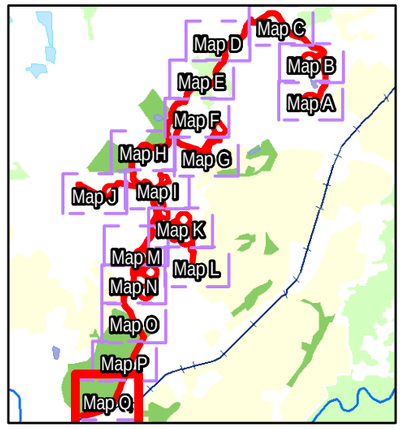
Offices also in: Sydney, Canberra, Ballarat, Melbourne, Wangaratta

N

Date: 06 September 2012, File number: 13320
Checked by: BWM, Drawn by: ANP
Location:P:\13320\d13320\Mapping\Vegetation Mapping June 2012\V4 Report Figures_FINAL\13320 F6 V4_Vegetation_20120830.mxd

Acknowledgements: Digital Topographic Database © State of New South Wales, Land and Planning Management Authority, 2011. Aerial Imagery - NearMap 2011. Vegetation Data - NPWS/OEH





Legend

Vegetation Communities
- Cumberland Plain Woodland (TSC Act & EPBC Act)
- Cumberland Plain Woodland (TSC Act)
- Alluvial Woodland (RFEFCF)
- Moist Shale Woodland
- Shrubland

Well Locations
- Well Surface Location
- Well Assessment Area

Gas Gathering Lines
- Gas Gathering Line
- Gas Gathering Line Envelope
- Main Gas Gathering Spine
- Main Gas Gathering Spine Envelope

Access Tracks
- Access Track
- Access Track Envelope

Survey Area
- Surface Project Area
- Subsurface Project Area

Figure 6Q: Vegetation Mapping of the Subject Site including Cumberland Plain Woodland (TSC Act), Cumberland Plain Woodland (EPBC & TSC Act) and River Flat Eucalypt Forest on Coastal Floodplain Threatened Ecological Communities

0 50 100 150 200 250

Meters

Scale: 1:5,800 @ A3

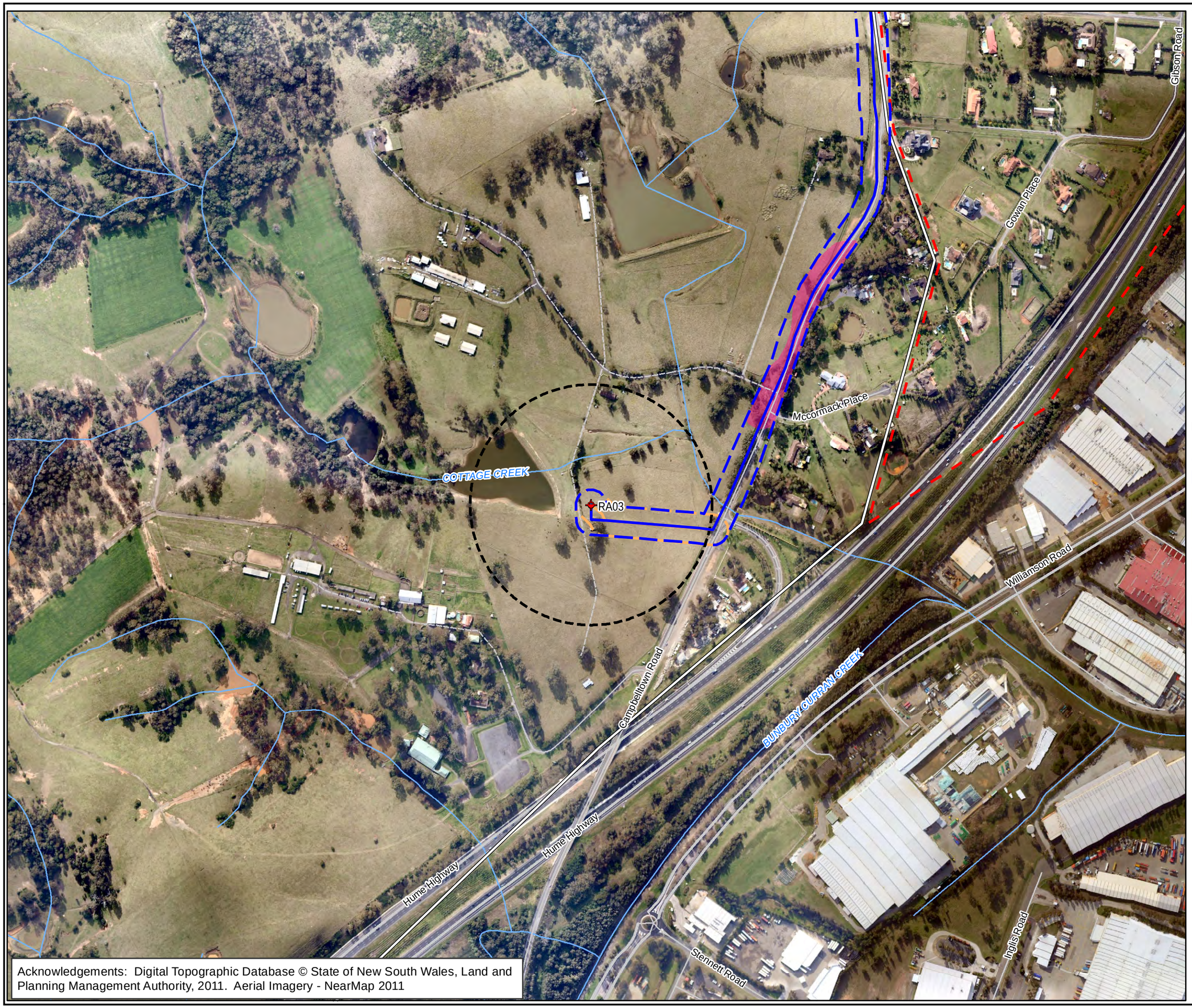
Coordinate System: GDA 1994 MGA Zone 56

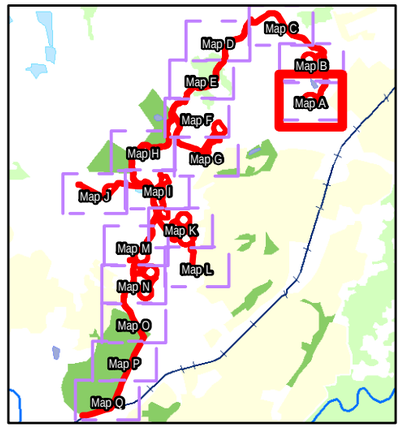
Biosis Research Pty. Ltd.
8 Tate Street
Wollongong
NEW SOUTH WALES
2500

Offices also in: Sydney, Canberra, Ballarat, Melbourne, Wangaratta

N

Date: 06 September 2012, File number: 13320
Checked by: BWM, Drawn by: ANP
Location:P:\13320\d13320\Mapping\Vegetation Mapping June 2012\V4 Report Figures_FINAL\13320 F6 V4_Vegetation_20120830.mxd





Legend

Biodiversity Exclusion and Impact Minimisation

- Avoid By Exclusion
- Minimise By Detailed Ground Survey and Construction Method
- Minimise By Underbore
- Minimised By Construction Method

Well Locations

- Well Surface Location
- Well Assessment Area

Gas Gathering Lines

- Gas Gathering Line
- Gas Gathering Line Envelope
- Main Gas Gathering Spine
- Main Gas Gathering Spine Envelope

Access Tracks

- Access Track
- Access Track Envelope

Survey Area

- Surface Project Area
- Subsurface Project Area

Acknowledgements: Digital Topographic Database © State of New South Wales, Land and Planning Management Authority, 2011. Aerial Imagery - NearMap 2011

Figure 7A: Biodiversity Impact Avoidance and Minimisation Measures

0 50 100 150 200 250

Meters

Scale: 1:5,800 @ A3

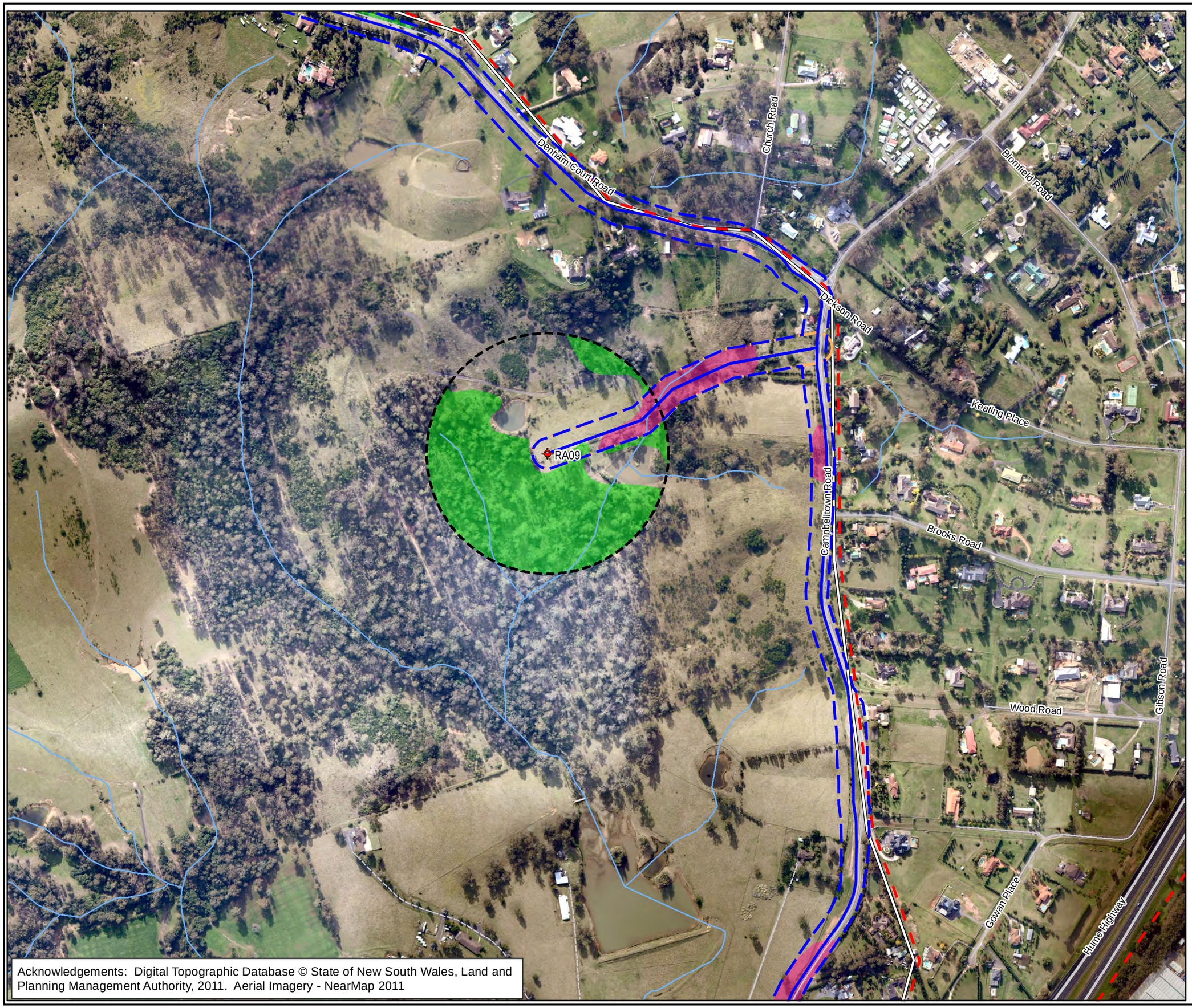
Coordinate System: GDA 1994 MGA Zone 56

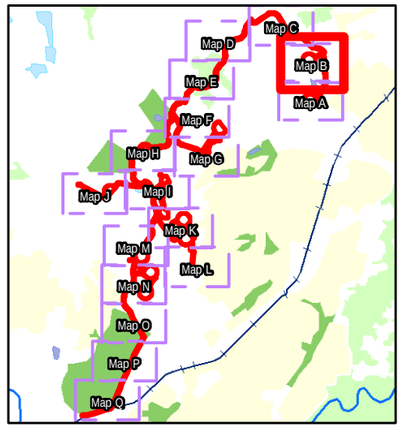
Biosis Research Pty. Ltd.
8 Tate Street
Wollongong
NEW SOUTH WALES
2500

Offices also in: Sydney, Canberra, Ballarat, Melbourne, Wangaratta

N

Date: 06 September 2012, File number: 13320
Checked by: BWM, Drawn by: ANP
Location:P:\13300s\13320\Mapping\Avoidance Mapping June 2012\V4 Report Figures_FINAL\13320 F7 V4_Impacts_20120830.mxd





Legend

Biodiversity Exclusion and Impact Minimisation
- Avoid By Exclusion
- Minimise By Detailed Ground Survey and Construction Method
- Minimise By Underbore
- Minimised By Construction Method

Well Locations
- Well Surface Location
- Well Assessment Area

Gas Gathering Lines
- Gas Gathering Line
- Gas Gathering Line Envelope
- Main Gas Gathering Spine
- Main Gas Gathering Spine Envelope

Access Tracks
- Access Track
- Access Track Envelope

Survey Area
- Surface Project Area
- Subsurface Project Area

Acknowledgements: Digital Topographic Database © State of New South Wales, Land and Planning Management Authority, 2011. Aerial Imagery - NearMap 2011

Figure 7B: Biodiversity Impact Avoidance and Minimisation Measures

0 50 100 150 200 250

Meters

Scale: 1:5,800 @ A3

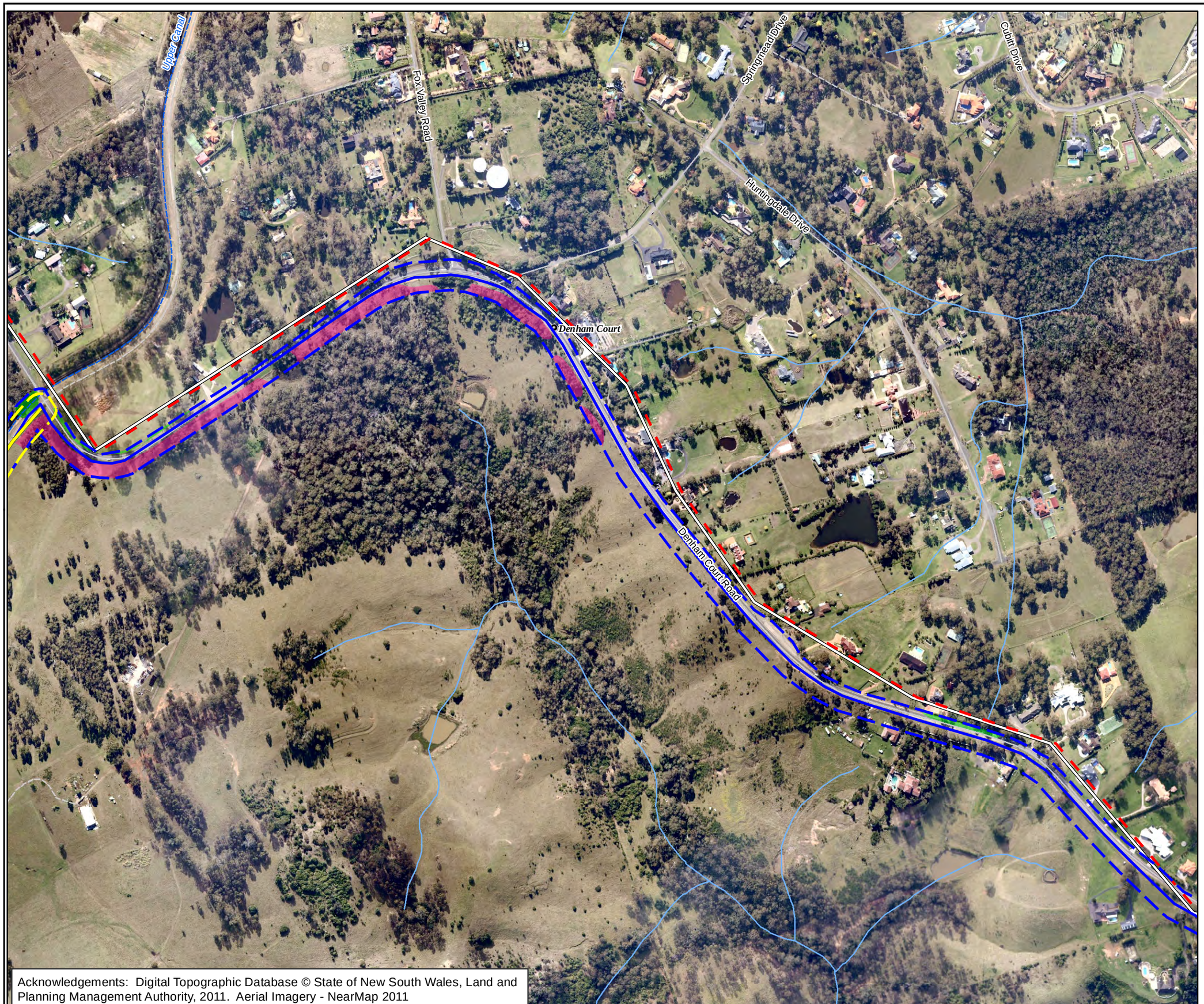
Coordinate System: GDA 1994 MGA Zone 56

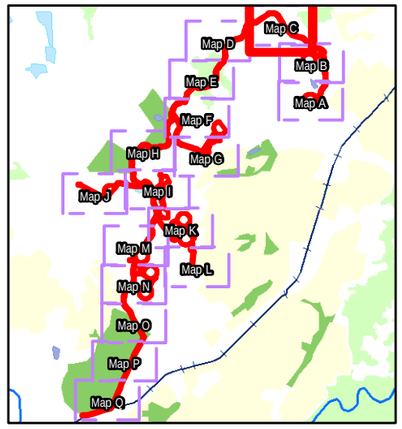
Biosis Research Pty. Ltd.
8 Tate Street
Wollongong
NEW SOUTH WALES
2500

Offices also in: Sydney, Canberra, Ballarat, Melbourne, Wangaratta

N

Date: 06 September 2012, File number: 13320
Checked by: BWM, Drawn by: ANP
Location:P:\13320\GIS\13320\Mapping\Validation Mapping June 2012\V4 Report Figures_FINAL\13320 F7 V4_Impacts_20120830.mxd





Legend

Biodiversity Exclusion and Impact Minimisation

- Avoid By Exclusion
- Minimise By Detailed Ground Survey and Construction Method
- Minimise By Underbore
- Minimised By Construction Method

Well Locations

- Well Surface Location
- Well Assessment Area

Gas Gathering Lines

- Gas Gathering Line
- Gas Gathering Line Envelope
- Main Gas Gathering Spine
- Main Gas Gathering Spine Envelope

Access Tracks

- Access Track
- Access Track Envelope

Survey Area

- Surface Project Area
- Subsurface Project Area

Acknowledgements: Digital Topographic Database © State of New South Wales, Land and Planning Management Authority, 2011. Aerial Imagery - NearMap 2011

Figure 7C: Biodiversity Impact Avoidance and Minimisation Measures

0 50 100 150 200 250

Meters

Scale: 1:5,800 @ A3

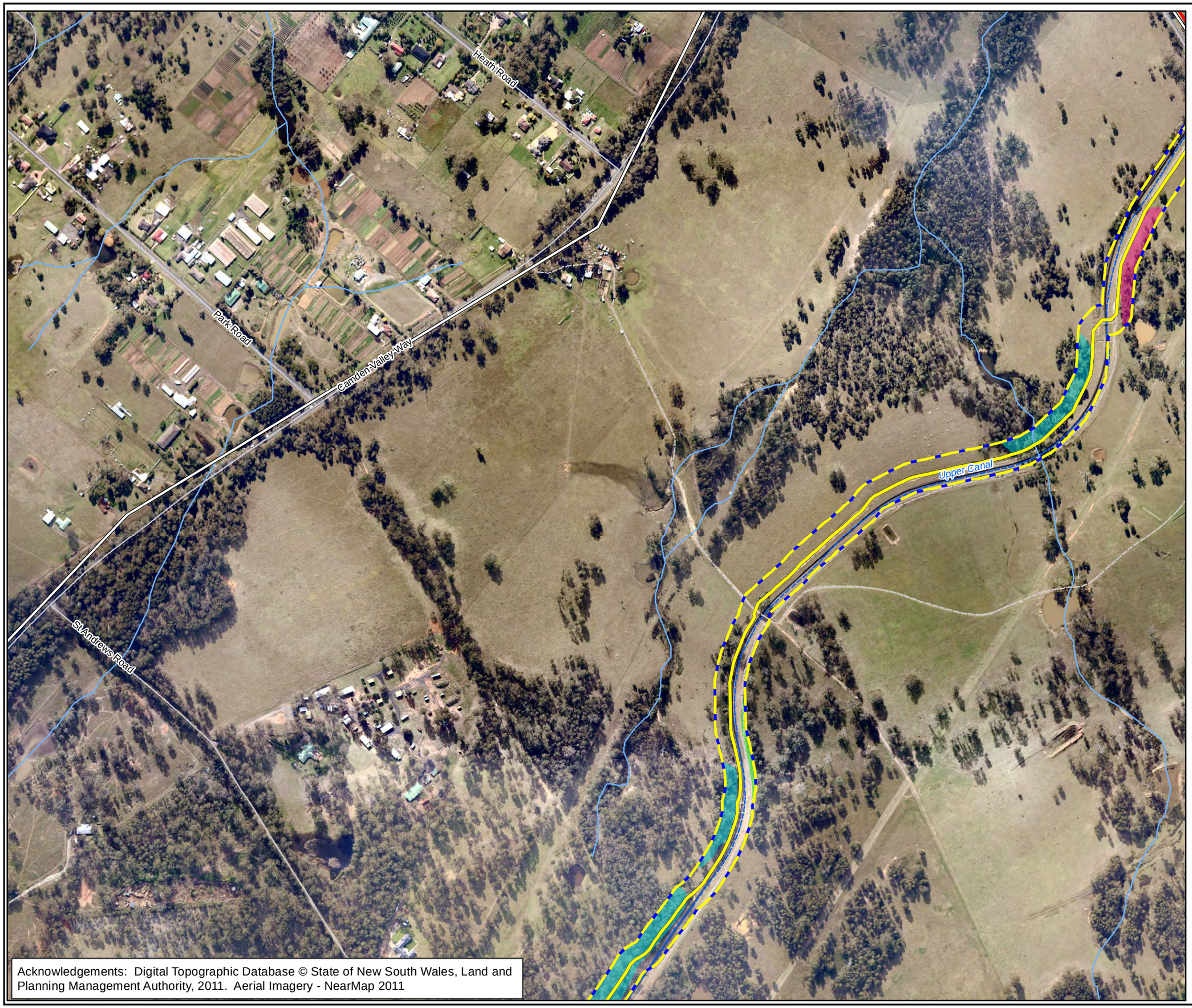
Coordinate System: GDA 1994 MGA Zone 56

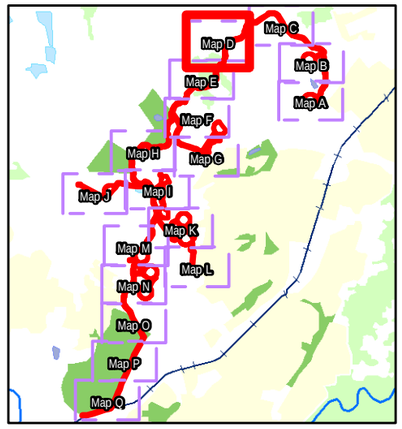
Biosis Research Pty. Ltd.
8 Tate Street
Wollongong
NEW SOUTH WALES
2500

Offices also in: Sydney, Canberra, Ballarat, Melbourne, Wangaratta

N

Date: 06 September 2012, File number: 13320
Checked by: BWM, Drawn by: ANP
Location:P:\13320\s13320\Mapping\Variation Mapping June 2012\V4 Report Figures_FINAL\13320 F7 V4_Impacts_20120830.mxd





Legend

Biodiversity Exclusion and Impact Minimisation

- Avoid By Exclusion
- Minimise By Detailed Ground Survey and Construction Method
- Minimise By Underbore
- Minimised By Construction Method

Well Locations

- Well Surface Location
- Well Assessment Area

Gas Gathering Lines

- Gas Gathering Line
- Gas Gathering Line Envelope
- Main Gas Gathering Spine
- Main Gas Gathering Spine Envelope

Access Tracks

- Access Track
- Access Track Envelope

Survey Area

- Surface Project Area
- Subsurface Project Area

Acknowledgements: Digital Topographic Database © State of New South Wales, Land and Planning Management Authority, 2011. Aerial Imagery - NearMap 2011

Figure 7D: Biodiversity Impact Avoidance and Minimisation Measures

0 50 100 150 200 250

Meters

Scale: 1:5,800 @ A3

Coordinate System: GDA 1994 MGA Zone 56

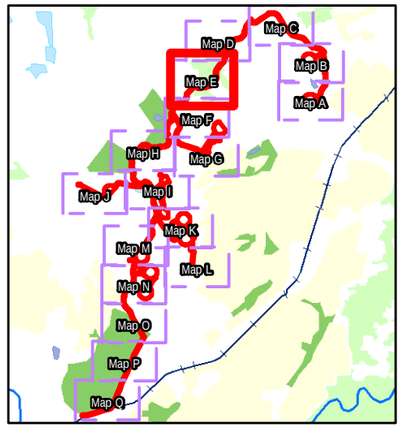
Biosis Research Pty. Ltd.
8 Tate Street
Wollongong
NEW SOUTH WALES
2500

Offices also in: Sydney, Canberra, Ballarat, Melbourne, Wangaratta

N

Date: 06 September 2012, File number: 13320
Checked by: BWM, Drawn by: ANP
Location:P:\13300s\13320\Mapping\Avoidance Mapping June 2012\V4 Report Figures_FINAL\13320 F7 V4_Impacts_20120830.mxd

George Road
Camden Valley Way
St Andrews Road
Upper Canal
St Andrews Road
St James Road



Legend

Biodiversity Exclusion and Impact Minimisation
- Avoid By Exclusion
- Minimise By Detailed Ground Survey and Construction Method
- Minimise By Underbore
- Minimised By Construction Method

Well Locations
- Well Surface Location
- Well Assessment Area

Gas Gathering Lines
- Gas Gathering Line
- Gas Gathering Line Envelope
- Main Gas Gathering Spine
- Main Gas Gathering Spine Envelope

Access Tracks
- Access Track
- Access Track Envelope

Survey Area
- Surface Project Area
- Subsurface Project Area

Acknowledgements: Digital Topographic Database © State of New South Wales, Land and Planning Management Authority, 2011. Aerial Imagery - NearMap 2011

Figure 7E: Biodiversity Impact Avoidance and Minimisation Measures

0 50 100 150 200 250

Meters

Scale: 1:5,800 @ A3

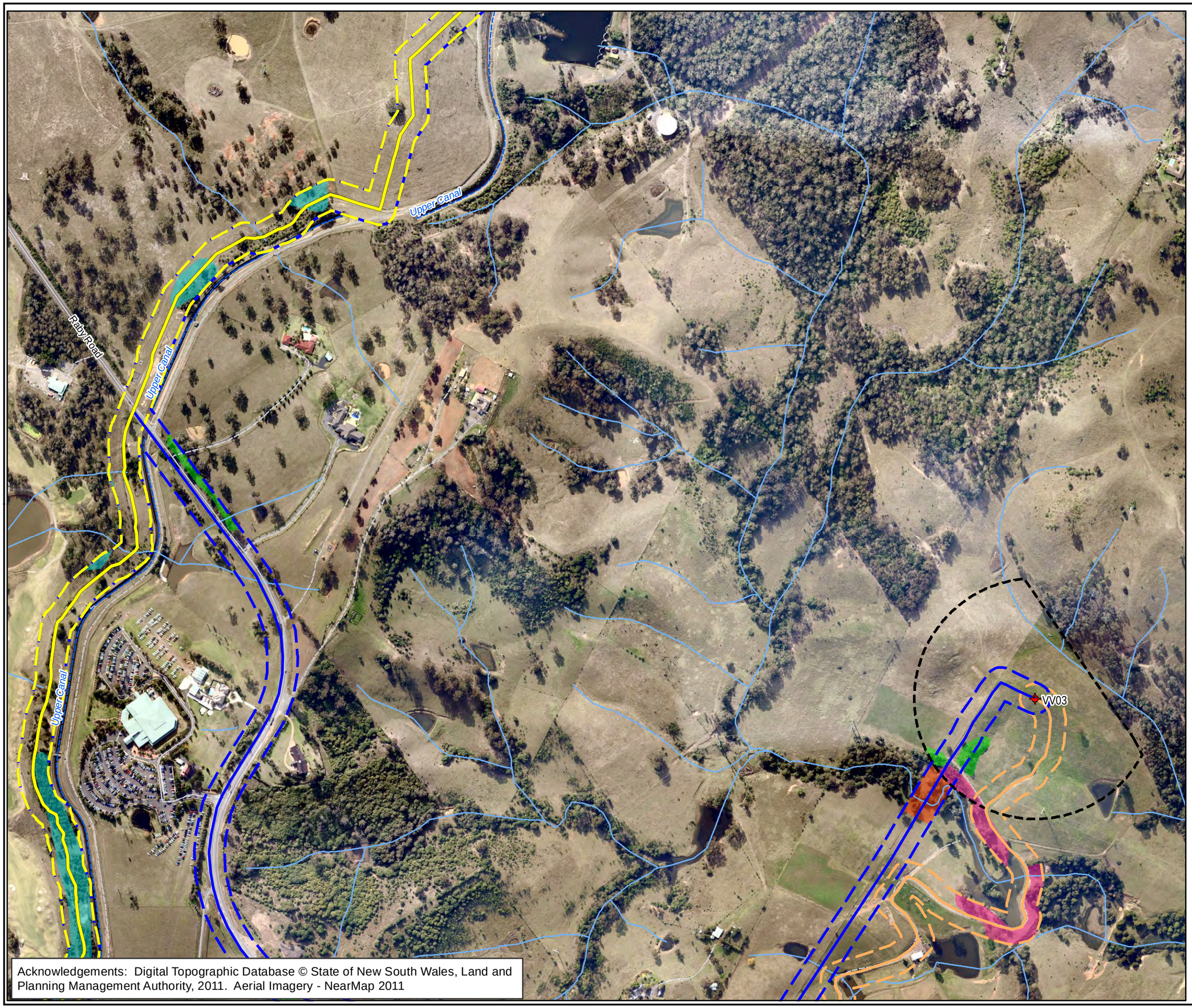
Coordinate System: GDA 1994 MGA Zone 56

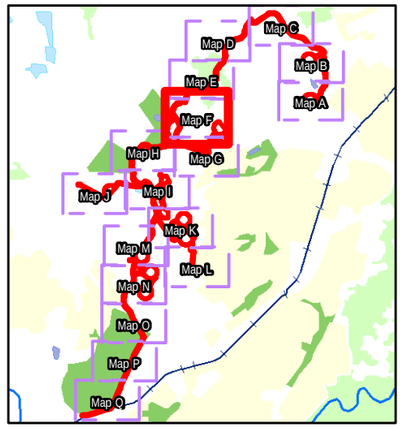
Biosis Research Pty. Ltd.
8 Tate Street
Wollongong
NEW SOUTH WALES
2500

Offices also in: Sydney, Canberra, Ballarat, Melbourne, Wangaratta

N

Date: 06 September 2012, File number: 13320
Checked by: BWM, Drawn by: ANP
Location:P:\13300s\13320\Mapping\Variation Mapping June 2012\V4 Report Figures_FINAL\13320 F7 V4_Impacts_20120830.mxd





Legend

Biodiversity Exclusion and Impact Minimisation

- Avoid By Exclusion
- Minimise By Detailed Ground Survey and Construction Method
- Minimise By Underbore
- Minimised By Construction Method

Well Locations

- Well Surface Location
- Well Assessment Area

Gas Gathering Lines

- Gas Gathering Line
- Gas Gathering Line Envelope
- Main Gas Gathering Spine
- Main Gas Gathering Spine Envelope

Access Tracks

- Access Track
- Access Track Envelope

Survey Area

- Surface Project Area
- Subsurface Project Area

Figure 7F: Biodiversity Impact Avoidance and Minimisation Measures

0 50 100 150 200 250

Meters

Scale: 1:5,800 @ A3

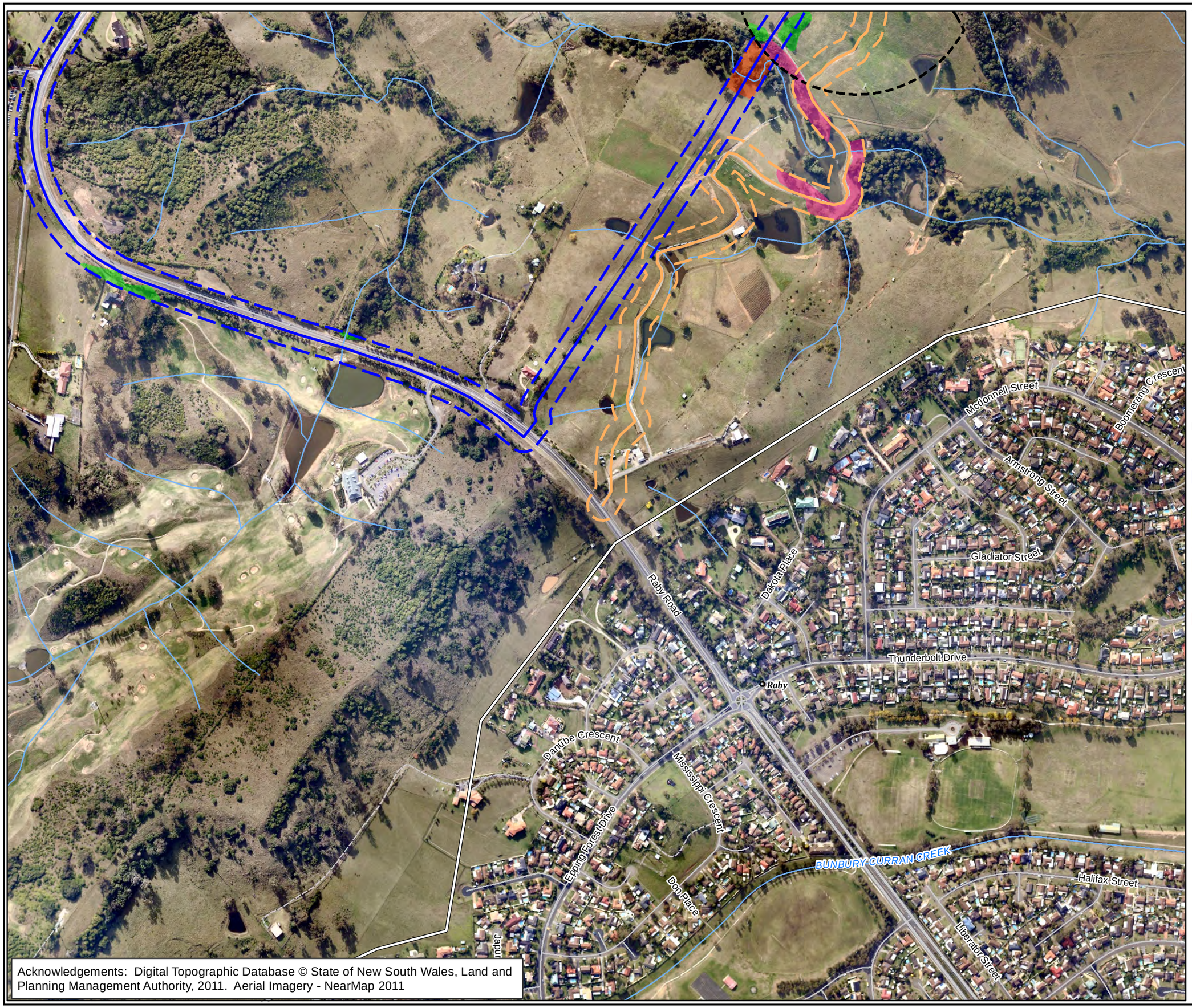
Coordinate System: GDA 1994 MGA Zone 56

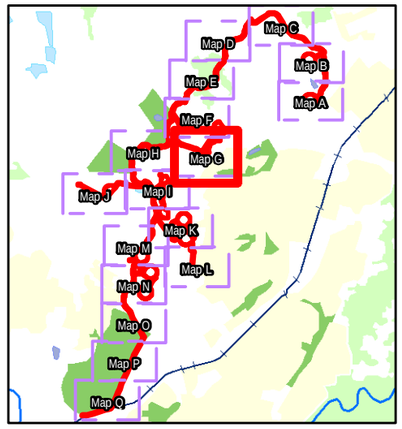
Biosis Research Pty. Ltd.
8 Tate Street
Wollongong
NEW SOUTH WALES
2500

Offices also in: Sydney, Canberra, Ballarat, Melbourne, Wangaratta

N

Date: 06 September 2012, File number: 13320
Checked by: BWM, Drawn by: ANP
Location:P:\13320\GIS\13320Mapping\Avoidance Mapping June 2012\V4 Report Figures_FINAL\13320 F7 V4_Impacts_20120830.mxd





Legend

Biodiversity Exclusion and Impact Minimisation
- Avoid By Exclusion
- Minimise By Detailed Ground Survey and Construction Method
- Minimise By Underbore
- Minimised By Construction Method

Well Locations
- Well Surface Location
- Well Assessment Area

Gas Gathering Lines
- Gas Gathering Line
- Gas Gathering Line Envelope
- Main Gas Gathering Spine
- Main Gas Gathering Spine Envelope

Access Tracks
- Access Track
- Access Track Envelope

Survey Area
- Surface Project Area
- Subsurface Project Area

Figure 7G: Biodiversity Impact Avoidance and Minimisation Measures

0 50 100 150 200 250

Meters
Scale: 1:5,800 @ A3
Coordinate System: GDA 1994 MGA Zone 56

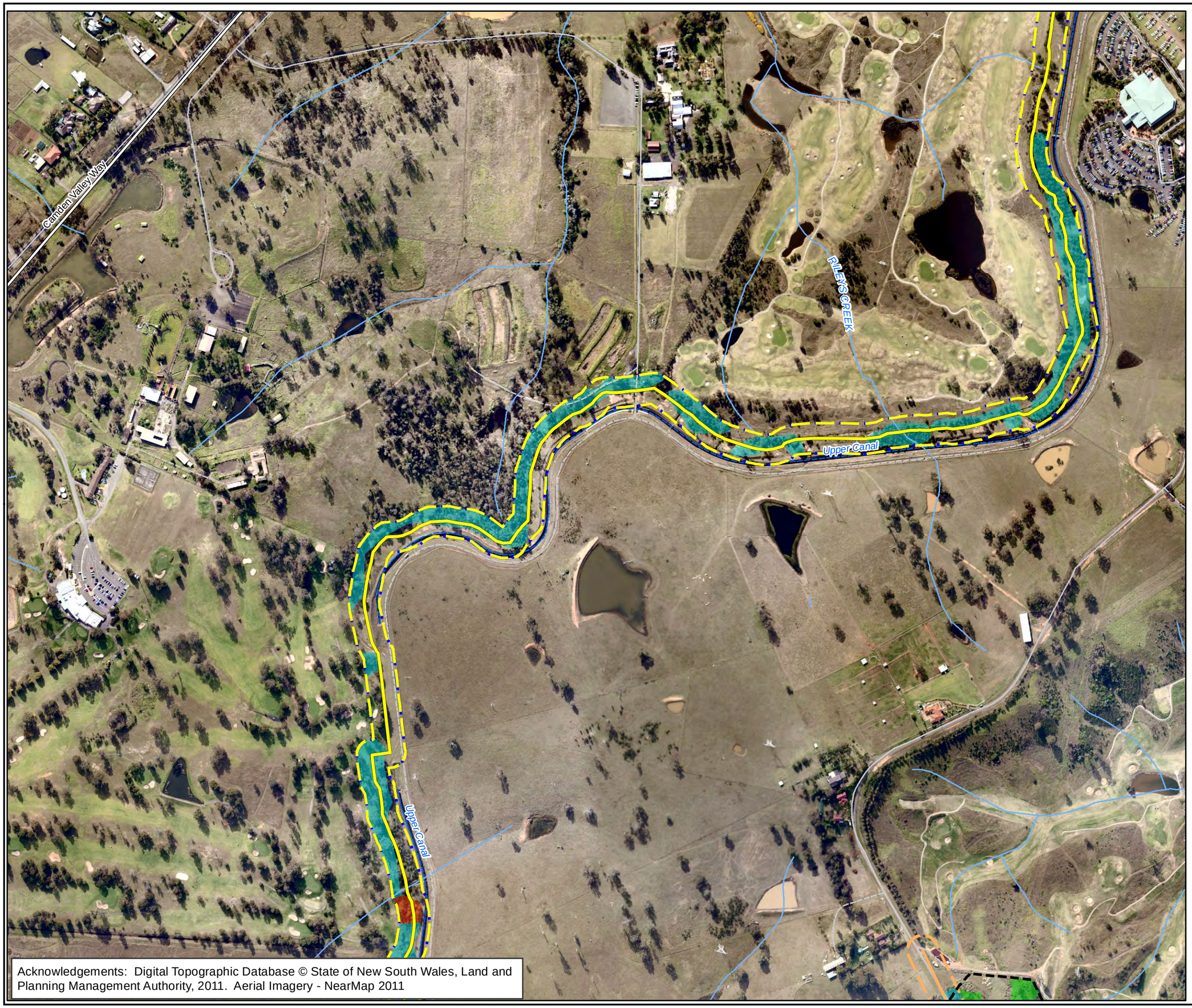
Biosis Research Pty. Ltd.
8 Tate Street
Wollongong
NEW SOUTH WALES
2500

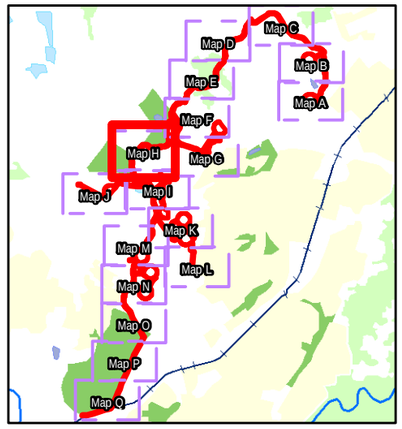
Offices also in: Sydney, Canberra, Ballarat, Melbourne, Wangaratta

N

Date: 06 September 2012, File number: 13320
Checked by: BWM, Drawn by: ANP
Location:P:\13320\GIS\13320 Mapping\Variation Mapping June 2012\V4 Report Figures_FINAL\13320 F7 V4_Impacts_20120830.mxd

Acknowledgements: Digital Topographic Database © State of New South Wales, Land and Planning Management Authority, 2011. Aerial Imagery - NearMap 2011





Legend

Biodiversity Exclusion and Impact Minimisation
- Avoid By Exclusion
- Minimise By Detailed Ground Survey and Construction Method
- Minimise By Underbore
- Minimised By Construction Method

Well Locations
- Well Surface Location
- Well Assessment Area

Gas Gathering Lines
- Gas Gathering Line
- Gas Gathering Line Envelope
- Main Gas Gathering Spine
- Main Gas Gathering Spine Envelope

Access Tracks
- Access Track
- Access Track Envelope

Survey Area
- Surface Project Area
- Subsurface Project Area

Figure 7H: Biodiversity Impact Avoidance and Minimisation Measures

0 50 100 150 200 250

Meters
Scale: 1:5,800 @ A3
Coordinate System: GDA 1994 MGA Zone 56

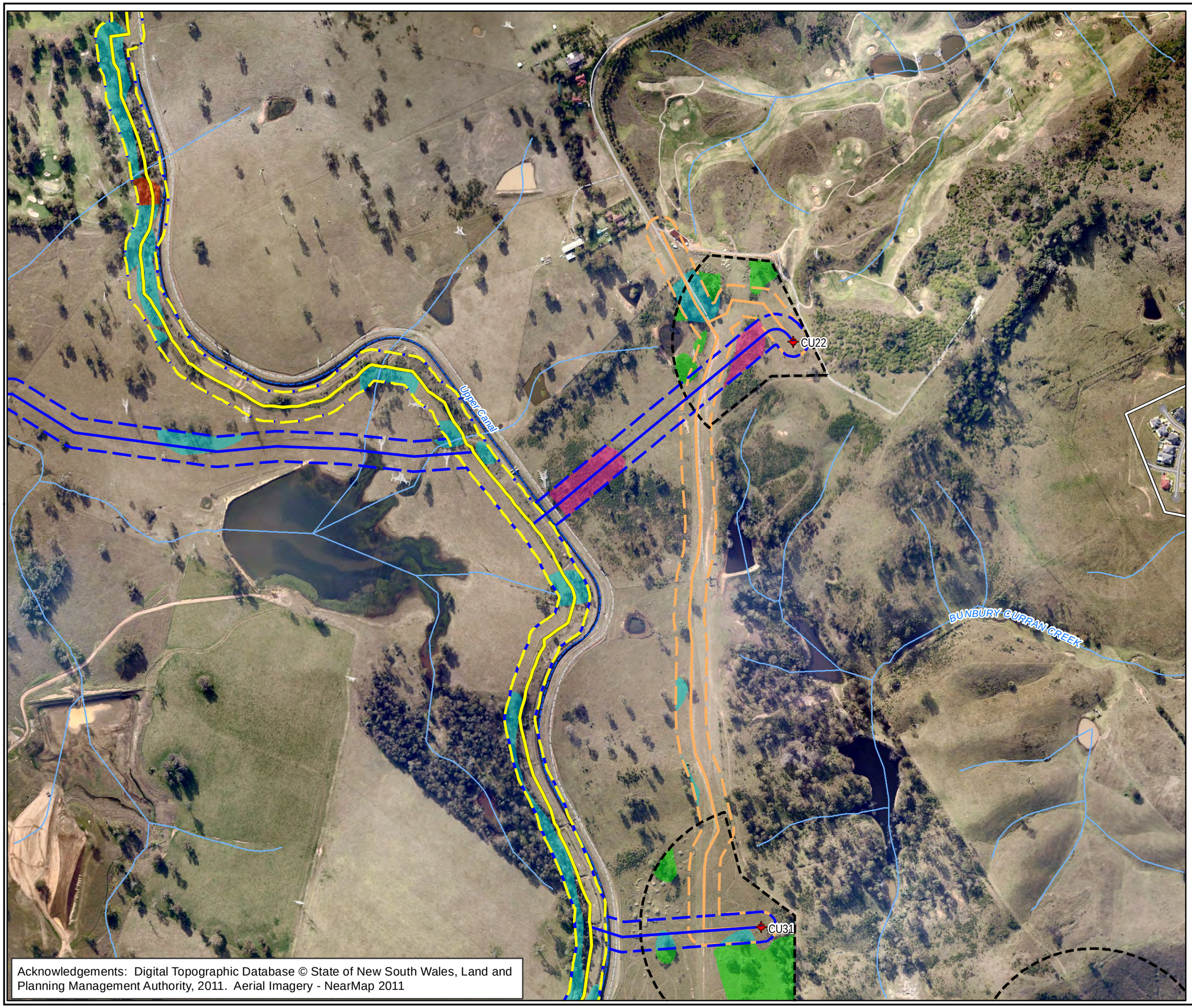
Biosis Research Pty. Ltd.
8 Tate Street
Wollongong
NEW SOUTH WALES
2500

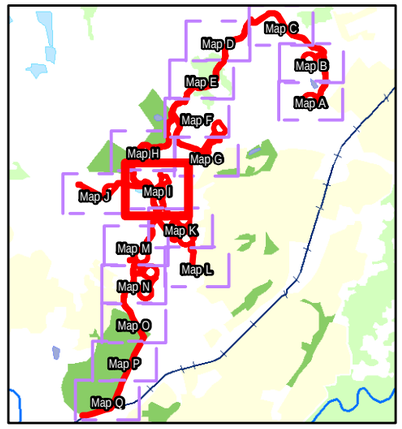
Offices also in: Sydney, Canberra, Ballarat, Melbourne, Wangaratta

N

Date: 06 September 2012, File number: 13320
Checked by: BWM, Drawn by: ANP
Location:P:\13320\GIS\13320 Mapping\Validation Mapping June 2012\V4 Report Figures_FINAL\13320 F7 V4_Impacts_20120830.mxd

Acknowledgements: Digital Topographic Database © State of New South Wales, Land and Planning Management Authority, 2011. Aerial Imagery - NearMap 2011





Legend

Biodiversity Exclusion and Impact Minimisation
- Avoid By Exclusion
- Minimise By Detailed Ground Survey and Construction Method
- Minimise By Underbore
- Minimised By Construction Method

Well Locations
- Well Surface Location
- Well Assessment Area

Gas Gathering Lines
- Gas Gathering Line
- Gas Gathering Line Envelope
- Main Gas Gathering Spine
- Main Gas Gathering Spine Envelope

Access Tracks
- Access Track
- Access Track Envelope

Survey Area
- Surface Project Area
- Subsurface Project Area

Figure 7I: Biodiversity Impact Avoidance and Minimisation Measures

0 50 100 150 200 250

Meters
Scale: 1:5,800 @ A3
Coordinate System: GDA 1994 MGA Zone 56

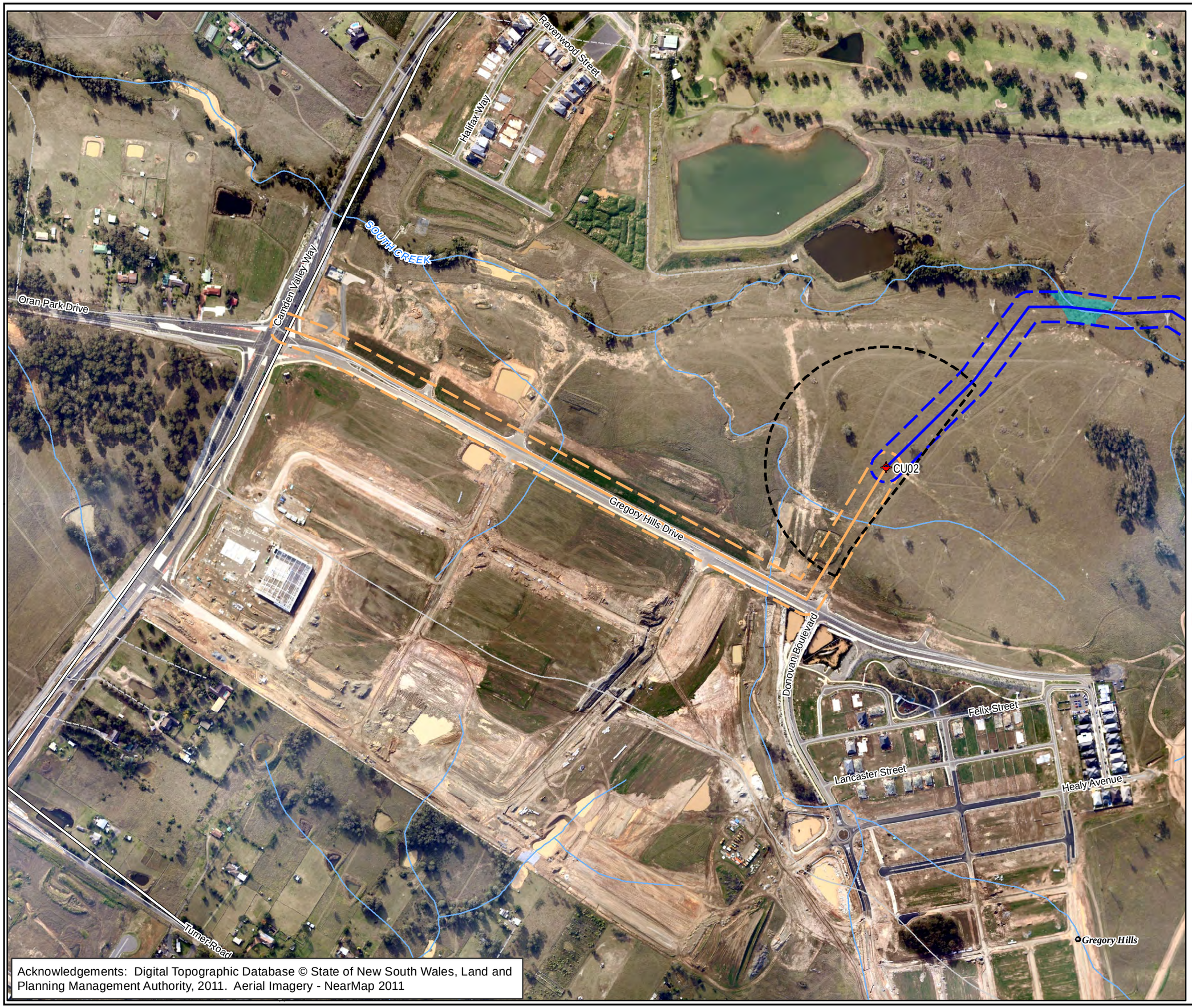
Biosis Research Pty. Ltd.
8 Tate Street
Wollongong
NEW SOUTH WALES
2500

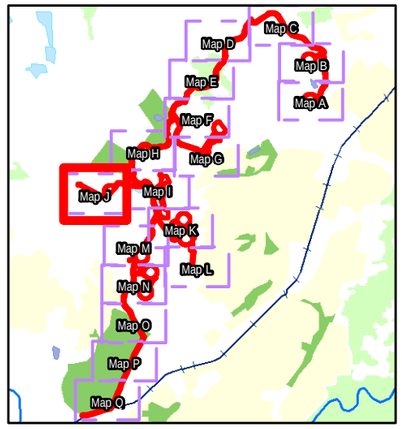
Offices also in: Sydney, Canberra, Ballarat, Melbourne, Wangaratta

N

Date: 06 September 2012, File number: 13320
Checked by: BWM, Drawn by: ANP
Location:P:\13320\GIS\13320 Mapping\Avoidance Mapping June 2012\V4 Report Figures_FINAL\13320 F7 V4_Impacts_20120830.mxd

Acknowledgements: Digital Topographic Database © State of New South Wales, Land and Planning Management Authority, 2011. Aerial Imagery - NearMap 2011





Legend

Biodiversity Exclusion and Impact Minimisation
- Avoid By Exclusion
- Minimise By Detailed Ground Survey and Construction Method
- Minimise By Underbore
- Minimised By Construction Method

Well Locations
- Well Surface Location
- Well Assessment Area

Gas Gathering Lines
- Gas Gathering Line
- Gas Gathering Line Envelope
- Main Gas Gathering Spine
- Main Gas Gathering Spine Envelope

Access Tracks
- Access Track
- Access Track Envelope

Survey Area
- Surface Project Area
- Subsurface Project Area

Figure 7J: Biodiversity Impact Avoidance and Minimisation Measures

0 50 100 150 200 250

Meters

Scale: 1:5,800 @ A3

Coordinate System: GDA 1994 MGA Zone 56

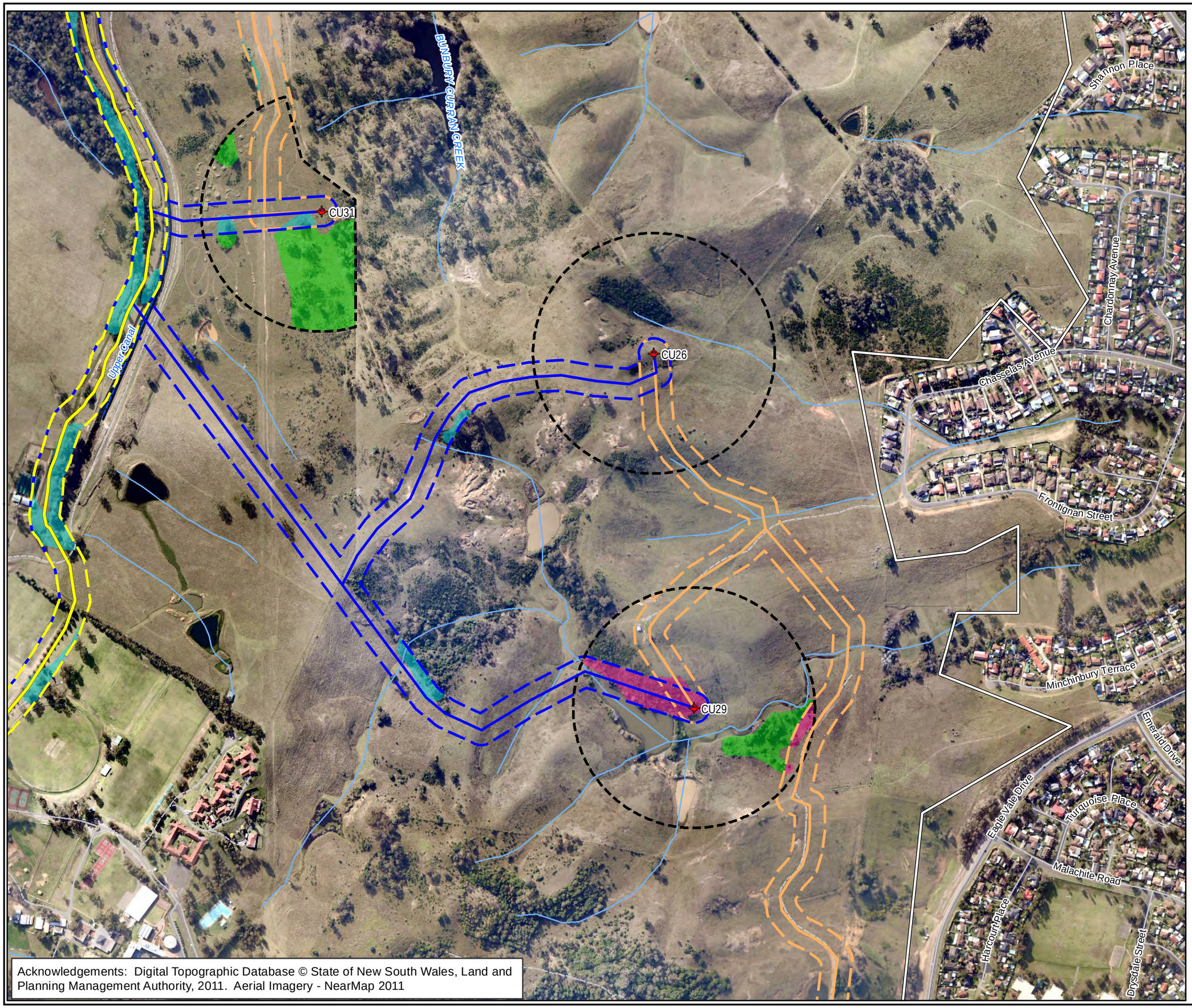
Biosis Research Pty. Ltd.
8 Tate Street
Wollongong
NEW SOUTH WALES
2500

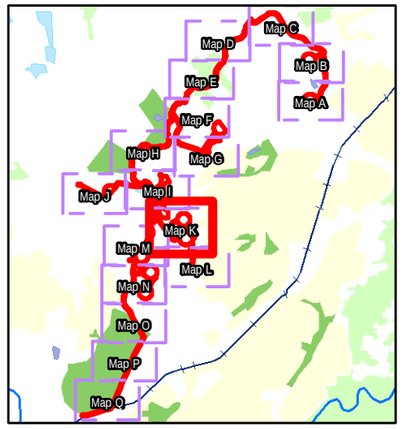
Offices also in: Sydney, Canberra, Ballarat, Melbourne, Wangaratta

N

Date: 06 September 2012, File number: 13320
Checked by: BWM, Drawn by: ANP
Location:P:\13320\GIS\13320Mapping\Vegetation Mapping June 2012\V4 Report Figures_FINAL\13320 F7 V4_Impacts_20120830.mxd

Acknowledgements: Digital Topographic Database © State of New South Wales, Land and Planning Management Authority, 2011. Aerial Imagery - NearMap 2011





Legend

Biodiversity Exclusion and Impact Minimisation
- Avoid By Exclusion
- Minimise By Detailed Ground Survey and Construction Method
- Minimise By Underbore
- Minimised By Construction Method

Well Locations
- Well Surface Location
- Well Assessment Area

Gas Gathering Lines
- Gas Gathering Line
- Gas Gathering Line Envelope
- Main Gas Gathering Spine
- Main Gas Gathering Spine Envelope

Access Tracks
- Access Track
- Access Track Envelope

Survey Area
- Surface Project Area
- Subsurface Project Area

Figure 7K: Biodiversity Impact Avoidance and Minimisation Measures

0 50 100 150 200 250

Meters

Scale: 1:5,800 @ A3

Coordinate System: GDA 1994 MGA Zone 56

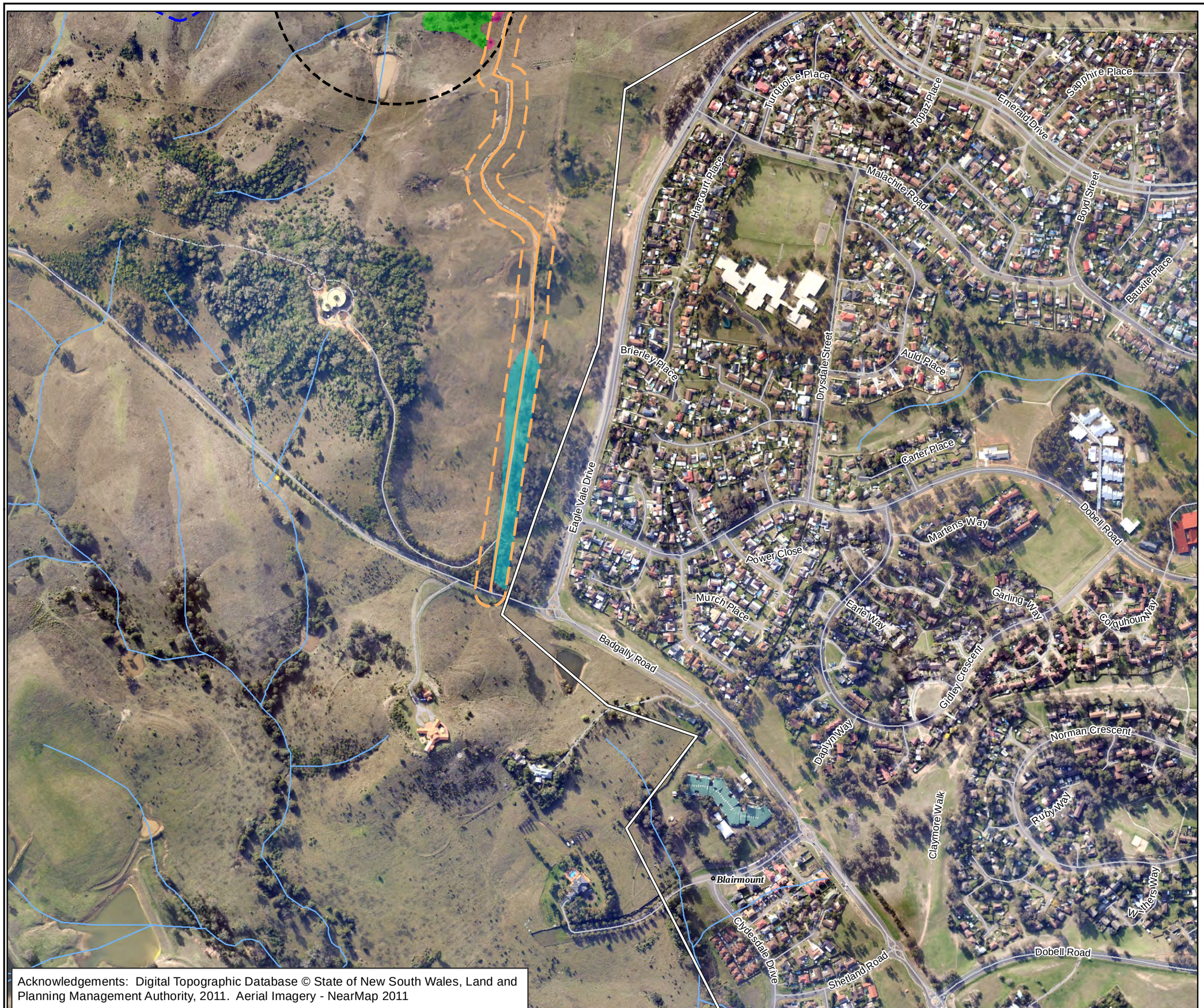
Biosis Research Pty. Ltd.
8 Tate Street
Wollongong
NEW SOUTH WALES
2500

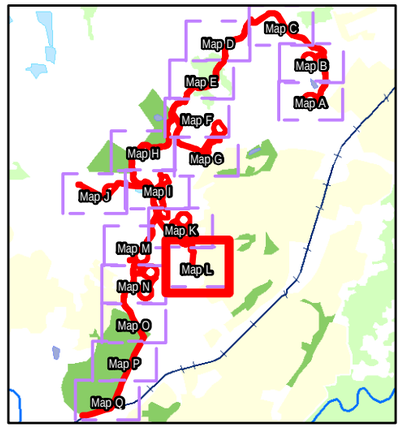
Offices also in: Sydney, Canberra, Ballarat, Melbourne, Wangaratta

N

Date: 06 September 2012, File number: 13320
Checked by: BWM, Drawn by: ANP
Location:P:\13320\GIS\13320MappingVariation Mapping June 2012\V4 Report Figures_FINAL\13320 F7 V4_Impacts_20120830.mxd

Acknowledgements: Digital Topographic Database © State of New South Wales, Land and Planning Management Authority, 2011. Aerial Imagery - NearMap 2011





Legend

Biodiversity Exclusion and Impact Minimisation
- Avoid By Exclusion
- Minimise By Detailed Ground Survey and Construction Method
- Minimise By Underbore
- Minimised By Construction Method

Well Locations
- Well Surface Location
- Well Assessment Area

Gas Gathering Lines
- Gas Gathering Line
- Gas Gathering Line Envelope
- Main Gas Gathering Spine
- Main Gas Gathering Spine Envelope

Access Tracks
- Access Track
- Access Track Envelope

Survey Area
- Surface Project Area
- Subsurface Project Area

Acknowledgements: Digital Topographic Database © State of New South Wales, Land and Planning Management Authority, 2011. Aerial Imagery - NearMap 2011

Figure 7L: Biodiversity Impact Avoidance and Minimisation Measures

0 50 100 150 200 250

Meters

Scale: 1:5,800 @ A3

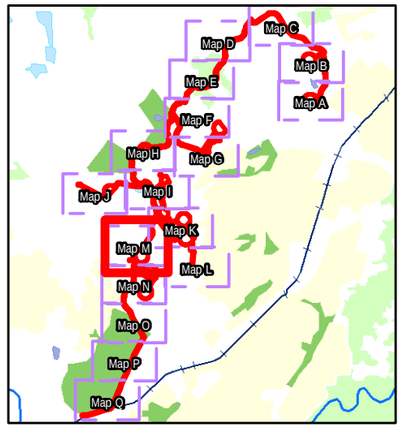
Coordinate System: GDA 1994 MGA Zone 56

Biosis Research Pty. Ltd.
8 Tate Street
Wollongong
NEW SOUTH WALES
2500

Offices also in: Sydney, Canberra, Ballarat, Melbourne, Wangaratta

N

Date: 06 September 2012, File number: 13320
Checked by: BWM, Drawn by: ANP
Location:P:\13320\s13320\Mapping\Variation Mapping June 2012\V4 Report Figures_FINAL\13320 F7 V4_Impacts_20120830.mxd



Legend

Biodiversity Exclusion and Impact Minimisation
- Avoid By Exclusion
- Minimise By Detailed Ground Survey and Construction Method
- Minimise By Underbore
- Minimised By Construction Method

Well Locations
- Well Surface Location
- Well Assessment Area

Gas Gathering Lines
- Gas Gathering Line
- Gas Gathering Line Envelope
- Main Gas Gathering Spine
- Main Gas Gathering Spine Envelope

Access Tracks
- Access Track
- Access Track Envelope

Survey Area
- Surface Project Area
- Subsurface Project Area

Acknowledgements: Digital Topographic Database © State of New South Wales, Land and Planning Management Authority, 2011. Aerial Imagery - NearMap 2011

Figure 7M: Biodiversity Impact Avoidance and Minimisation Measures

0 50 100 150 200 250

Meters

Scale: 1:5,800 @ A3

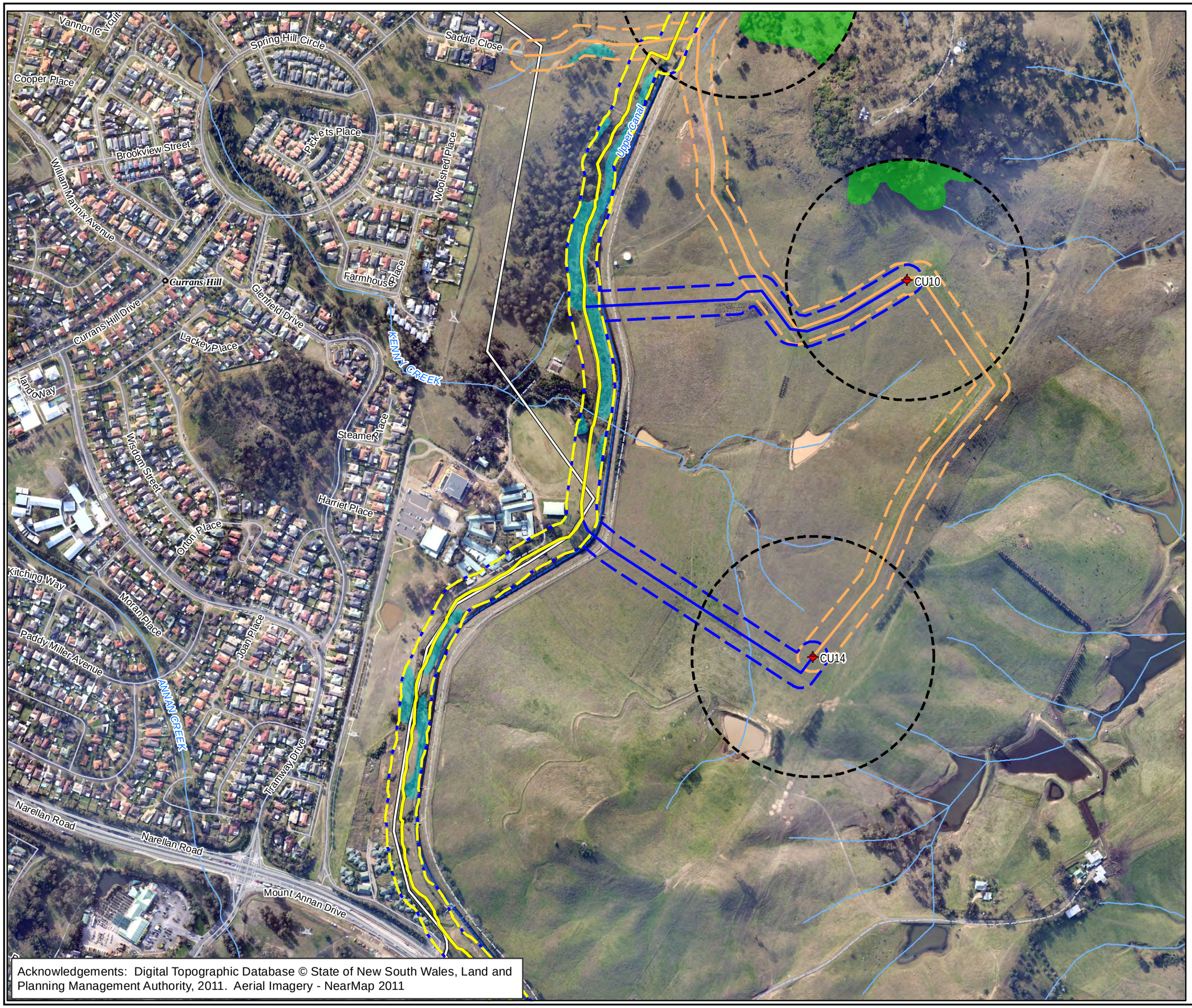
Coordinate System: GDA 1994 MGA Zone 56

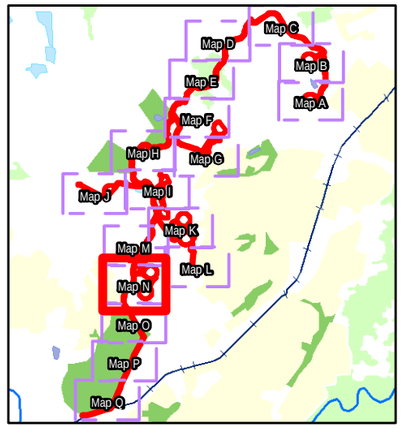
Biosis Research Pty. Ltd.
8 Tate Street
Wollongong
NEW SOUTH WALES
2500

Offices also in: Sydney, Canberra, Ballarat, Melbourne, Wangaratta

N

Date: 06 September 2012, File number: 13320
Checked by: BWM, Drawn by: ANP
Location:P:\13320\GIS\13320MappingValidation Mapping June 2012\V4 Report Figures_FINAL\13320 F7 V4_Impacts_20120830.mxd





Legend

Biodiversity Exclusion and Impact Minimisation
- Avoid By Exclusion
- Minimise By Detailed Ground Survey and Construction Method
- Minimise By Underbore
- Minimised By Construction Method

Well Locations
- Well Surface Location
- Well Assessment Area

Gas Gathering Lines
- Gas Gathering Line
- Gas Gathering Line Envelope
- Main Gas Gathering Spine
- Main Gas Gathering Spine Envelope

Access Tracks
- Access Track
- Access Track Envelope

Survey Area
- Surface Project Area
- Subsurface Project Area

Figure 7N: Biodiversity Impact Avoidance and Minimisation Measures

0 50 100 150 200 250

Meters
Scale: 1:5,800 @ A3
Coordinate System: GDA 1994 MGA Zone 56

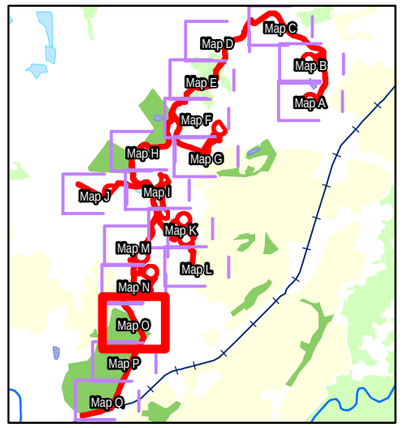
Biosis Research Pty. Ltd.
8 Tate Street
Wollongong
NEW SOUTH WALES
2500

Offices also in: Sydney, Canberra, Ballarat, Melbourne, Wangaratta

N

Date: 06 September 2012, File number: 13320
Checked by: BWM, Drawn by: ANP
Location:P:\13320\GIS\13320Mapping\Variation Mapping June 2012\V4 Report Figures_FINAL\13320 F7 V4_Impacts_20120830.mxd

Acknowledgements: Digital Topographic Database © State of New South Wales, Land and Planning Management Authority, 2011. Aerial Imagery - NearMap 2011



Legend

Biodiversity Exclusion and Impact Minimisation
- Avoid By Exclusion
- Minimise By Detailed Ground Survey and Construction Method
- Minimise By Underbore
- Minimised By Construction Method

Well Locations
- Well Surface Location
- Well Assessment Area

Gas Gathering Lines
- Gas Gathering Line
- Gas Gathering Line Envelope
- Main Gas Gathering Spine
- Main Gas Gathering Spine Envelope

Access Tracks
- Access Track
- Access Track Envelope

Survey Area
- Surface Project Area
- Subsurface Project Area

Acknowledgements: Digital Topographic Database © State of New South Wales, Land and Planning Management Authority, 2011. Aerial Imagery - NearMap 2011

Figure 7O: Biodiversity Impact Avoidance and Minimisation Measures

0 50 100 150 200 250

Meters

Scale: 1:5,800 @ A3

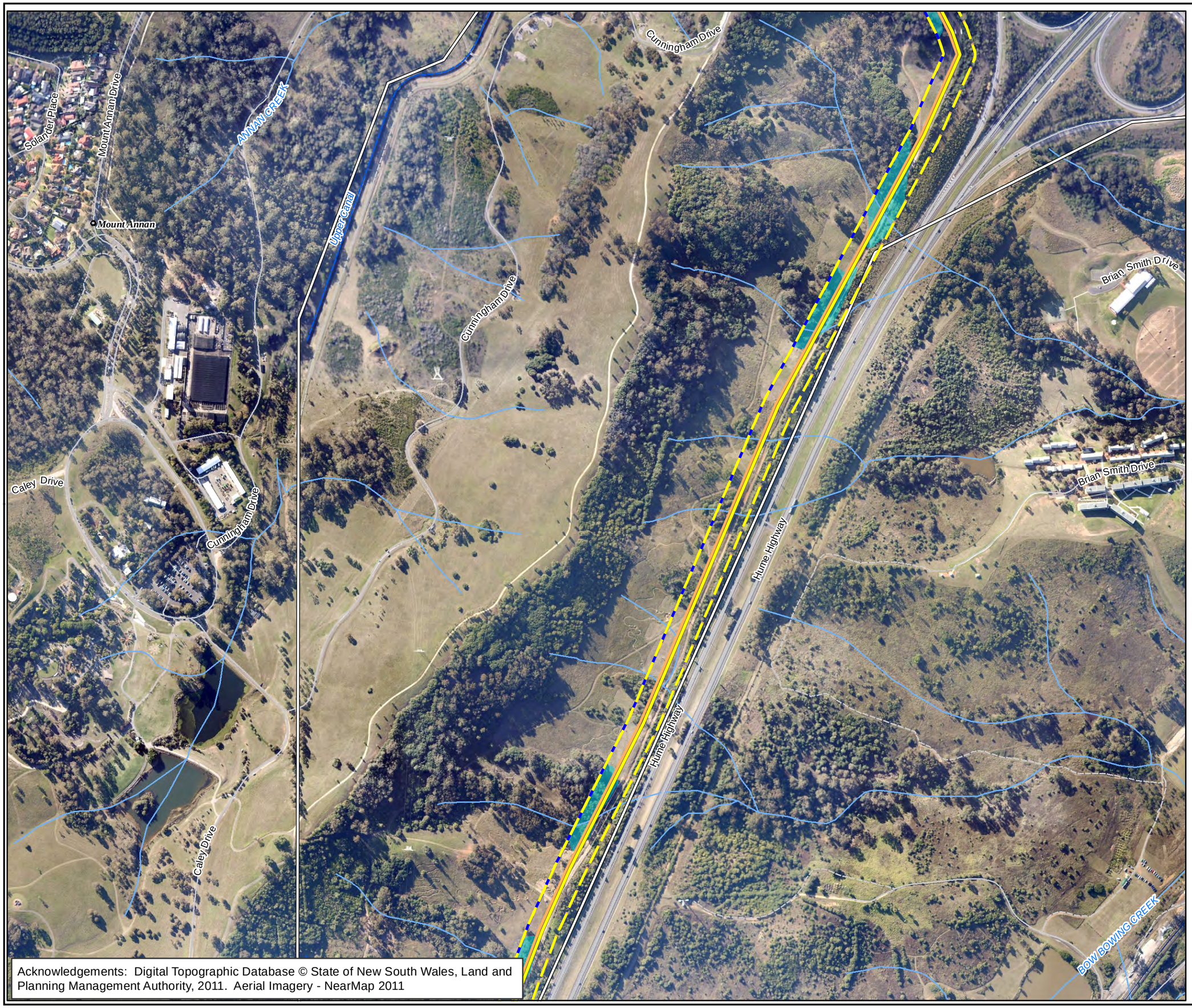
Coordinate System: GDA 1994 MGA Zone 56

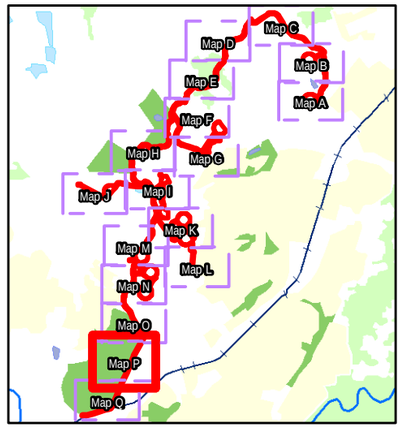
Biosis Research Pty. Ltd.
8 Tate Street
Wollongong
NEW SOUTH WALES
2500

Offices also in: Sydney, Canberra, Ballarat, Melbourne, Wangaratta

N

Date: 26 October 2012, File number: 13320
Checked by: BWM, Drawn by: ANP
Location:P:\13300s\13320\Mapping\Variation Mapping June 2012\V4 Report Figures_FINAL\13320 F7 V4_Impacts_20120830.mxd





Legend

Biodiversity Exclusion and Impact Minimisation
- Avoid By Exclusion
- Minimise By Detailed Ground Survey and Construction Method
- Minimise By Underbore
- Minimised By Construction Method

Well Locations
- Well Surface Location
- Well Assessment Area

Gas Gathering Lines
- Gas Gathering Line
- Gas Gathering Line Envelope
- Main Gas Gathering Spine
- Main Gas Gathering Spine Envelope

Access Tracks
- Access Track
- Access Track Envelope

Survey Area
- Surface Project Area
- Subsurface Project Area

Figure 7P: Biodiversity Impact Avoidance and Minimisation Measures

0 50 100 150 200 250

Meters
Scale: 1:5,800 @ A3
Coordinate System: GDA 1994 MGA Zone 56

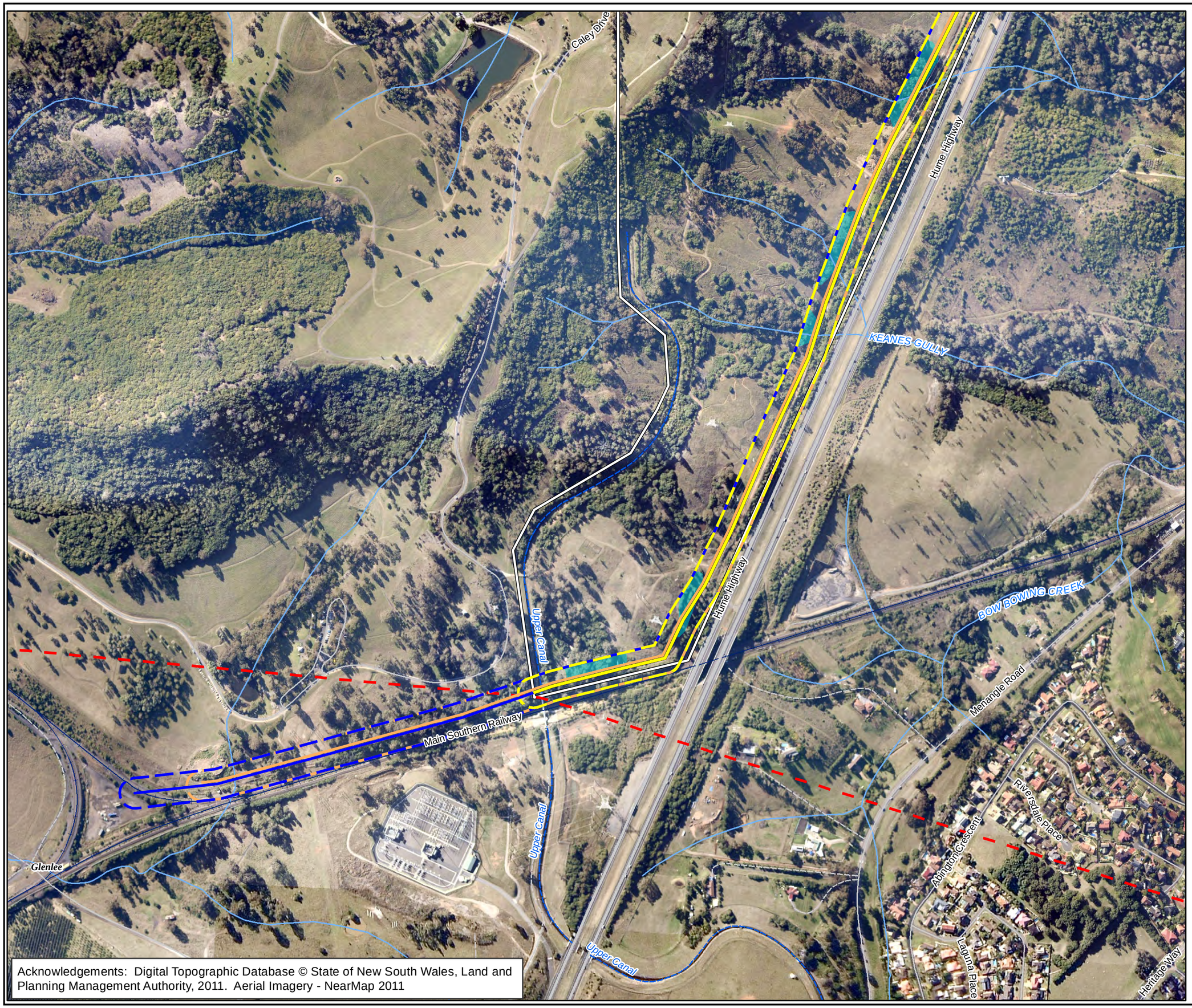
Biosis Research Pty. Ltd.
8 Tate Street
Wollongong
NEW SOUTH WALES
2500

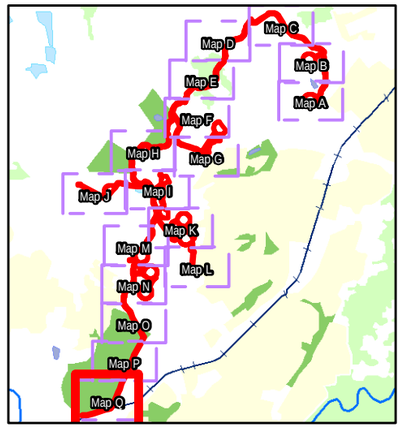
Offices also in: Sydney, Canberra, Ballarat, Melbourne, Wangaratta

N

Date: 06 September 2012, File number: 13320
Checked by: BWM, Drawn by: ANP
Location:P:\13300s\13320\Mapping\Avoidance Mapping June 2012\V4 Report Figures_FINAL\13320 F7 V4_Impacts_20120830.mxd

Acknowledgements: Digital Topographic Database © State of New South Wales, Land and Planning Management Authority, 2011. Aerial Imagery - NearMap 2011





Legend

Biodiversity Exclusion and Impact Minimisation

- Avoid By Exclusion
- Minimise By Detailed Ground Survey and Construction Method
- Minimise By Underbore
- Minimised By Construction Method

Well Locations

- Well Surface Location
- Well Assessment Area

Gas Gathering Lines

- Gas Gathering Line
- Gas Gathering Line Envelope
- Main Gas Gathering Spine
- Main Gas Gathering Spine Envelope

Access Tracks

- Access Track
- Access Track Envelope

Survey Area

- Surface Project Area
- Subsurface Project Area

Acknowledgements: Digital Topographic Database © State of New South Wales, Land and Planning Management Authority, 2011. Aerial Imagery - NearMap 2011

Figure 7Q: Biodiversity Impact Avoidance and Minimisation Measures

0 50 100 150 200 250

Meters

Scale: 1:5,800 @ A3

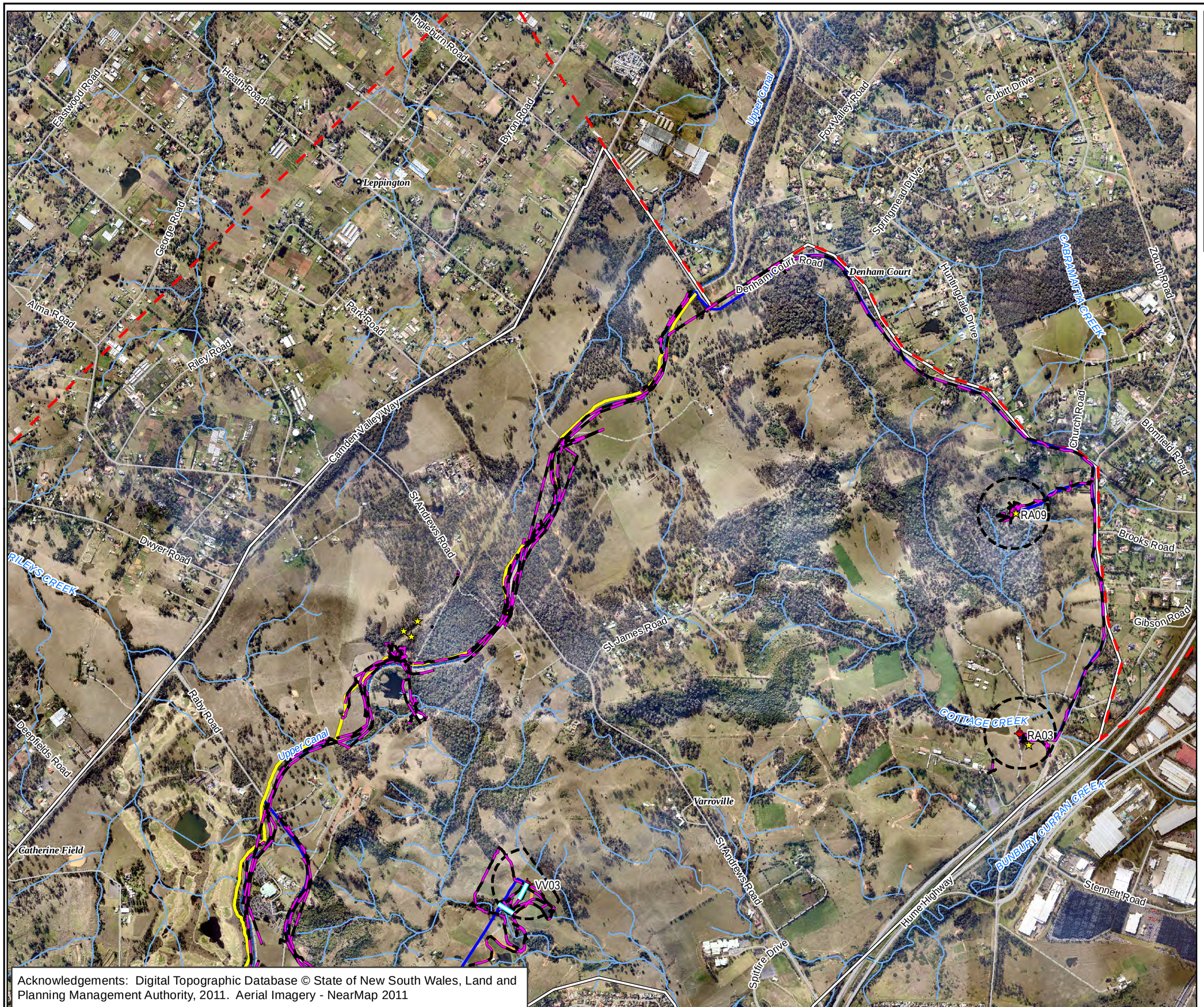
Coordinate System: GDA 1994 MGA Zone 56

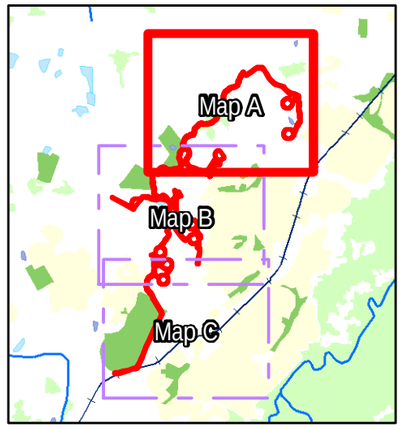
Biosis Research Pty. Ltd.
8 Tate Street
Wollongong
NEW SOUTH WALES
2500

Offices also in: Sydney, Canberra, Ballarat, Melbourne, Wangaratta

N

Date: 06 September 2012, File number: 13320
Checked by: BWM, Drawn by: ANP
Location:P:\13320\s13320\Mapping\Avoidance Mapping June 2012\V4 Report Figures_FINAL\13320 F7 V4_Impacts_20120830.mxd





Legend

Survey Effort
- Flora and Fauna Random Meanders
- Vegetation Quadrats
- Vegetation Survey Transect

Well Locations
- Well Surface Location
- Well Assessment Area

Gas Gathering Lines
- Gas Gathering Line
- Main Gas Gathering Spine

Access Tracks
- Access Track

Survey Area
- Surface Project Area
- Subsurface Project Area

Figure 8A: Flora and Fauna Survey Effort

0 0.2 0.4 0.6 0.8 1

Kilometers

Scale: 1:20,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

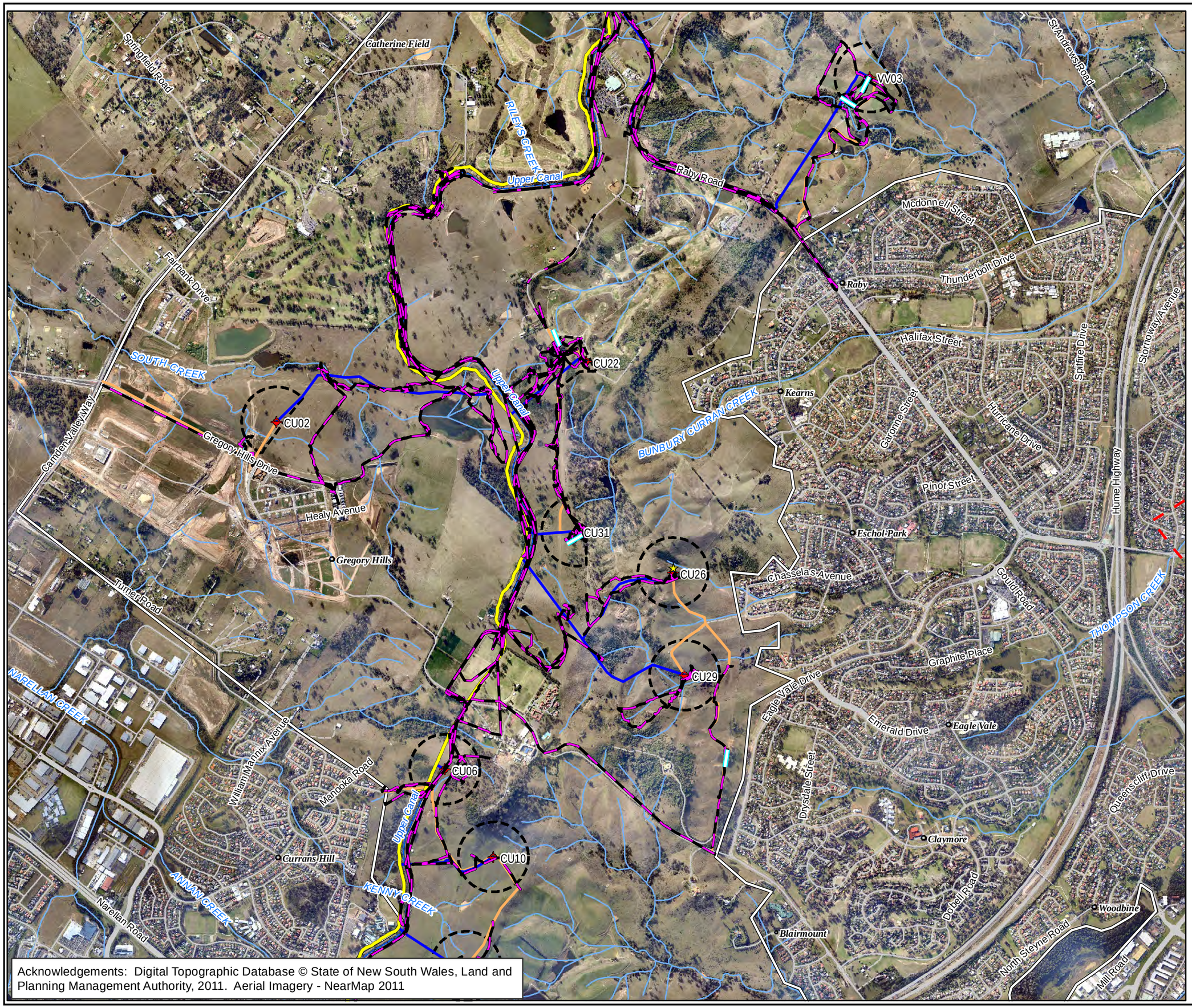
Biosis Research Pty. Ltd.
8 Tate Street
Wollongong
NEW SOUTH WALES
2500

Offices also in: Sydney, Canberra, Ballarat, Melbourne, Wangaratta

N

Date: 06 September 2012, File number: 13320
Checked by: BWM, Drawn by: ANP
Location:P:\13320\s13320\Mapping\Variation Mapping June 2012\V4 Report Figures_FINAL\13320 FB V4_Survey Locations_20120830.mxd

Acknowledgements: Digital Topographic Database © State of New South Wales, Land and Planning Management Authority, 2011. Aerial Imagery - NearMap 2011



Acknowledgements: Digital Topographic Database © State of New South Wales, Land and Planning Management Authority, 2011. Aerial Imagery - NearMap 2011

Figure 8B: Flora and Fauna Survey Effort

0 0.2 0.4 0.6 0.8 1

Kilometers

Scale: 1:20,000 @ A3

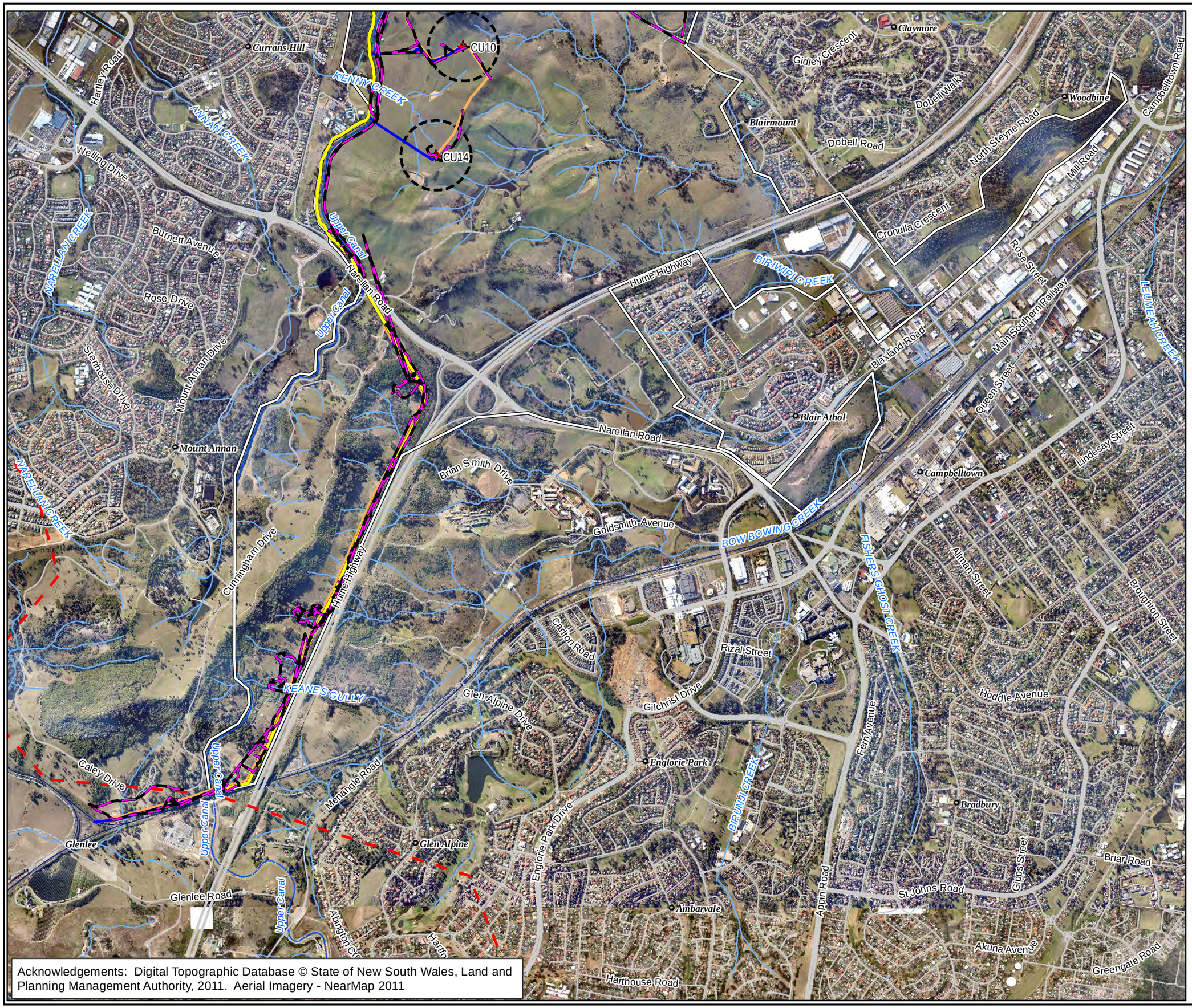
Coordinate System: GDA 1994 MGA Zone 56

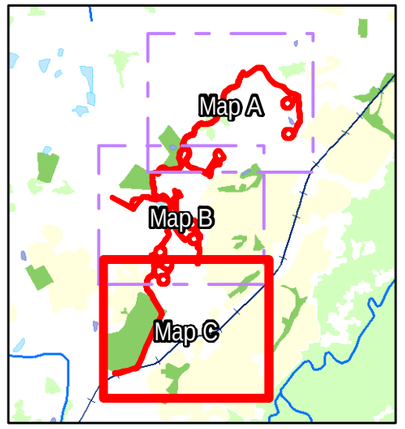
Biosis Research Pty. Ltd.
8 Tate Street
Wollongong
NEW SOUTH WALES
2500

Offices also in: Sydney, Canberra, Ballarat, Melbourne, Wangaratta

N

Date: 06 September 2012, File number: 13320
Checked by: BWM, Drawn by: ANP
Location P:\13320\GIS\13320Mapping\Variation Mapping June 2012\V4 Report Figures_FINAL\13320 FB V4_Survey Locations_20120830.mxd





Legend

Survey Effort
- Flora and Fauna Random Meanders
- Vegetation Quadrats
- Vegetation Survey Transect

Well Locations
- Well Surface Location
- Well Assessment Area

Gas Gathering Lines
- Gas Gathering Line
- Main Gas Gathering Spine

Access Tracks
- Access Track

Survey Area
- Surface Project Area
- Subsurface Project Area

Figure 8C: Flora and Fauna Survey Effort

0 0.2 0.4 0.6 0.8 1

Kilometers

Scale: 1:20,000 @ A3

Coordinate System: GDA 1994 MGA Zone 56

Biosis Research Pty. Ltd.
8 Tate Street
Wollongong
NEW SOUTH WALES
2500

Offices also in: Sydney, Canberra, Ballarat, Melbourne, Wangaratta

N

Date: 06 September 2012, File number: 13320
Checked by: BWM, Drawn by: ANP
Location:P:\13320\GIS\13320_Mapping\Validation Mapping June 2012\V4 Report Figures_FINAL\13320 F8 V4_Survey Locations_20120830.mxd

APPENDICES

APPENDIX 1

Flora Results

General Status	
*	Exotic (not native to Australia)
c N( )	Noxious weeds and 'Control Class' as listed on the NSW Noxious Weeds Act 1993 for both the Camden and Campbelltown LGA's
cd N( )	Noxious weeds and 'Control Class' as listed on the NSW Noxious Weeds Act 1993 for Camden LGA
ct N( )	Noxious weeds and 'Control Class' as listed on the NSW Noxious Weeds Act 1993 for Campbelltown LGA
ni	Non - indigenous native species (does not naturally occur at this locality)
Conservation Status	
CE	Critically Endangered - listed under Schedule 1A of the TSC Act
E	Endangered - listed under Schedule 1 of the TSC Act
V	Vulnerable - listed under Schedule 2 of the TSC Act
CE +	Critically Endangered - listed under the EPBC Act
E +	Endangered - listed under the EBPC Act
V +	Vulnerable - listed under the EPBC Act

Status	Family	Genus species	Common Name
*	Fabaceae - Mimosoideae	*Acacia decurrens*	Black Wattle
	Fabaceae - Mimosoideae	*Acacia falcata*	
	Fabaceae - Mimosoideae	*Acacia implexa*	Hickory Wattle
	Fabaceae - Mimosoideae	*Acacia longifolia* ssp. *longifolia*	Sydney Golden Wattle
	Fabaceae - Mimosoideae	*Acacia parramattensis*	Sydney Green Wattle
	Fabaceae - Mimosoideae	*Acacia* sp	
	Poaceae	*Agrestic* sp	
	Casuarinaceae	*Allocasuarina littoralis*	Black She-oak
	Casuarinaceae	*Allocasuarina toluolsa*	Forest Oak
	Loranthaceae	*Amyema* sp	
*	Primulaceae	*Anagallis arvensis*	Scarlet Pimpernel
	Myrtaceae	*Angophora floribunda*	Apple
*	Apocynaceae	*Araujia sericifera*	Moth Vine
	Poaceae	*Aristida ramosa*	Purple Wiregrass
	Poaceae	*Aristida vagans*	Threeawn Speargrass
c N5	Asparagaceae	*Asparagus asparagoides*	Bridal Creeper
	Rubiaceae	*Asperula conferta*	Common Woodruff
	Ericaceae	*Astroloma pinifolium*	Pine Heath
	Poaceae	*Austrodanthonia fulva*	Wallaby Grass
	Poaceae	*Austrodanthonia tenuior*	
*	Poaceae	*Axonopus fissifolius*	Narrow-leafed Carpet Grass
*	Asteraceae	*Bidens pilosa*	Cobblers Pegs
	Poaceae	*Bothriochloa macra*	Red Grass
	Poaceae	*Bothriochloa* sp	
	Euphorbiaceae	*Breynia oblongifolia*	Coffee Bush
*	Poaceae	*Briza minor*	Shivery Grass
*	Poaceae	*Briza subaristata*	
	Acanthaceae	*Brunoniella australis*	Blue Trumpet
ct N4	Crassulaceae	*Bryophyllum delagoense*	Mother-of-millions
	Pittosporaceae	*Bursaria spinosa* ssp. *spinosa*	Blackthorn
	Asteraceae	*Cassinia uncata*	Sticky Cassinia
*	Gentianaceae	*Centaurium erythraea*	Common Centaury
	Apiaceae	*Centella asiatica*	Indian Pennywort
	Adiantaceae	*Cheilanthes sieberi* ssp. *sieberi*	Mulga Fern
*	Poaceae	*Chloris gayana*	Rhodes Grass
	Poaceae	*Chloris truncata*	Windmill Grass
	Poaceae	*Chloris ventricosa*	Plump Windmill Grass
	Asteraceae	*Chrysocephalum apiculatum*	Common Everlasting

Status	Family	Genus species	Common Name
*	Asteraceae	*Cirsium vulgare*	Spear Thistle
*	Asteraceae	*Conyza* sp	Fleabane
ni	Myrtaceae	*Corymbia citriodora*	Lemon-scented Gum
	Myrtaceae	*Corymbia maculata*	Spotted Gum
*	Asteraceae	*Cotula* sp	
	Asteraceae	*Cymbonotus lawsonianus*	Bears-ear
	Poaceae	*Cymbopogon refractus*	Barbed Wire Grass
	Poaceae	*Cynodon dactylon*	Couch
	Cyperaceae	*Cyperus gracilis*	Slender Flat-sedge
	Fabaceae - Faboideae	*Daviesia genistifolia*	Broom Bitter Pea
	Fabaceae - Faboideae	*Daviesia ulicifolia*	Gorse Bitter Pea
	Fabaceae - Faboideae	*Desmodium varians*	Slender Tick-trefoil
	Phormiaceae	*Dianella revoluta* ssp. *revoluta*	Blueberry Lily
	Poaceae	*Dichanthium sericeum* ssp. *sericeum*	Queensland Bluegrass
	Poaceae	*Dichelachne crinita*	Longhair Plumegrass
	Poaceae	*Dichelachne micrantha*	Shorthair Plumegrass
	Convolvulaceae	*Dichondra repens*	Kidney Weed
	Fabaceae - Faboideae	*Dillwynia sieberi*	
*	Poaceae	*Ehrharta erecta*	Panic Veldtgrass
	Chenopodiaceae	*Einadia hastata*	Berry Saltbush
	Chenopodiaceae	*Einadia polygonoides*	
	Chenopodiaceae	*Einadia trigonos* ssp. *trigonos*	Fishweed
	Poaceae	*Eragrostis brownii*	Brown's Lovegrass
*	Poaceae	*Eragrostis curvula*	African Lovegrass
*	Fabaceae - Faboideae	*Erythrina sykesii*	Coral Tree
	Myrtaceae	*Eucalyptus crebra*	Narrow-leaved Ironbark
	Myrtaceae	*Eucalyptus eugenioides*	Thin-leaved Stringybark
	Myrtaceae	*Eucalyptus fibrosa*	Red Ironbark
	Myrtaceae	*Eucalyptus moluccana*	Grey Box
	Myrtaceae	*Eucalyptus punctata*	Grey Gum
	Myrtaceae	*Eucalyptus tereticornis*	Forest Red Gum
*	Euphorbiaceae	*Euphorbia peplus*	Petty Spurge
	Santalaceae	*Exocarpos cupressiformis*	Cherry Ballart
*	Asteraceae	*Facelis retusa*	
*	Asteraceae	*Gamochaeta americana*	Cudweed
	Geraniaceae	*Geranium homeanum*	Native Geranium
	Geraniaceae	*Geranium solanderi* ssp. *solanderi*	Native Geranium
	Fabaceae - Faboideae	*Glycine clandestina*	
	Fabaceae - Faboideae	*Glycine microphylla*	Small-leaf glycine
	Fabaceae - Faboideae	*Glycine tabacina*	
*	Apocynaceae	*Gomphocarpus fruticosus*	Narrow-leaved Cotton Bush
	Goodeniaceae	*Goodenia hederacea* ssp. *hederacea*	Forest Goodenia
	Goodeniaceae	*Goodenia* sp	
	Fabaceae - Faboideae	*Hardenbergia violacea*	Purple Coral Pea
	Clusiaceae	*Hypericum gramineum*	Small St. John's Wort
c N4	Clusiaceae	*Hypericum perforatum*	St. Johns Wort
*	Asteraceae	*Hypochaeris radicata*	Catsear
	Fabaceae - Faboideae	*Indigofera australis*	Australian Indigo
	Juncaceae	*Juncus usitatus*	Common Rush
c N4&N5	Verbenaceae	*Lantana camara*	Lantana
	Brassicaceae	*Lepidium* sp	
	Ericaceae	*Leucopogon juniperinus*	Prickly Beard-heath
	Linaceae	*Linum marginale*	Native Flax

Status	Family	Genus species	Common Name
	Ericaceae - Styphelioideae	*Lissanthe strigosa* ssp. *strigosa*	Peach Heath
*	Poaceae	*Lolium perenne*	Perennial Ryegrass
	Lomandraceae	*Lomandra longifolia*	Spiny-headed Mat-rush
c N4	Solanaceae	*Lycium ferocissimum*	African Boxthorn
*	Fabaceae - Faboideae	*Medicago minima*	Woolly Burr Medic
	Poaceae	*Microlaena stipoides* var *stipoides*	Weeping Grass
*	Malvaceae	*Modiola caroliniana*	Red-flowered Mallow
c N4	Poaceae	*Nassella neesiana*	
*	Oleaceae	*Olea europaea* ssp. *cuspidata*	Olive
c N4	Cactaceae	*Opuntia* sp	
*	Asteraceae	*Osteospermum ecklonis*	Cape Daisy
*	Oxalidaceae	*Oxalis corniculata*	
	Oxalidaceae	*Oxalis perennans*	
c N5	Oxalidaceae	*Oxalis* sp	
	Asteraceae	*Ozothamnus diosmifolius*	Rice Flower
*	Poaceae	*Paspalum dilatatum*	Paspalum
*	Poaceae	*Pennisetum clandestinum*	Kikuyu Grass
*	Poaceae	*Phalaris aquatica*	Phalaris
	Euphorbiaceae	*Phyllanthus similis*	
*	Pinaceae	*Pinus radiata*	Radiata Pine
*	Pinaceae	*Pinus* sp	Pine
*	Plantaginaceae	*Plantago lanceolata*	Lamb's Tongues
	Lobeliaceae	*Pratia purpurascens*	Whiteroot
*	Malaceae	*Pyracantha angustifolia*	Orange Firethorn
*	Ranunculaceae	*Ranunculus* sp	
c N5	Iridaceae	*Romulea rosea*	Onion Grass
c N4	Rosaceae	*Rubus fruticosus* agg sp	Blackberry
*	Anacardiaceae	*Schinus areira*	Pepper Tree
*	Asteraceae	*Senecio madagascariensis*	Fireweed
*	Fabaceae - Caesalpinioideae	*Senna pendula* var *glabrata*	
*	Poaceae	*Setaria gracilis*	Slender Pigeon Grass
*	Malvaceae	*Sida rhombifolia*	Paddy's Lucerne
	Malvaceae	*Sida spinosa*	
*	Solanaceae	*Solanum linnaeanum*	
	Solanaceae	*Solanum prinophyllum*	Forest Nightshade
*	Asteraceae	*Soliva sessilis*	Bindyi
*	Asteraceae	*Sonchus oleraceus*	Common Sowthistle
*	Poaceae	*Sporobolus africanus*	Parramatta Grass
	Poaceae	*Sporobolus creber*	Western Rat-tail Grass
	Poaceae	*Sporobolus elongatus*	Slender Rat's Tail Grass
*	Poaceae	*Sporobolus fertilis*	Giant Parramatta Grass
	Poaceae	*Sporobolus* sp	
*	Caryophyllaceae	*Stellaria media*	Common Chickweed
*	Asteraceae	*Taraxacum officinale*	Dandelion
	Poaceae	*Themeda australis*	Kangaroo Grass
*	Fabaceae - Faboideae	*Trifolium pratense*	Red Clover
*	Fabaceae - Faboideae	*Trifolium repens*	White Clover
	Juncaginaceae	*Triglochin rheophilum*	
*	Urticaceae	*Urtica urens*	
*	Verbenaceae	*Verbena bonariensis*	Purpletop
*	Verbenaceae	*Verbena officinalis*	Vervain
	Asteraceae	*Vernonia cinerea* ssp. *cinerea*	
*	Scrophulariaceae	*Veronica arvensis*	

Status	Family	Genus species	Common Name
	Scrophulariaceae	*Veronica plebeia*	Trailing Speedwell
	Asteraceae	*Vittadinia muelleri*	
	Campanulaceae	*Wahlenbergia stricta* ssp. *stricta*	Australian Bluebell

APPENDIX 2

Conservation Rating According to Briggs and Leigh (1995)

Conservation Rating According to Briggs and Leigh (1996)

Briggs and Leigh (1996) list over 5,031 species, subspecies and varieties of plants (5% of native vascular flora of Australia) that have been ranked according to their conservation status. While many of these species are contained within the schedules of various state and federal threatened species legislation (eg. TSC Act and EPBC Act), and are subject to legislative provisions under those acts, a great many more do not and as a such are extraneous to statutory assessment processes.

The modified list below presents the range of codes that are, in various combinations, applied to each listed plant species.

1	Species only known from one collection
2	Species with a geographic range of less than 100km in Australia
3	Species with a geographic range of more than 100km in Australia
X	Species presumed extinct; no new collections for at least 50 years
E	Endangered species at risk of disappearing from the wild state if present land use and other causal factors continue to operate
V	Vulnerable species at risk of long-term disappearance through continued depletion.
R	Rare, but not currently considered to be endangered.
K	Poorly known species that are suspected to be threatened.
C	Known to be represented within a conserved area.
a	At least 1,000 plants are known to occur within a conservation reserve(s).
i	Less than 1,000 plants are known to occur within a conservation reserve(s).
-	The reserved population size is unknown.
t	The total known population is reserved.
+	The species has a natural occurrence overseas.

APPENDIX 3

Fauna Results

General Status	
*	Introduced (not native to Australia)
Conservation Status	
CE	Critically Endangered - listed under Schedule 1A of the TSC Act
E	Endangered - listed under Schedule 1 of the TSC Act
V	Vulnerable - listed under Schedule 2 of the TSC Act
CE +	Critically Endangered - listed under the EPBC Act
E +	Endangered - listed under the EBPC Act
V +	Vulnerable - listed under the EPBC Act
Observation type	
Vis	Visual
H	Heard calling
I	Indirect including track, scat, hair, nest, feeding signs or other
Db	DECCW Wildlife Atlas record for locality

Family Name	Latin Name	Common Name	EPBC Act	TSC Act (NSW)	Observation Type
AMPHIBIANS					
Hylidae	*Litoria fallax*	Eastern Dwarf Tree Frog			Db
Hylidae	*Litoria peronii*	Peron's Tree Frog			Db
Hylidae	*Litoria verreauxii*	Verreaux's Frog			H
Myobatrachidae	*Crinia signifera*	Common Eastern Froglet			H
Myobatrachidae	*Limnodynastes peronii*	Brown-striped Frog			H
BIRDS					
Acanthizidae	*Acanthiza chrysorrhoa*	Yellow-rumped Thornbill			Db
Acanthizidae	*Acanthiza lineata*	Striated Thornbill			Db
Acanthizidae	*Acanthiza nana*	Yellow Thornbill			Db
Acanthizidae	*Acanthiza pusilla*	Brown Thornbill			Db
Acanthizidae	*Gerygone olivacea*	White-throated Gerygone			Db
Acanthizidae	*Sericornis frontalis*	White-browed Scrubwren			Db
Acanthizidae	*Smicrornis brevirostris*	Weebill			Db
Accipitridae	*Elanus axillaris*	Black-shouldered Kite			Vis
Accipitridae	*Aquila audax*	Wedge-tailed Eagle			Vis
Alcedinidae	*Dacelo novaeguineae*	Laughing Kookaburra			Db
Alcedinidae	*Todiramphus sanctus*	Sacred Kingfisher			Db
Anatidae	*Anas gracilis*	Grey Teal			Db
Anatidae	*Anas superciliosa*	Pacific Black Duck			Vis
Anatidae	*Aythya australis*	Hardhead			Db
Anatidae	*Chenonetta jubata*	Australian Wood Duck			Vis
Anatidae	*Cygnus atratus*	Black Swan			Vis
Anhingidae	*Anhinga*	Darter			Db

Family Name	Latin Name	Common Name	EPBC Act	TSC Act (NSW)	Observation Type
	melanogaster				
Ardeidae	*Ardea alba*	Great Egret	M		Db
Ardeidae	*Bubulcus ibis*	Cattle Egret			Vis
Ardeidae	*Egretta novaehollandiae*	White-faced Heron			Vis
Ardeidae	*Ardea ibis*	Cattle Egret	M		Vis
Artamidae	*Artamus cyanopterus*	Dusky Woodswallow			Db
Artamidae	*Cracticus torquatus*	Grey Butcherbird			Vis
Artamidae	*Gymnorhina tibicen*	Australian Magpie			Vis
Artamidae	*Strepera graculina*	Pied Currawong			Vis
Cacatuidae	*Cacatua galerita*	Sulphur-crested Cockatoo			Vis
Cacatuidae	*Cacatua tenuirostris*	Long-billed Corella			Vis
Cacatuidae	*Calyptorhynchus funereus*	Yellow-tailed Black-Cockatoo			Vis
Cacatuidae	*Eolophus roseicapillus*	Galah			Vis
Cacatuidae	*Cacatua roseicapilla*	Galah			Vis
Campephagidae	*Coracina novaehollandiae*	Black-faced Cuckoo-shrike			Vis
Centropodidae	*Centropus phasianinus*	Pheasant Coucal			Db
Charadriidae	*Vanellus miles*	Masked Lapwing			Vis
Climacteridae	*Cormobates leucophaea*	White-throated Treecreeper			H
Columbidae	*Geopelia humeralis*	Bar-shouldered Dove			Vis
Columbidae	*Ocyphaps lophotes*	Crested Pigeon			Vis
Columbidae	*Phaps chalcoptera*	Common Bronzewing			Db
Corcoracidae	*Corcorax melanorhamphos*	White-winged Chough			Db
Corvidae	*Corvus coronoides*	Australian Raven			Vis
Cuculidae	*Cacomantis flabelliformis*	Fan-tailed Cuckoo			Db
Cuculidae	*Scythrops novaehollandiae*	Channel-billed Cuckoo			Db
Dicaeidae	*Dicaeum hirundinaceum*	Mistletoebird			Db
Dicruridae	*Grallina cyanoleuca*	Magpie-lark			Vis
Dicruridae	*Rhipidura albiscapa*	Grey Fantail			Vis
Dicruridae	*Rhipidura leucophrys*	Willie Wagtail			Vis
Estrildidae	*Neochmia temporalis*	Red-browed Finch			Vis
Estrildidae	*Taeniopygia bichenovii*	Double-barred Finch			Db
Falconidae	*Falco berigora*	Brown Falcon			Vis
Falconidae	*Falco cenchroides*	Nankeen Kestrel			Vis
Hirundinidae	*Hirundo neoxena*	Welcome Swallow			Vis

Family Name	Latin Name	Common Name	EPBC Act	TSC Act (NSW)	Observation Type
Maluridae	*Malurus cyaneus*	Superb Fairy-wren			Vis
Maluridae	*Malurus lamberti*	Variegated Fairy-wren			Vis
Meliphagidae	*Acanthorhynchus tenuirostris*	Eastern Spinebill			Vis
Meliphagidae	*Anthochaera chrysoptera*	Little Wattlebird			Db
Meliphagidae	*Lichenostomus chrysops*	Yellow-faced Honeyeater			Vis, H
Meliphagidae	*Lichenostomus leucotis*	White-eared Honeyeater			Vis
Meliphagidae	*Manorina melanocephala*	Noisy Miner			Vis, H
Meliphagidae	*Manorina melanophrys*	Bell Miner			Vis,H
Meliphagidae	*Meliphaga lewinii*	Lewin's Honeyeater			Db
Meliphagidae	*Melithreptus brevirostris*	Brown-headed Honeyeater			Vis
Oriolidae	*Oriolus sagittatus*	Olive-backed Oriole			Vis
Pachycephalidae	*Colluricincla harmonica*	Grey Shrike-thrush			Db
Pachycephalidae	*Pachycephala pectoralis*	Golden Whistler			Db
Pachycephalidae	*Pachycephala rufiventris*	Rufous Whistler			Db
Pardalotidae	*Pardalotus punctatus*	Spotted Pardalote			Db
Pardalotidae	*Pardalotus striatus*	Striated Pardalote			Vis
Pelecanidae	*Pelecanus conspicillatus*	Australian Pelican			Vis
Petroicidae	*Eopsaltria australis*	Eastern Yellow Robin			Db
Phalacrocoracidae	*Phalacrocorax melanoleucos*	Little Pied Cormorant			Db
Phalacrocoracidae	*Phalacrocorax sulcirostris*	Little Black Cormorant			Db
Phalacrocoracidae	*Phalacrocorax varius*	Pied Cormorant			Vis
Phasianidae	*Coturnix ypsilophora*	Brown Quail			Db
Podargidae	*Podargus strigoides*	Tawny Frogmouth			Db
Podicipedidae	*Tachybaptus novaehollandiae*	Australasian Grebe			Db
Psittacidae	*Alisterus scapularis*	Australian King-Parrot			Db
Psittacidae	*Glossopsitta concinna*	Musk Lorikeet			Vis
Psittacidae	*Psephotus haematonotus*	Red-rumped Parrot			Vis
Psittacidae	*Trichoglossus haematodus*	Rainbow Lorikeet			Vis, H
Psittacidae	*Platycercus elegans*	Crimson Rosella			Vis
Psittacidae	*Platycercus eximius*	Eastern Rosella			Vis, H
Pycnonotida	*Pycnonotus jocosus*	Red-whiskered		U	Vis, H

Family Name	Latin Name	Common Name	EPBC Act	TSC Act (NSW)	Observation Type
e		Bulbul			
Rallidae	*Fulica atra*	Eurasian Coot			Db
Rallidae	*Gallinula tenebrosa*	Dusky Moorhen			Db
Rallidae	*Porphyrio porphyrio*	Purple Swamphen			Vis
Sturnidae	*Acridotheres tristis*	Common Mynah		U	Vis
Sturnidae	*Sturnus vulgaris*	Common Starling		U	Vis
Threskiornithidae	*Platalea regia*	Royal Spoonbill			Db
Threskiornithidae	*Plegadis falcinellus*	Glossy Ibis			Vis
Threskiornithidae	*Threskiornis molucca*	Australian White Ibis			Db
Threskiornithidae	*Threskiornis spinicollis*	Straw-necked Ibis			Db
Turnicidae	*Turnix varia*	Painted Button-quail			Db
Zosteropidae	*Zosterops lateralis*	Silvereye			Vis
MAMMALS					
Bovidae	*Bos taurus*	Domestic Cattle		U	Vis
Canidae	*Canis familiaris*	Domestic Dog		U	I
Canidae	*Vulpes vulpes*	Fox		U	I
Leporidae	*Oryctolagus cuniculus*	European Rabbit		U	Vis, I
Macropodidae	*Wallabia bicolor*	Swamp Wallaby			Db
Molossidae	*Tadarida australis*	White-striped Freetail-bat			Db
Petauridae	*Petaurus breviceps*	Sugar Glider			Db
Phalangeridae	*Trichosurus vulpecula*	Common Brushtail Possum			Db
Pseudocheiridae	*Pseudocheirus peregrinus*	Common Ringtail Possum			Db
Tachyglossidae	*Tachyglossus aculeatus*	Short-beaked Echidna			Db
Vespertilionidae	*Chalinolobus gouldii*	Gould's Wattled Bat			Db
Vespertilionidae	*Chalinolobus morio*	Chocolate Wattled Bat			Db
Vespertilionidae	*Scotorepens orion*	Eastern Broad-nosed Bat			Db
Vespertilionidae	*Vespadelus vulturnus*	Little Forest Bat			Db
REPTILES					
Agamidae	*Physignathus lesueurii*	Eastern Water Dragon			Db
Agamidae	*Pogona barbata*	Bearded Dragon			Db
Chelidae	*Chelodina longicollis*	Eastern Snake-necked Turtle			Db
Elapidae	*Pseudechis porphyriacus*	Red-bellied Black Snake			Db
Elapidae	*Pseudonaja textilis*	Eastern Brown Snake			I
Scincidae	*Ctenotus robustus*	Robust Ctenotus			Db

Family Name	Latin Name	Common Name	EPBC Act	TSC Act (NSW)	Observation Type
Scincidae	*Eulamprus quoyii*	Eastern Water-skink			Db
Scincidae	*Lampropholis delicata*	Dark-flecked Garden Sunskink			Vis
Scincidae	*Lampropholis guichenoti*	Pale-flecked Garden Sunskink			Db
Scincidae	*Tiliqua scincoides*	Eastern Blue-tongue			Db

APPENDIX 4

Impact Assessment - Guidelines for Threatened Species Assessment Part 3A of the EP&A Act

Ecological Communities

An impact assessment is undertaken for CPW that will be disturbed as a result of the Amended Project.

Cumberland Plain Woodland

Vegetation mapping by NPWS (2002d) and modified by Biosis has identified 868 ha of CPW in the Surface Project Area. The majority of CPW mapped by NPWS (2002d) occurs in the northern lobe of the Surface Project Area incorporating some large patches with a high level of connectivity provided by corridors and disjunct strands (Figure 2). The community has been identified in the current investigations on the Subject Site (Figures 6a to 6q) and is proposed to be modified in some locations (Figures 7a to 7q). Condition of the community throughout the Subject Site varies from Poor to Good and this includes areas that are likely to be disturbed.

How is the proposal likely to affect the lifecycle of a threatened species and/or population?

Not applicable, CPW is not a species or population.

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

Approximately 40.35 ha of CPW is estimated to occur in the Subject Site, including access tracks, GGLs, Main Spine and WSLs. Impacts to all areas of CPW will be avoided and minimised. Thus a significant effect on CPW is unlikely to occur as a result of the Amended Project.

Does the proposal affect any threatened species or populations that are at the limit of its known distribution?

Not applicable, CPW is not a species or population.

How is the proposal likely to affect current disturbance regimes?

The main disturbances affecting CPW include:

- Continuing clearing for urban or rural development, and the subsequent impacts from fragmentation;
- Grazing and slashing or mowing;
- Alteration of hydrological processes including surface flows in ephemeral or running drainage lines resulting in erosion, sedimentation and soil chemistry;
- Weed invasion; and
- Inappropriate fire regimes that alter the floristic and structural integrity.

The Amended Project will contribute to the clearing of CPW by temporary modification of some areas of CPW. The Amended Project is unlikely to increase the operation or impacts of any of the other key disturbances identified above.

How is the proposal likely to affect habitat connectivity?

Figure 2 shows the distribution of CPW in the Surface Project Area. The majority of CPW mapped by NPWS (2002d) occurs in the northern sector incorporating some large patches with a high level of connectivity provided by corridors and partially isolated stands. CPW is sparser through the central and southern sectors of the Surface Project Area, smaller in area and relatively disjunct.

Impacts to all areas of CPW will be avoided and minimised and the Amended project is unlikely to affect habitat connectivity.

How is the proposal likely to affect critical habitat?

Under the TSC Act, the Director-General of OEH maintains a Register of Critical Habitat. To date, no critical habitat has been declared for CPW.

An impact assessment is undertaken for RFEFCF (Alluvial Woodland) that will be disturbed as a result of the Amended Project.

River Flat Eucalypt Forest on Coastal Floodplains

Vegetation mapping by NPWS (2002d) and modified by Biosis Research as has identified 42.24 ha of RFEFCF in the Surface Project Area. The majority of RFEFCF mapped by NPWS (2002d) occurs as disjunct linear stands on drainage lines east of the central ridge of low hills extending north to south in the Surface Project Area (Figure 2). The community has been identified in the current investigations on the Subject Site (Figures 6a to 6q) with some areas mapped as Alluvial Woodland (corresponding to RFEFCF) modified following field surveys to be included and mapped as CPW. RFEFCF mapped in the current surveys is proposed to be modified in some locations (Figures 7a to 7q). Condition of the community throughout the Subject Site varies from Poor to Moderate and this includes areas that are likely to be subject to some disturbance.

How is the proposal likely to affect the lifecycle of a threatened species and/or population?

Not applicable, RFEFCF is not a species or population.

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

Approximately 3.46 ha of RFEFCF is estimated to occur in Subject Site, including access tracks, GGLs, Main Spine and WSLs. Impacts to all areas of RFEFCF will be avoided and minimised, and the Amended Project is unlikely to significantly affect RFEFCF and its habitat.

Does the proposal affect any threatened species or populations that are at the limit of its known distribution?

Not applicable, RFEFCF is not a species or population.

How is the proposal likely to affect current disturbance regimes?

The main disturbances affecting RFEFCF include:

Continuing clearing for urban or rural development, and the subsequent impacts from fragmentation;

Grazing and slashing or mowing;

Alteration of hydrological processes including surface flows in ephemeral or running drainage lines resulting in erosion, pollution, sedimentation and soil chemistry including acid sulphate soils;

Weed invasion; and

Inappropriate fire regimes that alter the floristic and structural integrity.

The Amended Project will contribute to the clearing of RFEFCF by minor and temporary modification of the groundcover and shrub stratum in some areas of RFEFCF. The Amended Project is unlikely to increase the operation or impacts of any of the other key disturbances identified above.

How is the proposal likely to affect habitat connectivity?

Figure 2 shows the distribution of RFEFCF in the Surface Project Area. The majority of RFEFCF mapped by NPWS (2002d) occurs as disjunct linear stands on drainage lines east of the central ridge of low hills extending north to south in the Surface Project Area (Figure 2). Several disjunct patches of the community are also mapped to the west of the central ridge in the upper reaches and tributaries of South Creek.

Impacts to all areas of REFCF will be avoided and minimised and the Amended project is unlikely to affect habitat connectivity.

How is the proposal likely to affect critical habitat?

Under the TSC Act, the Director-General of OEH maintains a Register of Critical Habitat. To date, no critical habitat has been declared for RFEFCF.

Flora

Impact assessments were undertaken for the following threatened flora species that were assessed to have a medium to high likelihood of occurrence within the Surface Project Area and may be impacted by the Amended Project;

Acacia pubescens;

Cynanchum elegans;

Pimelea spicata;

Pomaderris brunnea; and

Thesium australe.

In addition, one Endangered Population was also found to likely occur within the Surface Project Area:

Marsdenia viridiflora ssp. *viridiflora* in Bankstown, Blacktown, Camden, Campbelltown, Fairfield, Holroyd, Liverpool and Penrith local government areas.

Acacia pubescens

Acacia pubescens is listed as Vulnerable under the TSC Act and EPBC Acts.

Acacia pubescens is a spreading shrub 1-4 m high with brilliant yellow flowers, bipinnate leaves and conspicuously hairy branches (NPWS 2003c). This species is known to occur on alluviums, shales and at the intergrade between shales and sandstones. The species has been recorded within Cumberland Plain Woodland (CPW), Cooks River Castlereagh Ironbark Forest and Shale Gravel Transition Forest (NPWS 2003c).

Acacia pubescens was not recorded in the Surface Project Area during the current surveys; however potential habitat for the species exists within CPW.

How is the proposal likely to affect the lifecycle of a threatened species and/or population?

Flowering of *Acacia pubescens* occurs between August and October and it more typically reproduces vegetatively than from seeds. Percentage of pod production is believed to be low from this species (NPWS 2003). It is thought that a fire free period of between 5 to 7 years is required to permit germination of this species.

This species was not recorded during the current survey, despite it being previously recorded approximately 6 km north-east of the Surface Project Area and within the locality. Consequently, since no individuals were recorded in the Surface Project Area and fire regimes will remain the same as current; it is unlikely that the lifecycle of this species will be affected by the Amended Project.

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

Acacia pubescens occurs on alluviums, shales and the transition between shale and sandstone. It is most commonly found in a variety of plant communities including CPW, Cooks River/ Castlereagh Ironbark Forest and Shale/ Gravel Transition Forest.

Acacia pubescens was not recorded during field surveys. However, it has been recorded north-east of the Surface Project Area adjacent to the Hume Highway. The Surface Project Area provides potential habitat in the form of CPW. Impacts to CPW will be avoided and minimised, and no residual impact is likely to occur.

The invasion of weeds is a known threat to the habitat of this species. Given the predominance of weed and pasture species present in the ground layer of the Surface Project Area, the Amended Project is considered unlikely to introduce further weed seed to any remaining areas of habitat.

The Amended Project is unlikely to have a significant effect on the habitat of the species in the locality.

Does the proposal affect any threatened species or populations that are at the limit of its known distribution?

Acacia pubescens was not recorded during field surveys. However, it has been recorded north-east of the Surface Project Area adjacent to the Hume Highway. This species is concentrated around Bankstown-Rookwood-Fairfield area and the Pitt Town area, with outliers occurring at Barden Ridge, Oakdale and Mountain Lagoon.

Therefore, this species is not considered at the limit of its known distribution.

How is the proposal likely to affect current disturbance regimes?

The Amended Project is unlikely to modify the intensity and frequency of fires or flooding flows.

How is the proposal likely to affect habitat connectivity?

Potential habitat for *Acacia pubescens* within the Surface Project Area is primarily present within remnant and regrowth CPW. CPW is currently fragmented across a majority of the Surface Project Area with the exception of the northern sections, which will not be significantly impacted by the Amended Project.

Consequently, it is considered unlikely that the Amended Project will affect habitat connectivity for the species.

How is the proposal likely to affect critical habitat?

Under the TSC Act, the Director-General of OEH maintains a Register of Critical Habitat. To date, no critical habitat has been declared for *Acacia pubescens*.

The Amended Project will not have an adverse effect on critical habitat (directly or indirectly).

Cynanchum elegans	**White-flowered Wax Plant**

Cynanchum elegans is listed as Endangered under the TSC Act and EPBC Act.

Cynanchum elegans is a climber with variable forms. This species typically occurs on the edge of dry rainforest vegetation. It is also associated with other vegetation types such as, littoral rainforest, Coastal Tea-tree *Leptospermum laevigatum* – Coastal Banksia *Banksia integrifolia* subsp. *integrifolia* coastal scrub; Forest Red Gum *Eucalyptus tereticornis* aligned open forest and woodland; Spotted Gum *Eucalyptus maculata* aligned open forest and woodland; and Bracelet Honeymyrtle *Melaleuca armillaris* scrub to open scrub.

This species was not recorded during field surveys, despite one previous record within the Surface Project Area and several records within the broader locality.

How is the proposal likely to affect the lifecycle of a threatened species and/or population?

Cynanchum elegans flowers between August and May and seed dispersal is thought to be predominantly wind driven. The soil stored seed bank is considered to be non-existent for this species. Plants are capable of suckering in response to grazing and/or slashing.

This species was not recorded during the current field surveys, despite previous records within the Surface Project Area and locality. Potential habitat for this species exists in CPW, RFEFCF, MSW and WSDR particularly in association with *Eucalyptus tereticornis*. No MSW and WSDR occurs within areas to be directly and indirectly affected. All impacts to CPW and RFEFCF will be avoided and minimised.

Consequently, given the marginal habitat present for this species within the Surface Project Area, as well as the potential for higher quality habitat to be available within the locality, the Amended Project is unlikely to significantly impact on the lifecycle of this species.

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

Cynanchum elegans is typically found on the margins of dry rainforest and may also be associated with *Eucalyptus tereticornis*. *E. tereticornis* is abundant across the Surface Project Area, thus potential habitat is likely to occur. In addition, there is one previous record located within the northern section of the Surface Project Area. All impacts to potential habitat for this species will be avoided and minimised.

The invasion of weeds, grazing and inappropriate fire regimes are known threats to the habitat of this species. The Amended Project is unlikely to significantly contribute to any of these existing threats within the Surface Project Area. Consequently, it is considered improbable that the construction of WSLs, GGL's and access tracks will significantly affect the habitat of this species.

Does the proposal affect any threatened species or populations that are at the limit of its known distribution?

Cynanchum elegans is restricted to eastern NSW where it is distributed from Brunswick Heads on the north coast to Gerroa south of the Illawarra region.

Therefore, this species is not considered at the limit of its known distribution.

How is the proposal likely to affect current disturbance regimes?

The Amended Project is unlikely to modify the intensity and frequency of fires or flooding flows.

How is the proposal likely to affect habitat connectivity?

Potential habitat for *Cynanchum elegans* within the Surface Project Area is present within remnant and regrowth CPW, RFEFCF, MSW and WSDR. These vegetation communities are currently fragmented across a majority of the Surface Project Area with the exception of the northern sections of CPW, which will not be impacted by the Amended Project. No further fragmentation of suitable habitat will result from the Amended Project.

Consequently, it is considered unlikely that the Amended Project will affect habitat connectivity.

How is the proposal likely to affect critical habitat?

Under the TSC Act, the Director-General of OEH maintains a Register of Critical Habitat. To date, no critical habitat has been declared for *Cynanchum elegans*.

The Amended Project will not have an adverse effect on critical habitat (directly or indirectly).

Pimelea spicata — Spiked Rice Flower

Pimelea spicata is listed as Endangered on the TSC Act and the EPBC Act. The species is a small spreading or erect shrub growing to 50 cm (NPWS 2004). The leaves are opposite and elliptical, to 20 mm long by 8 mm wide (DECC 2005). The white, pink-tinged flowers are tubular, to 10 mm long, with four spreading petals (DECC 2005). They may appear at any time of the year, but are mostly seen in summer (DECC 2005). The species is known to occur in areas supporting or areas previously supporting Cumberland Plain Woodland.

Once widespread on the Cumberland Plain, *Pimelea spicata* occurs in two disjunct areas, the Cumberland Plain (Western Sydney) and the Illawarra. In both the Cumberland Plain and Illawarra region, this species is found on well-structured clay soils (DECC 2005). In the coastal Illawarra it occurs commonly in *Banksia integrifolia* open woodland with a more well developed shrub and grass understorey.(DECC 2005).

It is also known from highly disturbed areas including road verges, table drains, road embankments and ploughed paddocks (DECC 2005).

Pimelea spicata was not recorded during the field surveys, despite several previous records being found within the Surface Project Area and the broader locality.

How is the proposal likely to affect the lifecycle of a threatened species and/or population?

Although *Pimelea spicata* was not recorded in the Surface Project Area, the species is cryptic and difficult to detect, particularly when not in flower. The species flowers sporadically throughout the year, with flowering likely to depend upon climatic conditions, particularly rainfall (NPWS 2000d).

Thirty-one records of *P. spicata* are known within 10 km of the Surface Project Area (OEH Atlas of Wildlife). In addition, there is also high potential habitat within the remnant and regrowth CPW throughout the Surface Project Area. All impacts to CPW will be avoided and minimised.

The proposal is considered unlikely to impact on the pollination or dispersal of a local population (if one exists) of *Pimelea spicata* given that the Amended Project:

Will not result in the removal of suitable habitat;

Will not interfere with fire regimes within the Surface Project Area or locality;

Will not increase vehicular, bike, pedestrian, or other, access to a known population of the species;

Is unlikely to increase rubbish dumping within known or potential habitats for the species; and,

Is unlikely to significantly increase levels of weed invasion within adjacent areas as they are already largely cleared and subject to high levels of weed invasion.

Given that no individuals were detected within the Surface Project Area, it is unlikely that the Amended Project will have an adverse impact on the lifecycle of the species.

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

Within CPW, this species is typically found on well-structured clay soils and it is associated with *Eucalyptus moluccana* and Ironbark species (e.g *Eucalyptus crebra*). There are thirty-one previous records of this species within the locality, of which three are located within the Surface Project Area.

All impacts to suitable habitat for this species will be avoided and minimised.

Known threats to the habitat of this species include weed invasion, high frequency fire and grazing. It is considered unlikely that the Amended Project will significantly contribute to any of these known threats.

Given the condition and size of the potential habitat within the Surface Project Area, avoidance and minimisation of impacts to habitat and the current threats posed to the species it is not considered that the impacts resulting from the Amended Project would affect the habitat of *Pimelea spicata.*

Does the proposal affect any threatened species or populations that are at the limit of its known distribution?

Pimelea spicata is restricted to two distinct areas, the Cumberland Plain (Narellan, Marayong, Prospect Reservoir areas) and the Illawarra (Shellharbour to northern Kiama).

Therefore, this species is near the limit of its known distribution, with Camden being the approximate most western boundary of its distribution.

How is the proposal likely to affect current disturbance regimes?

The Amended Project is unlikely to modify the intensity and frequency of fires or flooding flows.

How is the proposal likely to affect habitat connectivity?

A majority of CPW within the Surface Project Area is currently fragmented. CPW within the northern section of Surface Project Area is of better quality and will not be significantly impacted by the Amended Project. Consequently, the temporary modification of some potential habitat would not result in the isolation of any areas of potential habitat. Furthermore, it is also considered unlikely that the Amended Project would affect habitat connectivity in terms of dispersal or pollination of this species.

How is the proposal likely to affect critical habitat?

Under the TSC Act, the Director-General maintains a Register of Critical Habitat. To date, no critical habitat has been declared for *Pimelea spicata.*

Pomaderris brunnea	**Brown Pomaderris**

Pomaderris brunnea is listed as Vulnerable under the TSC Act and the EPBC Act. This species is a shrub to 3m in height with distinctively hairy stems. The small flowers have no petals, are yellowish and form dense clusters at the ends of the branches.

Pomaderris brunnea has a very limited distribution around the Nepean and Hawkesbury Rivers, where it grows in moist woodland, semi-cleared scrub or forest on clay and alluvial soils on floodplains and creek lines.

Pomaderris brunnea was not recorded during the field surveys. There are 23 previous records of this species within the locality, of which a majority occur approximately 6 km to the south of the

Surface Project Area on the Nepean River floodplain at Menangle. The Surface Project Area supports marginal potential habitat for this species in the form of CPW on clay and RFEFCF.

How is the proposal likely to affect the lifecycle of a threatened species and/or population?

Pomaderris brunnea flowers in September and October. Relatively little is known about the life cycle of this species. Pollination is likely to be via insects and seed dispersal via wind.

This species was not recorded during current field surveys. Potential habitat within the Surface Project Area exists in remnant or regrowth native plant communities in moist valleys or depressions.

The Amended Project is considered unlikely to impact on the pollination or dispersal of a local population (if one exists) and inturn the lifecycle of *Pomaderris brunnea* given that the Amended Project:

- Will not increase fire intensity, as the species is known to be affected by too frequent burning; and
- Will not disturb the seed bank of this species, as only minor clearing is likely to occur in moist depressions or valleys within that are present in the Surface Project Area.

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

Habitat for *Pomaderris brunnea* consists of woodland and semi-cleared scrub, on clay and alluvial soils of floodplain and creek lines. Thus, habitat for this species exists within the Surface Project Area is relatively restricted.

All impacts to suitable habitat for this species will be avoided and minimised.

Consequently, given the relatively small amount of marginal habitat clearance it is considered unlikely that the Amended Project will impact on the habitat of this species.

Does the proposal affect any threatened species or populations that are at the limit of its known distribution?

Pomaderris brunnea has been recorded from the Nepean River floodplain at Menangle, in creek lines at Wirrimbirra Sanctuary (Bargo) and along the Colo River. It also occurs at Walcha on the New England Tablelands and in far eastern Gippsland, Victoria.

Therefore, this species is not considered at the limit of its known distribution.

How is the proposal likely to affect current disturbance regimes?

The Amended Project is unlikely to modify the intensity and frequency of fires or flooding flows.

How is the proposal likely to affect habitat connectivity?

Habitat for *Pomaderris brunnea* consists of woodland and semi-cleared scrub, on clay and alluvial soils of floodplain and creek lines. The Amended Project is unlikely to impact on these areas within the Surface Project Area, and as a result will not isolate or fragment population of this species that may be present.

How is the proposal likely to affect critical habitat?

Under the TSC Act, the Director-General maintains a Register of Critical Habitat. To date, no critical habitat has been declared for *Pomaderris brunnea.*

Thesium australe Austral Toadflax

Thesium australe is listed as Vulnerable under the TSC Act and the EPBC Act.

Thesium australe is a small, straggling herb to 40 cm tall. Leaves are pale green to yellow-green, somewhat succulent, 1 - 4 cm long and 0.5 - 1.5 mm wide (DEC 2005). Flowers are minute and white, emerging where the leaves meet the stems and appearing in spring. The fruit is small and nut-like, developing in summer. This species is often hidden amongst grasses and herbs (DEC 2005).

The species is found in very small populations scattered across eastern NSW, along the coast, and from the Northern to Southern Tablelands (DEC 2005). It is also found in Tasmania and Queensland and in eastern Asia (DEC 2005).

Thesium australe occurs in grassland or grassy woodland, often in damp sites in association with Kangaroo grass *Themeda australis* (DEC 2005). The species is a root parasite that takes water and some nutrient from other plants, especially *Themeda australis* (DEC 2005).

This species was not recorded within the Surface Project Area. *Thesium australe* is considered to be inconspicuous and difficult to detect regardless of the flowering season. Vegetation within the Surface Project Area that is considered potential habitat includes CPW remnants and regrowth and exotic grassland.

How is the proposal likely to affect the lifecycle of a threatened species and/or population?

Relatively little is known regarding the life cycle of *Thesium australe* aside from its apparent association with host grass species, especially *Themeda australe*. Literature suggests that fire induces re-sprouting and seed germination in the species (DSE 2003), it has been further suggested that maintenance of open areas by frequent burning may be important in maintaining suitable open habitat for the species. The Amended Project is unlikely to interfere with existing fire regimes in the Surface Project Area.

Seed dispersal mechanisms are unknown. Possible dispersal mechanisms for the species including wind, insects, animals or local seed drop are unlikely to be affected by the Amended Project.

Further, the Amended Project will not fragment the potential habitat of this species such that potential pollination mechanisms would be adversely affected.

Consequently, the Amended Project is considered unlikely to have an adverse effect on the lifecycle of the species.

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

Themeda australis is distributed throughout the Surface Project Area in CPW remnants and regrowth, as well as in exotic grassland. This species provides potential habitat for *Thesium australe*

Approximately 21km^2 of potential habitats for *Thesium australe* exists within the Locality including CPW and Closed Grassland dominated by exotic groundcovers which covers a majority of the area. The Amended Project will involve the direct loss of Closed Grassland constituting potential habitat for *Thesium australe*.

The potential habitat for this species within the Amended Project Area is already subject to fragmentation. The Amended Project will not increase this degree of fragmentation within the Surface Project Area such that potential habitat for this species will become isolated from other areas of potential habitat.

Given that there is only one previous record within the Locality, current threats including grazing, the relative importance of habitat within the Surface Project Area for the long-term survival of the species is considered low. Consequently, it is unlikely that the Amended Project will affect the habitat for this species.

Does the proposal affect any threatened species or populations that are at the limit of its known distribution?

Thesium australe is found in small scattered populations across eastern NSW, along the coast and the Northern and Southern Tableland.

Therefore, this species is not considered at the limit of its known distribution.

How is the proposal likely to affect current disturbance regimes?

The Amended Project is unlikely to modify the intensity and frequency of fires or flooding flows.

How is the proposal likely to affect habitat connectivity?

The potential habitat for *Thesium australe* within the Surface Project Area is currently fragmented and grazed. Thus, it is considered unlikely that the Amended Project will affect habitat connectivity and inturn pollination and dispersal of this species.

How is the proposal likely to affect critical habitat?

Under the TSC Act, the Director-General maintains a Register of Critical Habitat. To date, no critical habitat has been declared for *Thesium australe*.

Marsdenia viridiflora ssp. viridiflora

Marsdenia viridiflora subsp. *viridiflora* is listed as an Endangered Population in Bankstown, Blacktown, Camden, Campbelltown, Fairfield, Holroyd, Liverpool and Penrith local government areas under Part 2 of Schedule 1 of the TSC Act.

The *Marsdenia viridiflora* subsp. *viridiflora* population in the Bankstown, Blacktown, Camden, Campbelltown, Fairfield, Holroyd, Liverpool and Penrith local government areas, occurs as very scattered plants in areas of remnant vegetation (NSW Scientific Committee 2002).

Marsdenia viridiflora subsp. *viridiflora* grows in vine thickets and open shale woodlands, open scrub and forest. This species is a climber with twining stems to 4m high. Leaves are narrow, 2 - 12 cm long and 1 – 18 mm wide (6 - 15 times as long as broad). Fruit are large and pear-shaped, up to 80 mm long.

This species was not recorded during field surveys, however potential habitat exists in CPW, RFEFCF, MSW and WSDR within the Surface Project Area.

How is the proposal likely to affect the lifecycle of a threatened species and/or population?

Relatively little is known about the lifecycle of *Marsdenia viridiflora* subsp. *viridiflora.*

Potential habitat for the species exists within CPW, RFEFCF, MSW and WSDR in the Surface Project Area. Since no individuals were recorded in the Surface Project Area, it is unlikely that the Amended Project will have an adverse impact on the lifecycle of the species that constitutes the endangered population.

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

Marsdenia viridiflora subsp. *viridiflora* is known to occur in woodland and scrub. In the Surface Project Area, potential habitat for the species occurs in CPW. Based on the modified regional vegetation mapping (NPWS 2002e) this assessment estimates a total of 906 ha of CPW, RFEFCF, MSW and WSDR within the Surface Project Area. No MSW and WSDR occurs within areas to be directly and indirectly affected. All impacts to CPW and RFEFCF will be avoided and minimised.

The woodland and forest vegetation that constitutes potential habitat for *Marsdenia viridiflora* ssp. *viridiflora* within the Surface Project Area is currently highly fragmented due to agricultural and other development. Consequently, it is unlikely that the Amended Project will affect the habitat for this species.

Does the proposal affect any threatened species or populations that are at the limit of its known distribution?

Marsdenia viridiflora subsp. *viridiflora* has a wide distribution in sub-coastal and southern Queensland but has been recorded rarely in NSW and from a disjunct occurrence near Sydney. In the southern part of its range the species is sporadic in distribution (NSW Scientific Committee 2002).

Although the species is not at the limit of its distribution, the Camden and Campbelltown LGA are at the limits of the distribution for the listed population.

How is the proposal likely to affect current disturbance regimes?

The Amended Project is unlikely to modify the intensity and frequency of fires or flooding flows.

How is the proposal likely to affect habitat connectivity?

The majority of native plant communities providing habitat for this species within the Surface Project Area are currently fragmented. The large patch of CPW within the northern section of Surface Project Area is of better quality and will not be impacted by the Amended Project.

No further fragmentation of potential habitat for this species will result from the Amended Project.

How is the proposal likely to affect critical habitat?

Under the TSC Act, the Director-General maintains a Register of Critical Habitat. To date, no critical habitat has been declared for *Marsdenia viridiflora* ssp.. *viridiflora.*

Fauna

Impact assessments were undertaken for the following threatened fauna species that were assessed to have a medium to high likelihood of occurrence within the Surface Project Area and may be impacted by the Amended Project:

Cumberland Plain Land Snail (CPLS);

Grey-headed Flying-fox;

Microchiropteran Bats (Greater Broad-nosed Bat, Eastern False Pipistrelle, Eastern Freetail-bat, Eastern Bentwing Bat, and Large-footed Myotis);

Threatened woodland birds (Little Eagle, Diamond Firetail, Hooded Robin, Speckled Warbler, Little Lorikeet and the Swift Parrot, and Bush-stone Curlew).

Cumberland Plain Land Snail *Meridolum corneovirens*

CPLS occur on the Cumberland Plain west of Sydney and this species is generally associated with CPW. CPLS live under the litter of bark, leaves and logs, or shelter in loose soil around grass clumps and feed on fungus. During drought, this species is known to burrow deeper into the soil to avoid the dry conditions. There is relatively little known about the ecology of this species (NPWS 1999b).

Potential habitat for this species exists within CPW throughout the Surface Project Area. This species was recorded during the current field surveys at one location to the south of and outside the assessment envelope of the CU22 GGL. Additionally there are numerous previous records within the Surface Project Area.

The CPLS is listed as Endangered under the TSC Act.

How is the proposal likely to affect the lifecycle of a threatened species and/or population?

Relatively little is known of the ecology and biology of the CPLS. It occurs within CPW and Castlereagh Woodlands of the Cumberland Plain region. The snails feed on fungus associated with decaying leaf litter and bark of eucalypts. CPLS can probably breed year-round, laying up to 25 eggs when conditions are suitable (i.e. prevalent damp conditions). It is currently not known what number of individuals constitutes a viable local population, what the dispersal patterns are or how far individuals can travel (NPWS 1999b; NPWS 2000a).

This species was recorded during the current field surveys at one location to the south of and outside the assessment envelope of the CU22 GGL. There are several previous records of the species located within the Surface Project Area. The main potential habitat for this species is located within the remnant and regrowth CPW stands throughout the Surface Project Area. All impacts to CPW will be avoided and minimised.

Consequently, the Amended Project is unlikely to impact on breeding and dispersal of a population of the species within the Surface Project Area.

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

Modified vegetation mapping by NPWS (2002f) has estimated 906 ha of native vegetation in the Surface Project Area including 868 ha of CPW in varying condition. The largest and most intact stands of CPW are in the north of the Surface Project Area and these are estimated to cover a reasonably contiguous area of approximately 200 ha. These areas are considered to support the most optimal habitat for this species with a minor amount of the project infrastructure proposed in this this large area of potential habitat.

All impacts to CPW will be avoided and minimised.

Does the proposal affect any threatened species or populations that are at the limit of its known distribution?

The CPLS has a restricted distribution, where it lives in a very small area of the Cumberland Plain. It is confined to Richmond and Windsor south to Picton and from Liverpool west to the Nepean and Hawkesbury Rivers at the base of the Blue Mountains. The Surface Project Area is not at the limit of the distribution of this species.

How is the proposal likely to affect current disturbance regimes?

Threats to the CPLS include clearing and degradation of CPW remnants, high frequency fire, weed invasion and the loss of vegetative cover (NPWS 1999b). Preferred habitat for CPLS in the WSL assessment envelopes, GGLs, Main Gas Gathering Spine and new access tracks will be avoided and there is unlikely to be any permanent clearing of CPW. The Amended Project is not likely to exacerbate disturbances, such as an increased fire frequency or any promotion of weed dispersal such that CPLS will be adversely affected.

How is the proposal likely to affect habitat connectivity?

The large and moderately continuous stand of optimal habitat for the species (approximately 200 ha of CPW in the north of the Surface Project Area) will not be affected by the Amended Project. Other areas where preferred habitat for the species occurs within the Surface Project Area including WSL assessment envelopes, GGLs, Main Gas Gathering Spine and new access tracks will be avoided as far as possible. Consequently, habitat connectivity is unlikely to be adversely affected for the CLS.

How is the proposal likely to affect critical habitat?

Critical habitats are areas of land that are crucial to the survival of particular threatened species, populations or ecological communities. Under the TSC Act, the Director-General of the DECCW maintains a register of critical habitat. To date, no critical habitat has been declared for the CPLS.

Grey-headed Flying-fox *Pteropus poliocephalus*

The Grey-headed Flying-fox is listed as Vulnerable on Schedule 2 of the TSC Act and as Vulnerable on the EPBC Act. The Grey-headed Flying-fox was not recorded during the current survey, but has been recorded in the past within the Surface Project Area (DECC Atlas of NSW Wildlife).

Potential foraging habitat for this species occurs within the woodland habitat in the Surface Project Area where flowering eucalypts provide potential foraging resources.

How is the proposal likely to affect the lifecycle of a threatened species and/or population?

This species congregates in large numbers at roosting sites (camps) in a wide range of vegetation types. Individuals generally exhibit a high fidelity to traditional camps and return annually to give birth and rear offspring. Grey-headed Flying-foxes are known to travel up to 50 km from their camps to forage (NPWS 2001a). The diet of the Grey-headed Flying-fox is varied, encompassing a wide range of fruits and blossoms from both native and non-native trees (Strahan 1995).

The Grey-headed Flying-fox has been recorded at a number of sites within the Surface Project Area and at other locations within the locality. All impacts to stands of native vegetation containing potential foraging habitat for this species will be avoided. In other areas with scattered trees, no trees are proposed for removal as part of the Amended Project. Potential habitat for the Grey-headed Flying-fox will persist in the Surface Project Area and also in larger, continuous, higher quality stands of vegetation within the locality.

There area no known camps within the Surface Project Area. However, there is one known camp within the locality at Menangle, approximately 8 km south of the Surface Project Area (DECC 2007). It is unlikely that the proposal would interfere with breeding of the Grey-headed Flying-fox at this camp site.

Given no removal of trees is proposed as a part of the Amended Project, the mobility of this species, the lack of camps within the Surface Project Area and the extent of higher quality potential habitat within the locality, it is unlikely that the Amended Project would disrupt the lifecycle of the Grey-headed Flying-fox.

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

No trees are proposed for removal. Large areas of continuous, higher quality stands of vegetation are present outside the Surface Project Area within the Locality. The Amended Project would not fragment any stands of vegetation which present potential habitat for the Grey-headed Flying-fox.

The Grey-headed Flying-fox may forage at a distance of up to 50 km from its camp each night (NPWS 2001a). Thus, given the mobility of this species, the absence of camps from within the Surface Project Area and the extent of higher quality potential habitat within the Locality it is unlikely that the Amended Project would have a significant impact on the habitat for this species.

Does the proposal affect any threatened species or populations that are at the limit of its known distribution?

Grey-headed Flying-foxes are found within 200 km of the eastern coast of Australia, from Bundaberg in Queensland to Melbourne in Victoria. The Surface Project Area is not at the limit of the distribution for this species.

How is the proposal likely to affect current disturbance regimes?

The Amended Project is unlikely to affect fire regimes or the natural flooding regime of the Surface Project Area.

How is the proposal likely to affect habitat connectivity?

No impacts to foraging habitat for the Grey-headed Flying-fox will result from the Amended Project. Where possible, impacted areas will be generally restricted to cleared areas and would not cause major fragmentation of habitat or create any barriers that would impede the movement of this species. In view of the substantial retention of canopy, the mobility of these species, and the extent of similar potential foraging habitat in the locality, it is unlikely that the Amended Project would significantly fragment or isolate any areas of potential foraging habitat or movement corridors for the Grey-headed Flying-fox.

How is the proposal likely to affect critical habitat?

Critical habitats are areas of land that are crucial to the survival of particular threatened species, populations or ecological communities. Under the TSC Act, the Director-General maintains a register of critical habitat. To date, no critical habitat has been declared for this species.

Microchiropteran Bats

The Greater Broad-nosed Bat, Eastern False Pipistrelle, Eastern Freetail-bat, Eastern Bentwing Bat, and Large-footed Myotis are listed as Vulnerable on Schedule 2 of the TSC Act.

The Eastern Bentwing Bat is a cave-roosting species, whereas the Greater Broad-nosed Bat, Eastern False Pipistrelle, and Eastern Freetail-bat are forest bats, which are dependent on hollows for roosting. The Large-footed Myotis is a cave and hollow roosting species. These five microchiropteran bat species have been grouped on the basis of their similar foraging habitat requirements and previous local recordings.

Potential foraging and roosting habitat for the forest bat species occurs within the woodland and water body habitats present in the Surface Project Area. Only foraging habitat exists for the Eastern Bentwing Bat, as there is no roosting habitat in the form of caves or road culverts for this species present within the Surface Project Area.

How is the proposal likely to affect the lifecycle of a threatened species and/or population?

Factors likely to disrupt the life cycle of the forest bat species include the loss, disruption or modification of roost sites, which include tree hollows and the bark of trees. No hollow bearing trees will be removed or modified by the Amended Project.

However, the loss of suitable foraging areas and habitat for prey items can disrupt the life cycle of these species. No impacts to potential foraging and breeding habitat (excluding the Eastern Bentwing-bat), in the form of woodland and forest habitats present in the Surface Project Area will result from theAmended Project. Given the mobility of these species and extent of potential habitat in the immediate vicinity of the Surface Project Area it is unlikely to have a significant effect on the lifecycle of these species.

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

Potential habitat for this species occurs in the woodland, forest and water body habitat types within the Surface Project Area. The Amended Project wil not result in thre removal of habitat for this species.

Potential foraging and breeding habitat (excluding the Eastern Bentwing-bat) within the Surface Project Area ranges from poor condition in small isolated woodland patches through to moderate to good condition in larger patches of remnant CPW. Finer scale habitat features such as abundant tree hollows, bark and watercourses provide foraging and roosting habitat for these bat species. These habitat features have also been widely identified in the local area. Hollow bearing trees or other potential roosting sites will not be removed and/or disturbed by the Amended Project. Overall, the quality of potential foraging and roosting habitat within the Surface Project Area and broader locality is unlikely to decline in response to the Amended Project.

Does the proposal affect any threatened species or populations that are at the limit of its known distribution?

The Large-footed Myotis is found in the coastal band from the north-west of Australia, across the top-end and south to western Victoria. It is rarely found more than 100 km inland, except along major rivers.

The Eastern Freetail-bat is found along the east coast from south Queensland to southern NSW.

The Eastern False Pipistrelle is found on the south-east coast and ranges of Australia, from southern Queensland to Victoria and Tasmania.

The Eastern Bentwing-bat has a wide distribution throughout non-arid regions of NSW, including the Sydney Basin Bioregion. The species appears to be moderately common within the region but is most frequently found along the coast.

The distribution of the Greater Broad-nosed Bat is poorly known. It is restricted to east coast and adjacent Great Dividing Range from the Queensland to the Victorian border (Parnaby and Cherry 1992).

The Surface Project Area is not at the limit of the distribution of these five microbat species.

How is the proposal likely to affect current disturbance regimes?

The Amended Project is unlikely to alter the existing fire regime of the Surface Project Area.

These bat species are not known to be dependant on a certain flooding regime. The Amended Project is unlikely to affect the natural flooding regime of the Surface Project Area.

How is the proposal likely to affect habitat connectivity?

The Amended Project is unlikely to result in any fragmentation or isolation of potential habitat for these microchiropteran bat species and good quality potential habitat is continuous within the Locality. The areas that may be temporarily modified by the Amended Project are generally restricted to areas of Shrubland which do not provide important foraging habitat for these species. Consequently, given the mobility of these species, and the extent of similar or better quality potential foraging habitat in the locality, it is unlikely that the Amended Project would significantly fragment or isolate any areas of potential foraging habitat or movement corridors utilised by any of these microbat species.

How is the proposal likely to affect critical habitat?

Critical habitats are areas of land that are crucial to the survival of particular threatened species, populations or ecological communities. Under the TSC Act, the Director-General maintains a register of critical habitat. To date, no critical habitat has been declared for any of these five microbat species.

Little Eagle (*Hieraaetus morphnoides)*, Diamond Firetail (*Stagonopleura guttata*), Hooded Robin (*Melanodryas cucullata cucullata*) Speckled Warbler (*Chthonicola sagittata)*, Little Lorikeet (*Glossopsitta pusilla*) and Swift Parrot (*Lathamus discolor*)

The Little Eagle, Diamond Firetail, Hooded Robin, Speckled Warbler and Little Lorikeet are listed as Vulnerable under Schedule 2 of the TSC Act. The Swift Parrot is listed as Endangered on Schedule 2 of the TSC Act and as Endangered on the EPBC Act.

Potential habitat for these threatened woodland birds exists within the Surface Project Area. These species have been grouped together on the basis of their similar habitat requirements.

How is the proposal likely to affect the lifecycle of a threatened species and/or population?

The Little Eagle is most abundant in lightly timbered areas with open areas nearby providing an abundance of prey species(NSW Scientific Committee 2009c). It has often been recorded foraging in grasslands, crops, treeless dune fields, and recently logged areas. The Little Eagle nests in tall living trees within farmland, woodland and forests(Marchant and Higgins 1993). Potential habitat exists for this species in the form of woodland and cleared habitats within the Surface Project Area.

The Diamond Firetail is found in grassy open eucalypt woodland such as CPW, open forest, mallee, Natural Temperate Grassland, and in secondary grasslands derived from other communities. The species is often found in riparian areas (rivers and creeks), and occasionally in lightly wooded farmland (DEC 2005e). This species feeds exclusively on the ground, on ripe and partly-ripe grass and herb seeds, green leaves, and insects (especially in the breeding season) (DEC 2005e). It prefers nesting in Mistletoe (Cooney and Watson 2005), but are also known to nest in a shrubby understorey, and occasions they have been found higher up in the canopy, especially under hawk's or raven's nests (DEC 2005e). Potential habitat exists for this species in the form of woodland and cleared habitats within the Surface Project Area.

The Hooded Robin exhibits preferences for lightly wooded country, and in particular open eucalypt woodland, acacia scrub and mallee adjacent to clearings. This species requires a high degree of structural habitat diversity, comprising mature eucalypts, saplings and tall grass. This species feeds low to the ground on insects. Territories range from 10 ha in the breeding season (July and November) to 30 ha outside of this period. They nest in the fork of trees about 1 to 5 m above the ground (DEC 2005n). Potential habitat exists for this species in the form of woodland within the Surface Project Area.

The Speckled Warbler is distributed from south-eastern Queensland, through central and eastern NSW to Victoria. In NSW, Speckled Warblers occupy eucalypt and cypress woodlands on the slopes west of the Great Dividing Range, with an extension of range into the cypress woodlands of the northern Riverina. Populations also occur in drier coastal areas such as the Cumberland Plain, Western Sydney and the Hunter and Snowy River valleys (Blakers *et al.* 1984; NSW Scientific Committee 2008a). They prefer woodlands with a grassy understorey, often on ridges or gullies (Blakers *et al.* 1984; NSW Scientific Committee 2008a). The species is sedentary, living in pairs or trios and nests on the ground in grass tussocks, dense litter and fallen branches. They forage on the ground and in the understorey for arthropods and seeds (Blakers *et al.* 1984; NSW Scientific Committee 2008a). Home ranges vary from 6-12 hectares (NSW Scientific Committee 2008a). Woodland of the Surface Project Area provides potential habitat for this species.

Distributed in forests and woodlands from the coast to the western slopes of the Great Dividing Range in NSW, extending westwards to the vicinity of Albury, Parkes, Dubbo and Narrabri. Mostly occur in dry, open eucalypt forests and woodlands. They feed primarily on nectar and pollen in the tree canopy. Nest hollows are located at heights of between 2 m and 15 m, mostly in living, smooth-barked eucalypts. Most breeding records come from the western slopes(NSW Scientific Committee 2008b).

The Swift Parrot breeds in Tasmania during spring and summer, migrating in the autumn and winter months to south-eastern Australia from Victoria and the eastern parts of South Australia to south-east Queensland. In NSW the species mostly occurs on the coast and south west slopes (DEC 2005r). Therefore, it is considered unlikely that the Surface Project Area supports a local population of the Swift Parrot, however it is possible that this species would utilise the woodland habitats within the Surface Project Area to forage.

The habitat types utilised by these species for nesting and foraging are widely distributed throughout the locality (948 ha comprising 868 ha of woodland habitat in the form of CPW). Given that these species are highly mobile and the large extent of potential habitat within the locality, it is unlikely that the Diamond Firetail, Hooded Robin, Speckled Warbler and Swift Parrot would be dependant on the habitat resources within the Surface Project Area for continued survival. All impacts to suitable habitat have been avoided and minimised. Therefore, it is unlikely that the Amended Project would have a major impact on the lifecycle of these species.

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

The Little Eagle, Diamond Firetail, Speckled Warbler, Hooded Robin and Little Lorikeet have potential nesting and foraging habitat within the Surface Project Area in the form of CPW remnants and adjacent cleared areas. Additional potential habitat for these species exists within the locality.

In NSW the Swift Parrot mostly occurs on the coast and south west slopes (DEC 2005r). When migrating during the non-breeding season, the Swift Parrot can occur on the mainland in areas where eucalypts are flowering profusely or where there are abundant lerp (from sap-sucking bugs) infestations. Favoured feed trees include winter flowering species such as *Eucalyptus robusta, Corymbia maculata, C. gummifera, E. sideroxylon*, and *E. albens*. Commonly used lerp infested trees include *E. microcarpa*, *E. moluccana* and *E. pilularis* (DEC 2005r). Within the Surface Project Area, foraging habitat exists within CPW for this species. It is unlikely that this Amended Project would have any major impacts on the composition of potential habitat for the Swift Parrot. Furthermore, given the lack of preferred foraging trees within the Surface Project Area it is unlikely to constitute prime or core habitat for this species. However, it is possible that the Swift Parrot would utilise these resources within the Surface Project Area on occasions.

All impacts to suitable habitat for these species have been avoided and minimised. Larger, higher quality areas of potential habitat occur within the locality and as such it is unlikely that the habitat that may be modified is important to the long-term survival of these species.

Does the proposal affect any threatened species or populations that are at the limit of its known distribution?

The Little Eagle is distributed throughout the Australian mainland except the most densely forested parts of the Dividing Range escarpment. It occurs as a single population throughout NSW(NSW Scientific Committee 2009c).

The Diamond Firetail is widely distributed throughout New South Wales with a concentration of records within the Tablelands, Central and South Western Slopes, the North West Plains and the Riverina. The Diamond Firetail is also found in the Australian Capital Territory, Queensland, Victoria and South Australia. This species is not commonly found on the coast.

The Speckled Warbler is distributed from south-eastern Queensland, through central and eastern NSW to Victoria. In NSW the species occurs on the slopes west of the Great Dividing Range, with an extension of range into the northern Riverina and populations in drier coastal areas such as the Cumberland Plain, Western Sydney and the Hunter and Snowy River valleys.

The Hooded Robin (south-eastern form) is common in a few places from Brisbane to Adelaide and inland New South Wales, with the exception of the north-west. This species is typically known to be sedentary and is rarely found on the coast (DEC 2005n).

The distribution of the Little Lorikeet extends from just north of Cairns, around the east coast of Australia, to Adelaide. In New South Wales Little Lorikeets are distributed in forests and woodlands from the coast to the western slopes of the Great Dividing Range, extending westwards to the vicinity of Albury, Parkes, Dubbo and Narrabri slopes(NSW Scientific Committee 2008b).

The Swift Parrot breeds in Tasmania during spring and summer, migrating in the autumn and winter months to south-eastern Australia from Victoria and the eastern parts of South Australia to south-east Queensland.

The Surface Project Area is not at the limit of the distribution for the Little Eagle, Diamond Firetail, Speckled Warbler, Hooded Robin, Little Lorikeet or the Swift Parrot.

How is the proposal likely to affect current disturbance regimes?

The Amended Project is unlikely to affect fire regimes or the natural flooding regime of the Surface Project Area.

How is the proposal likely to affect habitat connectivity?

No suitable habitat will be affected as a part of the Amended Project. The Amended Project will not further fragment any stands of vegetation which present potential habitat for these species into two or more fragments. As such, given the mobility of these species, and the extent of similar potential foraging habitat in the locality, it is unlikely that the Amended Project would significantly fragment or isolate any areas of potential foraging habitat or movement corridors for these species.

How is the proposal likely to affect critical habitat?

Critical habitats are areas of land that are crucial to the survival of particular threatened species, populations or ecological communities. Under the TSC Act, the Director-General maintains a register of critical habitat. To date, no critical habitat has been declared for the Little Eagle, Diamond Firetail, Speckled Warbler, Hooded Robin, Little Lorikeet or the Swift Parrot.

Bush-stone Curlew *Burhinus grallarius*

The Bush-stone Curlew is listed as Endangered under the TSC Act. Potential habitat exists for this species within the Surface Project Area and there are previous records that are located to the north of this area.

How is the proposal likely to affect the lifecycle of a threatened species and/or population?

The species inhabits open forests and woodlands with a sparse and grassy ground layer typically comprising fallen timber. The species may also utilise wetland habitats. Dry, open grassland and cropland, with cover nearby, may also provide habitat for this species (NPWS 1999a). The Bush Stone-curlew nests on the ground in a scrape or small bare patch of soil and lays two eggs in early spring or summer. They consume insects, frogs and reptiles. One of the major threats posed to this species is the predation by introduced species such as the feral cat and red fox, as well as the trampling of eggs by cattle.

Potential nesting and foraging habitat exists for this species in CPW remnants and waterbodies within the Surface Project Area. Factors considered likely to disrupt the life cycle of the Bush-stone Curlew includes the clearing of woodland habitats, modification and destruction of ground habitats through the removal of leaf litter, fallen timber and the introduction of exotic grasses. No suitable habitat for this species will be permanently affected by the Amended Project. Furthermore, the implementation of mitigation measures such as pre-clearing surveys and avoiding nesting periods will ensure minimal impact to the lifecycle of this species that may be imposed by the Amended Project.

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

The Bush Stone-curlew prefers open forests and woodlands with a sparse grassy ground layer and fallen timber. These habitats are patchy in the locality. No additional fragmentation will result from the Amended Project. This is considered unlikely to increase the level of fragmentation currently present within the locality.

There are no records of the Bush Stone-curlew in the Surface Project Area and the species is rare within the region with only one previous record within the locality. The low occurrence of this species in the locality is likely to be a direct result of cat and fox predation, as well as agricultural practices such as cattle grazing and land clearance. Therefore, it is unlikely that the Surface Project

Area represents important habitat for this species in the locality. The temporary modification of vegetation in the Surface Project Area is not likely to reduce the viability of the Bush Stone-curlew in the locality.

Does the proposal affect any threatened species or populations that are at the limit of its known distribution?

The Bush-stone Curlew is present across Australia, with the exception of the central southern coast and inland, the far south-east coast corner, and Tasmania. The species is common in northern Australia and in south-east of the country it is either rare or extinct in parts of its former range.

The Surface Project Area is not at the limit of the distribution for the Bush-stone Curlew.

How is the proposal likely to affect current disturbance regimes?

The Amended Project is unlikely to affect fire regimes or the natural flooding regime of the Surface Project Area.

How is the proposal likely to affect habitat connectivity?

The Bush Stone-curlew has not been recorded within the Surface Project Area but there are nearby records within the locality. The closest record occurs approximately 3 km north of the Surface Project Area, which was collected in 1950.

The Bush Stone-curlew inhabits open forests and woodlands with a sparse grassy ground layer and fallen timber. The species may also utilise wetland habitats. Potential habitat for the Bush Stone-curlew exists within the Surface Project Area in the form of the woodland habitat (as CPW).

CPW is currently fragmented within the Surface Project Area. No suitable habitat for this species will be removed as a part of the Amended Project. Consequently, it is considered unlikely that the Amended Project would create any barrier in the movement of this species or affect corridors that this species may utilise. Furthermore, the activation of mitigation measures such as pre-clearing surveys to replace potential habitat for this species in nearby CPW remnants will ensure minimal impact to habitat connectivity for this species.

How is the proposal likely to affect critical habitat?

Critical habitats are areas of land that are crucial to the survival of particular threatened species, populations or ecological communities. Under the TSC Act, the Director-General maintains a register of critical habitat. To date, no critical habitat has been declared for the Bush Stone-curlew.

APPENDIX 5

EPBC Act Significant Impact Criteria

Significant Impact Guidelines

The EPBC Act Significant Impact Guidelines (DEWHA 2009) provide a set of Significant Impact Criteria for matters of national environmental significance that should be taken into consideration to determine whether a Amended Project is likely to have a significant impact on threatened species, populations or ecological communities that are known to occur or potentially occur in the Surface Project Area.

Under the EPBC Act, if an action (in this case the Amended Project) has the potential to have an adverse impact on a threatened species, population or ecological community listed on the Act, the Amended Project must be referred to the Federal Minister for the Environment for further consideration. In general terms the test for significance depends on whether an impact is important, notable or of consequence, having regard to its context or intensity (DEWHA 2009).

Endangered Ecological Communities

CPSW and its habitat occur within the Surface Project Area and on the subject site. CPSW is listed on the EPBC Act as a CEEC. The potential impacts of the Amended Project on this biota are assessed against the Significant Impact Criteria of the EPBC Act below.

Cumberland Plain Woodland

An action is likely to have a significant impact on a critically endangered or endangered ecological community if there is a real chance or possibility that it will:

Reduce the extent of an ecological community

Based on mapping by NPWS (2002d) the extent of CPW in the Surface Project Area is approximately 868 ha (Figure 2). Of this it is estimated 299 ha of CPW corresponding to CPSW is present in the Surface Project Area (based on ratios present within the Subject Site) with the extent of the community on the Subject Site including the proposed WSL, Main Gas Gathering Spine, GGLs, and access tracks totalling 13.9 ha (Figures 6a to 6q). The most likely locations where CPW may be temporarily affected by the Amended Project including disturbance of vegetation and the soil profile are the Main Gas Gathering Spine Line and GGL's. Approximately 3.71 ha of CPSW is estimated to occur in the GGL assessment envelopes including small areas in RA09 GGL, RA09 to Main Gas Gathering Spine Line, and Mt Annan GGL. All impacts to CPSW have been avoided and minimised and no residual impacts will occur from the Amended Project.

Fragment or increase fragmentation of an ecological community

Figures 6a to 6o shows the distribution of CPSW from the current field surveys and the community may cover additional areas of the Surface Project Area. The majority of CPSW mapped by Biosis Research occurs in the northern sector incorporating some large patches with a high level of connectivity provided by corridors and partially isolated stands. The current Amended Project will not significantly affect the connectivity of the broader stand of the community on the Subject Site or in the Surface Project Area.

Adversely affect habitat critical to the survival of an ecological community

'Habitat critical to the survival of a species or ecological community' is defined by DEH (2006) as areas that are necessary:

- For activities such as foraging, breeding, roosting, or dispersal;
- For the long-term maintenance of the species or ecological community (including the maintenance of species essential to the survival of the species or ecological community, such as pollinators);
- To maintain genetic diversity and long term evolutionary development; or,
- For the reintroduction of populations or recovery of the species or ecological community.

Such habitat may be, but is not limited to: habitat identified in a recovery plan for the species or ecological community as habitat critical for that species or ecological community; and/or habitat listed on the Register of Critical Habitat maintained by the Minister under the EPBC Act (DEH 2006).

To date, there is no critical habitat listed by the Minister for DSEWPAC for CPSW. Recovery of this CEEC is addressed in the recovery plan prepared for threatened biodiversity for the broader Cumberland Plain by (2009a). However the Cumberland Plain recovery plan identifies that for the purposes of the EPBC Act, the habitats critical to the survival of the entities addressed in the recovery plan are the Priority Conservation Lands. The Priority Conservation Lands are areas defined as 'the best remaining opportunities to secure long-term biodiversity benefits in the region for the lowest possible cost' and these are mapped by (2009b). Review of the mapping in the recovery plan maps indicates that some areas in the vicinity of Mt Annan which are most likely CPW vegetation, are considered as Priority Conservation Lands.

Modify or destroy abiotic (non-living) factors (such as water, nutrients, or soil) necessary for an ecological community's survival

No direct impacts to CPSW will result from the Amended Project. Potential soil disturbance within large stands of CPSW may result in areas where impact will be minimised by detailed ground survey and /or construction method.

The main abotic factor that will be modified may be the soil profile including surface and subsoils in locations of earthworks, primarily in the GGL's including the Main Gas Gathering Spine. These modifications to the soil profile and some semi-permanent water bodies in location of CPSW will be temporary during construction.

There would be no modification or destruction of abotic factors that are necessary for the survival CPW in the Surface Project Area outside of the impact sites on the subject site.

Cause a substantial change in the species composition of an occurrence of an ecological community, including causing a decline or loss of functionally important species

CPSW within the Subject Site that will be retained and that which occurs in the Surface Project Area that will not be directly impacted includes both regrowth and remnant stands that vary in condition from Poor to Good.

The main factors that could cause a substantial change to the species composition of CPW are:

Modification of surface hydrological processes and features;

Inappropriate fire regimes;

The amplification of the impacts of existing introduced flora and fauna; or

Introduction of new and invasive introduced flora and fauna.

Other than where CPSW will be temporarily modified on the subject site, the proposed action is unlikely to cause a substantial change in the species composition of the retained stands of the community through minor and temporary modifications to surface hydrology. It is unlikely that there will be an increase in the impact of introduced flora and fauna that are impacting on the community in the region. The proposed action is not likely to further affect the altered status of the current fire regime that stands of the community on the Subject Site or in the Surface Project Area will be subject to.

Cause a substantial reduction in the quality or integrity of an occurrence of an ecological community, including, but not limited to:

Assisting invasive species, that are harmful to the listed ecological community, to become established; or

The classes of invasive introduced flora species that are identified as posing the highest level of threat to CPSW are exotic vines and scramblers, exotic perennial grasses and woody weeds. There are several key species affecting CPSW in each of these weed classes with all of them common to abundant throughout the Cumberland Plain and wider region. Land degradation and grazing by European rabbits is a threat to CPSW particularly in view of the floristic structure of the community where the groundcover stratum supports the highest level of plant species richness. The proposed action will not assist invasive species that are identified as a posing a threat to become further established. Similarly the proposed action will not promote the introduction and establishment of additional exotic species that may impact on CPW in the locality or region.

Causing regular mobilisation of fertilisers, herbicides or other chemicals or pollutants into the ecological community which kill or inhibit the growth of species in the ecological community

The proposed action will not involve the use of chemicals or result in the mobilisation of pollutants that will kill or interfere with the life cycle of flora and fauna species that occur in CPSW on the Subject Site or in the Surface Project Area.

To interfere with the recovery of an ecological community

The NSW and National Recovery Plan Cumberland Plain Recovery Plan (Recovery Plan) by DECCW addresses the threatened species, populations and ecological communities that are endemic (or primarily endemic) to western Sydney including CPW (DECCW, 2009).

Key principles on which the Draft Recovery Plan is based are;

- the protection and management of large, intact remnants is more effective and efficient than for smaller, fragmented remnants;
- recovery efforts need to aim to ensure that a representative sample of biodiversity is conserved;
- active management to best practice standards is needed to prevent the degradation of bushland in a fragmented landscape;
- where impacts on biodiversity cannot be avoided, they should be offset using appropriate means.

Significantly the Recovery Plan seeks to focus recovery efforts on those lands which represent the best opportunities to secure viable, long-term conservation outcomes in the region. These lands, referred to as the priority conservation lands mapped and generally described in the draft Recovery Plan. In summary the priority conservation lands of the Recovery Plan represent the best remaining opportunities in the region to maximise long-term biodiversity benefits for the lowest possible cost, including the least likelihood of restricting land supply. The recovery plan considers these lands, which cover approximately 25,566 ha, to be the highest priority for future recovery efforts associated with the threatened biodiversity. CPSW of the Surface Project Area is not mapped as occurring in priority conservation lands in Figure 1 of the Recovery Plan.

The Amended Project is not considered likely to interfere with the recovery of CPSW.

Conclusion

Avoidance of significant flora and fauna habitats such as regrowth and remnant CPSW has been a continuous process through inception phases, field surveys and culminating in the current design of the proposed action. Based on the assessments above and the application of sustainability principles in the planning phase including measures to avoid or reduce impacts on matters of national environmental significance, it is unlikely that the current proposed action will have a significant impact on CPSW. The Amended Project that places the 11 WSLs in disturbed Closed Grasslands of the WSL, Main Gas Gathering Spine and GGLs that avoids CPSW and access tracks that will be mainly confined to existing tracks or cleared and disturbed areas is unlikely to reduce the extent of, fragment, adversely affect and interfere with CPSW such that the survival of the community is placed at risk in the Surface Project Area, Locality or region.

In view of the above, the Amended Project is not likely to have a significant impact on any TEC and a referral under the EPBC Act is not required. However, AGL may consider lodging a referral

on the basis that the Amended Project is "not a controlled action" in order to confirm whether approval is required under the EPBC Act.

Endangered Species

Flora

There is a medium to high likelihood of occurrence based on potential habitat and previous records within the Surface Project Area for the following species listed as Vulnerable under the EPBC Act:

Acacia pubescens;

Pomaderris brunnea; and

Thesium australe.

In addition, potential habitat also occurs within the Surface Project Area for the following species listed as Endangered under the EPBC Act:

Cynanchum elegans; and

Pimelea spicata.

The potential impacts of the Amended Project on these species are assessed against the Significant Impact Criteria of the EPBC Act below.

None of theses species were recorded by direct observation within the Surface Project Area during the current survey.

Acacia pubescens

Acacia pubescens is a spreading shrub 1-4 m high with brilliant yellow flowers, bipinnate leaves and conspicuously hairy branches (NPWS 2003c). This species is known to occur on alluviums, shales and at the intergrade between shales and sandstones. The species has been recorded within Cumberland Plain Woodland (CPW), Cooks River Castlereagh Ironbark Forest and Shale Gravel Transition Forest (NPWS 2003c).

Acacia pubescens was not recorded in the Surface Project Area during the current surveys; however potential habitat for the species exists within CPW. Potential habitat of *Acacia pubescens* that occurs in the Surface Project Area is not considered to constitute an important area for a population of the species, because:

It is unlikely to be a key source population either for breeding or dispersal;

It is unlikely to be necessary for maintaining genetic diversity; and,

The Surface Project Area is not at or near the limit of the species range.

Is the action likely to lead to a long-term decrease in the size of an important population of a species?

Potential habitat within the Surface Project Area does not support an important population of *Acacia pubescens. Acacia pubescens* was not recorded during the current surveys, despite it being previously recorded within the Locality. All impacts to suitable habitat for this species have been avoided and minimised. Given this, it is considered unlikely that the Amended Project would lead to a long-term decrease in the size of the population of this species.

Is the action likely to reduce the area of occupancy of an important population of this species?

Potential habitat within the Surface Project Area does not support an important population of *Acacia pubescens.* Potential habitat for *Acacia pubescens* exists within the CPW present in the Surface Project Area. All impacts to suitable habitat for this species have been avoided and minimised. It is considered unlikely that the Amended Project would lead to a reduction in the area of occupancy of an important population of this species.

Is the action likely to fragment an existing important population into two or more populations?

Acacia pubescens is not recorded in the current field surveys or database searches of the Surface Project Area. An important population of the species is unlikely to be fragmented as a result of the proposed action.

Is the action likely to adversely affect habitat critical to the survival of a species?

'Habitat critical to the survival of a species or ecological community' is defined by DEH (2006) as areas that are necessary:

- For activities such as foraging, breeding, roosting, or dispersal;
- For the long-term maintenance of the species or ecological community (including the maintenance of species essential to the survival of the species or ecological community, such as pollinators);
- To maintain genetic diversity and long term evolutionary development; or,
- For the reintroduction of populations or recovery of the species or ecological community.

Such habitat may be, but is not limited to: habitat identified in a recovery plan for the species or ecological community as habitat critical for that species or ecological community; and/or, habitat listed on the Register of Critical Habitat maintained by the Minister under the EPBC Act (DEH 2006). The potential habitat within the Surface Project Area is not considered to be habitat critical for survival of this species.

Is the action likely to disrupt the breeding cycle of an important population?

The potential habitat for *Acacia pubescens* within the Surface Project Area is not considered to constitute an important population. Thus, the action is unlikely to disrupt the breeding cycle of an important population. The proposed action is unlikely to disrupt the breeding cycle of any populations of the species in the Locality or region.

Is the action likely to modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?

All impacts to suitable habitat for this species have been avoided and minimised. Consequently, the Amended Project is unlikely to result in the decline of the species.

Is the action likely to result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat?

The action is unlikely to result in an increase in the establishment of invasive species above the current levels within the potential habitat of this species.

Is the action likely to introduce disease that may cause the species to decline?

Infection of native plants by the fungus, *Phytophthora cinnamomi* is considered a potential risk to native plants in the Surface Project Area. Vehicles and machinery could potentially introduce and spread *Phytophthora cinnamomi* throughout the Surface Project Area. As a precaution, it is recommended that vehicles and machinery be washed down prior to use on site.

Is the action likely to interfere substantially with the recovery of the species?

The action will not interfere with the recovery of the species in the Locality or region.

Conclusion

Based on the above assessment, the Amended Project is unlikely to have a significant impact on the *Acacia pubescens*, and as such, a referral under the EPBC Act is not required for these species. However, AGL may consider lodging a referral on the basis that the Amended Project is "not a controlled action" in order to confirm whether approval is required under the EPBC Act.

Pomaderris brunnea

Pomaderris brunnea is a shrub to 3 m in height with distinctively hairy stems. The small flowers have no petals, are yellowish and form dense clusters at the ends of the branches.

Pomaderris brunnea has a very limited distribution around the Nepean and Hawkesbury Rivers, where it grows in moist woodland, semi-cleared scrub or forest on clay and alluvial soils on floodplains and creek lines.

Pomaderris brunnea was not recorded during the field surveys. There are twenty-three previous records of this species within the locality, of which a majority occur approximately 6 km to the south of the Surface Project Area on the Nepean River floodplain at Menangle. The Surface Project Area supports marginal potential habitat for this species in the form of CPW on clay and RFEFCF.

Potential habitat of *Pomaderris brunnea* that occurs in the Surface Project Area is not considered to constitute an important area for a population of the species, because:

It is unlikely to be a key source population either for breeding or dispersal;

It is unlikely to be necessary for maintaining genetic diversity; and,

The Surface Project Area is not at or near the limit of the species range.

Is the action likely to lead to a long-term decrease in the size of an important population of a species?

Potential habitat within the Surface Project Area does not support an important population of *Pomaderris brunnea. Pomaderris brunnea* was not recorded during the current surveys, despite it being previously recorded within the Locality. All impacts to suitable habitat for this species have been avoided and minimised. Given this, it is considered unlikely that the Amended Project would lead to a long-term decrease in the size of an important or other population of this species.

Is the action likely to reduce the area of occupancy of an important population of this species?

Potential habitat within the Surface Project Area does not support an important population of *Pomaderris brunnea*. All impacts to suitable habitat for this species have been avoided and minimised. It is considered unlikely that the Amended Project would lead to a reduction in the area of occupancy of an important population of this species.

Is the action likely to fragment an existing important population into two or more populations?

Pomaderris brunnea is not recorded in the current field surveys or database searches of the Surface Project Area. An important population of the species is unlikely to be fragmented as a result of the proposed action.

Is the action likely to adversely affect habitat critical to the survival of a species?

'Habitat critical to the survival of a species or ecological community' is defined by DEH (2006) as areas that are necessary:

For activities such as foraging, breeding, roosting, or dispersal;

For the long-term maintenance of the species or ecological community (including the maintenance of species essential to the survival of the species or ecological community, such as pollinators);

To maintain genetic diversity and long term evolutionary development; or,

For the reintroduction of populations or recovery of the species or ecological community.

Such habitat may be, but is not limited to: habitat identified in a recovery plan for the species or ecological community as habitat critical for that species or ecological community; and/or, habitat listed on the Register of Critical Habitat maintained by the Minister under the EPBC Act (DEH 2006). The potential habitat within the Surface Project Area is not considered to be habitat critical for survival of this species.

Is the action likely to disrupt the breeding cycle of an important population?

The potential habitat for *Pomaderris brunnea* within the Surface Project Area is not considered to constitute an important population. Thus, the action is unlikely to disrupt the breeding cycle of an important population. The proposed action is unlikely to disrupt the breeding cycle of any populations of the species in the Locality or region.

Is the action likely to modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?

All impacts to suitable habitat for this species have been avoided and minimised. Consequently, the Amended Project is unlikely to result in the decline of the species.

Is the action likely to result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat?

The action is unlikely to result in an increase in the establishment of invasive species above the current levels within the potential habitat of this species.

Is the action likely to introduce disease that may cause the species to decline?

Infection of native plants by the fungus, *Phytophthora cinnamomi* is considered a potential risk to native plants in the Surface Project Area. Vehicles and machinery could potentially introduce and spread *Phytophthora cinnamomi* throughout the Surface Project Area. As a precaution, it is recommended that vehicles and machinery be washed down prior to use on site.

Is the action likely to interfere substantially with the recovery of the species?

The action will not interfere with the recovery of the species in the Locality or region.

Conclusion

Based on the above assessment, the Amended Project is unlikely to have a significant impact on the *Pomaderris brunnea* , and as such, a referral under the EPBC Act is not required for these species. However, AGL may consider lodging a referral on the basis that the Amended Project is "not a controlled action" in order to confirm whether approval is required under the EPBC Act.

Thesium australe

Thesium australe is a small, straggling herb to 40 cm tall. Leaves are pale green to yellow-green, somewhat succulent, 1 - 4 cm long and 0.5 - 1.5 mm wide (DEC 2005). Flowers are minute and white, emerging where the leaves meet the stems and appearing in spring. The fruit is small and nut-like, developing in summer. This species is often hidden amongst grasses and herbs (DEC 2005}).

The species is found in very small populations scattered across eastern NSW, along the coast, and from the Northern to Southern Tablelands (DEC 200}). It is also found in Tasmania and Queensland and in eastern Asia (DEC 200}).

Thesium australe occurs in grassland or grassy woodland, often in damp sites in association with Kangaroo grass *Themeda australis* (DEC 2005}). The species is a root parasite that takes water and some nutrient from other plants, especially *Themeda australis* (DEC 2005).

This species was not recorded within the Surface Project Area. *Thesium australe* is considered to be inconspicuous and difficult to detect regardless of the flowering season. Vegetation within the Surface Project Area that is considered potential habitat includes CPW remnants and regrowth and exotic grassland.

Potential habitat of *Thesium australe* that occurs in the Surface Project Area is not considered to constitute an important area for a population of the species, because:

It is unlikely to be a key source population either for breeding or dispersal;

It is unlikely to be necessary for maintaining genetic diversity; and,

The Surface Project Area is not at or near the limit of the species range.

Is the action likely to lead to a long-term decrease in the size of an important population of a species?

The potential habitat of *Thesium australe* within the Surface Project Area does not constitute an important population of this species. Within the Project Area, small patches or clumps of *Themeda australis* occurring within CPW and exotic grassland are considered to provide potential habitat for this species. Given the large area of known and potential habitat within the Locality, the relatively small area of potential habitat within the Surface Project Area is considered of low importance to the survival of a population of the species. The Amended Project is therefore considered unlikely to lead to a long term decrease in the size of an important population of *Thesium australe.*

Is the action likely to reduce the area of occupancy of an important population of this species?

The potential habitat of *Thesium australe* within the Surface Project Area does not constitute an important area for this species. Within the Surface Project Area, small patches or clumps of *Themeda australis* occurring within CPW and exotic grassland are considered to provide potential habitat for this species. *Themeda australis* is also an abundant pasture species within the locality. Taking into account the worst case scenario, the area to be impacted by the Amended Project is extremely small compared to the potential habitat that will remain in the locality. The Amended Project is not considered likely to reduce the area of occupancy of an important population.

Is the action likely to fragment an existing important population into two or more populations?

Potential habitat within the Surface Project Area does not support an important population of *Thesium australe.* When considering the pre-existing degree of fragmentation and the likely extent of influence on the Surface Project Area, the Amended Project would not significantly increase the magnitude of fragmentation or isolation of areas of potential habitat for this species. On this basis the action is unlikely to fragment an existing population into two or more populations.

Is the action likely to adversely affect habitat critical to the survival of a species?

'Habitat critical to the survival of a species or ecological community' is defined by DEH (2006) as areas that are necessary:

- For activities such as foraging, breeding, roosting, or dispersal;
- For the long-term maintenance of the species or ecological community (including the maintenance of species essential to the survival of the species or ecological community, such as pollinators);
- To maintain genetic diversity and long term evolutionary development; or,
- For the reintroduction of populations or recovery of the species or ecological community.

Such habitat may be, but is not limited to: habitat identified in a recovery plan for the species or ecological community as habitat critical for that species or ecological community; and/or, habitat listed on the Register of Critical Habitat maintained by the Minister under the EPBC Act (DEH 2006). To date, there is no critical habitat listed by the Minister for the DEWHA for *Thesium australe*. Further, the potential habitat in the Surface Project Area is not considered to meet the above definition of critical habitat for *Thesium australe.*

Is the action likely to disrupt the breeding cycle of an important population?

Little information is available regarding the life cycle of *Thesium australe* aside from its apparent association with host grass species, especially *Themeda australis.* Literature suggests that fire induces re-sprouting and seed germination in the species (DSE 2003). It has also been suggested that maintenance of open areas by frequent firing may be important in maintaining suitable open

habitat for the species. The Amended Project is unlikely to interfere with existing fire regimes in the Surface Project Area.

Seed dispersal mechanisms are unknown. Possible dispersal mechanisms for the species; such as wind, insects, animals or local seed drop are unlikely to be affected by the Amended Project.

Is the action likely to modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?

The species was not recorded within the Surface Project Area during the field surveys, however, *Thesium australe* is considered to be inconspicuous and difficult to detect regardless of the flowering season. Approximately 21km^2 of potential habitats for *Thesium australe* exists within the Locality including CPW and Closed Grassland dominated by exotic groundcovers which covers a majority of the area. Given the availability of large areas of potential habitat in the Locality, compared to the area to be impacted by the Amended Project, it is considered unlikely that the Amended Project would modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.

Is the action likely to result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat?

The action is unlikely to result in an increase in the establishment of invasive species above the current levels within the potential habitat of this species.

Is the action likely to introduce disease that may cause the species to decline?

Infection of native plants by the fungus, *Phytophthora cinnamomi* is considered a potential risk to native plants in the Surface Project Area. Vehicles and machinery could potentially introduce and spread *Phytophthora cinnamomi* throughout the Surface Project Area. As a precaution, it is recommended that vehicles and machinery be washed down prior to use on site.

Is the action likely to interfere substantially with the recovery of the species?

The action will not interfere with the recovery of this threatened species within the Surface Project Area, Locality or region .

Conclusion

Based on the above assessment, the Amended Project is unlikely to have a significant impact on the *Thesium australe* , and as such, a referral under the EPBC Act is not required for these species. However, AGL may consider lodging a referral on the basis that the Amended Project is "not a controlled action" in order to confirm whether approval is required under the EPBC Act.

Cynanchum elegans

Cynanchum elegans is a climber with variable forms. This species typically occurs on the edge of dry rainforest vegetation. It is also associated with other vegetation types such as, littoral rainforest, Coastal Tea-tree *Leptospermum laevigatum* – Coastal Banksia *Banksia integrifolia* subsp.

integrifolia coastal scrub; Forest Red Gum *Eucalyptus tereticornis* aligned open forest and woodland; Spotted Gum *Eucalyptus maculata* aligned open forest and woodland; and Bracelet Honeymyrtle *Melaleuca armillaris* scrub to open scrub.

This species was not recorded during field surveys, despite one previous record within the Surface Project Area and several records within the broader locality.

Is the action likely to lead to a long-term decrease in the size of a population of a species?

Cynanchum elegans was not recorded in the Surface Project Area during field surveys. However one record of the species is detected from the database searches in the northern area of the Surface Project Area. All impacts to suitable habitat for this species have been avoided and minimised.

Is the action likely to reduce the area of occupancy of a population of this species?

A population of *Cynanchum elegans* is recorded from database searches in the northern section of the Surface Project Area. The proposed action will not impact on the area of the previous record of the species in the Surface Project Area or Locality. The proposed action is not likely to reduce the area of occupancy of a population of the species.

Is the action likely to fragment an existing population into two or more populations?

A population of *Cynanchum elegans* is recorded from database searches in the northern sector of the Surface Project Area. Additional database records of the species are clustered to the west of the Surface Project Area. The proposed action will not fragment the previously recorded population of the species in the Surface Project Area or those previously recorded in the Locality.

Is the action likely to adversely affect habitat critical to the survival of a species?

'Habitat critical to the survival of a species or ecological community' is defined by DEH (2006) as areas that are necessary:

- For activities such as foraging, breeding, roosting, or dispersal;
- For the long-term maintenance of the species or ecological community (including the maintenance of species essential to the survival of the species or ecological community, such as pollinators);
- To maintain genetic diversity and long term evolutionary development; or,
- For the reintroduction of populations or recovery of the species or ecological community.

Such habitat may be, but is not limited to: habitat identified in a recovery plan for the species or ecological community as habitat critical for that species or ecological community; and/or, habitat listed on the Register of Critical Habitat maintained by the Minister under the EPBC Act (DEH 2006). To date, there is no critical habitat listed by the Minister for the DEWHA for *Cynanchum elegans*. Further, the potential habitat in the Surface Project Area does not meet the above definition of critical habitat for *Cynanchum elegans*.

Is the action likely to disrupt the breeding cycle of a population?

Due to the minimal amount of temporary disturbance to native vegetation of the Amended Project, the proposed action is unlikely to disrupt the breeding cycle of any populations of the species previously recorded in the north of the Surface Project Area, in the Locality or the region.

Is the action likely to modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?

The proposed action will not impact on the area of the previously recorded population of the species in the Surface Project Area or those previously recorded in the Locality.

All impacts to suitable habitat for this species have been avoided and minimised. Consequently, the Amended Project is unlikely to result in the decline of the species.

Is the action likely to result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species´ habitat?

The Surface Project Area contains a high level of weeds. Thus, it is considered unlikely that the Amended Project would increase the threat of weed invasion, above the current level.

Is the action likely to introduce disease that may cause the species to decline?

The proposed action is not likely to introduce disease that may cause the species to decline. As a precaution, construction/earth moving vehicles should be washed down prior to use on site.

Is the action likely to interfere with the recovery of the species?

No Recovery Plan as published by DEWHA is available for *Cynanchum elegans*. The threatened species profile for *Cynanchum elegans* refers to nine priority actions to assist in recovery of the species (DEC 2005v). Those relevant to the Amended Project include (DEC 2005):

- Consider off-site impacts in the assessment of nearby developments;
- Install fencing to exclude livestock and machinery, and control access where required;
- Protect areas of known and potential habitat from clearing and further fragmentation;
- Restore degraded habitat using bush regeneration techniques (note that it is crucial that workers are able to distinguish the species from the exotic Moth Plant Araujia sericifera);
- Mark sites and potential habitat onto maps used for planning maintenance work; and,
- Map known sites and conduct searches of potential habitat for new sites.

With the exception of the removal of a small area of potential habitat, the Amended Project is not inconsistent with the priority actions that relate to the recovery of *Cynanchum elegans*.

Conclusion

Based on the above assessment, the Amended Project is unlikely to have a significant impact on the *Cynanchum elegans* and, as such, a referral under the EPBC Act is not recommended for this species. However, AGL may consider lodging a referral on the basis that the Amended Project is "not a controlled action" in order to confirm whether approval is required under the EPBC Act.

Pimelea spicata

Pimelea spicata is a small spreading or erect shrub growing to 50 cm (NPWS 2004). The leaves are opposite and elliptical, to 20 mm long by 8 mm wide (DECC 2005). The white, pink-tinged flowers are tubular, to 10 mm long, with four spreading petals (DECC 2005). They may appear at any time of the year, but are mostly seen in summer (DECC 2005). The species is known to occur in areas supporting or areas previously supporting Cumberland Plain Woodland.

Once widespread on the Cumberland Plain, *Pimelea spicata* occurs in two disjunct areas, the Cumberland Plain (Western Sydney) and the Illawarra. In both the Cumberland Plain and Illawarra region, this species is found on well-structured clay soils (DECC 2005). In the coastal Illawarra it occurs commonly in *Banksia integrifolia* open woodland with a more well developed shrub and grass understorey (DECC 2005).

It is also known from highly disturbed areas including road verges, table drains, road embankments and ploughed paddocks (DECC 2005).

Pimelea spicata was not recorded during the field surveys, despite several previous records being found within the Surface Project Area and the broader locality.

Is the action likely to lead to a long-term decrease in the size of a population of a species?

Although, *Pimelea spicata* was not recorded within the Surface Project Area during the current field survey, the species is cryptic and difficult to detect, particularly when not in flower. There are three previous record locations of this species within the Surface Project Area. The species flowers sporadically throughout the year. All impacts to suitable habitat for this species have been avoided and minimised. The Amended Project is not likely to lead to a long-term decrease in the size of the population known fro the Surface Project Area.

Is the action likely to reduce the area of occupancy of a population of this species?

Populations of *Pimelea spicata* are recorded from database searches in the western area of the Surface Project Area. The proposed action will not impact on the area of the previous record of the species in the Surface Project Area or Locality. The proposed action is not likely to reduce the area of occupancy of a population of the species.

Is the action likely to fragment an existing population into two or more populations?

No known populations of *Pimelea spicata* would be impacted by the Amended Project. The Amended Project would impact on a very small proportion of potential habitat and this is not

expected to result in the fragmentation of any populations of this species or areas of potential habitat.

Is the action likely to adversely affect habitat critical to the survival of a species?

'Habitat critical to the survival of a species or ecological community' is defined by DEH (2006) as areas that are necessary:

- For activities such as foraging, breeding, roosting, or dispersal;
- For the long-term maintenance of the species or ecological community (including the maintenance of species essential to the survival of the species or ecological community, such as pollinators);
- To maintain genetic diversity and long term evolutionary development; or,
- For the reintroduction of populations or recovery of the species or ecological community.

Such habitat may be, but is not limited to: habitat identified in a recovery plan for the species or ecological community as habitat critical for that species or ecological community; and/or habitat listed on the Register of Critical Habitat maintained by the Minister under the EPBC Act (DEH 2006). To date, there is no critical habitat listed by the Minister for the Department of the Environment, Water, Heritage and the Arts for *Pimelea spicata*.

Critical habitat for *Pimelea spicata* has not been identified in the recovery plan for the species (DEC 2004). However, the recovery plan identifies the habitat features and locations that would contain habitat that is important to the survival of the species, as required by the EPBC Act (DEC 2004). These include 28 known locations throughout the species known distribution. The Surface Project Area is not one of these known locations.

The potential habitat in the Surface Project Area is not an area considered to be necessary for breeding, dispersal or succession; to maintain genetic diversity; or for the reintroduction of populations or recovery of the species. Therefore, the Amended Project will not impact on habitat critical to the survival of the *Pimelea spicata.*

Is the action likely to disrupt the breeding cycle of a population?

The Amended Project is considered unlikely to impact the pollination or dispersal of a population (if one exists) of *Pimelea spicata* given that the Amended Project;

- Will not resulting in the total destruction of habitat,
- Will not interfere with fire regimes within the Surface Project Area or locality,
- Will not increase vehicular, bike, pedestrian, or other, access to a known population of the species,
- Is unlikely to increase rubbish dumping within known or potential habitats for the species, and,

Is unlikely to significantly increase levels of weed invasion within adjacent areas as they are already subject high levels of weed invasion.

Given that no individuals were detected within the Subject Site of the Surface Project Area, it is unlikely that the Amended Project will disrupt the lifecycle of the species.

Is the action likely to modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?

All impacts to suitable habitat for this species have been avoided and minimised. Furthermore, the Amended Project will not result in the isolation or fragmentation of potential habitat for the species.

It is considered unlikely that the Amended Project would affect the long term survival the species. The Amended Project is not likely to modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.

Is the action likely to result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species´ habitat?

The vegetation within the Surface Project Area that provides potential habitat for *Pimelea spicata* is already subject to invasion by weeds and grazing. Further disturbance as a result of the Amended Project would be minimal and it is considered unlikely to significantly increase weed invasion in the Surface Project Area.

Is the action likely to introduce disease that may cause the species to decline?

The Amended Project is unlikely to introduce disease that may cause *Pimelea spicata* to decline. However, as a precautionary measure plant and vehicles should be clean and free of dirt and organic materials prior to use on sites near areas of native vegetation.

Is the action likely to interfere with the recovery of the species?

No Recovery Plan as published by DEWHA is available for *Pimelea spicata* (Department of Environment and Heritage 2005), however, a draft recovery plan has been prepared for *Pimelea spicata* by NSW Department of Environment and Climate Change (DEC 2004a). The overall objective of this recovery plan is to ensure the continued and long-term survival of *P. spicata* in the wild by promoting the *in-situ* conservation of the species across its natural range. Specific recovery objectives include:

Conserve *P. spicata* using land-use and conservation planning mechanisms;

Identify and minimise the operation of threats at sites where *P. spicata* occurs;

Develop and implement a survey and monitoring program that will provide information on the extent and viability of *P. spicata*;

Provide the community with information that assists in conserving the species;

Raise awareness of the species and involve the community in the recovery program; and

Conduct research that will assist future management decisions.

Conclusion

Based on the above assessment, the Amended Project is unlikely to have a significant impact on the *Pimelea spicata* and, as such, a referral under the EPBC Act is not required for this species.However, AGL may consider lodging a referral on the basis that the Amended Project is "not a controlled action" in order to confirm whether approval is required under the EPBC Act.

Fauna

There is a medium to high likelihood of occurrence within the Surface Project Area for two fauna species listed as threatened under the EPBC Act:

Swift Parrot listed (Endangered); and

Grey-headed Flying-fox (Vulnerable).

Swift Parrot (*Lathamus discolor*)

The Swift Parrot breeds in Tasmania during spring and summer, migrating in the autumn and winter months to south-eastern Australia from Victoria and the eastern parts of South Australia to south-east Queensland. In NSW the species mostly occurs on the coast and south west slopes (DEC 2005r).

Is the action likely to lead to a long-term decrease in the size of a population of the species?

The Swift Parrot was not recorded during the current surveys; however it has previously been recorded within the Locality of the Surface Project Area. All impacts to suitable habitat for this species have been avoided and minimised. Consequently, the Amended Project is unlikely to result in the long-term decrease in the size of a population of the species.

Is the action likely to reduce the area of occupancy of a population of this species?

All impacts to suitable habitat for this species have been avoided and minimised. In view of the retention of key foraging resources, the extent of potential habitat within the local area (872 ha), the quality of potential habitat and the mobility of this species, it is unlikely that the Amended Project would reduce the area of occupancy of a population of this species.

Is the action likely to fragment an existing population into two or more populations?

The Swift Parrot is a highly mobile species, migrating from Tasmania to south-east mainland Australia in winter. The Amended Project is unlikely to fragment existing populations of such a highly mobile species.

Is the action likely to adversely affect habitat critical to the survival of a species?

'Habitat critical to the survival of a species or ecological community' is defined by DEH (2006) as areas that are necessary:

For activities such as foraging, breeding, roosting, or dispersal;

For the long-term maintenance of the species or ecological community (including the maintenance of species essential to the survival of the species or ecological community, such as pollinators);

To maintain genetic diversity and long term evolutionary development; or,

For the reintroduction of populations or recovery of the species or ecological community.

Such habitat may be, but is not limited to habitat identified in a recovery plan for the species or ecological community as habitat critical for that species or ecological community; and/or, habitat listed on the Register of Critical Habitat maintained by the Minister under the EPBC Act (DEH 2006).

Taking into account the worst case scenario for this Amended Project, the action may temporarily modify a small amount of the potential habitat for this species. However, given the availability of similar habitat within the Surface Project Area and the broader locality, as well as the mobility of this species, the relatively small amount of potential habitat that may be modified is not considered to be critical to the survival of the species.

Is the action likely to disrupt the breeding cycle of a population?

The Swift Parrot breeds in Tasmania and as such, the Amended Project is unlikely to impact directly on the breeding cycle of this species. In addition, given the relatively small proportion and component of potential foraging habitat that may be temporarily modified (up to 0.3% within the Surface Project Area) it is unlikely that the action would disrupt the breeding cycle of this species.

Is the action likely to modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?

All impacts to suitable habitat for this species have been avoided and minimised. The Amended Project is, therefore, unlikely to result in the decline of the species.

Is the action likely to result in invasive species that are harmful to a critically endangered or endangered/vulnerable species becoming established in the endangered or critically endangered species/vulnerable habitat?

The action is unlikely to increase the extent and distribution of invasive pests and weeds in the region above the current levels.

Is the action likely to introduce disease that may cause the species to decline?

The Amended Project is not likely to lead to the introduction of a disease (e.g. Beak and Feather Disease - Psittacosis) that would cause a decline in Swift Parrots

Is the action likely to interfere substantially with the recovery of this species?

The action will not interfere with the recovery of any threatened species within the local area.

Conclusion

Based on the above assessment the Swift Parrot is unlikely to be significantly impacted by the activities, and as such, a Referral under the EPBC Act is not recommended for this species.

Grey-headed Flying-fox *Pteropus poliocephalus*

Populations of the Grey-headed Flying-fox that may occur within the development footprint are not considered important populations because:

- they are unlikely to be key source populations either for breeding or dispersal;
- they are unlikely to be necessary for maintaining genetic diversity; and,
- the study site is not at or near the limit of the species range.

The Grey-headed Flying Fox was not recorded within the Surface Project Area during the current survey. However, there are several previous records of this species within the Surface Project Area and broader locality (DECCW Atlas of NSW Wildlife).

Is the action likely to lead to a long-term decrease in the size of an important population of a species?

All impacts to suitable foraging habitat for this species have been avoided and minimised. The species is not known to form roosting camps at the site. Furthermore, given the range and mobility of this species, it is unlikely to be wholly dependent upon resources within the Surface Project Area. Consequently, the Amended Project is unlikely to result in the long-term decrease in the size of an important population of this species.

Is the action likely to reduce the area of occupancy of an important population?

This species is highly mobile and it is known to travel up to 50 km to forage. Consequently, the Amended Project is unlikely to reduce the area of occupancy of an important population.

Is the action likely to fragment an existing important population into two or more populations?

The Surface Project Area is not known to contain a resident population or camp of Grey-headed Flying-fox. As such, the Amended Project is unlikely to fragment an existing population into two or more populations.

Is the action likely to adversely affect habitat critical to the survival of a species?

'Habitat critical to the survival of a species or ecological community' is defined by DEH (2006) as areas that are necessary:

- For activities such as foraging, breeding, roosting, or dispersal;
- For the long-term maintenance of the species or ecological community (including the maintenance of species essential to the survival of the species or ecological community, such as pollinators);
- To maintain genetic diversity and long term evolutionary development; or,

For the reintroduction of populations or recovery of the species or ecological community.

Such habitat may be, but is not limited to: habitat identified in a recovery plan for the species or ecological community as habitat critical for that species or ecological community; and/or, habitat listed on the Register of Critical Habitat maintained by the Minister under the EPBC Act (DEH 2006). The potential habitat within the Surface Project Area is not considered to be habitat critical for survival of this species.

Is the action likely to disrupt the breeding cycle of an important population?

The Surface Project Area is not considered to contain an important population of the Grey-headed Flying-fox. Therefore, the proposed action is unlikely to disrupt the breeding cycle of an important population.

Is the action likely to modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?

All impacts to suitable habitat for this species have been avoided and minimised. Consequently, the Amended Project is unlikely to result in the decline of the species.

Is the action likely to result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat?

The action is unlikely to result in an increase in the establishment of invasive species above the current levels within the potential habitat of this species.

Is the action likely to introduce disease that may cause the species to decline?

The action is unlikely to result in the introduction of a disease that will cause Grey-headed Flying-fox to decline.

Is the action likely to interfere substantially with the recovery of the species?

The action will not interfere with the recovery of this threatened species within the Surface Project Area or region.

Conclusion

Based on the above assessment, the Amended Project is unlikely to have a significant impact on the Grey-headed Flying-fox, and as such, a referral under the EPBC Act is not recommended for these species. However, AGL may consider lodging a referral on the basis that the Amended Project is "not a controlled action" in order to confirm whether approval is required under the EPBC Act.

APPENDIX 6

Threatened Flora and Fauna Likelihood of Occurrence Assessment Criteria

Likelihood of Occurrence	Assessment Criteria
Low	Species considered to have a low likelihood of occurrence include species not recorded in the field surveys that fit one or more of the following criteria: Have not been recorded previously in the Surface Project Area or locality and the Surface Project Area is beyond the known distribution or range. Are dependant on a narrow range or specific habitats that do not or are not likely to occur in the Surface Project Area. Are considered locally extinct. Are a non-cryptic perennial flora species that were targeted during field surveys. Are flora species that have a very limited range and highly specific dispersal mechanisms.
Medium	Species considered to have a moderate likelihood of occurrence include species not recorded in the field surveys that fit one or more of the following criteria: There are infrequent recorded for the species in the Surface Project Area and locality. Preferential habitats of the species are present in the Surface Project Area but these are mainly in a poor or modified condition. May use or occur in habitats within the Surface Project Area opportunistically during seasonal migration but are unlikely to be present on permanent basis as a populations or vagrant individuals. Are cryptic flowering flora species that were not seasonally targeted during surveys.
High	Species considered to have a high likelihood of occurrence include species recorded during the field surveys or species not recorded that fit one or more of the following criteria: Have a high incidence of previous records in the Surface Project Area and locality. Preferentially use habitats that are present in the Surface Project Area which are abundant and/or in good condition. Resident populations are known in the Surface Project Area or locality. Are known to regularly use habitats of the site or locality or are highly likely to visit the site during seasonal dispersal or migration.

APPENDIX 7

Recommended Species for Revegetation Works

Life form	Genus species	Planting Densities
Tree	*Eucalyptus crebra*	1/4m2
Tree	*Eucalyptus eugenioides*	1/4m2
Tree	*Eucalyptus fibrosa*	1/4m2
Tree	*Eucalyptus maculata*	1/4m2
Tree	*Eucalyptus moluccana*	1/4m2
Tree	*Eucalyptus tereticornis*	1/4m2
Tree	*Melaleuca decora*	1/4m2
Shrub	*Acacia decurrens*	1/2m2
Shrub	*Acacia falcata*	1/2m2
Shrub	*Acacia implexa*	1/2m2
Shrub	*Acacia parramattensis*	1/2m2
Shrub	*Bursaria spinosa*	1/2m2
Shrub	*Daviesia ulicifolia*	1/2m2
Shrub	*Dillwynia sieberi*	1/2m2
Shrub	*Indigofera australis*	1/2m2
Scrambler	*Glycine clandestina*	1/1m2
Scrambler	*Glycine tabacina*	1/1m2
Scrambler	*Hardenbergia violacea*	1/1m2
Herb	*Commelina cyanea*	4/1m2
Herb	*Dianella longifolia*	4/1m2
Herb	*Dianella revoluta*	4/1m2
Herb	*Dichondra repens*	4/1m2
Herb	*Lomandra filiformis*	4/1m2
Herb	*Lomandra multiflora*	4/1m2
Grass	*Aristida ramosa*	4/1m2
Grass	*Aristida vagans*	4/1m2
Grass	*Chloris truncata*	4/1m2
Grass	*Chloris ventricosa*	4/1m2
Grass	*Dichelachne micrantha*	4/1m2
Grass	*Echinopogon caespitosus*	4/1m2
Grass	*Echinopogon ovatus*	4/1m2
Grass	*Entolasia marginata*	4/1m2
Grass	*Microlaena stipoides*	4/1m2
Grass	*Oplismenus aemulus*	4/1m2
Grass	*Panicum simile*	4/1m2
Grass	*Themeda australis*	4/1m2

APPENDIX 8

Biosis Research Field Staff Summary CVs

BRETT MORRISEY

POSITION

Botanist, Biosis Research Pty. Ltd.

PROFESSIONAL AFFILIATIONS AND MEMBERSHIPS

Ecological Consultants Association of NSW

QUALIFICATIONS

B. App. Sc (Coastal Management). 1993 University of New England, Lismore.

Certificate 2 Bushland Regeneration, 1995 NSW College of TAFE, Ryde Campus

EMPLOYMENT PROFILE

2009	Botanist, Biosis Research
2003 – 2009	Project Officer - Environmental Consulting, Total Earth Care Pty Ltd, Sydney
2001 – 2003	Bush Regeneration Supervisor, Total Earth Care Pty Ltd, Sydney
2000 – 2001	Tour/Interpretive Guide, Jungle Adventures Pty Ltd, Cape Tribulation
1996 – 1999	Beachwatch Field Officer, NSW Environment Protection Authority, Sydney

FIELDS OF COMPETENCE:

- flora survey and identification
- bushland management & site assessment
- native plant and weed identification
- threatened species assessment (including EECs)
- native vegetation classification and mapping
- habitat restoration
- weed density mapping
- project management and report preparation
- monitoring rehabilitation of vegetation
- options and constraints assessment

PROFESSIONAL EXPERIENCE

Brett is a botanist with Biosis Research, Wollongong office. Brett has 10 years experience working with indigenous plant species in flora surveys, natural area restoration and weed management. Brett's experience includes consulting projects involving both flora and fauna assessment. Brett has undertaken flora assessments including targeted surveys for a wide range of threatened species, populations and ecological communities in a variety of locations across the Sydney basin bioregion stretching from littoral zones to the eastern ranges through the Central Coast, Sydney Metropolitan, Southern Highlands, Illawarra and South Coast districts. Brett has also been involved with restoration projects throughout the Sydney region involving the translocation of threatened flora species, soil translocations, revegetation, weed control and bush regeneration projects. This experience spans the supervision of on ground restoration works, project management and cost estimation for restoration projects.

Brett has participated in surveys and prepared reports for flora and fauna assessments, vegetation and weed density mapping, bush regeneration scopes of works, vegetation management plans, bushland management plans and vegetation monitoring programmes.

Examples of recent projects are provided below.

Botanist/Assisting Zoologist, general vegetation and targeted threatened flora and fauna surveys and vegetation condition assessment for a proposed rezoning of a 70 ha property at Bangalee in the Shoalhaven LGA. TSC and EPBC Act Assessments of Significance for multiple threatened flora species with potential habitat on or known from the subject site.

Ecologist, general vegetation and targeted threatened flora and fauna surveys and vegetation condition assessment for a Part 3A gas infrastructure project in south-western Sydney. EPBC Act assessment of significance for Cumberland Plain Woodland.

Botanist, general vegetation and targeted threatened flora surveys and plant community mapping for a telecommunications tower at Cordeaux Colliery. Assessment of significance for Pultenaea aristata.

Botanist, general vegetation and targeted threatened flora surveys, plant community mapping and constraints assessment for 33kv overhead/underground power line between Springhill and Wongawilli. Assessment of significance for Illawarra Lowland Grassy Woodland EEC.

Botanist, targeted exotic flora species survey, weed density mapping, resilience assessment and vegetation management measures for a Weed Management Plan at Dendrobium Mine Pit Top, Mount Kembla.

Botanist, general vegetation and targeted threatened flora surveys and plant community mapping of the main bushland reserves in the Kogarah LGA.

Botanist, establish and record baseline data at 60 of 200 photo point monitoring sites over approximately 2,000 ha of the Western Sydney Parklands ecological corridor. Rapid field assessment of vegetation condition, structure, cover, floristics, resilience and habitat features.

Botanist, field survey, vegetation and habitat assessment, vegetation community mapping, vegetation management recommendations including assigning responsibilities, preparation of indicative budgets, timing and staging of works for a VMP at a council reserve in Liverpool LGA.

Botanist, field survey, vegetation and habitat assessment, vegetation community and weed density mapping, vegetation management recommendations including restoration strategies, preparation of indicative budgets, timing and staging of works in Campbelltown LGA bushland reserve.

Botanist, targeted field survey, habitat assessment and mapping of Downy Wattle Acacia pubescens, and preparation of a translocation plan for the species from a road easement.

Botanist, Document review, field survey, site assessment, and preparation of a scope of works for a bush regeneration and revegetation project in EEC remnants (Cumberland Plain Woodland and River Flat Eucalypt Forest on Coastal Floodplains).

Botanist, document review, field survey, site assessment, and preparation of a scope of works for a bush regeneration and revegetation project in EEC remnants on a western Sydney arterial road upgrade.

Botanist, 7-part Tests for Blue Gum High Forest CEEC and Sydney Turpentine-Ironbark Forest EEC for a proposed multi-dwelling residential development in northern Sydney.

Botanist, prepare and deliver a one day weed identification and management training programme to patrol officers employed by an infrastructure management and development company.

General Ecologist, general diurnal ecological surveys to inform a REF addendum for a road upgrade at Green Point on the Central Coast. . Assessment of significance for Swamp Sclerophyll Forest EEC.

General Ecologist, general and targeted diurnal and nocturnal ecological surveys at Potts Hill Reservoir, identification of constraints to inform property maintenance. Recommendations for management of threatened and non-threatened biodiversity and preparation of a VMP.

General Ecologist, general diurnal and nocturnal ecological surveys and targeted searches for threatened flora, fauna and ecological communities, identification of constraints to inform the master planning process and EIS for a Part 3A project application under the EP&A Act.

General Ecologist, general and targeted diurnal and nocturnal ecological surveys at Prospect Reservoir, identification of constraints to inform property maintenance. Recommendations for management of threatened and non-threatened biodiversity and preparation of a VMP.

CONSULTANT REPORTS:

A sample of reports that Brett has prepared or contributed to in his professional ecological consulting career are listed below:

2011 Maldon Employment Lands Local Environmental Study - Flora and Fauna Survey and Constraints Assessment (Wollondilly Shire Council).

2011 Appin Area 9 Biodiversity Management Plan (BHP Billiton Illawarra Coal).

2010 Picton, Thirlmere, Tahmoor Local Environmental Study - Flora and Fauna Survey and Constraints Assessment (Wollondilly Shire Council).

2009 Flora & Fauna Assessment – Twin Creeks Reserve, Turramurra (Prepared for Networks Alliance).

2009 Flora Biodiversity Study – Kogarah Local Government Area (Prepared for Kogarah City Council).

2009 Flora & Fauna Assessment, Property EMP and VMP – Prospect Reservoir (Prepared for Sydney Water).

2009 Bushfire Hazard Reduction Activities Vegetation Monitoring North Head STP. (Prepared for Sydney Water).

2009 7-part Tests for Blue Gum High Forest CEEC & Sydney Turpentine-Ironbark Forest EEC. Proposed multi-dwelling residential development, Beaconsfield Pde, Lindfield. (Prepared for Staldone Corporation).

2008 Flora & Fauna Assessment and VMP – Northern Sites Package 1. (Prepared for Sydney Water).

2008 Flora and Fauna Assessment. Cochlear Global Headquarters Project – Stage 1, Macquarie University. (Prepared for DEM).

2008 EPBC Act Significant Impact Assessments for Sydney Turpentine Ironbark Forest and Cumberland Plain Woodland EEC's, *Acacia pubescens* (Downy Wattle) and Grey Headed Flying-Fox - Potts Hill Reservoir. (Prepared for Sydney Water).

2007 Biodiversity Assessments - Cardiff, Floraville, and Jewells. (Prepared for Lake Macquarie Council).

2007 Preliminary Flora and Fauna Assessment. Proposed 33kV Powerline, Terry Hills Zone Substation to Sydney East Bulk Supply Point. (Prepared for EnergyAustralia).

2007 Targeted Threatened Species Survey. Proposed Scour Pipeline, Ashfield to Liverpool Sewer Pipeline Upgrade, Chullora. (Prepared for Leighton Contractors Pty Ltd).

2007 Revised Vegetation Management Plan. 3875 Old Northern Rd, Canoelands. (Prepared for Flora Pacific Nursery).

2007 Restoration Plan. Noorumba Reserve, Rosemeadow (Prepared for Campbelltown City Council).

2007 Targeted Threatened Species Survey, St Patricks Estate Asset Protection Zone (Prepared for Lend Lease Developments).

2006/07Citywide Bushland Management Plan. Holroyd City Council (Prepared for Holroyd City Council).

2006 Vegetation Management Plan. Allied Mills Grain Milling Facility, Picton Road, Maldon. (Prepared for Kellogg, Brown & Root Pty Ltd).

2005 Vegetation Management Plan. Windsor Road Upgrade, Mile End Rd to Boundary Rd, Rouse Hill. (Prepared for NSW RTA).

2005 Translocation Plan for Downy Wattle *Acacia pubescens*, Lyn Pde Extension, Prestons (Prepared for AMBS).

2005 Randwick Environmental Park. Bush Regeneration and Rehabilitation Scope of Works. (Prepared for Department of Defence).

LUKE BAKER

POSITION:

Field Botanist, Biosis Research Pty. Ltd

QUALIFICATIONS

Bachelor Applied Science Environmental Management – University of Western Sydney.

Conservation Land Management (Natural Area Restoration) Certificate III at Ryde NSWTAFE

EMPLOYMENT PROFILE:

2009-2010 Field Botanist, Biosis Research Pty Ltd., Sydney

2008-2009 Research Assistant, Biosis Research Pty. Ltd., Sydney

2008-2008 Technical Assistant, Biosis Research Pty. Ltd., Sydney

2007-2008 Bush Regenerator, Toolijooa Bushland Restoration Pty Ltd, Sydney

2006-2007 Office Clerk, Baker & McKenzie Global Law firm, Sydney

2004-2005 Office Clerk, Back Schwartz Vaughan Solicitors, Sydney

PROFESSIONAL EXPERIENCE:

Luke has conducted and assisted with fieldwork on the following Biosis Research projects:

Field Botanist, Illawong Public School Flora and Fauna Assessment (2010 for Arup Pty Ltd)

Project Manager/Botanist, Hammondville Development site Flora & Fauna Impact Assessment (2009 for Morgan Moore & Associates)

Field Botanist, Spring Farm/Menangle Gas Gathering Line Flora & Fauna Impact Assessment (2009 for AGL Energy Ltd)

Field Botanist, Yarrawarrah Public School Flora and Fauna Assessment (2009 for Arup Pty)

Field Botanist, Alfords Point Public School Flora and Fauna Assessment (2009 for Arup Pty)

Field Botanist, Flora surveys at Wongawilli, (2009 for Gujarat NRE Mineral Ltd.)

Field Botanist, Borehole and seismic line assessment - BHPBIC Exploration REFs FY 09-10 Flora and Fauna (2009 for BHP Billiton)

Field Botanist, Nebo Boreholes REF: Cultural Heritage, Flora and Fauna Assessment (2009 for Gujarat NRE FCGL Pty Ltd)

Field Botanist, Flora surveys, Swamp monitoring (2009 for BHP Billiton)

Field Assistant, Maroota Flora and Fauna Surveys (2009 for Baulkham Hills City Council)

Field Assistant, Tintenbar to Ewingsdale - Targeted surveys for Arthraxon hispidus (2009 for Arup

Field Assistant, Googong Urban Release Fauna Surveys (2008 Ecowise Environmental)

Field Assistant, Photographic Survey (2009 Great Western Highway Upgrade: Woodford to Hazelbrook Archival Photographic Recording)

Field Assistant, Tree Assessment, Googong Spillway additional infrastructure work (2009 for ACTEW Corporation Ltd).

Field Assistant, Queensland to Hunter Gas Pipeline flora survey (2008 for NGH Environmental Pty Ltd)

Field Assistant, Flora and Fauna Assessment: Central Coast Hwy (2008 for Connell Wagner Pty Ltd).

Field Assistant, Stoney Pinch Vegetation Mapping Assessment (2008 for Donaldson Coal Pty Ltd)

Field Assistant, Central Coast Hwy, Erina - Additional Tree Assessment (2008 for Connell Wagner Pty Ltd)

Field Assistant, West Cliff Emplacement Archaeological and Cultural Heritage Sub-Surface Testing (2008 for BHP Billiton)

Field Assistant, Tomago Substation Augmentation SIS (2008 Transgrid)

Logistics Coordinator, Victorian Desalination Project flora & fauna assessment (GHD)

Field Assistant, Trapping, Bird and Herpetology surveys (2008 for Beveridge Williams and Co. Pty Ltd)

Field Assistant, Murrumbidgee River to Googong Water Pipeline (2008 for ACTEW Corporation Ltd)

CONSULTANT REPORTS:

A sample of the reports that Luke has contributed to are listed below:

2009 Flora & Fauna Assessment for Hammondville Development Site, Hammondville (for Morgan Moore & Associates)

2009 Scoping the requirements for development of the Ecological Character Description and updated Ramsar information sheet for the Cobourg Peninsula Ramsar site. (Report for Department of Environment, Water, Heritage and the Arts)

2009 Yarrawarrah Public School Detailed Threatened Species Assessment. (Report for AbiGroup Contractors)

2009 Grays Point Public School Threatened Species Assessment Report (for AbiGroup Contractors)

2009 Tharawal School Threatened Species Assessment. (Report for AbiGroup Contractors)

2009 Tree Assessment 'Hillside' at Greenhill, 190 Princes Highway, Figtree. (Report for Alizan Pty Ltd)

2009 Assessment of Significance of several patches of Hairy-joint grass Arthraxon hispidus near bangalow (Report for Arup Infrastructure on behalf of the RTA)

2009 Alfords Point Threatened Species Assessment. (Report for AbiGroup Contractors)

2009 Flora & Fauna Assessment: Proposed Avon, Nebo and Wongawilli Boreholes (Report for Gujarat NRE Minerals Limited)

2009 Flora & Fauna Assessment Proposed Exploration Program Dendrobium Area 3C. (Report for BHP Billiton)

2009 Hunter Expressway Electricity Adjustments - Species Impact Statement (Report for Energy Australia and Roads and Traffic Authority)

SIAN WILKINS

POSITION

Senior Botanist, Biosis Research Pty. Ltd.

QUALIFICATIONS

Bachelor of Environmental Science (Hons I) (Terrestrial Biology) 2001 University of New South Wales

Accredited Biobanking Assessor 2009

Ryde TAFE College / Department of Environment and Climate Change Statement of Attainment in Bushland Weed Control 2002 Padstow TAFE

PROFESSIONAL AFFILIATIONS AND MEMBERSHIPS

Ecological Society of Australia

Australian Network for Plant Conservation

EMPLOYMENT PROFILE

2004- 2010 Botanist, Biosis Research Pty. Ltd.

2002-2004 Botanist, Anne Clements and Associates Pty. Ltd.

FIELDS OF COMPETENCE

- Flora survey and identification – techniques include habitat assessment, random meander surveys, plot based (quadrat/transect) surveys
- native vegetation classification and mapping
- rare or threatened species and ecological communities assessment
- conservation significance assessment
- impact minimisation (mitigation) guidelines and offsets
- project management, research, data analysis and report preparation (statement of environmental effects, review of environmental factors, species impact statement, environmental impact statement)
- monitoring rehabilitation of vegetation
- digital mapping & GIS systems - natural areas

- advice on route selection - linear infrastructure development
- revegetation/rehabilitation guidelines
- weed management
- rare and threatened species management
- natural area conservation and management

PROFESSIONAL EXPERIENCE

Sian has over seven years experience in applied conservation biology and consulting. Sian has experience conducting vegetation surveys in a range of different environments across NSW, including identification and assessment of endangered ecological communities and targeted surveys for threatened plant species.

Sian has been involved in a number of major projects during her time with Biosis Research. She has been the senior botanist on a number of road projects including the upgrade of the Pacific Highway from Tintenbar to Ewingsdale, the Ballina Bypass and the upgrade of the Princes Highway from Gerringong to Bomaderry. These projects involved providing advice on route selection and assessment of impacts under state and commonwealth legislation, including recommending mitigation measures and offsets. Sian has also been involved in a number of projects for major coal mining companies, including long-term ongoing monitoring of the impacts of subsidence due to longwall mining on native vegetation, as well as survey and impact assessments for proposed longwall mining and coal mining exploration activities in the Sydney Catchment Area south of Sydney. Sian has also been involved in a number of smaller projects such as upgrades of local roads, residential subdivisions, upgrades and installations of small substations and powerlines and investigations of proposed school sites.

Sian has extensive experience in report preparation, including flora impact assessments in accordance with the relevant state and commonwealth legislation. Sian also has experience preparing vegetation management plans and preparing reports for proceedings in the Land and Environment Court.

A sample of key professional experience at Biosis Research is presented below.

Project Manager/Botanist, terrestrial ecology investigations, constraints mapping, targeted surveys and vegetation mapping for the Princes Highway Upgrade from Gerringong to Bomaderry (for Maunsell and RTA).

Project Manager/Botanist, threatened flora targeted surveys, Appin (for BHPB Illawarra Coal).

Project Manager/Botanist, constraints and impact assessment for the Appin, Wilton and Douglas Park Sewerage Scheme (for Sydney Water.).

Project Manager/Botanist, survey and impact assessment of the Illawarra Coal Seam Gas Exploration Drilling Program (for Apex Energy).

Project Manager/Botanist, end of panel reports assessing longwall mining subsidence impacts on terrestrial flora and fauna (for BHPB Illawarra Coal).

Project Manager/Botanist, survey and impact assessment of the proposed rehabilitation of Bulli Colliery No. 4 Vent Shaft Site and Transmission Line (for BHPB Illawarra Coal).

Project Manager/Botanist, survey and impact assessment of Ballina Bypass modifications (for Arup and RTA).

Project Manager/Botanist, assessment of the impacts of subsidence from proposed longwall mining on terrestrial flora and fauna (for BHP Billiton and Centennial Coal).

Project Manager/Botanist, targeted survey for Eucalyptus macarthurii and impact assessment for proposed school site at Bowral (for Department of Commerce).

Project Manager/Botanist, targeted survey for Melaleuca biconvexa, the Entrance Road upgrade (for RTA).

Project Manager/Botanist, targeted survey for Acacia chrysotricha for the Nambucca District Water Supply Scheme Augmentation (for Department of Commerce).

Project Manager/Botanist, survey and impact assessment of proposed school sites (for Department of Commerce).

Botanist, Assessment of compensatory measures for West Cliff Colliery stage 3 coal wash emplacement (2007 for BHP Billiton Illawarra Coal)

Botanist, Preparation of conservation advice documents for federally listed threatened species (2008 for the Department of Environment, Water, Heritage and the Arts).

Botanist, terrestrial ecology investigations, constraints mapping, targeted surveys and assessment of the upgrade of the Pacific Highway from Tintenbar to Ewingsdale in the North Coast (for RTA).

Botanist, ground-truthing of vegetation mapping and targeted surveys for the upgrade of the Pacific Highway from Woodburn to Ballina (for Hyder Consulting).

Botanist, flora surveys, vegetation mapping and impact assessment for West Cliff emplacement area (for BHP Billiton).

Botanist, independent ecological review of Species Impact Statement for a proposed commercial development at Byron Bay (for Department of Planning).

Botanist, long-term monitoring of the potential effects of subsidence due to longwall mining on rainforest, sclerophyll woodland and upland swamps in the Sydney Catchment Area (for BHP Billiton).

Botanist, monitoring of impacts of quarrying on native vegetation, Hartley (for Austen Quarry).

Botanist, survey and conservation assessment of native vegetation communities of the Meeting Place Precinct, Botany Bay National Park (for Department of Environment and Conservation).

Botanist, survey and impact assessment of coal mining exploration activities in the Sydney Catchment Area (for BHP Billiton).

Botanist, survey and impact assessment, including preliminary constraints assessment and options assessment, F3 to Raymond Terrace (for RTA).

CONSULTANT REPORTS:

A sample of the reports that Sian has contributed to at Biosis Research are listed below:

2009 Appin, Wilton and Douglas Park Sewerage Scheme: Aquatic and Riparian Ecology Assessment. Report for Sydney Water.

2009 Flora and Fauna Impact Assessment: Illawarra Coal Seam Gas Exploration Drilling Program. Report for Apex Energy.

2009 Vegetation Management Plan: Telecommunications Facility Kings Point Drive, Ulladulla. Report for Daly International..

2008 Flora and Fauna Assessment Appin Area 7: Longwall 701 End of Panel Report. Report for BHPB Illawarra Coal.

2008 Bulli Colliery No. 4 Vent Shaft Site and Transmission Line Rehabilitation: Flora and Fauna Impact Assessment. Report for BHPB Illawarra Coal.

2008 Appin, Wilton and Douglas Park Sewerage Scheme Terrestrial Flora and Fauna Impact Assessment. Report for Sydney Water.

2008 Flora and Fauna Impact Assessment: Bulli Pass Upgrade. Report for RTA.

2007 Pacific Highway Upgrade Woodburn to Ballina Concept Design Report: Terrestrial and Aquatic Ecology Investigations (Draft) Report for Hyder Consulting Pty Ltd.

2007 Tintenbar to Ewingsdale Pacific Highway Upgrade: Environmental Assessment Terrestrial Flora and Fauna Report. Report for Arup.

2007 Gerringong to Bomaderry Princes Highway Upgrade: Preliminary Biological Report - Terrestrial Flora and Fauna. Report for Maunsell Australia Pty. Ltd.

2007 West Cliff Colliery - Stage 3 Coal Wash Emplacement Application Volume 3 Species Impact Statement. Report for BHP Billiton Illawarra Coal.

2006 Independent Ecological Review of North Beach Byron Development Proposal. Report for Department of Planning. Authors: E. Taylor-Wood, R. Harrington and S. Wilkins

2006 Pacific Highway Upgrade Tintenbar to Ewingsdale: Terrestrial Ecology Working Paper: Report for Arup.

2006 Terrestrial Flora and Fauna Habitat Assessment: Appin Area 3 Seismic Survey and Borehole Investigations. Report for BHP Billiton. Authors:

2006 Third Crossing of the Hunter River, Maitland: Terrestrial Flora and Fauna Assessment. Report for RTA. Authors:

2006 Shallow Crossing Group Scheme: Flora and Fauna Impact Assessment, Stage 2. Report for Country Energy.

2005 Native Vegetation of the Meeting Place Precinct, Botany Bay National Park: Conservation Significance Assessment. Report for Design 5, on behalf of the Department of Environment and Conservation.

2005 Hoxton Park Airport Flora and Fauna Assessment: Opportunities and Constraints Report. Report for HPAL Freehold Pty Limited.

2005 Terrestrial Flora and Fauna Habitat Assessment: Appin Colliery Area 3 Seismic Survey Investigations. Report for BHP Billiton.

PUBLICATIONS

Wilkins S., Keith D. A., and Adam P. (2003) *Measuring success: Evaluating the Restoration of a Grassy Eucalypt Woodland on the Cumberland Plain, Sydney, Australia*. Restoration Ecology Vol. 11 (4), 489-503.

MATTHEW SWAN

POSITION:

Zoologist, Biosis Research Pty. Ltd.

PROFESSIONAL AFFILIATIONS AND MEMBERSHIPS:

Ecological Society of Australia

QUALIFICATIONS:

Bachelor of Science (Hons) in Zoology, University of Melbourne.

EMPLOYMENT PROFILE:

2007 Zoologist, Biosis Research Pty. Ltd.

2007 Technical Assistant, Radiation Detection Systems, Adelaide.

2006 Research Assistant, Animal Behaviour and Evolution Group, University of Melbourne, Department of Zoology.

2005-2006 Research Assistant, Puckapunyal Military Range, (for University of Melbourne)

FIELDS OF COMPETENCE:

- Zoology
- Fauna survey and identification (Birds, Mammals, Amphibians, Reptiles)
- Fauna impact assessment
- Habitat assessment
- Mammalian fauna research
- Terrestrial fauna monitoring
- Threatened species survey and assessment
- Radio tracking
- Tadpole identification

PROFESSIONAL EXPERIENCE:

A sample of key professional experience is presented below.

Project Manager/Zoologist, Enactment of the Flora and Fauna Management Plan for the West Cliff Stage 3 Emplacement area infrastructure(2008/9 for Abigroup Contractors and BHP Billiton)

Project Manager/Zoologist, Fauna impact assessment for a telecommunications facility at Bendalong (2008 for Daly International/Optus)

Project Manager/Zoologist, Fauna impact assessment for a telecommunications facility at King's Point (2008 for Daly International/Telstra).

Zoologist, Terrestrial ecology investigations, constraints mapping, targeted surveys for the Princes Highway Upgrade from Gerringong to Bomaderry (for Maunsell and RTA).

Zoologist, Fauna impact assessment for proposed sewage upgrades to Appin, Wilton and Douglas Park (2008 for Sydney Water Corporation)

Zoologist, Fauna impact assessment for a proposed powerline at Mt Kiera (2008 for Olsen Environmental Consulting)

Zoologist, Fauna habitat and impact assessment for Appin area 7 subsidence management plan (2008 for BHP Billiton)

Zoologist, Assisted with the preparation of conservation advice documents for federally listed threatened species (2008 for the Department of Environment, Water, Heritage and the Arts).

Zoologist, Post mining fauna habitat assessment for Denrobium Longwall 3 End of Panel Report (2008 for BHP Billiton).

Zoologist, Targeted surveys for Earless Dragon (Tympanocryptis pinguicolla) and Striped Legless Lizard (Delma impar) at Macgregor West, ACT (2007 for Village Building Co. Limited).

Zoologist, Fauna habitat assessment for proposed upgrade of Bulli Pass (2007 for NSW RTA).

Zoologist, Terrestrial fauna monitoring to assess the potential impacts of subsidence in Dendrobium Area 2, seasonal surveys (2007 for BHP Billiton).

Zoologist, Fauna habitat assessment for Appin Area 3 End of Panel Report (2007 for BHPBilliton).

Zoologist, Terrestrial fauna monitoring to assess the potential impacts of mining subsidence in Elouera Swamps, seasonal surveys (2007 for BHP Billiton).

Zoologist, Terrestrial fauna monitoring to assess the potential impacts of mining subsidence in Dendrobium Area 1, seasonal surveys (2007 for BHP Billiton).

Technical Assistant, Conducted field surveys and laboratory analysis for clients in the radiation protection industry.

Research Assistant, Coordinated field research on the reproductive ecology of the black swan (Cygnus atratus).

Research Assistant, Member of Puckapunyal kangaroo census team, investigating population density of Eastern Grey Kangaroos, as part of an ongoing monitoring program.

Volunteer Field Assistant, Assisted with radio tracking of western grey kangaroos (Macropus fuliginosus) in Murray Sunset N.P Vic.

Honours Research, Investigated the ecology of the swamp wallaby (Wallabia bicolor) in forest managed for timber harvesting.

Volunteer Field Assistant, Assisted with research investigating the effects of hormonal sterilisation of female koalas in French Island N.P.

CONSULTANT REPORTS:

2008 Appin Colliery Area 7 – Longwalls 705-710 Impacts of Subsidence on Terrestrial Flora and Fauna. Wilkins S, Swan M and Richardson M.

2008 Terrestrial Flora and Fauna Impact Assessment: Telecommuncations Facility, King's Point Drive, Ulladulla. Swan, M and Wilkins, S

2008 Flora and Fauna Assessment Dendrobium Area 2 – Longwall 3 End of Panel Report. Swan, M and Wilkins, S.

2008 Flora and Fauna Impact Assessment: Bulli Pass Upgrade. Wilkins, S., Swan, M. and Herring, J.

2007 Flora and Fauna Assessment Appin Area 3 – Longwall 301 & 302 End of Panel Report. Swan, M. and Wilkins, S.

PUBLICATIONS:

Swan, M., Di Stefano, J., Greenfield, A., & Coulson G. (2008). *Fine scale habitat selection by adult female swamp wallabies (Wallabia bicolor)*. Australian Journal of Zoology 56, 305-309.

Di Stefano, J., York, A., Swan, M., Greenfield, A., & Coulson, G. (In Press). *Habitat selection by the swamp wallaby (Wallabia bicolor) in relation to diel period, food and shelter*, Austral ecology.

MATTHEW B.G. RICHARDSON

POSITION

Wollongong Resource Group Manager/Senior Consultant Botanist

PROFESSIONAL AFFILIATIONS AND MEMBERSHIPS

Ecological Society of Australia

Australian Network for Plant Conservation

QUALIFICATIONS

Bachelor of Science (Hons I) (Plant Ecology/Population Genetics) University of Wollongong

EMPLOYMENT PROFILE

2007- 2009	Wollongong Resource Group Manager, Biosis Research Pty. Ltd.
1998-2007	Botanist, Biosis Research Pty. Ltd.
1998	Research Assistant, Australian Museum Business Services (AMBS)
1997-98	Field Botanist, Gary Leonard and Associates Botanical and Horticultural Consultants
1997-98	Research Assistant, Ecological Genetics Laboratory; University of Wollongong

FIELDS OF COMPETENCE

- project management
- flora survey and identification
- native vegetation classification and mapping
- rare or threatened species assessment
- environmental impact statement – natural environment
- impact minimisation (mitigation) guidelines
- expert evidence
- plant mating system research
- plant population genetics and gene flow research

- field and laboratory experimental techniques

PROFESSIONAL EXPERIENCE

Matthew has over 12 years experience in applied conservation biology and consulting. A sample of key professional experience is presented below.

Project Manager/Botanist, assessment of potential impacts of subsidence on terrestrial and aquatic ecological values above workings of the Appin and West Cliff Collieries (2002 for BHP Billiton)

Botanist, Assessment of instream and riparian vegetation of the Woronora River for management purposes through environmental flows (2002 for Patterson Britton)

Project Manager/Botanist, targeted surveys for Acacia baueri ssp.. aspera on the proposed Stage Three Coal Wash Emplacement at West Cliff Colliery (2002 for BHP Billiton)

Project Manager/Botanist, identification of areas of ecological significance and development constraints and opportunities for the proposed stages 14 and 15 of the Rouse Hill residential development area (2001-2002 for Rouse Hill Infrastructure Pty Ltd)

Project Manager/Botanist, targeted surveys for threatened flora and fauna species with the site of the proposed Two-Fold Bay Naval Ammunitioning Facility, Eden (2001-2003 for GHD)

Project Manager/Botanist, identification of ecological values occurring on private lands for potential inclusion in public the Gosford City Council reserve system, Gosford, (2002 for Gosford City Council)

Botanist, preparation of vegetation mapping for the Menindee Lakes, Ecological Sustainable Development Project (2001 for DLWC)

Project Manager/Botanist, presentation of expert evidence at the Dendrobium Coal Project Commission of Inquiry (2001 for BHP Illawarra Coal)

Project Manager/Botanist, targeted threatened species impact assessment for the proposed Dendrobium Coal Mine Project (2001 for BHP Illawarra Coal)

Project Manager/Botanist, habitat level assessment for the proposed Dendrobium Coal Mine Project in the Illawarra (2000 for BHP Illawarra Coal)

Botanist, assessment of the potential impact of a proposed industrial development on Wilsonia backhousei, a threatened species saltmarsh species, and preparation of expert evidence for the Land and Environment Court (2000 for Trafalgar Corporate)

Project Manager/Ecologist, terrestrial and aquatic flora and fauna survey and significance assessment, proposed raod upgrading, Young (2000 for Young Shire Council)

Botanist, preparing the flora and fauna component of the Environmental Impact Assessment for the proposed widening of the Princes Highway near Mogo on the NSW South Coast (2000 for Ove Arup)

Botanist, preparing a Native Vegetation Management Plan for Section A of the proposed Queensland Interconnection Transmission Line, Northern Table Lands, NSW (1999 for TransGrid)

Botanist, implementing Site Assessment Protocols, including rapid flora survey, threatened species impact assessment and report preparation from Section A of the proposed Queensland Interconnection Transmission Line, Northern Table Lands, NSW (1999 for TransGrid)

Project Manager/Botanist, flora survey for an area of proposed residential subdivision, Greensborough, Victoria (1999 WBCM Developments Vic)

Botanist, flora survey and provision of management recommendations for grassy-woodland remnants near Cranbourne South, Victoria (1999 Bosco Johnson Pty. Ltd.)

Botanist, targeted threatened flora survey of the proposed Hume Freeway by-pass, Albury-Wodonga (1998 for VicRoads)

Botanist, flora survey, mapping of Acacia pubescens and assisting in the preparation a plan of management for vegetation of the Yennora Woolstores (for A.T. Cocks and Partners Pty Ltd)

Botanist, assessment of gas affected die back, and regeneration potential of vegetation in the Cataract River area for BHP Collieries (Gary Leonard and Associates)

PUBLICATIONS

Matthew has been involved in publishing of over 70 consultants reports and the following scientific papers.

Richardson M.B.G., Ayre D.J.A. and Whelan R.J. (1998) *Pollinator behaviour, mate choice and the realised mating systems of Grevillea mucronulata and Grevillea sphacelata*. Australian Journal of Botany Vol. 48: 357-366.

Battam H., Richardson M., Watson A., Buttemer W.A. (undated) *Proximate composition and physical properties of cuttlefish (Sepia apama) and assimilation efficiency of Diomedea albatrosses*. Unpublished manuscript

KYLIE REED

POSITION

Zoologist, Biosis Research Pty. Ltd.

PROFESSIONAL AFFILIATIONS AND MEMBERSHIPS

Ecological Society of Australia

Ecological Consultants Association of NSW

Birds Australia

QUALIFICATIONS

Bachelor of Advanced Environmental Science (Hons I) (Life Sciences), University of Wollongong

EMPLOYMENT PROFILE

2010 -	Zoologist, Biosis Research Pty. Ltd.
2008-2010	Environmental Education Tours, Boronia Tours
2008-2010	Field Ecologist, UBM Ecological Consultants
2007-2008	Project Support Officer, Omega Environmental

FIELDS OF COMPETENCE

- fauna survey and impact assessment
- habitat assessment
- threatened terrestrial fauna monitoring, especially those involving the assessment of impacts and the testing of the effectiveness of proposed mitigation measures
- home range and habitat utilisation assessments using radio tracking
- fauna population census and abundance estimation
- ecological data interpretation and analysis
- provision of natural resource management plans

PROFESSIONAL EXPERIENCE

Kylie has over 5 years experience in applied conservation biology and consulting. A sample of key professional experience is presented below.

Project Manager/Zoologist: Ongoing monitoring of Wongawilli and NEBO Lease Area creeks and swamps in the Avon and Cordeaux Catchments to inform Gujarat NRE FCGL Pty Ltd. of any impacts Longwall Mining is having on Amphibian populations, including targeted surveys for Littlejohn's Tree Frog and the Giant Burrowing Frog.

Project Manager/Zoologist: Ongoing monitoring of Wongawilli Lease Area ridgelines in the Avon and Cordeaux Catchments to inform Gujarat NRE FCGL Pty Ltd. of any impacts Longwall Mining is having on reptile populations.

Project Manager/Zoologist: Ongoing monitoring of Dendrobium Lease Area 2 and 3 creeks and swamps in the Avon and Cordeaux catchments to inform BHP Billiton Illawarra coal of any impacts Longwall mining is having on Amphibian populations.

Project Manager/Zoologist: Monitoring point set-up for No. Colliery East Lease Area Ecological Monitoring Program for ongoing Amphibian Surveys. Gujarat NRE FCGL Pty Ltd.

Project Manager/Zoologist: Targeted surveys for the Green and Golden Bell Frog at Gujarat NRE's No. 1 site as Russell Vale to inform their application for an upgrade of surface works under Part 3A of the Environmental Planning and Assessment Act 1979. This included provision of advice and a referral of the project under the Environmental Protection and Biodiversity Conservation act 1995.

Project Manager/Zoologist: Targeted surveys for the Giant Burrowing Frog *Heleioporus australiacus* at West Ulladulla supplement existing surveys undertaken by Biosis Research. Assessment of Significance report to determine the impact the Amended Project would have on this species.

Project Manager/Zoologist: Supervision of vegetation clearing works undertaken at West Ulladulla. Hollow-bearing Tree Assessment and rescuing injured or startled wildlife.

Zoologist: Fauna habitat assessment and assessment of impacts Whytes Gully Resource Recovery Park New Landfill Cell Part 3A project West Dapto, Golder and Associates.

Zoologist: Fauna habitat assessment and assessment of impacts for the Camden Amended Area Modification. AGL Energy Limited.

Zoologist: Deployment of microbat detectors and analysis of calls for 193 Lawrence Hargrave Drive, Coalcliff.

Zoologist: Hollow-bearing Tree Assessment at North Nowra to accompany clients submission to Council regarding rezoning of the new Local Environment Plan.

Zoologist: Assessment of the flora and fauna values of the proposed expansion of Jamberoo Action Park, Jamberoo. Including flora and fauna assessment, preparation of assessment report and referral to the State and/or Federal Environment Minister for determination of whether the project constitutes a controlled impact.

Zoologist: Assessment of the flora and fauna values of the proposed expansion of Tahmoor Colliery Reject Emplacement Area. Including flora and fauna assessment and preparation of assessment report.

Zoologist: Targeted pitfall survey of Pink-tailed Worm-lizard & Striped Legless Lizard in association with ACT Gov Territory and Municipal Services (Conservation, Planning and Research) proposed re-zoning and residential expansion of Canberra suburbs.

REFERENCES

AECOM (2010). Camden Gas Project Northern Expansion: Environmental Assessment. AECOM Australia Pty Ltd, Sydney, October 2010.

AECOM (2012). Northern Expansion of the Camden Gas Project: Submissions Report. AECOM Australia Pty Ltd, Sydney.

AGL (2012). Groundwater Management Plan for the Camden Gas Project. Version 2.3 submitted to NOW and EPA for compliance purposes.

Augee M and Ford D (1999) Radio-tracking studies of Grey-headed Flying-foxes, *Pteropus poliocephalus*, from the Gordon colony, Sydney. *Proceedings of the Linnaean Society of New South Wales* 121**,** 61-70.

Australian Museum (2009). Flame Robin Fact File, http://www.austmus.gov.au/factsheets/flame_robin.htm, Australian Museum

Barker J *et al.* (1995) 'A Field Guide to Australian Frogs.' Surrey Beatty and Sons, Sydney.

Belcher C *et al.* (2008) Spotted-tailed Quoll *Dasyurus maculatus*. Pp. 60-62 In 'The Mammals of Australia' (Eds S Van Dyck and R Strahan). Reed New Holland, Sydney.

Bell SAJ (2001) Notes on population size and habitat of the vulnerable *Cryptostylis hunteriana* (Orchidaceae) from the Central Coast of New South Wales. *Cunninghamia* 7**,** 195-204.

Bishop T (1996) 'Field Guide to the Orchids of New South Wales and Victoria.' UNSW Press, Sydney.

Blakers M *et al.* (1984) 'The Atlas of Australian Birds.' Melbourne University Press, Melbourne.

Braithwaite RW (1995) Southern Brown Bandicoot. Pp. 176-177 In 'The Mammals of Australia' (Ed. R Strahan). Reed New Holland, Sydney.

Bureau of Meteorology (2009b). Climate Data Online, Australian Government

Bureau of Meteorology (2009a). Climate Data Online, Australian Government

Bureau of Meteorology (2012). Atlas of Groundwater dependant Ecosystems. http://www.bom.gov.au/water/groundwater/gde/index.shtml. Accessed 8 October 2012.

Churchill S (2008) 'Australian Bats. Second Edition.' Allen & Unwin, Sydney.

Claridge A *et al.* (2007) 'Bettongs, Potoroos and the Musky Rat-kangaroo.' CSIRO Publishing, Melbourne.

Cogger HG (1992) 'Reptiles and Amphibians of Australia.' Reed Books, Sydney.

Cooney SJN and Watson DM (2005) Diamond Firetails (Stagonopleura guttata) preferentially nest in mistletoe. *Emu* 105**,** 317-322.

Cropper SC (1993a) 'Management of Endangered Plants.' CSIRO Australia, Melbourne.

Cropper SC (1993b) Management of Endangered Plants. CSIRO Australia, Melbourne.

Daly G (1996) Observations of the Eastern Owl Frog *Helioporous australiacus* (Anura: Myobatrachidae) in Southern NSW. *Herpetofauna* 26**,** 33-42.

Debus S and Chafer C (1994a) The Powerful Owl *Ninox strenua* in New South Wales. *Australian Birds* 28**,** 21-39.

Debus S and Chafer C (1994b) The Sooty Owl, *Tyto tenebricosa* & Powerful Owl, *Ninox strenua* in NSW. *Australian Birds* 28 Supplement**,** 2.

DEC (1999). Squirrel Glider: Threatened Species Information, http://www2.nationalparks.nsw.gov.au/PDFs/tsprofile_squirrel_glider.pdf, NSW Department of Environment, Climate Change and Water

DEC (2004a) 'Draft Recovery Plan for *Pimelea spicata*.' Department of Environment and Conservation.

DEC (2004b). Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities - Working Draft, http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/profile.aspx?id=10544, Department of Environment and Conservation

DEC (2005a). *Acacia bynoeana* - Threatened Species Profile, http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/profile.aspx?id=10006, Department of Environment and Conservation

DEC (2005b). Barking Owl: Threatened Species Profile, http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/profile.aspx?id=10561, Department of Environment and Conservation

DEC (2005c). *Caladenia tessellata* - Threatened Species Profile, http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/profile.aspx?id=10124, Department of Environment and Conservation

DEC (2005d). *Cryptostylis hunteriana* - Threatened Species Profile, http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/profile.aspx?id=10187, Department of Environment and Conservation

DEC (2005e). Diamond Firetail: Threatened Species Profile, http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/profile.aspx?id=10768, Department of Environment and Conservation

DEC (2005f). Dillwynia tenuifolia, http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/profile.aspx?id=10226,

DEC (2005g). *Diuris aequalis* - Threatened Species Profile, http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/profile.aspx?id=10235, Department of Environment and Conservation

DEC (2005h) 'Draft NSW and National Recovery Plan for *Persoonia nutans*.' DEC NSW, Hurstville, NSW.

DEC (2005i). *Genoplesium baueri* - Threatened Species Profile, http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/profile.aspx?id=10875, Department of Environment and Conservation

DEC (2005j). Giant Barred Frog - threatened species profile, http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/profile.aspx?id=10538, Department of Environment and Conservation

DEC (2005k). Green and Golden Bell Frog: Threatened Species Profile, http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/profile.aspx?id=10483, Department of Environment and Conservation

DEC (2005l). *Grevillea parviflora* subsp. *parviflora* - Threatened Species Profile, http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/profile.aspx?id=10373, Department of Environment and Climate Change

DEC (2005m). Gyrostemon thesioides - Threatened Species Profile, http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/profile.aspx?id=10384,

DEC (2005n). Hooded Robin (south-eastern form): Threatened Species Profile, http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/profile.aspx?id=10519, http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/profile.aspx?id=10519

DEC (2005o). Koala: Threatened Species Profile, http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/profile.aspx?id=10616, Department of Environment and Conservation

DEC (2005p). Leucopogon fletcheri ssp. fletcheri - Threatened Species Profile, http://threatenedspecies.environment.nsw.gov.au/tsprofile/profile.aspx?id=10474,

DEC (2005q). Marsdenia viridiflora R. Br subsp. viridiflora - Threatened Species Profile, http://threatenedspecies.environment.nsw.gov.au/tsprofile/profile.aspx?id=10508,

DEC (2005r). *Melaleuca deanei* - Threatened Species Profile, http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/profile.aspx?id=10515, Department of Environment and Conservation

DEC (2005s). *Persoonia bargoensis* - Threatened Species Profile, http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/profile.aspx?id=10592, Department of Environment and Conservation

DEC (2005t) 'Persoonia nutans.R BR (Nodding Gebung) Recovery Plan.' NSW Department of Environment and Conservation, Hurstville, NSW.

DEC (2005u). *Pomaderris brunnea* - Threatened Species Profile, http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/profile.aspx?id=10647, Department of Environment and Climate Change and Water

DEC (2005v). Powerful Owl: Threatened Species Profile, http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/profile.aspx?id=10562, Department of Environment and Conservation

DEC (2005w). Pterostylis nigricans - Threatened Species Profile,

DEC (2005x). *Pultenaea aristata* - Threatened Species Profile, http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/profile.aspx?id=10710, Department of Environment and Conservation

DEC (2005y). Pultenaea parviflora - Threatened Species Profile, http://threatenedspecies.environment.nsw.gov.au/tsprofile/profile.aspx?id=10715,

DEC (2005z). Pultenaea pedunculata - Threatened Species Profile, http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/profile.aspx?id=10716,

DEC (2005{). Regent Honeyeater: Threatened Species Profile, http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/profile.aspx?id=10841, Department of Environment and Conservation (NSW)

DEC (2005|). *Syzygium paniculatum* - Threatened Species Profile, http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/profile.aspx?id=10794, http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/profile.aspx?id=10794

DEC (2005}). *Thesium australe* - Threatened Species Profile, http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/profile.aspx?id=10802, Department of Environment and Conservation

DEC (2005□). Threatened Species Profile, *Cynanchum elegans*, http://threatenedspecies.environment.nsw.gov.au/tsprofile/profile.aspx?id=10196,

DEC (2005~). Threatened Species Profile, *Cynanchum elegans*, http://threatenedspecies.environment.nsw.gov.au/tsprofile/profile.aspx?id=10196, Department of Environment and Climate Change and Water

DEC (2005€). Threatened Species Profile, *Leucopogon exolasius*, http://threatenedspecies.environment.nsw.gov.au/tsprofile/profile.aspx?id=10473, Department of Environment and Conservation

DEC (2005•). Threatened Species Profile, Pterostylis saxicola, http://threatenedspecies.environment.nsw.gov.au/tsprofile/profile.aspx?id=10705, http://threatenedspecies.environment.nsw.gov.au/tsprofile/profile.aspx?id=10705

DEC & DPI (2005) 'Draft Guidelines for Threatened Species Assessment - Part 3A of the Environmental Planning and Assessment Act 1979.' NSW Department of Environment and Conservation and Department of Primary Industries.

DECC (2005). *Pimelea spicata* Threatened Species Profile, http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/profile.aspx?id=10632, http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/profile.aspx?id=10632

DECC (2007) 'Threatened and pest animals of Greater Southern Sydney.' Department of Environment and Climate Change.

DECCW (2009a) 'Draft Recovery Plan for the Cumberland Plain.' Department of Environment, Climate Change and Water, Sydney.

DECCW (2009b) 'Draft Recovery Plan for the Cumberland Plain.' Department of Environment, Climate Change and Water, Sydney.

DEWHA (2009) 'Matters of National Environmental Significance: Significant Impact Guidelines 1.1.' Commonwealth of Australia, Canberra.

DEWHA (2010). Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest EPBC Act policy statement, http://www.environment.gov.au/epbc/publications/cumberland-plain-shale-woodlands.html, Department of Environment, Water, Heritage and the Arts

Dickman CR and Read DG (1992) 'The biology & management of dasyurids of the arid zone in NSW.' NPWS, NSW, No. 11.

DLWC (2002), Map and Guidelines to accompany Map of Salinity Potential in Western Sydney. Department of Land and Water Conservation.

DoP (1995). State Environmental Planning policy no 44 - Koala Habitat Protection, http://www.legislation.nsw.gov.au/viewtop/inforce/epi+5+1995+FIRST+0+N/?fullquery=(((%22state%22%20AND%20%22environmental%22%20AND%20%22planning%22%20AND%20%22policy%22))), Department of Planning

DSE (2003). Flora and Fauna Guarantee Action Statement, Austral Toad Flax *Thesium australe*, http://www.dse.vic.gov.au, The State of Victoria, Department of Sustainability and Envrironment

Edgar R and Belcher C (1995) Spotted-tailed Quoll. Pp. 67-68 In 'The Mammals of Australia' (Ed. R Strahan). Reed New Holland, Sydney.

Eldridge MDB and Close RL (1995) Brush-tailed Rock-wallaby. Pp. 383-385 In 'The Mammals of Australia' (Ed. R Strahan). Reed New Holland, Sydney.

Fairley A (2004) 'Seldom Seen - Rare Plants of Greater Sydney.' Reed New Holland Publishers,

Fairley A and Moore P (1995) 'Native Plants of the Sydney District.' Kangaroo Press, Sydney.

Fairley A and Moore P (2000) 'Native Plants of the Sydney District: An Identification Guide. Revised Edition.' Kangaroo Press, Sydney.

Forshaw JM and Cooper WT (1981) 'Australian Parrots (2nd Ed).' Lansdowne Press, Melbourne.

Garnett S (1992) 'Threatened and Extinct Birds of Australia.' York Press, Richmond.

Gibbons P and Lindenmayer DB (1997) Conserving Hollow-dependent Fauna in Timber Production Forest. *Environmental Heritage Monograph* 3**,** 110.

Goldingay RL and Jackson SM (2004) A review of the ecology of the Australian Petauridae. Pp. 376-400 In 'The Biology of Australian Possums and Gliders' (Eds RL Goldingay and SM Jackson). Surrey Beatty & Sons, Chipping Norton.

Harden G (1991) 'Flora of New South Wales Volume 2.' NSW University Press, Kensington.

Harden G (1992) 'Flora of New South Wales Volume 3.' NSW University Press, Kensington.

Harden GJ (1993) 'Flora of New South Wales Volume 4.' NSW University Press, Kensington.

Harden GJ (2002) 'Flora of New South Wales Volume 2 (Revised Edition).' University of New South Wales Press Ltd., Kensington.

Hazelton PA and Tille PJ (1990) 'Soil landscapes of the Wollongong-Port Hacking 1:100 000 Sheet.' Soil Conservation Service of NSW, Sydney.

Higgins PJ (1999) 'Handbook of Australian, New Zealand and Antarctic Birds. Volume 4: Parrots to Dollarbird.' Oxford University Press, Melbourne.

Higgins PJ and Davies SJJF (1996) 'Handbook of Australian, New Zealand and Antarctic Birds. Volume 3: Snipe to Pigeons.' Oxford University Press, Melbourne.

Higgins PJ *et al.* (2006) 'Handbook of Australian, New Zealand & Antarctic Birds. Volume 7: Boatbills to Starlings.' Oxford University Press, Melbourne.

Higgins PJ *et al.* (2001) 'Handbook of Australian, New Zealand and Antarctic Birds. Volume 5: Tyrant-flycatchers to Chats.' Oxford University Press, Melbourne.

Hoye GA and Hall LS (2008) Eastern Bent-winged Bat: *Miniopterus schreibersii oceanensis*. Pp. 507-508 In 'The Mammals of Australia' (Eds S Van Dyck and R Strahan). Reed New Holland, Sydney.

Hoye GA *et al.* (2008) East-coast Free-tailed Bat *Mormopterus norfolkensis*. Pp. 491-492 In 'The Mammals of Australia' (Eds S van dyck and R Strahan). Reed New Holland, Sydney.

Hoye GA and Schulz M (2008) Large-eared Pied Bat: *Chalinolobus dwyeri*. Pp. 531-532 In 'The Mammals of Australia' (Eds S Van Dyck and R Strahan). Reed New Holland, Sydney.

James T *et al.* (1999) 'Rare Bushland Plants of Western Sydney.' Royal Botantical Gardens,

Johnston PG (2008) Long-nosed Potoroo *Potorous tridactylus*. Pp. 302-304 In 'The Mammals of Australia' (Eds S Van Dyck and R Strahan). Reed New Holland, Sydney.

Law BS *et al.* (2008) Eastern False Pipistrelle *Falsistrellus tasmaniensis*. Pp. 542-543 In 'Mammals of Australia' (Eds S Van Dyck and R Strahan). Reed New Holland, Sydney.

Marchant S and Higgins PJ (1990) 'Handbook of Australian, New Zealand and Antarctic Birds. Volume 1 Ratites to Ducks: Part B Australian Pelican to Ducks.' Oxford University Press, Melbourne.

Marchant S and Higgins PJ (1993) 'Handbook of Australian, New Zealand and Antactic Birds. Volume 2 Raptors to Lapwings.' Oxford University Press, Melbourne.

Martin RW *et al.* (2008) Koala *Phascolarctos cinereus*. Pp. 198-201 In 'The Mammals of Australia' (Eds S Van Dyck and R Strahan). Reed New Holland, Sydney.

Maxwell S, Burbidge AA, and Morris K (1996) 'The Action Plan for Australian Masupials and Monotremes.' Australian Marsupial and Monotremes Specialist Group, IUCN Survival Commission, Environment Australia Endangered Species Program No. 500, Canberra.

McDonald C (1996) Ecosystem resilience and the restoration of damaged plant communities: A discussion focusing on Australian case studies. University of Western Sydney.

Menkhorst PW and Lumsden LF (1995) Eastern False Pipistrelle.In 'Mammals of Victoria' (Ed. PW Menkhorst). Oxford University Press, Melbourne.

Menkhorst PW, Weavers BW, and Alexander JSA (1988) Distribution, habitat and conservation status of the Squirrel Glider *Petaurus australis* (Petauridae: Marsupialia) in Victoria. *Australian Wildlife Research* 15**,** 59-71.

MSEC (2007) 'Camden Gas Project Proposed Expansion of Stage 2. Report on The Potential for Coal Seam Methane Gas Extraction to result in Subsidence at the Surface.' Mine Subsidence Engineering Consultants Pty Ltd, Chatswood.

NOW (2012). Risk assessment guidelines for groundwater dependant ecosystems. NSW Office of Water, Sydney.

NPWS (1999a) 'Bush Stone-curlew: Threatened Species Information.' NSW National Parks and Wildlife Service, Hurstville.

NPWS (1999b) 'Cumberland Plain Land Snail: Threatened Species Information.' NPWS, Hurstville.

NPWS (1999c). Glossy Black Cockatoo: Threatened Species Information, http://www2.nationalparks.nsw.gov.au/PDFs/tsprofile_glossy_black_cockatoo.pdf, NSW National Parks and Wildlife Service

NPWS (1999d). Green and Golden Bell Frog: Threatened Species Information, http://www.nationalparks.nsw.gov.au/PDFs/tsprofile_green_golden_bell_frog.pdf, National Parks and Wildlife Service

NPWS (1999e). Regent Honeyeater: Threatened Species Information, http://www.nationalparks.nsw.gov.au/PDFs/tsprofile_regent_honeyeater.pdf, NSW National Parks and Wildlife Service

NPWS (1999f). Spotted-tailed Quoll: Threatened Species Information, http://www.nationalparks.nsw.gov.au/PDFs/tsprofile_spotted_tailed_quoll.pdf, New South Wales National Parks and Wildlife Service

NPWS (1999g). Threatened Species Information; Square-tailed Kite, http://www2.nationalparks.nsw.gov.au/PDFs/tsprofile_squaretailed_kite.pdf, NSW National Parks and Wildlife Service

NPWS (2000a) 'Cumberland Plain Large Land Snail - Meridolum corneovirens - Threatened Species Information.' NPWS Hurstville..

NPWS (2000b) 'Eucalyptus benthamii: Threatened Species Information.' NPWS, Hurstville.

NPWS (2000c) 'Persoonia bargoensis: Threatened Species Information.' NPWS, Hurstville.

NPWS (2000d) *Pimelea spicata* - Environmental Impact Assessment Guidelines.

NPWS (2002a) '*Dillwynia tenuifolia* - Environmental Impact Assessment Guidelines.' NSW National Parks and Wildlife Service, Hurstville.

NPWS (2002b) '*Grevillea juniperina* ssp. *juniperina* - Threatened Species Information.'.

NPWS (2002c). *Grevillea parviflora* subsp. *parviflora* Environmental Impact Assessment Guidelines, http://www2.nationalparks.nsw.gov.au/PDFs/Gparviflora_eia_0802.pdf, http://www2.nationalparks.nsw.gov.au/PDFs/Gparviflora_eia_0802.pdf

NPWS (2002d) 'Interpretation Guidelines for the Native Vegetation Maps of the Cumberland Plain, Western Sydney. Final Edition.' Threatened Species Unit, Conservation Programs and Planning Division, Central Directorate. NSW National Parks and Wildlife Service..

NPWS (2002e) 'Native Vegetation of the Cumberland Plain.' NPWs, CD-ROM .

NPWS (2002f) 'Native Vegetation of the Cumberland Plain, Western Sydney. NSW National Parks and Wildlife Service 1:25 000 Map Series.' NSW NPWS., Hurstville.

NPWS (2002g) 'Pultenaea parviflora: Threatened Species Information.'.

NPWS (2002h). Threatened Species Information - Pultenaea pedunculata, http://www.nationalparks.nsw.gov.au/PDFs/TSprofile_Pultenaea_pedunculata.pdf,

NPWS (2003). *Acacia pubescens*: Threatened Species Information, http://www.environment.nsw.gov.au/resources/nature/tsprofileAcaciaPubescens.pdf, NSW National Parks and Wildlife Service

NPWS (2004) '*Pimelea spicata:* Threatened Species Information.' NSW National Parks and Wildlife Service.

NSW Government (2009). BioNet, http://www.bionet.nsw.gov.au/Area.cfm, NSW Government

NSW Scientific Committee (1999) 'Final determination to list Leucopogon fletcheri ssp. fletcheri as an endangered species.' NPWS, Hurstville.

NSW Scientific Committee (2002). Final Determination to list *Eucalyptus scoparia* as an Endangered Species, http://www.nationalparks.nsw.gov.au/npws.nsf/Content/Eucalyptus+scoparia+a+tree+endangered+species+listing, http://www.nationalparks.nsw.gov.au/npws.nsf/Content/Eucalyptus+scoparia+a+tree+endangered+species+listing

NSW Scientific Committee (2003) 'Final determination to list the population of *Marsdenia viridiflora* ssp *viridiflora* in Bankstown, Blacktown, Camden, Campbelltown, Fairfield, Holroyd, Liverpool and Penrith Local Government Areas as an Endangered Population.' NPWS, Hurstville.

NSW Scientific Committee (2004) 'River Flat Eucalypt Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions - Endangered Ecological Community listing.' Department of Environment and Conservation.

NSW Scientific Committee (2008a). Final Determination to list Speckled Warbler as a Vulnerable species under the TSC Act, http://www.nationalparks.nsw.gov.au/npws.nsf/Content/Speckled+warbler+-+vulnerable+species+listing, NSW Department of Enviroment and Climate Change

NSW Scientific Committee (2008b). Little Lorikeet *Glossopsitta pusilla* - proposed vulnerable species listing, http://www.environment.nsw.gov.au/determinations/littlelorikeetpd.htm, http://www.environment.nsw.gov.au/determinations/littlelorikeetpd.htm

NSW Scientific Committee (2009a). Cumberland Plain Woodland in the Sydney Basin Bioregion - critically endangered ecological community listing, http://www.environment.nsw.gov.au/determinations/cumberlandwoodlandsFD.htm

NSW Scientific Committee (2009b). Flame Robin *Petroica phoenicea* - Final Determination of proposed vulnerable species listing, http://www.environment.nsw.gov.au/determinations/flamerobinpd.htm, Department of Environment, Climate Change and Water

NSW Scientific Committee (2009c). Little Eagle *Hieraaetus morphnoides* - proposed vulnerable species listing, http://www.environment.nsw.gov.au/determinations/littleeaglepd.htm, NSW Scientific Committee

NSW Scientific Committee (2009d). Scarlet Robin *Petroica boodang* - proposed vulnerable species listing, http://www.environment.nsw.gov.au/determinations/scarletrobinpd.htm, http://www.environment.nsw.gov.au/determinations/scarletrobinpd.htm

NSW Scientific Committee (2010). Spotted Harrier *Circus assimilis* - Final Determination of vulnerable species listing, http://www.environment.nsw.gov.au/determinations/spottedharrierFD.htm, Department of Environment, Climate Change and Water

Office of Water (2012). Water Sharing Plan for the Greater Metropolitan Groundwater Sources 2011. NSW Office of Water, Sydney.

PB (2011), Phase 1 Groundwater Assessment and Conceptual Hydrogeological Model - Northern Expansion of Camden Gas Project. Unpublished report for AGL Upstream Investments. Parsons Brinkerhoff, Sydney.

PB (2012a). Peer Review of the Groundwater Management Plan for the Camden Gas Project - Interim Report. Unpublished letter report for AGL Upstream Investments. Parsons Brinkerhoff, Sydney.

PB (2012b). Update on the Camden North Phase 2 Groundwater Program – Denham Court. Unpublished report for AGL Upstream Investments. Parsons Brinkerhoff, Sydney.

Penman TD, Lemckert FL, and Mahony MJ (2008) Spatial ecology of the giant burrowing frog (*Heleioporus australiacus*): implications for conservation prescriptions. *Australian Journal of Zoology* 56**,** 179-186.

Pennay M (2008) A maternity roost of the Large-eared Pied Bat *Chalinolobus dwyeri* (Ryan) (Microchiroptera: Vespertilionidae) in central New South Wales Australia. *Australian Zoologist* 34**,** 564-569.

Pizzey G and Knight F (1997) 'The Field Guide to the Birds of Australia.' Angus and Robertson, Sydney.

Powell, J. M (2007). *Leucopogon exolasius*, http://plantnet.rbgsyd.nsw.gov.au/cgi-bin/NSWfl.pl?page=nswfl&lvl=sp&name=Leucopogon~exolasius, The Plant Information Network System of Botanic Gardens Trust, Sydney, Australia, 1999-2007

Quin DG (1995) Population ecology of the Squirrel Glider (*Petaurus norfolcensis*) and the Sugar Glider (*P. breviceps*) (Marsupialia: Petauridae) at Limeburners Creek, on the central North Coast of New South Wales. *Wildlife Research* 22**,** 471-505.

Recsei J (1996) Eastern Owl Frog, *Heleioporus australiacus*. Pp. 55-64 In 'Threatened Frogs of New South Wales: Habitats, Status and Conservation.' (Ed. H Ehmann). Frog and Tadpole Study Group of NSW, Sydney South.

Richards GC (2008) Yellow-bellied Sheath-tailed Bat *Saccolaimus flaviventris*. Pp. 472-473 In 'Mammals of Australia' (Eds S Van Dyck and R Strahan). Reed New Holland, Sydney.

Richards GC *et al.* (2008) Large-footed Myotis: *Myotis macropus*. Pp. 544-545 In 'The Mammals of Australia' (Eds S Van Dyck and R Strahan). Reed New Holland, Sydney.

Robinson L (1994) 'Field Guide to the Native Plants of Sydney.' Kangaroo Press, Sydney.

Shields J and Crome F (1992) 'Parrots and Pigeons of Australia.' Angus and Robertson, Sydney.

Simpson K and Day N (1996) 'Field guide to the birds of Australia.' Viking. Penguin Books Australia Ltd., Ringwood.

Standards Australia (2009) 'Australian Standard. Protection of trees on development sites.' Australian Standards, Sydney.

Threatened Species Scientific Committee (2008). *Commonwealth Listing Advice on* Thelymitra sp. Kangaloon (D.L.Jones 18108), http://www.environment.gov.au/biodiversity/threatened/species/pubs/81971-listing-advice.pdf, Department of the Environment, Water, Heritage and the Arts

Thumm K and Mahoney M (2002) Evidence for continuous iteroparity in a temperate-zone frog, the Red-crowned Toadlet, *Pseudophryne australis* (Anura: Myobatrachidae). *Australian Journal of Zoology* 50**,** 151-167.

Thumm K and Mahony M (1997) Red-crowned Toadlet *Pseudophryne australis*. Pp. 125-135 In 'Threatened Frogs of New South Wales: Habitats, Status and Conservation' (Ed. H Ehmann). Frog and Tadpole Study Group of NSW, Sydney South.

Tidemann CR (1995) Grey-headed Flying-fox. Pp. 439-440 In 'The Mammals of Australia' (Ed. R Strahan). Reed New Holland, Sydney.

Tozer M (2003) The native vegetation of the Cumberland Plain, western Sydney: systematic classification and field identification of communities. *Cunninghamia* 8**,** 1-75.

Tozer MGTKSCKDABPMBTD&PC (2006) 'Native vegetation of southeast NSW: a revised classification and map for the coast and eastern tablelands. Version 1.0.'.

Traill BJ and Duncan S (2000) 'Status of birds in the New South Wales temperate woodlands region.' Consultancy report to the NSW National Parks and Wildlife Service by the Australian Woodlands Conservancy, Chiltern, Victoria.

TSSC (2009) '*Commonwealth Listing Advice on Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest*.' Threatened Species Scientific Committee, Canberra.

Turner V and Ward SJ (1995) Eastern Pygmy-possum. Pp. 217-218 In 'The Mammals of Australia' (Ed. R Strahan). Reed New Holland, Sydney.

Van der Ree R and Suckling GC (2008) Squirrel Glider *Petaurus norfolcensis*.In 'The Mammals of Australia' (Eds S Van Dyck and R Strahan). New Holland Publishers (Australia) Pty Ltd, Sydney.

van dyck S and Strahan R (2008) 'The Mammals of Australia Third Edition.' Reed New Holland, Sydney.

Ward SJ (1990) Life history of the eastern pygmy possum, *Cercartetus nanus* (Burramyidae, Marsupialia) in south-eastern Australia. *Australian Journal of Zoology* 38**,** 287-304.

Webb JK (1996) Ecology and Conservation of the Threatened Broad-headed Snake

Hoplocephalus bungaroides.PhD Dissertation,' University of Sydney.

Webb JK and Shine R (1998) Ecological characteristic of an endangered snake species *Hoplocephalus bungeroides* (Sepentes: Elapidae). *Animal Conservation* 1**,** 185-193.

Wellington R and Wells R (1985) 'Fauna survey of the Morisset Forestry District, Central Coast NSW. Reptiles and Amphibians.' State Forests of NSW, Pennant Hills.

White AW and Pyke GH (1996) Distribution and conservation status of the Green and Golden Bell Frog *Litoria aurea* in New South Wales. *Australian Zoologist* 30**,** 177-189.