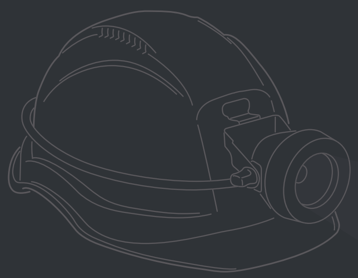
Wallarah 2
COAL PROJECT

Wallarah 2 Coal Project

Environmental Impact Statement

April 2013

Volume 1 - Main Report



Hansen Bailey
ENVIRONMENTAL CONSULTANTS

EIS Statement

Submission of Environmental Impact Statement (EIS) Under Section 78A(8A) of the *Environmental Planning and Assessment Act 1979*

EIS Prepared by	
Name	James Bailey
Qualifications	B. Natural Resources, MBA
Address	Hansen Bailey PO Box 473 SINGLETON NSW 2330
In Respect of	Wallarah 2 Coal Project
Proponent Name	Wyong Areas Coal Joint Venture
Proponent Address	PO Box 3039 TUGGERAH NSW 2259
Land to be Developed	See **Appendix A** of this EIS.
Proposed Development	Development and operation of the Wallarah 2 Coal Project and associated activities as outlined in **Section 3** of this EIS.
Environmental Impact Statement	An EIS for the Project is attached.
Certification	I certify that I have read and am aware of the terms of the Expert Witness Code of the Land & Environment Court of NSW. I further certify that I have prepared the contents of this EIS, and to the best of my knowledge: • It is in accordance with Section 78A(8A) of the *Environmental Planning and Assessment Act 1979*; • Meets the form and content requirements under Clauses 6 and 7 of Schedule 2 of the *Environmental Planning and Assessment Regulation 2000*; • It contains all available information that is relevant to this EIS for the activity to which it relates; and • The information contained in this EIS is neither false nor misleading.
Signature	
Name	James Bailey, Director
Date	April 2013

Wallarah 2 Coal Project

Environmental Impact Statement

April 2013

Volume 1

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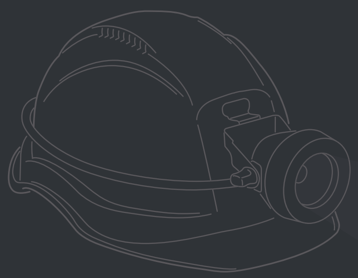

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Executive Summary

Introduction

In 1995 the NSW Government invited competitive tenders for the Wyong Coal Development Areas comprising Exploration Licence 4911, Exploration Licence 4912 and Authorisation 405. These exploration areas contained substantial coal resources in the Central Coast region of NSW. Wyong Areas Coal Joint Venture (WACJV) was successful in this tender and was awarded the tenements. Exploration Licence 5903 was granted to WACJV in November 2001.

Coal Operations Australia Ltd (COAL) was the original majority shareholder of WACJV with Kores Australia Pty Ltd (Kores) and other Korean and Japanese interests holding minority shareholdings. BHP Billiton subsequently became the majority shareholder in WACJV through the acquisition of COAL in 2002. BHP Billiton later sold its interest to Kores in 2005. This sale increased Kores' equity in the venture to 82.25% and it is now the major shareholder and manager of the WACJV. In the period since 1995, WACJV has undertaken extensive programs of exploration, environmental monitoring, environmental assessment, community consultation, technical planning and economic analysis of the Project.

WACJV seeks a Development Consent under Division 4.1 of Part 4 of the *Environmental Planning & Assessment Act 1979* (EP&A Act) to construct and operate an underground coal mine and associated facilities for 28 years (the Project). The Project will involve the extraction of up to 5 Million tonnes per annum of export quality thermal coal via underground longwall mining methods. The Project generally comprises:

- An underground longwall mine;
- Coal handling and storage facilities;
- Rail loop and loading infrastructure;
- An underground drift entry and ventilation shafts;
- Gas and water management facilities; and
- Maintenance facilities and administration buildings.

WACJV previously sought Project Approval for the Wallarah 2 Coal Project under the recently repealed Part 3A of the EP&A Act. This application was supported by the 'Wallarah 2 Coal Project Environmental Assessment' and was recommended for approval by the Planning Assessment Commission expert panel but was ultimately refused by the Minister for Planning on 3 March 2011.

Additional field monitoring and survey, modelling and assessment work has been undertaken to address the issues raised in the Minister's refusal and the Director-General's Requirements issued on 12 January 2012 (with supplementary Director-General's Requirements issued 11 July 2012). The results of this work are presented in this Environmental Impact Statement.

Existing Environment

Regional Setting

The Project is located on the Central Coast in the north-east of the Sydney Basin and in the southern part of the Newcastle Coalfield. The Central Coast has a current urban population of 285,000 people. The closest township to the Project is Wyong which is approximately 4.7 km to the south-east of the Project Boundary. The F3 Freeway and Main Northern Railway Line run generally north – south, adjacent to the eastern extent of the Project Boundary and form part of the major road and rail network that provides access throughout the Central Coast.

The Project lies wholly within the Wyong Local Government Area. The major urban areas in the Area are located to the east of the F3 Freeway and to the east and south of the Project Boundary. The Extraction Area lies within the Hue Hue and Wyong Mine Subsidence Districts.

Catchment

The Project is located within the Tuggerah Lakes Basin, which has a catchment area of approximately 700 km^2. The major rivers and tributaries of the catchment include the Wyong River, Jilliby Jilliby Creek and Ourimbah Creek. Wyong River is located on the south of the Project Boundary and flows into Tuggerah Lake, a large coastal saltwater lagoon. Most of the Extraction Area lies within the Jilliby Jilliby Creek catchment. The Tooheys Road Site (i.e. the Project's coal loading facilities) is located within the Wallarah Creek catchment, which is a tributary of Budgewoi Lake.

Gosford City and Wyong Shire Councils have a joint water supply system managed by the Gosford Wyong Councils Water Authority (GWCWA). The Authority harvests water from four coastal streams: Wyong River, Mangrove Creek, Mooney Mooney Creek and Ourimbah Creek. GWCWA's surface water infrastructure includes a network of dams, weirs, reservoirs and water treatment plants interconnected by tunnels and pipelines.

Proposed future development of the water supply system, described in 'WaterPlan 2050' will progressively raise the annual system yield to 50,000 megalitres and is anticipated to provide sufficient water to satisfy demands until 2050. The Gosford Wyong catchment system is also connected to the Hunter Water System by a two way pipeline capable of supplying up to 35 megalitres/day of treated drinking water in either direction.

The Project's Extraction Area of 37 km^2 occurs totally within the GWCWA catchment and represents about 5% of the total catchment area contributing to the Scheme. Coal extraction will not occur beneath any of the GWCWA's surface infrastructure.

Land Use

The area surrounding and within the Project Boundary accommodates several land uses, ranging from light industrial, commercial and housing developments to small townships and acreages. Major transport routes traverse the area to the east of the Project Boundary. The western extent of the Project Boundary area features heavily timbered hills, most of which are included in Wyong State Forest and Jilliby State Conservation Area. The predominant land uses of the valley floor and near slopes are small scale beef grazing, horse enterprises and rural-residential lifestyle blocks. The beef grazing enterprises are predominantly low input, low intensive management operations with many being sub-commercial in scale. Turf farming is carried out at one location within the Project Boundary.

Over the last 20 years, large holdings have been fragmented and converted to hobby farms, rural weekend retreats, market gardens, nurseries and horse properties. As a result, the character is more rural-residential than agricultural. Scattered rural dwellings follow the river flats and the small communities of Yarramalong and Dooralong are at the heads of their respective valleys.

Land Ownership

The majority of the land required for the development of the Project's surface facilities is owned by WACJV. The exceptions are the proposed rail spur partially on Crown and Darkinjung Local Aboriginal Land Council owned land, and the Western Ventilation Shaft located on land owned by State Forests.

Climate

Regional climatic conditions of the Central Coast are characterised by seasonal variations of warm summer months giving way to mild winters. February is the hottest month, with an average maximum temperature of 25.9ºC and July is the coldest month with an average minimum temperature of 9.7ºC. The average annual maximum and minimum temperatures are 22.1ºC and 15.1ºC respectively.

Rainfall is highest during the autumn months and is lowest during spring. The mean monthly rainfall ranges from 56 mm in October to 163 mm in May. There is a direct correlation between temperature and evaporation with monthly evaporation levels ranging from 48 mm in June to 146 mm in December.

In the autumn and winter months, the region experiences dominant winds from the west and west-southwest. Wind direction is more evenly distributed during the spring and summer months.

Geology

The Project is located in the southern part of the Newcastle Coalfield. Economic coal resources in this region are contained within the upper part of the Permian Newcastle Coal Measures. These strata outcrop to the far north and north-east and dip gently to the south-west beneath the Project Boundary area. The presence of coal in the subsurface of the Wyong area has been recognised for more than 100 years. To the north-east of the Project Boundary, the full sequence of coal resource utilisation comprising coal discovery, exploration, mining, and in some instances, reserve exhaustion, final mine closure and new land use succession (such as on the Wallarah Peninsula) has already occurred. The currently operating Mandalong Mine lies to the immediate north-west abutting WACJV's exploration tenements.

The target coal resources for the Project are the coalesced Wallarah and Great Northern Coal Seams. A total resource of over 700 Million tonnes has been identified within WACJV's tenements.

The Project has identified an environmentally feasible, mineable coal resource of approximately 150 Million tonnes. This coal resource will be sufficient to sustain mining at 5 Million tonnes per annum for at least the proposed 28 year period sought. Extensive drilling, seismic, aeromagnetic and other exploration investigations have confirmed that the proposed Extraction Area is free from major geological faults and structures.

Environmental Management

WACJV has developed and implemented an Environmental Monitoring Program for the Project which includes the regular collection of environmental monitoring data including meteorology, air quality, noise, surface water quality, groundwater and aquatic ecology.

Project Overview

The Project will involve the extraction of up to 5 Million tonnes per annum of export quality thermal coal via underground longwall mining methods. The Project requires the construction of an underground longwall mine, coal handling and storage facilities, rail loop and loading infrastructure, a drift entry, ventilation shafts, gas and water management facilities and administration buildings.

The Project surface facilities will be located on land zoned largely for industrial development and include:

- The Tooheys Road Site surface facilities between the Motorway Link Road and the F3 Freeway which will include (at least) a rail loop and spur, stockpiles, water and gas management facilities, workshop and offices;
- The Buttonderry Site Surface Facilities between Sparks Road and the Wyong Shire Council's Buttonderry Waste Management Facility. This facility will include (at least) the main personnel access to the mine, main ventilation facilities, offices and employee amenities; and
- The Western Ventilation Shaft located in the Wyong State Forest which is required for ventilation purposes by Year 13.

An inclined tunnel (or "drift") will be constructed from the surface at the Tooheys Road Site to the coal seam around 350 m beneath the Buttonderry Site. The drift will be primarily used for transportation of coal to the surface.

Coal mining will be undertaken at depths of between 350 m and 690 m below the surface within the underground Extraction Area. Mining and related activities will occur 24 hours a day, seven days a week for a period of 28 years including up to three years of construction and at least 25 years of coal extraction.

All coal will be transported by rail to either the Newcastle port for export or to local domestic power stations. The site construction workforce will be up to 450 employees and the permanent operational workforce will be approximately 300 full-time equivalent employees for the Project life.

Regulatory Framework

The *Environmental Planning and Assessment Amendment (Part 3A Repeal) Act 2011* inserted a new Division 4.1 into Part 4 of the EP&A Act. This Division provides for a new planning assessment and determination regime for State Significant Development in NSW.

Activities at the Buttonderry Site, Tooheys Road Site and Western Ventilation Shaft Site are permissible with Development Consent under the *Wyong Local Environmental Plan 1991*. Although substantially permissible with development consent, there are several areas within the Extraction Area which are zoned 7(a) Conservation, 7(b) Scenic Protection, 7(c) Scenic Protection: Small Holdings and 6(a) Open Space and Recreation where mining is prohibited subject to the application of *State Environmental Planning Policy (Mining, Petroleum Production and Extractive Industries) 2007* (Mining SEPP).

The Mining SEPP prevails over an Environmental Planning Instrument to the extent of any inconsistency. The practical effect of clause 5(3) is that if there is any inconsistency between the provisions in the Mining SEPP and those contained in any other Environmental Planning Instrument, including relevantly the *Wyong Local Environmental Plan 1991*, the provisions of the Mining SEPP will prevail.

Accordingly, as the Project in its entirety can be characterised as development for the purpose of "underground mining" (which incorporates in its definition the defined term "mining"), the Project is permissible with Development Consent on the land on which the Project will be carried out.

WACJV sought Director-General's Requirements for the Environmental Assessment of the Project on 13 October 2011 supported by the 'Wallarah 2 Coal Project Background Document' (dated October 2011). Director General's Requirements were issued for the Project under Part 2 of Schedule 2 of the *Environmental Planning and Assessment Regulation 2000* on 12 January 2012 (supplementary issued on 11 July 2012).

On 15 June 2012, the Federal Minister's delegate confirmed that the Project's assessment under Division 4.1 of Part 4 of the EP&A Act was an accredited assessment process under the *Environment Protection & Biodiversity Conservation Act 1999*. The Project was deemed a "controlled action" due to the potential for impact on Charmhaven Apple, Black-eyed Susan, Spotted-tailed Quoll and the Giant Barred Frog.

Stakeholder Engagement

The stakeholder engagement program included consultation with Local, State and Commonwealth government agencies, neighbouring land owners and industries, the Aboriginal and wider local community.

A series of Project briefings and presentations were provided to community groups, Government and relevant regulators throughout the preparation of this Environmental Impact Statement. Feedback from the stakeholder engagement has been incorporated into this Environmental Impact Statement.

Focus groups and a telephone survey were undertaken during 2011 and 2012 to canvass community attitudes towards both the Project and the preferred means for community communication or contact with WACJV.

Project newsletters were delivered to WACJV's near neighbours, the wider local community, regulators and other interested stakeholders throughout the preparation of this Environmental Impact Statement. Over 5,200 newsletters were distributed in each of October 2011, February 2012, April 2012, June 2012 and November 2012. Further newsletters are scheduled for distribution throughout the assessment process.

The Community Reference Group was formed in February 2012 and currently meets bi-monthly. Meetings have occurred on 19 April, 14 June, 23 August and 31 October 2012 and will continue throughout the assessment process. The Group is comprised of six representatives (nominated in response to a newspaper advertisement) from a cross section of the community and representatives from the Australian Coal Alliance, Wyong Shire Council, Darkinjung Local Aboriginal Land Council and local business.

Advertised Community Information Days were held at the WACJV Office in Tuggerah on 26 April, 10 May, 24 May and 7 June 2012. The Community Information Days were initiated by WACJV to provide the local community an opportunity to gain additional information regarding the Project and to obtain face to face feedback from Project staff.

WACJV has established the Wallarah 2 Foundation Apprenticeship Scheme, which involves the sponsoring of four apprenticeships each year, comprised of two candidates sourced from the general community and two candidates from Wyong Trade High School. WACJV will fund the education of participating apprentices through host employers within the Wyong LGA, with apprentices undertaking vocational training through TAFE NSW – Hunter Institute. For this purpose, WACJV has also entered into a Memorandum of Understanding with TAFE NSW.

To manage the program and engage suitable host employers for the apprentices, a Memorandum of Understanding has also been formed with Central Coast Group Training, a leading group training provider based at Tuggerah.

A website is maintained by WACJV that contains Project contact details and is updated with the latest Project documents and information.

Impacts, Mitigation and Management

A risk assessment was undertaken to identify potential environmental and social issues associated with the Project. The purpose of the risk assessment process was to identify, evaluate and prioritise the required environmental assessments for the Project in consideration of the Director-General's Environmental Assessment Requirements and the findings from stakeholder engagement.

Subsidence

A Subsidence Impact Assessment has been completed for the Project by SCT Operations Pty Ltd, Mine Subsidence Engineering Consultants Pty Ltd and WACJV. Subsidence related issues (particularly their potential effect on residential structures, water catchments and groundwater regimes) within the Project Boundary were a key factor for consideration in the mine design process. Similarly, any disruption to the surface water regime that may result in water ingress into the proposed mine workings was identified as a major safety risk that needed to be eliminated through appropriate mine design.

Extensive numerical modelling undertaken by SCT Operations Pty Ltd has informed the design of a mine layout from which the resultant surface subsidence is manageable within the three main surface environments, namely: the Hue Hue Mine Subsidence District, the alluvial floodplains, and the forested hills (that comprise the western half of the Project's Extraction Area). Accordingly, the range of predicted subsidence ground movements varies within the Project Boundary with maximum predicted total subsidence occurring in the western forested hills where seam extraction height and panel widths are greater than those proposed in the floodplain or the Hue Hue areas. Typical subsidence predicted for the three zones are:

- Hue Hue Area: 600 mm – 1,000 mm;
- Valley Area (floodplain): 1,200 mm – 1,400 mm; and
- Forest Area: 1,500 mm – 2,000 mm.

The conservative subsidence management approach determined various elements of the mine design, including the varying longwall panel widths and coal seam extraction height. Panel widths vary from 125 m at the initial Hue Hue panels to typically 175 m in the floodplain and up to 255 m in the western forested hills.

Extraction heights in the 6.0 m coal seam vary from 4.5 m down to 3.0 m to ensure that the conservative criteria stipulated for subsidence management are achieved.

The numerical modelling undertaken by SCT demonstrates that due to the high depths of cover of underground mining operations within the Extraction Area and the type of rock strata layers that are present at the Project, there will be no connectivity between the mining induced fracture system and the surface. The proposed mine layout has been specifically designed to avoid such connectivity to minimise the impact on surface water resources and avoid the potential for flooding of the mine.

Conventional subsidence effects of tilt and strain in the Hue Hue area have been restricted to 4 mm/m and 3 mm/m respectively, which meet the stringent criteria of the Hue Hue Mine Subsidence District. All houses built in this area since the Hue Hue Mine Subsidence District was proclaimed in 1985 have been constructed to these criteria.

The position and extent of longwall panels with respect to streamlines and other surface environmental features have been determined with subsidence management as a primary consideration. Panels have been set back from the Wyong River to ensure minimal subsidence of that watercourse and the nearby Mardi-Mangrove Creek Dam Pipeline. Longwall panels were shortened in the area of the confluence of Jilliby Jilliby Creek and Little Jilliby Jilliby Creek to mitigate subsidence and ensure channel stability of these stream sections.

A key mine design feature that provides effective subsidence management is the alignment of the permanent main roadways (a non-subsiding set of access and ventilation tunnels in the middle of the mine layout). These run approximately east-west beneath the Little Jilliby Jilliby Valley that also includes several dwellings and a school, and provides appropriate mitigation and management of subsidence in the valley. Also, the gateroad pillars between longwall panels have been designed to yield during subsidence and modelled profiles confirm that differential subsidence between the centre and edge of longwall panels is minimised.

The impact assessments provided in this Environmental Impact Statement indicate that the levels of impact on the natural features and items of surface infrastructure can be managed by the preparation and implementation of the appropriate management strategies. These strategies will be developed in conjunction with landowners and the owners of infrastructure, and will be documented in management plans to be approved by the relevant government agencies.

Detailed monitoring of actual subsidence behaviour will be undertaken and reported to the Division of Resources & Energy – Mineral Resources on a regular basis. This data will be used to further validate and refine the model predictions and inform modifications to the mine plan if necessary.

Consequently, an adaptive management approach will be undertaken for any modifications to the longwall layout (other than minor in nature) and will be subject to further assessment to the satisfaction of the Department of Planning and Infrastructure.

The subsidence predictions in this study are conservative and as such the degree of subsidence that will actually result from future mining is likely to be less than those upon which the current management strategies have been formulated.

WACJV will prepare a Subsidence Management Plan or Extraction Plan (as required by conditions of Development Consent) to manage the Project's subsidence impacts. Mitigation and management measures will be proactively undertaken in conjunction with landowners and relevant stakeholders. The Project's proactive and adaptive management of subsidence will also be undertaken in consultation with the Mine Subsidence Board to minimise the extent of impacts and the potential cost of remediation, as well as to enable adaptive management in response to any subsidence impacts in a timely and appropriate manner.

The Extraction Plan process involves the development of Property Subsidence Management Plans. These are property specific management plans prepared in consultation with potentially affected property owners. The Property Subsidence Management Plans will contain arrangements for the mitigation and remediation of impacts to property due to subsidence.

Groundwater

A Groundwater Impact Assessment was completed for the Project by Mackie Environmental Research.

Longwall panels are planned to be 125 m to 255 m wide and with panel lengths of 1.4 km to 3.4 km. As extraction progresses, longwall panels will pass beneath both hard rock areas and alluvial lands associated with Jilliby Jilliby Creek and Hue Hue Creek catchments, and hard rock areas associated with drainage to the lower reaches of the Wyong River. The fine-textured Patonga Claystone directly underlies the alluvial sediments of the Jilliby Jilliby Creek floodplain in the Dooralong Valley. No significant or highly productive aquifers occur within the Project Boundary, although there are 12 existing bores located within this area.

Computer based groundwater model simulations of proposed mining operations have been conducted in order to understand the many complex subsurface flow processes that could evolve during the extraction of longwall panels. The basic model design is a finite difference scheme that simulates variably saturated flow in hard rock and alluvial strata over an area of more than 575 km^2.

Panel extraction will result in depressurisation of the deep coal seam and surrounding strata in the caved zone. Model simulations of longwall mining predict that panel extraction will depressurise the Wallarah/Great Northern Coal Seam for lateral distances of up to 3 km beyond the panels during the mining period. The depressurisation will also expand through overlying strata at a slow rate. However, major depressurisation effects featuring relatively free drainage only extend upwards through the strata to the limit of connective cracking in the zone known as the fractured zone.

The overlying strata in the constrained zone do not feature connected vertical fracturing and depressurisation effects are relatively insignificant. The generally low permeabilities of the strata in this zone further limit the potential for water movement and depressurisation. Given the significant depths at which coal extraction occurs, the constrained zone will be very thick and will act as a safeguard protecting and separating the surface water system from the effects of the caving and fracturing zones associated with longwall mining. The depressurisation of hard rock strata is not expected to have any significant impacts on the quality of groundwater in the hard rock aquifers.

Mine water seepage is predicted to occur from a rate of less than 0.1 megalitres/day at commencement of mining (development) to a predicted peak rate of about 2.5 megalitres/day. This seepage range may be enhanced from time to time by potential dewatering of unidentified fracture related storage at depth. This may lead to short term increases of approximately 0.5 megalitres/day which should dissipate over a period of a few weeks to a few months.

Leakage induced by deep depressurisation is not predicted to impact in a measurable way upon any shallow groundwater flows, creek flows or existing bores/wells located in the alluvium. Upon cessation of mining, groundwater levels/pressures within the hard rock strata will be re-established over the long term. The only area where the hard rock water table is predicted to be drawn down is in the immediate vicinity of the access drift at the Tooheys Road site.

Monitoring of the alluvial groundwater system demonstrates the alluvial water table to be variable and highly responsive to rainfall recharge. As subsidence occurs progressively with sequential extraction of longwall panels, there will be short term and localised changes in the alluvial water table as the groundwater levels re-equilibrate across the affected area. Although the alluvial groundwater system alongside alluvial streams will not be significantly affected post-mining as the drainage lines (hydrological control points) are also equally subsided, the water table in some areas may be shallower on average. However, the alluvial water table will continue to be dependent upon climatic conditions.

As a result of subsidence effects, there is predicted to be a slight increase in the storage capacity of the alluvial aquifer (less than 0.1% increase).

A number of existing bores/wells have been identified in the vicinity of the Project that draw water in some cases from the alluvium but mostly from the hard rock strata. Yields are generally low and water qualities vary from fresh to brackish. The slow reduction in hard rock pressures will not affect the long term yield at these locations.

Similarly, any change in water table elevation in subsided areas is unlikely to affect pumping yield. The subsidence process may affect the structural integrity of the 12 bores located within the subsidence zone. These bores/wells will be repaired and/or re-drilled if damaged, without loss of yield, as required.

There are not predicted to be any measurable impacts on the water quality of surface aquifers due to the underground storage of salt and brine. The underground mine is expected to behave as a groundwater sink for at least 500 years after mining. This will inhibit the outward migration of the salt and brine products.

A number of groundwater dependent ecosystems have been identified along surface drainage channels, including Paperbark, Coachwood, Blackbutt and other species that rely at least in part on the shallow water table within the alluvium. As subsidence effects occur across the floodplain from progressive longwall extraction, alluvial groundwater in the locality will respond by flowing from un-subsided areas to subsided areas. Due to the low permeabilities of the alluvial materials, the migration of groundwater will be limited. As a result, the impact on groundwater dependent ecosystems will not be significant.

WACJV will undertake extensive management and mitigation measures for the Project. These include extending the existing groundwater monitoring program to include depressurisation, mine water seepage and water quality.

Surface Water

A Surface Water Impact Assessment was completed for the Project by WRM Water and Environment. A site surface water management system is proposed to both provide suitable water for mine site use and to ensure that untreated mine water is not released from the site.

Mine water requiring treatment will be a combination of deep groundwater pumped from the underground mine workings and surface water that has been captured on site and potentially become saline from contact with coal stockpiles. The Project will also generate water through runoff from buildings and paved surfaces. This water is not expected to be saline and will only require treatment using sedimentation dams.

The water management system will intercept surface water runoff within the Buttonderry Creek and Wallarah Creek Catchments. The Wallarah Creek catchment area to the downstream Project Boundary will be reduced by approximately 9%. The Buttonderry Creek catchment area is reduced by approximately 1.1% to the downstream Project Boundary.

The Water Treatment Plant will be utilised to treat mine water to meet the Project's operational needs and replace the environmental flows that have been removed from Wallarah Creek by the reduction in the creek's catchment area. The Water Treatment Plant will utilise dissolved air flotation, membrane filtration, ion exchange and reverse osmosis processes to achieve an output water quality that is compatible with the existing water quality in Wallarah Creek. The Water Treatment Plant also includes a Brine Treatment Plant to further reduce the volumes of brine to a semi-solid salt that will be stored within the underground workings. Mine water is:

- Retained underground for permanent storage in available underground mined out areas as these areas become available; and
- Treated in the Water Treatment Plant.

Treated water will be reused onsite to satisfy operational water requirements. Beneficial uses of water will include (at least): stockpile dust suppression, underground dust suppression and coal handling and coal moisture management.

A computer-based simulation model was used to assess the Project water balance on a daily basis over its 28 year duration. The water balance shows that the demand from external water supplies peaks at 52 megalitres in Year 1. The external water demand then decreases to approximately 20 megalitres/year over the first four years. From Year 4 onwards, the external water demand peaks at 49 megalitres/year in Year 14 before decreasing to approximately 20 megalitres/year for the remainder of the Project life.

Excess treated water at the Tooheys Road Site will be discharged into a tributary of Wallarah Creek. Any discharges will be carefully conducted in accordance with the conditions of an Environmental Protection Licence. The maximum annual discharge volume occurs in Year 7 and ranges from 50 megalitres/year in a median rainfall year to over 500 megalitres/year in a very wet year. These controlled discharges can be managed to compensate for the reduction in the Wallarah Creek catchment. There will be a small increase in the frequency of low flows, balanced by a decrease in the frequency of very low flows. Although most discharges will occur when there is no flow, the creek will remain ephemeral in nature.

The water balance model predicts that the water storages at the Tooheys Road Site will not experience any uncontrolled discharges (at the 99th percentile). The Entrance Dam at the Buttonderry Site is expected to experience a number of overflows of clean water. Under very wet conditions, the total volume of overflows will peak at 67 megalitres/year.

The Project is not expected to significantly impact the water quality of streams in the locality. Discharges to Wallarah Creek will be treated to a quality that is comparable to the background water quality. The discharges from the Entrance Dam will have been treated for sediment in accordance with the relevant guidelines and standards.

Subsidence caused by the Project is predicted to increase the storage capacity of the alluvial aquifer and cause some surface water runoff to be absorbed into the ground. This increase in storage capacity is estimated at less than 0.1% of the existing storage. It was conservatively assumed that the increase in alluvial storage resulted in an equivalent reduction in surface runoff. The reductions in runoff volumes are predicted to amount to 270 megalitres/year in the Jilliby Jilliby Creek catchment and 30 megalitres/year in the Wyong River catchment. These reductions in runoff volumes will have a negligible impact on the flow regimes of these streams.

Subsidence is not predicted to have a measurable impact on the geomorphology of the Wyong River. Some ponding is predicted along Jilliby Jilliby Creek. However, it is likely that natural stream processes will erode the creek bed to re-establish a free-draining profile. WACJV will implement the proposed water management system to minimise impacts on surface water and will also continue to conduct extensive monitoring of water quality and stream stability.

Flooding

A Flood Impact Assessment was undertaken for the Project by G Herman and Associates.

WACJV has commissioned a number of flood studies that have been used to both refine the baseline flood model and the impacts associated with the proposed mine plan. The current flood study advanced the previous assessments and utilised latest software and high resolution digital terrain information.

Pre- and post-mining flood assessments were undertaken for each catchment relevant to the Project. These comprise the Wyong River (in the Yarramalong Valley) and its tributary Jilliby Jilliby Creek (in the Dooralong Valley), Buttonderry Creek and Hue Hue Creek. The floodplains of the Jilliby Jilliby Creek and Wyong River are regularly flooded with overbank flows occurring regularly, typically during flows that are little more than 1 year Average Recurrence Interval (ARI) flow events.

There are 283 properties that are wholly or partially located within the floodplains of the Wyong River and Jilliby Jilliby Creek considered in the Flood Impact Assessment study area. Of these, there are 88 structures (83 dwellings and five sheds) within or close to these floodplains. Most of these dwellings are currently flood prone (within the 1 in 100 year flood level limit) and are generally located in low hazard flood storage areas or flood fringe areas.

Subsidence will generally result in a lowering of flood levels because the water level drops with the land surface. However, the flood depth will generally increase within subsided areas.

Changes in flood behaviours will be experienced along an 8.7 km length of Jilliby Jilliby Creek, upstream of its confluence with the Wyong River.

The following changes in flood behaviours are predicted to occur in the Dooralong Valley during a 100 year ARI event:

- Flood levels will decrease by up to 1.3 m, but there are areas in the valley where the flood levels will remain unchanged;
- Flood depths will increase by up to 1.3 m, but generally by less than 0.5 m;
- Inundation extent on a lateral basis will increase by up to 240 m in areas affected by subsidence; and
- An additional 33.2 hectares of land will become inundated; however 4.9 hectares of land will no longer be inundated, resulting in a net increase in inundation of approximately 28.3 hectares.

The post-subsidence flow velocities are predicted to be similar to existing flow velocities. The maximum conventional subsidence for the main channel and floodplain of the Wyong River is predicted to be 150 mm, which is not considered significant.

Flood behaviour in the Yarramalong Valley is not predicted to change significantly as a result of subsidence. This is due to the constraints incorporated into the mine plan to minimise subsidence effects on the Wyong River floodplain. The flood levels in the Yarramalong Valley are predicted to decrease by 0.01 m to 0.03 m. These small changes are due to subsidence effects in the Dooralong Valley creating a flood detention effect that reduces peak flows entering the Wyong River from Jilliby Jilliby Creek. The only increases in flood depths within the Yarramalong Valley occur at three small backwaters on the left bank of the Wyong River that will experience minor subsidence.

For a 100 year ARI flood event, 14 of the 83 identified dwellings within or in close proximity to the Wyong River or Jilliby Jilliby Creek floodplains will not experience any material changes to flood impacts. An additional 36 dwellings and three sheds) will be beneficially impacted by the Project. That is, the predicted subsidence will lead to reduced flood impacts to these dwellings.

Of the 33 dwellings and two sheds that are predicted to experience adverse impacts, four dwellings not previously subject to inundation by flooding are predicted to be impacted by flooding as a result of the subsidence from the Project. There are 10 dwellings and two sheds that will experience more frequent flood inundation. The remaining 19 dwellings are predicted to remain fully or partially within the flood limits, but will have reduced freeboard (height of the floor above the flood level). A similar range of impacts is expected in association with the 5 year ARI flood event following mining.

In the Hue Hue Creek floodplain, only one dwelling is currently flood prone in a 100 year ARI event. This dwelling will be subject to more frequent inundation as a result of subsidence and another dwelling will become flood prone.

Thirty-two low points in primary access roads that are currently inundated in a 100 year ARI event and/or 5 year ARI event in the vicinity of the Project were assessed for pre and post-mining constraints to vehicular access. There are 15 key points that are potentially affected by subsidence. The duration of inundation will increase for seven of these key points. The other eight key points will not experience any material changes to their duration of inundation.

The Flood Impact Assessment concludes that, in the absence of mitigation action, six dwellings will be impacted to a significant or major degree. A further nine dwellings and two sheds will be affected by moderate impacts. Mitigation and management strategies have been outlined to avoid or minimise impacts on dwellings, properties and road accessibility.

WACJV will prepare a Water Management Plan which will include details on the potential flood impacts, commitments to updating the flood model as further monitoring becomes available and the management and mitigation measures to be applied.

Management Plans will be prepared in consultation with individual landowners as part of the Subsidence Management Plan (or Extraction Plan) process.

Air Quality

An Air Quality Impact Assessment was undertaken for the Project by PAEHolmes.

A cumulative assessment, incorporating existing background levels, indicates the Project is unlikely to result in exceedances of relevant impact assessment criteria at the neighbouring receivers. Air quality particulate matter emission predictions from the Project indicate that no exceedances of relevant criteria will occur at privately owned receivers.

Dust emissions associated with train haulage of coal have been included as part of the modelling assessment on mining operations. PAEHolmes concludes that there is a minimal risk of adverse impacts due to fugitive coal emissions from trains associated with the Project. The results of monitoring and modelling indicate that the air quality levels at the edge of the rail corridor are below levels that are known to cause adverse impacts on amenity.

The potential for odour from the ventilation shaft at the Buttonderry Site was assessed and found to be minor. The modelling indicates that only one privately owned receiver in the vicinity of the Buttonderry Site is predicted to experience odour under worst case weather conditions above the most stringent odour impact assessment criterion of 2 Odour Units.

The proposed air quality controls for the Project are based on recommendations of the 'NSW Coal Mining Benchmarking Study: International Best Practice Measures to Prevent and/or Minimise Emissions of Particulate Matter from Coal Mining', a study that was commissioned by the NSW Environment Protection Authority.

Dust mitigation strategies include restricted land clearing, significant enclosure of coal handling facilities (such as conveyors, transfer points and crusher), telescopic chutes feeding coal to the stockpile, underground coal reclaim system from stockpiles, and water spraying at points of coal handling and stockpiling. The lack of a Coal Handling and Preparation Plant reduces dust emissions since there is no requirement for handling and emplacement of coal reject.

WACJV will continue to monitor air quality emissions using the existing environmental monitoring network to ensure compliance with the relevant air quality criteria. The existing monitoring network will be reviewed and augmented for the operation of the Project generally. WACJV will develop an Air Quality Management Plan for the construction and operation of the Project. The Air Quality Management Plan shall incorporate the air quality controls described above as well as other additional practical particulate minimisation and management measures.

Greenhouse Gas

A Greenhouse Gas Impact Assessment was undertaken for the Project by PAEHolmes.

The main sources of greenhouse gas emissions from the Project have been identified as resulting from electricity consumption, fugitive emissions of CO_2 and CH_4, diesel usage, emissions associated with flaring and the transport and final use of the product coal.

The proposed planned capture and flaring of remaining CH_4 during operations was found to have significant benefits in the reduction of greenhouse gas emissions. When compared with the base case involving unmitigated fugitive emissions of CH_4, the flaring scenario results in a greenhouse gas saving of approximately 8 Mt CO_{2-e} or 54% of Scope 1 emissions over the Project life. Additional greenhouse gas savings may be realised through the use of onsite power generation which will be implemented if economically suitable to do so.

The Project's contribution to projected climate change, and the associated impacts, will be in proportion with its contribution to global greenhouse gas emissions. Average annual scope 1 emissions from the Project (0.2 Mt CO_{2-e}) represent approximately 0.04% of Australia's annual average commitment under the Kyoto Protocol (591.5 Mt CO_{2-e}) and a very small portion of global greenhouse emissions, given that Australia contributed approximately 1.5% of global greenhouse gas emissions in 2005 (Commonwealth of Australia, 2011).

The Project will develop an Energy and Greenhouse Strategy within two years of the commencement of longwall coal extraction. The strategy will address interim and long term energy and greenhouse management plans and initiatives, including monitoring, reporting and continuous improvement.

Health Risk

A Human Health Risk Assessment was undertaken for the Project by PAEHolmes.

Analysis provided conservative estimates of the increase in annual and daily mortality due to dust emissions from the Project at the most affected receiver on the worst day. The increase in risk of daily mortality on the worst day in the life of the Project is estimated to be approximately 1 in 100,000 and as such represents a small risk. All other health outcomes risks are less than 1 in 100,000 including the negligible risks associated with fine particulates and respirable crystalline silica.

The Noise Impact Assessment shows that for each of the operational scenarios modelled there are no predicted exceedances of the NSW amenity criteria for noise impacts at residences. In regards to existing background noise, site audits confirmed that the local acoustic environments are currently influenced by road traffic, natural sources and localised domestic activities.

In regards to operational traffic and rail generated noise levels, criteria were satisfied or marginal increases (1-2 dBA) were predicted. As such there is no likelihood of increases in risks to health due to noise from the Project.

The proposed water management system will ensure the separation of clean and mine water on the site and no uncontrolled discharges from the Mine Water System under all but extreme weather conditions. As the Tooheys Road Site is located outside of the drinking water catchment, no site discharges are likely to affect the drinking water catchment. Given this, there is no likelihood of increases in risks to health from water discharge.

Noise

A Noise and Vibration Impact Assessment was undertaken for the Project by Atkins Acoustics.

Noise modelling assumed that fixed and mobile plant were operating simultaneously with train loading at the Tooheys Road Site, effectively providing a worst case modelling assumption. Modelling shows that appropriate Project Specific Noise Criteria will be met under all weather conditions at all private residences surrounding the Tooheys Road Site which is the location of the main noise emitting activities for the Project. As such, operational noise levels predicted at Blue Haven and the Warnervale Town Centre are also predicted at less than 35 dBA under worst-case weather conditions at the nearest private receivers. Traffic noise impacts during construction and operations are predicted to meet target noise assessment goals.

Noise modelling for peak annual production output of 5 Million tonnes per annum shows that the additional rail traffic noise will marginally increase (1-2 dBA) the existing $LA_{eq,\ 24\ hour}$ rail traffic noise levels on the Main Northern Rail Line. With respect to the LA_{max} noise levels, the Project is not expected to result in increases above the existing levels.

Minor sources of vibration from construction or operational related activities are anticipated to be from rollers, rock breakers, dozers and trucks. No noise or vibration impacts are predicted to be caused by underground activities. Vibration levels at private receivers are predicted to be within acceptable limits for human comfort.

In addition to the existing meteorological monitoring system, WACJV will develop a leading practice noise monitoring network surrounding the Tooheys Road Site and Buttonderry Site which is representative of the closest sensitive receivers.

WACJV will develop a Noise Management Plan for the construction and operation of the Project. The Noise Management Plan will incorporate the feasible and reasonable mitigation and noise monitoring network described above as well as additional practical noise minimisation and management.

Ecology

An Ecological Impact Assessment was undertaken for the Project by Cumberland Ecology. Numerous site flora and fauna surveys were undertaken within the Project Boundary, particularly within the Infrastructure Boundary and Biodiversity Offset Areas.

As a result of surveys undertaken, over 450 flora species (approximately 5% exotic) were recorded within the Project Boundary and Subsidence Impact Limit. The dominant flora families recorded included *Myrtaceae, Poaceae, Cyperaceae* and *Asteraceae*. Six threatened flora species listed under the *Threatened Species Conservation Act 1995* and *Environment Protection and Biodiversity Conservation Act 1999* were identified during surveys. No Endangered Ecological Communities listed under the *Environment Protection & Biodiversity Conservation Act 1999* were identified during the ecological surveys.

The Ecological Impact Assessment identified 13 vegetation communities within the Project Boundary. Of the vegetation communities identified, the following are listed as Endangered Ecological Communities under the *Threatened Species Conservation Act 1995*: the Blackbutt - Turpentine open forest of the foothills of the North Coast; Coachwood - Crabapple warm temperate rainforest of the North Coast and northern Sydney Basin; Paperbark swamp forest of the coastal lowlands of the North Coast and Sydney Basin; *Phragmites australis* and *Typha orientalis* coastal freshwater wetlands of the Sydney Basin; Rough-barked Apple - Red Gum grassy woodland of the MacDonald River Valley on the Central Coast, Sydney Basin; Spotted Gum - Broad-leaved Ironbark grassy open forest of dry hills of the lower Hunter Valley, Sydney Basin; Swamp Mahogany swamp forest on coastal lowlands of the North Coast and northern Sydney Basin; and Woollybutt - Paperbark sedge forest on alluvial plains of the Central Coast, Sydney Basin.

The various components of the surface facilities have been sited to avoid where possible and then to minimise any direct impact on creek lines and associated riparian corridors. Road, rail and services links at the Tooheys Road site will need to pass over several branches of Wallarah Creek that are not designated Key Fish Habitat but are designated Class 3 to Class 4 fish habitat and include important wetland plus Wallum froglet habitat. These crossings will be designed to minimise disturbance to riparian and aquatic ecosystems and to ensure minimum disturbance to stream hydrodynamics, water quality and aquatic habitat condition.

Subsidence modelling indicates that post-mining, the overall variation in valley floor topography will be similar to the pre-mining condition. Accordingly it is anticipated that there will be sufficient adaptive opportunities available to ensure that there would not be significant changes to the overall makeup and function of aquatic habitats within the creeks on the alluvial plain or within the ponded water bodies over the valley floor as mining progresses.

The vegetation communities that occur within the Project Boundary and Subsidence Impact Limit support habitat suitable for a range of fauna, including amphibians, reptiles, birds, bats and terrestrial and arboreal mammals. Over the course of surveys within the Project Boundary and Subsidence Impact Limit, 29 threatened and eight migratory fauna species were also identified.

Over the life of the Project, approximately 89 hectares of vegetation will be directly impacted, consisting of remnant and regenerating forest and woodland communities and large areas of open grassland and scattered trees located within the Disturbance Boundary. Suitable habitat is present within the Project Boundary and Subsidence Impact Limit for a number of threatened flora species. The Project will result in the removal of forest, woodland and grassland vegetation communities which provide foraging, shelter and breeding habitat for fauna species in the area.

Approximately 8.8 hectares of potential Groundwater Dependant Ecosystem vegetation will be removed by the Project, comprising 1.1 hectares of Paperbark Swamp Forest of the Coastal Lowlands of the North Coast and Sydney Basin, 1.8 hectares of Swamp Mahogany Forest on Coastal Lowlands of the North Coast and Northern Sydney Basin and 5.9 hectares of Blackbutt – Turpentine Open Forest of the Hills of the North Coast within the Disturbance Boundary. These areas represent a very small proportion of the extent of these communities in the area and the locality. All three of these communities are listed as Endangered Ecological Communities under the *Threatened Species Conservation Act 1995* and Assessments of Significance have been conducted. The assessment of the vegetation communities present within the Project Boundary and Subsidence Impact Limit indicate that due to the small area of each community that will be directly impacted and the large areas that remain, no significant impact to Groundwater Dependant Ecosystems is predicted to occur.

Management measures proposed for the Project have followed the Office of Environment and Heritage's 'Draft Guidelines for Threatened Species Assessment' (DEC 2005), with the aim to avoid, mitigate or offset identified impacts.

Impact avoidance measures implemented included the exclusion of an option to locate Project surface facilities to the west of the F3 Freeway. This would have resulted in impacts to vegetation that contained high conservation value identified in the Wyong Conservation Strategy.

In order to coordinate the implementation of the ecological mitigation measures proposed for the Project, a Biodiversity Management Plan will be prepared prior to the commencement of construction, to the satisfaction of relevant regulators. In addition to the description of mitigation measures for the Project, the Biodiversity Management Plan will also provide specifications for the restoration and management of biodiversity offset areas.

As part of the Biodiversity Management Plan, WACJV will implement a Land Disturbance Protocol for the Project which will require that the Environmental Manager (or delegated specialist) will carry out an inspection of proposed disturbance areas prior to any disturbance activities occurring.

Biodiversity Offset Strategy

As a component of the Ecological Impact Assessment, WACJV formulated a Biodiversity Offset Strategy for the Project in conjunction with Cumberland Ecology. This Biodiversity Offset Strategy was developed as a compensatory measure in response to the predicted ecological impacts for the Project, particularly those associated with direct disturbance to threatened vegetation communities and threatened species habitat.

The Biodiversity Offset Strategy for the Project has been developed to conserve specific areas within the existing landholdings of WACJV as biodiversity offsets. The three main areas proposed for conservation as biodiversity offsets for the Project total of approximately 261 hectares and include:

- Hue Hue Road Offset area (160 hectares);
- Tooheys Road Site North Offset area (48 hectares); and
- Tooheys Road Site Southern Offset area (53 hectares).

Detailed field assessment of the proposed offset areas were undertaken during the surveys for the Ecological Impact Assessment for the Project to determine their biodiversity values, including the vegetation communities, habitat and flora and fauna species present within each offset area.

These surveys confirmed that the vegetation communities within the offset areas were almost identical to those recorded within the Project Boundary. The offset areas also provide habitat for a suite of threatened species listed under the *Threatened Species Conservation Act 1995* and/or the *Environment Protection & Biodiversity Conservation Act 1999* that are known to occur in the locality.

The Biodiversity Offset Strategy will address the predicted loss of 53 hectares of remnant forest and woodland by provision of 261 hectares of offset land including 201 hectares of native vegetation. This addresses a loss of 40 hectares of non-Endangered Ecological Community native vegetation by provision of 118 hectares of non-Endangered native vegetation. This achieves a ratio of 2.9:1 for total non-Endangered Ecological Community native vegetation. The Biodiversity Offset Strategy also addresses the predicted loss of 13 hectares of State listed Endangered Ecological Communities by the provision of 83 hectares of like-for-like vegetation at a ratio of 6.3:1.

The Biodiversity Offset Strategy will provide 201 hectares of forest and woodland that provides habitat for the threatened species recorded from the Study Area including 135 hectares for *Angophora inopina*, 193 hectares for *Tetratheca juncea*, 119 hectares for the Spotted-tailed Quoll and 27 hectares for the Giant Barred Frog.

Traffic and Transport

A Traffic and Transport Impact Assessment was undertaken for the Project by Parsons Brinckerhoff.

All coal will be transported from the site by rail. The future road based traffic movements generated by the Project will be associated with normal construction and operational activities.

Road intersection performance was assessed using the SIDRA software package. The analysis indicated that the construction and operational activities of the Project will not materially impact on the performance of any of the intersections of the road network. That is, the capacity constraints arising at various intersections are not caused by the Project. Current development approvals and background growth rates will cause intersections in the area to perform or continue to perform at unacceptable levels in future scenarios irrespective of whether the Project proceeds or not. The main contributor to the future traffic is the Wyong Employment Zone scheduled to be in operation in Year 5.

With the additional traffic associated with the operational activities of the Tooheys Road Site, the road is expected to carry only 20 additional vehicles per peak hour – which equates to approximately 3% of the total traffic volume during the peak hour. Consequently, the additional forecast traffic associated the Project will not impose any adverse impact on Tooheys Road.

The design of the access points at the Tooheys Road Site, Buttonderry Site and Western Ventilation Shaft has taken road safety into consideration. The proposed turning lanes will reduce the potential for accidents caused by vehicles accessing these sites.

WACJV will prepare a Traffic and Transport Management Plan to manage possible impacts resulting from the construction of the Project and its operation and to ensure the traffic network can be managed throughout the Project.

Rail

A Rail Study was completed for the Project by Rail Management Consultants Australia Pty Ltd with substantial input provided by RailCorp.

Railsys software was used to model the future rail network infrastructure overlaid with projected future passenger, general freight and coal freight demand scenarios. The forecast growth in freight train movements on the line to Newcastle is an aggregate of increased numbers of interstate freight trains, coal trains supplying local domestic power stations and export coal trains to the port of Newcastle. The average number of daily train movements associated with the Project is 4.3 cycles per day. However, there is capacity to accommodate a theoretical maximum scenario of six train cycles per day, six days per week to assemble coal shipments at the Port of Newcastle.

The modelling indicates that passenger services are not compromised and the overall network growth can be accommodated by the provision of new passing loops at Awaba. These loops would also provide further future proofing ahead of significant expansions in interstate and coal freight traffic.

Rail movements generated by the Project will result in additional delays for road traffic at the level crossings at Adamstown and Islington. The closure time for the St James Road, Adamstown level crossing are predicted to increase from 432 minutes per day to 488 minutes per day. The closure time for the Clyde Street, Islington level crossing will increase from 463 minutes per day to 519 minutes per day as a result of the Project. The additional closures will typically occur in the evening and other non-peak traffic periods.

Aboriginal Archaeology and Cultural Heritage

An Aboriginal Cultural Heritage Assessment was undertaken for the Project by OzArk Environmental & Heritage Management.

This study builds on and combines several existing studies undertaken for WACJV and the findings of investigations for other projects in the region, for which there is a considerable body of literature. Additionally, targeted field surveys were undertaken with representatives of the Aboriginal community.

A total of 11 sites were identified within or in close proximity to the Project Boundary and on other WACJV owned land. Of these, an open site is located within the Infrastructure Boundary at the Tooheys Road Site. Seven axe grinding groove sites were located within or near the Subsidence Impact Limit. The remaining three sites were located on other WACJV owned land west of the Tooheys Road Site. No sites were located within either the Buttonderry Site or Western Ventilation Shaft Site.

Of the 11 sites, five axe grinding grooves are predicted to be subject to potential subsidence impacts. One open site at Tooheys Road Site will receive direct impacts associated with disturbance and the remaining six sites are not predicted to be impacted.

As part of the Subsidence Management Plan (or Extraction Plan), additional survey and assessment for Aboriginal heritage will be sequentially carried out for all relevant areas at least 3 years prior to indirect disturbance.

WACJV will develop an Aboriginal Cultural Heritage Management Plan for the Project which will be guided by specific policies and procedures to manage sites within the Project Boundary. The Plan will also be periodically reviewed in consultation with Aboriginal stakeholders and relevant regulators.

Historic Heritage

A Historical Heritage Assessment was undertaken for the Project by OzArk Environmental & Heritage Management.

There are 13 listed heritage items and 19 items identified in previous studies as being of potential heritage significance. Of the 13 listed heritage items, only three are located within the Subsidence Impact Limit: a Brick & Iron Silo, the dwelling “Bangalow” and a disused forestry road (WSF-HS1).

Of the 19 items that were previously identified as being of potential heritage significance, 10 are located within the Subsidence Impact Limit. These 10 items were surveyed to determine their heritage significance. Only the Little Jilliby Road Bridge was confirmed as having historical heritage significance. One dwelling was unable to be accessed during the survey which remains an item of potential heritage significance.

In total, four items of heritage significance and one item of potential heritage significance are predicted to be impacted by subsidence. No items will be impacted through direct disturbance.

Management strategies to limit the potential impacts of the Project on historical heritage items will be detailed in a Historical Heritage Management Plan which shall be prepared in consultation with the relevant regulators.

Visual

A Visual Impact Assessment was undertaken for the Project by The Design Partnership.

The Visual Impact Rating for the Tooheys Road Site was determined by assessing its visibility and Visual Absorption Capacity ratings. The Low level of visibility and the Moderate-High Visual Absorption Capacity given to the Tooheys Road Site result in a Low Visual Impact Rating. The main site facilities will be appropriately landscaped. Landscape works using native vegetation will involve a reinstatement of the local vegetated character and achieve a reduction in the visual impacts such that the Tooheys Road Site will result in a Low Visual Impact Rating category for both close range and distant views. The Tooheys Road Site is not anticipated to have any visual impact on the Warnervale Town Centre due to screening provided by vegetation and a ridgeline.

The Buttonderry site also has a Low level of visibility and the Moderate-High Visual Absorption Capacity and therefore a Low Visual Impact Rating. Effective enhancement of the Visual Absorption Capacity will be achieved by screen planting along the Hue Hue Road Boundary and particularly adjacent to the entrance and the access roadway.

The Buttonderry Site may be visible from locations within the Wyong Employment Zone. The light industrial character of the Buttonderry Site is similar to the character of the Wyong Employment Zone, resulting in a low visual impact.

The Western Ventilation Shaft is located within the Wyong State Forest and is not visible from any surrounding residences. There is anticipated to be no adverse visual impact from this site.

For private residences within 2 km with a direct view to the Tooheys Road Site, WACJV will implement visual impact mitigation measures in consultation with the landowner, to the satisfaction of the Department of Planning & Infrastructure.

For the Buttonderry Site, effective enhancement will be achieved by screen planting along the Hue Hue Road Boundary particularly adjacent to the entrance and the access roadway.

Social

A Social Impact Assessment was undertaken for the Project by Martin and Associates.

During the three year construction period, the Project will employ up to 450 direct construction personnel onsite with a further 590 indirect jobs being generated in the Secondary Study Area. During the operations phase the Project will employ approximately 300 full time equivalent personnel with a further 500 indirect jobs being generated in the Secondary Study Area.

As unemployment in the Wyong Local Government Area is approximately 8% (as at December 2011) and consistently higher than the New South Wales state average, the Project will provide increased employment opportunities in the area.

No significant impacts are anticipated on the various elements of community infrastructure in either the construction or operating phases of the Project. The number of additional education and childcare places required will be minimal, as will the impact on local outpatient health services. Additionally, population increases associated with the Project workforce is not predicted to place significant pressures on the local housing market.

WACJV will prepare a workforce recruitment strategy to assist in achieving a 70% local employment target. The strategy will address the needs of training the semi-skilled and unskilled workforce who are available locally but will require on the job and more specific operator training.

WACJV will also work with TAFE in Wyong and/or Newcastle to identify and assist in the development of training and apprenticeship programs for skills relevant to the Project. WACJV will also prepare a Voluntary Planning Agreement with Wyong Shire Council that takes into consideration the findings of the Social Impact Assessment.

Economics

An Economic Impact Assessment was undertaken for the Project by Gillespie Economics.

The Economic Impact Assessment considered both the economic efficiency of the Project (i.e. consideration of economic costs and benefits including the environmental costs and the opportunity cost of using agricultural resources) and the economic impacts of the Project (i.e. the economic activity that the Project would provide to the regional and NSW economies).

During the construction phase, the Project will contribute to the NSW economy through construction workforce expenditure and equipment purchases. In this phase, the Project will provide the following contributions to the NSW economy:

- $1,156 Million in direct and indirect output or business turnover;
- $514 Million in direct and indirect value-added;
- $368 Million in direct and indirect household income; and
- 1,697 direct and indirect jobs at the peak of construction.

During the 25 year operational period, the Project is predicted to provide the following contributions to the NSW economy:

- $900 Million in annual direct and indirect output or business turnover;
- $507 Million in annual direct and indirect value added;
- $154 Million in annual direct and indirect household income; and
- 1,711 direct and indirect jobs.

A Benefit Cost Analysis was also undertaken on the Project in consideration of all environmental, social and cultural impacts. The Project will make a substantial contribution to Regional, State and Federal Government revenue bases through company tax and royalty payments. These contributions over the 28 year Project life will amount to $1.58 billion (undiscounted value) or $346 million in net present value terms using a 7% discount rate.

Soils and Land Capability

A Soil and Land Capability Assessment was undertaken for the Project by Environmental Earth Sciences.

The Project Boundary comprises five soil types including areas of dermosol, kandasol, kurosol, sodosol and tenosol. The Disturbance Area is made up of kandasol and kurosol soils. The pre-mining land capability classification within the Project Boundary includes Class III, Class VI and Class VII, with Class VI being the dominant class in the existing environment. Class VI land is only suited to livestock grazing and is the lowest quality of grazing land as it is constrained by slope, acidity and shallow topsoil.

Direct impacts to the land as a result of the Project will be within the Infrastructure Boundary. Areas outside this Infrastructure Area are expected to remain the same as the pre mining class. An exception to this is the areas in the low lying slopes and floodplain which may be indirectly affected by mining through subsidence and increased flooding risk.

Overall, the percentage area of each class of agricultural suitability will remain similar to that of the existing environment. The extent of Class III land however, will reduce along the slopes of the subsidence areas, lowering the overall area of land suitable for regular cultivation. The rehabilitated lands post mining will be most suitable for livestock grazing with minimal cultivation.

WACJV will develop an internal Soil and Land Capability Procedure for management of its soil resources.

Agriculture

An Agriculture Impact Assessment was completed for the Project by Scott Barnett & Associates.

A maximum net annual agricultural production from within the Project Boundary was calculated at $1.4 Million from turf farming, beef production and horse activities. Approximately 90 hectares will be removed from agricultural production for the Disturbance Area. This area is currently used for low intensity managed beef grazing and generates a net annual agricultural production of approximately $6,500.

Approximately 21 hectares will be removed from agricultural production for the biodiversity offset area. This area is currently used for low intensity managed beef grazing and generates a net annual agricultural production of approximately $1,500.

Minimal impacts are predicted on the remaining agricultural land within the Subsidence Impact Limit. It is possible in a worst case scenario that a turf farm could require mitigating works and have a reduced production capability for up to two years after subsidence impacts in approximately Year 22. The complete loss of production for the turf farm over a two year period is estimated to have a maximum net value of $0.86 Million per annum. The overall total impacts to the agricultural contribution of the Disturbance Area, Subsidence Impact Limit and the biodiversity offset area is very small when compared to total agricultural production on a regional, state and national scale. The estimates of the reduced availability and productivity of this land will have a negligible impact on the overall agricultural industry.

WACJV will develop and implement a Land Management Plan including a weed and pest management plan for WACJV owned land. Any impacts to agricultural enterprises associated with subsidence will be managed as part of the Extraction Plan process. Monitoring of surface relief will be undertaken in the active mining areas within the Project Boundary. If subsidence is identified as a potential risk to any agricultural operation within the Project Boundary, WACJV will undertake mitigation and remediation activities to minimise any impacts, primarily through Property Subsidence Management Plans.

Forestry

A Forestry Impact Assessment was completed for the Project by GHD Pty Ltd.

Approximately 3.2 hectares of the Wyong State Forest will be cleared for the construction and operation of the Western Ventilation Shaft. The maximum economic loss of this area from forestry production for the life of the Project has been estimated at $23,000. Subsidence associated with the Project is not predicted to have any significant impact to forestry resources or forestry activities.

Forests NSW confirmed during consultation that subsidence issues were not a significant issue for native forest management. Continued consultation with Forests NSW will be undertaken to ensure any impacts to forestry resources and forestry activities are appropriately managed.

Contamination

A Phase 1 Contamination Impact Assessment was undertaken for the Project by DLA Environmental. No evidence was found to infer the presence of any significant existing soil or groundwater contamination by heavy metals, PAH compounds, pesticides or PCBs within the Infrastructure Boundary. Hydrocarbon contamination associated with a minor motor oil spill was identified in surface soils at one localised area at the Buttonderry Site and will require removal to a suitable licensed facility in accordance with relevant guidelines.

Other Studies

Hansen Bailey also undertook studies to address hazards, waste management, rehabilitation and closure. These assessments are discussed further in this Environmental Impact Statement.

This Environmental Impact Statement considered the cumulative environmental impacts of the Project and other mining operations. There are several mines in the Lake Macquarie local government area and one other mine in the Wyong local government area, with the nearest infrastructure being 10 km from the Project. Due to the significant distances to other mines, the contributions of other mines to cumulative environmental impacts are considered negligible.

Justification

After considering all options, the Project as designed will maximise the social and economic benefits from the extraction of the NSW Government owned coal resource within the WACJV mining authorisations. At the same time it will minimise any impacts to the natural and man-made environment. In particular, it has been determined that the Project will not unduly impact on either the surface or groundwater regime within or beyond the Project Boundary and will not affect in any measurable way the Central Coast water supply.

The Project will facilitate the recovery of a valuable, export quality, thermal coal. Thermal coal remains a highly sought after energy source in Asian countries, including Japan, Korea, China and India. This increasing demand supports the need for the Project and justifies further investment in the thermal coal mining industry.

The Project will provide much needed employment opportunities to the Wyong Local Government Area. The Wyong Local Government Area has fared poorly in relation to NSW in many measurements of socio-economic indicators.

In September 2012, the unemployment rate of the Wyong Local Government Area was 8.1%, compared to the NSW unemployment of 5.1% (DEEWR, 2012). The Wyong North-East Statistical Local Area was ranked the fifth most disadvantaged Statistical Local Area in the 'Index of Relative Socio-economic Advantage and Disadvantage' in the Greater Sydney Area in 2006 (Australian Bureau of Statistics (2008) Socio-Economic Indexes for Areas (SEIFA), Australia – Media Release March 26, 2008). The Wyong Local Government Area was ranked the 17th lowest Local Government Area in NSW (in a total of 153 LGAs) in the 'Index of Education and Occupation' in 2006 (Australian Bureau of Statistics (2008) Socio-Economic Indexes for Areas).

The operational phase of the Project is expected to generate a total of approximately 800 jobs in the Secondary Study Area – 300 direct and 500 indirect jobs. The Project is predicted to generate approximately 560 jobs in the Wyong, Lake Macquarie and Gosford Local Government Areas. In addition, approximately 240 jobs are also predicted to be filled by people currently living outside the Secondary Study Area, but who are likely to relocate to that Area due to the Project. Furthermore, the Project will generate over 1,700 direct and indirect jobs in NSW for the duration of the Project's operational life.

The Project is estimated to contribute $900 Million annually to the NSW economy throughout the Project's operational life. The Project is also estimated to make a substantial contribution to state and federal Government revenue bases paying company tax and royalty benefits of $1.58 billion (undiscounted) over the 28 year Project life (or $346 million in net present value terms using a 7% discount rate).

When the Project production costs (acquisition of affected land, opportunity cost of land, operating costs, environmental costs, decommissioning costs, etc.) are considered in the context of production benefits (revenues from production, residual values of land, etc.), the net financial benefits of the Project accruing to Australia are $346 Million (net present value) or $531 Million (net present value) if employment benefits are taken into account.

The Project has been assessed on a 'worst-case' environmental impact basis, assuming the Project will operate at the maximum coal production rate of 5 Million tonnes per annum, with all feasible and reasonable mitigation measures being applied. When the management and mitigation measures committed to in this Environmental Impact Statement are adopted, the residual environmental impacts of the Project are well within acceptable limits. These impacts are justifiable when considered against the need for the Project and its social and economic benefits.

WACJV will compensate for socio-economic impacts of the Project through the offer of a Voluntary Planning Agreement with Wyong Shire Council. The Project is consistent with the objects of the EP&A Act when its resultant social and economic benefits are weighed carefully against its predicted social and environmental costs.

It has been demonstrated that the Project will serve the essential purpose of providing thermal coal for current and future generations and will generate significant economic benefits in the process. The Project's social and environmental impacts will be minimised as far as practicable by implementing all reasonable and feasible management and mitigation measures. As a consequence, the socio-economic benefits of the Project will far outweigh its social and environmental costs. Therefore, the Project is in the public interest.

Wallarah 2
COAL PROJECT

Wallarah 2 Coal Project

Environmental Impact Statement

April 2013

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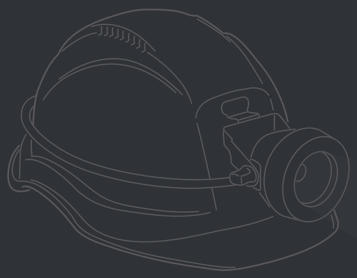

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Wallarah 2
COAL PROJECT

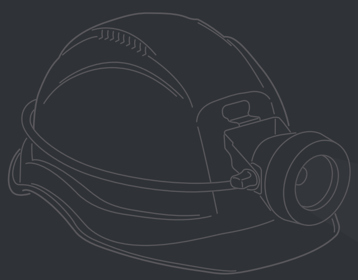
Wallarah 2 Coal Project

Environmental Impact Statement

April 2013

1

Introduction



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Introduction 1

This section provides an introduction to the Environmental Impact Statement (EIS) for the Wallarah 2 Coal Project. It describes the background and context of the Project, introduces the proponent and explains the structure and purpose of the EIS.

1.1 Background

In 1995 the NSW Government invited competitive tenders for the Wyong Coal Development Areas comprised of Exploration Licence (EL) 4911, EL 4912 and Authorisation 405 on the Central Coast of NSW. Wyong Areas Coal Joint Venture (WACJV) was successful in this tender and was awarded the authorisations. EL 5903 was later granted to WACJV in November 2001.

Coal Operations Australia Ltd (COAL) was the original majority shareholder of WACJV with Kores Australia Pty Ltd (Kores) and other Korean and Japanese interests holding minority shareholdings. BHP Billiton subsequently became the majority shareholder in WACJV through the acquisition of COAL in 2002. BHP Billiton later sold its interest to Kores in 2005. This sale increased Kores' equity in the venture to 82.25% and they are now the major shareholder and manager of the WACJV.

In the period since 1995, WACJV has undertaken extensive programs of exploration, environmental monitoring, environmental assessment, community consultation, technical planning and economic analysis of the Project. Exploration, mine planning and environmental investigations have defined significant coal resources beneath both the western areas (includes Yarramalong and Dooralong Valleys, Wyong and Olney State Forests, Jilliby State Conservation Area (SCA) and surrounding ranges) and eastern areas (Tuggerah Lake and surrounding area).

A potentially viable coal resource (referred to as the Primary Target Area) was identified, which contains 375 Million tonnes (Mt) of coal within the total western resource of approximately 878 Mt. Over half of the Primary Target Area resource lies beneath the forested hills and surrounding ranges. A significant proportion, however, lies beneath the Dooralong Valley and the Hue Hue area. Only a portion of the Primary Target Area (approximately half) has been selected to form the proposed mining area for this Development Application, based on a balance of environmental, social and economic considerations. This area is referred to as the 'Extraction Area'.

WACJV seeks a Development Consent under Division 4.1 of Part 4 of the *Environmental Planning & Assessment Act 1979* (EP&A Act) to mine coal within the Extraction Area for 28 years. The Project will involve the extraction of export quality thermal coal via underground longwall mining methods. The Project is generally comprised of an underground longwall mine, coal handling and storage facilities, rail loop and loading infrastructure, an underground drift entry, ventilation shafts, gas and water management facilities and administration buildings.

The Project is located within the Wyong Local Government Area (LGA), approximately 4.7 km north-west of central Wyong and approximately 45 km south-west of Newcastle. Figure 1 and Figure 2 illustrate the regional locality of the Project.

1.2 Previous Application

The WACJV previously sought Project Approval for the Wallarah 2 Coal Project (W2CP) under the recently repealed Part 3A of the EP&A Act. This application was supported by the 'Wallarah 2 Coal Project Environmental Assessment' (International Environmental Consultants, 2010) (W2CP EA) and was recommended for approval by the Planning Assessment Commission expert panel but was ultimately refused by the (then) Minister for Planning on 3 March 2011.

The Minister's refusal cited specific issues that required further information to improve the certainty of impact assessment conclusions. This included a requirement for additional information on the following:

- Subsidence prediction modelling, specifically for the western area;
- Heritage and ecological assessment, particularly in the western areas that are subject to the additional subsidence modelling; and
- Details of site water management and water balance at the surface facilities sites (particularly the Tooheys Road Site).

Additional field monitoring and survey, modelling and assessment work to address these issues has been undertaken with the results of this work presented in this EIS.

WALLARAH 2 COAL PROJECT

Wallarah 2 COAL PROJECT

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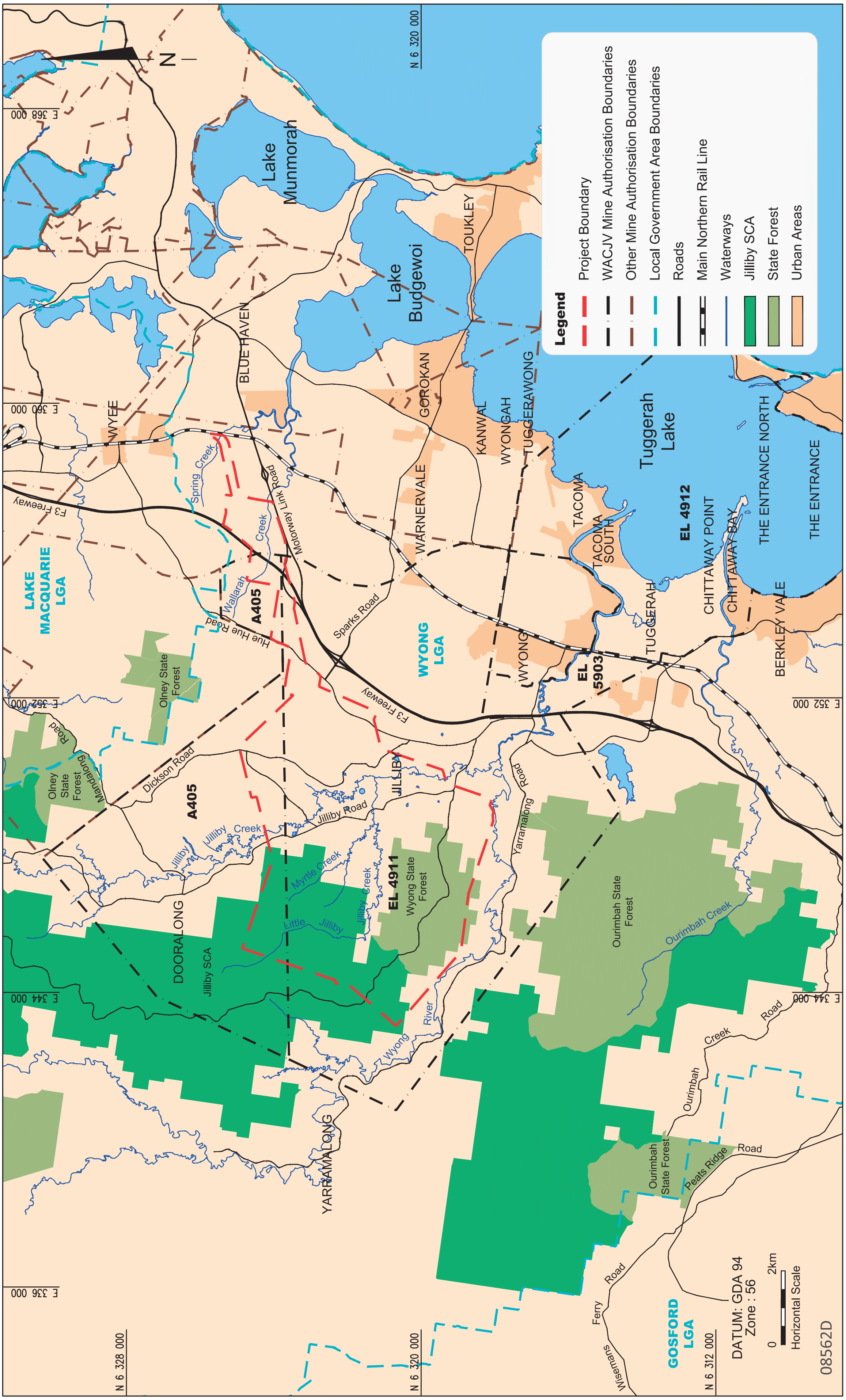
Project Location

FIGURE 1



WALLARAH 2 COAL PROJECT

Regional Locality

FIGURE 2

Wallarah 2 COAL PROJECT

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1.3 Project Overview

Figure 3 provides a general layout of the key features of the Project. The Project is described in detail in Section 3 and includes:

- The construction and operation of an underground mining operation extracting up to 5.0 Million tonnes per annum (Mtpa) of export quality thermal coal by longwall methods at a depth of between 350 m and 690 m below the surface within the underground Extraction Area;
- Mining and related activities will occur 24 hours a day, seven days a week for a period of 28 years which includes up to three years of construction and at least 25 years of coal extraction;
- Tooheys Road Site surface facilities on company owned and third party land (subject to a mining lease) between the Motorway Link Road and the F3 Freeway which will include (at least) a rail loop and spur, stockpiles, water and gas management facilities, workshop and offices;
- Buttonderry Site Surface Facilities on company owned land at Hue Hue Road between Sparks Road and the Wyong Shire Council's (WSC) Buttonderry Waste Management Facility. This facility will include (at least) the main personnel access to the mine, main ventilation facilities, offices and employee amenities;
- An inclined tunnel (or 'drift') constructed from the coal seam beneath the Buttonderry Site to the surface at the Tooheys Road Site;
- Construction and use of various mining related infrastructure including water management structures, Water Treatment Plant utilising Reverse Osmosis (RO), generator, second air intake ventilation shaft, boreholes, communications, water discharge point, powerlines, and easements to facilitate connection to the WSC (after July 2013, the Central Coast Water Corporation) water supply and sewerage system;
- Capture of methane for treatment, initially involving flaring as practicable for greenhouse emission management and ultimately for beneficial use of methane such as electricity generation at the Tooheys Road Site;
- Transport of coal by rail to either the Newcastle port for export or to domestic power stations;
- A construction workforce over a three year period of up to 450 employees and an operational workforce of approximately 300 full-time equivalent employees; and
- Rehabilitation and closure of the site at cessation of mining operations.

1.4 Proponent

The proponent is the WACJV, which is comprised of the following ownership structure:

- Kores Australia Pty Ltd 82.25%
- Catherine Hill Resources Pty Ltd 5.00%
- Kyungdong Australia Pty Ltd 4.25%
- SK Networks Resources Australia (Wyong) Pty Ltd 4.25%
- SK Networks Resources Pty Ltd 4.25%

The contact details for WACJV are:

Wyong Areas Coal Joint Venture
PO Box 3039
TUGGERAH NSW 2259
Phone: 02 4352 7500
www.wallarah.com.au

The proponent has maintained a good record of environmental performance. WACJV has not been subject to any proceedings under a Commonwealth or State law for the protection of the environment or the conservation and sustainable use of natural resources. All exploration activities have been undertaken in accordance with the conditions of WACJV's mining authorities.

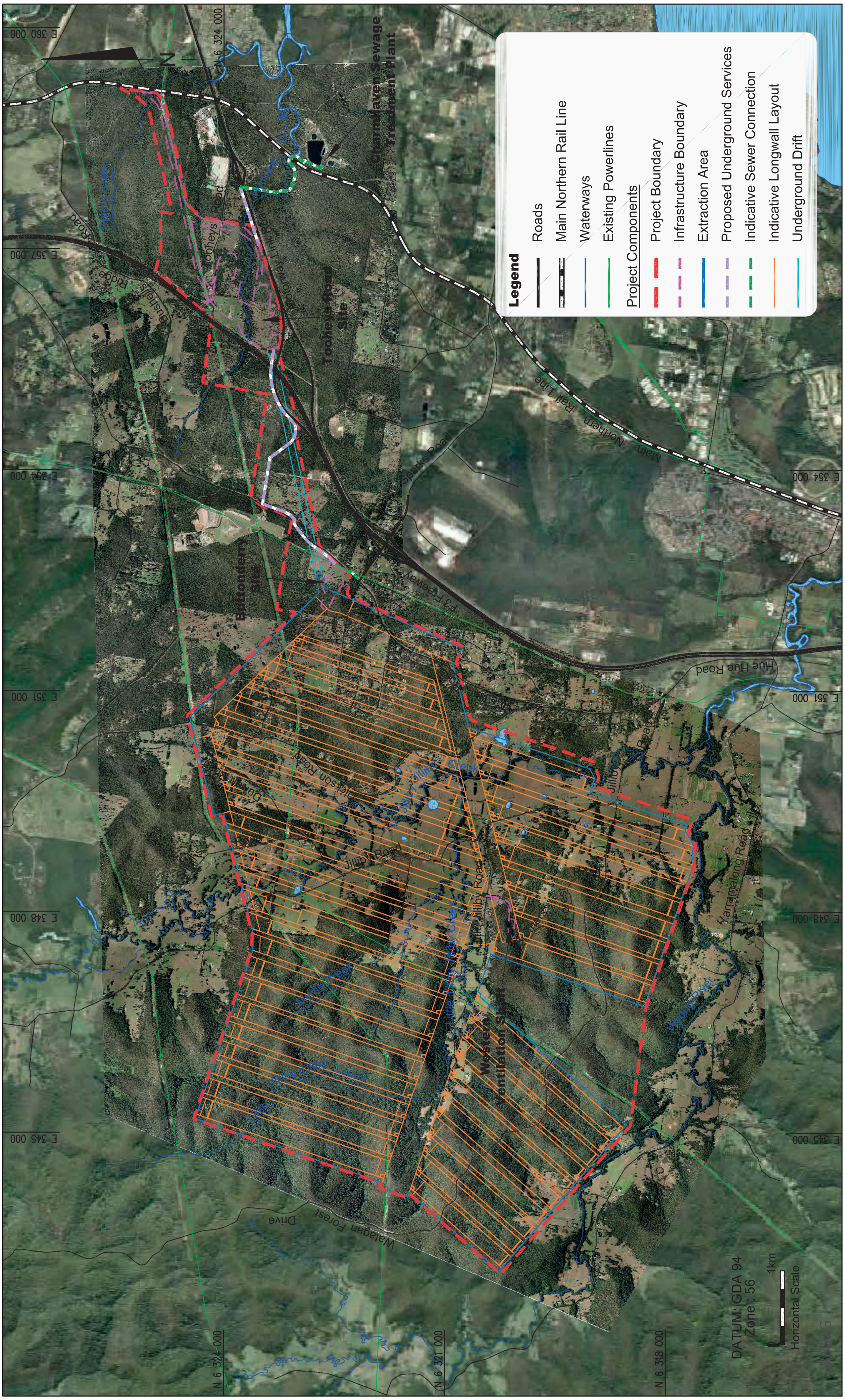
In order to facilitate responsible environmental management, WACJV conducts all of its activities in accordance with the WACJV Environmental Policy. Since 1996, WACJV has undertaken environmental monitoring for the purposes of collecting baseline data for the Project.

1.5 Document Purpose

The WACJV seeks Development Consent under Division 4.1 of Part 4 of the EP&A Act for the Project. The Background Document that supported WACJV's request for the Director-General's Requirements (DGRs) for the Project in accordance with Part 2 of Schedule 2 of the *Environmental Planning & Assessment Regulation 2000* (EP&A Regulation) was submitted in October 2011.

This EIS has been prepared by Hansen Bailey Environmental Consultants (Hansen Bailey) on behalf of WACJV to support an application for Development Consent. The Project Boundary to which this EIS applies is illustrated in Figure 2. The schedule of land to which this EIS applies (all land located either wholly or partly within the Project Boundary) is provided in Appendix A.

This EIS has been prepared to address the requirements of the DGRs issued (as revised, see Appendix B) by the Department of Planning & Infrastructure (DP&I) on 12 January 2012 by assessing the social, economic and environmental impacts of the Project to enable the Minister for Planning and Infrastructure to determine the Development Application as sought.



WALLARAH 2 COAL PROJECT

Conceptual Project Layout (Aerial)

FIGURE 3

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Wallarah 2 COAL PROJECT

This EIS and associated Appendices include the consideration of issues raised during the stakeholder engagement process undertaken for the Project.

A summary of stakeholder issues raised in relation to the Project and a checklist of each DGR and where these have been addressed in this EIS is presented in Section 5.

1.6 Document Structure

This EIS consists of six volumes. This volume (Volume 1) encompasses the main EIS report prepared by Hansen Bailey and (in relation to the Project) presents a description, summary of associated environmental, social and economic impacts and the mitigation and management measures proposed to be implemented.

This EIS is structured as follows:

- Section 2 provides relevant information on the existing environmental setting;
- Section 3 provides a detailed description of the Project;
- Section 4 outlines the regulatory framework applicable to the Project;
- Section 5 details stakeholder engagement undertaken for the Project and discusses issues raised. Specifically, this section lists the DGRs and identifies where these matters are addressed in this EIS;
- Section 6 provides a summary of the risk assessment process adopted to rank all identified environmental and social issues to assist in directing the focus of this EIS;
- Section 7 assesses environmental and social issues and impacts predicted for the Project and outlines the management and mitigation measures proposed for each;
- Section 8 presents the Project's management and monitoring summary;
- Section 9 provides a detailed Project justification;
- Section 10 lists abbreviations used throughout this EIS;
- Section 11 provides a list of all materials referenced in this EIS; and
- Section 12 presents the study team involved in the compilation of this EIS.

Volume 2 contains the schedule of land to which this EIS applies, regulatory correspondence, stakeholder engagement materials and the revised environmental risk assessment undertaken during the preparation of this EIS.

Volumes 2 to 6 present the remaining technical assessments, which support the main volume of this EIS.

The hard copy version of this EIS does not contain the annexes to Appendix K, Appendix N and Appendix AA. These annexes are reproduced in full in the digital version of the EIS which is available on the DP&I website and the CD on the inside cover of Volume 1 of the hard copies. These three annexes will be made available as a hard copy upon request.

Wallarah 2
COAL PROJECT

Wallarah 2 Coal Project

Environmental Impact Statement

April 2013

2

Existing Environment

Hansen Bailey
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Existing Environment 2

This section provides a description of the existing environment within the Project Boundary and the surrounding region. It describes the regional setting, significant natural features (including topography and water catchments), land use, land ownership and the existing climate and baseline data within and surrounding the Project Boundary. The geology of the area is also discussed as relevant to the Project.

2.1 Regional Setting

The closest township to the Project is Wyong which is located approximately 4.7 km to the south-east of the Project Boundary (see Figure 2). The Sydney – Newcastle Freeway (F3 Freeway) and Main Northern Railway Line run generally north – south, adjacent to the eastern extent of the area within the Project Boundary and form part of the major road and rail network that provides access throughout the region.

A large proportion of the Project's underground coal Extraction Area is located beneath the Wyong State Forest and adjacent forested hills, including part of the Jilliby SCA which was created in 2003. In the eastern section of the Extraction Area is Jilliby Jilliby Creek which joins Wyong River further to the south-east. Wyong River enters Tuggerah Lake, a large coastal saltwater lagoon on the Central Coast of NSW.

2.2 Topography

The Project is located within the Newcastle Coalfields which is in the north-eastern extent of the Sydney Basin Bioregion (SBBR). The SBBR extends for 380 km along the east coast of NSW and covers more than 64,000 km^2.

Topography within the Tooheys Road Site is characterised by gentle rises ranging in elevation from 10 m Australian Height Datum (AHD) near Wallarah and Spring Creeks to 50 m AHD at the south-western portion of the site and at Bushells Ridge to the north.

The Buttonderry Site is characterised by a gentle rise ranging in elevation from 5 m AHD near Hue Hue Road and Buttonderry Creek to 60 m AHD in the south-western and most elevated portion of the site, and to 40 m AHD in the north-western corner.

The topography in the vicinity of the Western Ventilation Shaft is generally hilly with steep slopes along an east-west orientated ridge. Areas proposed to be upgraded on Brothers Road are 21 m AHD and rise in elevation along the 700 m long impact footprint road and facilities area to 45 m AHD at the site.

The general topography of the Extraction Area ranges from the low alluvial floodplain areas of Jilliby Jilliby Creek in the east to the steep and rugged hills in the west. The local relief is generally between Reduced Level (RL) 25 – 225 m AHD with slope gradients outside of the floodplain ranging between 20-60%. Several smaller, steep-sided valleys are associated with tributaries into the Wyong River and Jilliby Jilliby Creek. These tributaries feature steep long slopes, separated by crests and ridges of the Wyong State Forest and Jilliby SCA.

The Yarramalong and Dooralong Valleys are comprised of low slopes and floodplains consisting mainly of flat to gently sloping floodplain terraces and low slopes / toe slopes.

2.3 Water Catchments

2.3.1 Background

The Project is located within the Tuggerah Lakes Basin, which has a catchment area of approximately 700 km^2. The major rivers and tributaries of the catchment include the Wyong River, Jilliby Jilliby Creek, and Ourimbah Creek.

The region is bordered by a series of small eastern flowing streams in the north, the Sugarloaf Ranges in the north-west, Watagan Mountains in the west and the Hunter Range in the south and south-west. The area covers a range of landscapes that include plateaus, ranges, hills, floodplains, estuarine and coastal areas (IEC, 2009).

The character of the region's rivers, creeks and floodplains has been changed dramatically by European settlement, with large areas of land cleared for agricultural activities. There are still considerable areas (approximately 58%) of State Forest and National Park within the region; however riparian vegetation has only been preserved in the upper reaches. The lower reaches and particularly the floodplain areas have been highly altered with little remnant vegetation existing (IEC, 2009).

The Tooheys Road Site is located within the Wallarah Creek catchment, which is a tributary of Budgewoi Lake. Wallarah Creek to the downstream extent of the Project Boundary has a total catchment area of approximately 4 km^2. Wallarah Creek flows east and enters Budgewoi Lake approximately 6.6 km downstream of the Tooheys Road Site. The entire catchment area of Wallarah Creek to Budgewoi Lake is approximately 45 km^2.

WALLARAH 2 COAL PROJECT

Project Catchments and Gosford - Wyong Drinking Water Catchments

FIGURE 4

The Buttonderry Site is located within the Buttonderry Creek catchment, which has an area of approximately 5.4 km^2 upstream of the Buttonderry Site. Buttonderry Creek joins Woongarrah Creek and Hue Hue Creek at the Porters Creek wetland. The Porters Creek wetland has a surface area of approximately 6 km^2 and a total catchment of 55 km^2. The Porters Creek wetland drains to the Wyong River, which is a tributary of Tuggerah Lake. The confluence of Porters Creek wetland and the Wyong River is approximately 7.6 km downstream of the Buttonderry Site. The Wyong River flows east and enters Tuggerah Lake 8.1 km further downstream.

The coal Extraction Area predominantly underlies the Jilliby Jilliby Creek catchment. The Western Ventilation Shaft lies within the catchment for Little Jilliby Jilliby Creek, which is a tributary of Jilliby Jilliby Creek. Jilliby Jilliby Creek is a major tributary of the Wyong River with a catchment area of approximately 100 km^2. The headwaters of the creek lie in the Olney State Forest, some 36 km upstream of its confluence with the Wyong River (IEC, 2009). Streamflow within Jilliby Jilliby Creek represent approximately 14% of the streamflow available under the Gosford-Wyong Water Supply Scheme.

The total potential Subsidence Impact Limit of approximately 37 km^2, located within the catchment area of the Gosford-Wyong Water Supply Scheme, represents approximately 5% of the total catchment contributing to the Scheme. Approximately 29 km^2 of the Subsidence Impact Limit is located within the Jilliby Jilliby Creek catchment, a further 4.2 km^2 is located in the catchment of Hue Hue Creek and the remaining 3.8 km^2 is located in the direct catchment of the Wyong River.

2.3.2 Gosford-Wyong Water Supply Scheme

Gosford City and Wyong Shire Councils have a joint water supply system managed by the Gosford Wyong Councils Water Authority (GWCWA) which serves a current urban population of 285,000 people (GWCWA, 2010). From July 2013, the GWCWA will become the Central Coast Water Corporation and will manage both the drinking water supply and the regional sewerage system. The present Gosford-Wyong Water Supply Scheme is based on harvesting potable water from four coastal streams: Wyong River, Mangrove Creek, Mooney Mooney Creek and Ourimbah Creek. The Water Supply Scheme surface water infrastructure includes a network of dams, weirs, reservoirs and water treatment plants interconnected by tunnels and pipelines (SKM, 2010) as shown in Figure 4.

There are three operational dams (Mangrove Creek Dam, Mardi Dam and Mooney Dam) and three operational weirs in the joint water supply system. A summary of the key storages is provided in Table 1. There are also two water treatment plants in the Scheme, one located at Mardi, in Wyong LGA and the other at Somersby in Gosford LGA.

The GWCWA system is also connected to the Hunter Water System by a two way pipeline capable of supplying up to 35 ML/day of treated drinking water in either direction.

Historical constraints on water supply in the region have been predominantly associated with limited water storage availability. Storages in the lower catchment (see Table 1) have a combined total capacity of only 12,445 ML, which is less than 7% of the capacity of the Mangrove Creek Dam (190,000 ML). It is also significant that the Mangrove Creek Dam has a relatively small catchment area (101 km^2) which generates average annual runoff of approximately 18,600 ML. Without any extractions, it would take on average about 10 years for the dam to fill.

Water from the Wyong River and Ourimbah Creek is transferred to Mardi Dam, which is an off-stream storage. The recently constructed Mardi-Mangrove Link (completed July 2012) links the Wyong River and Ourimbah Creek to Mangrove Creek Dam, via Mardi Dam.

If needed, water can be released from Mangrove Creek Dam to provide sufficient flows down Mangrove Creek. Alternatively, with the advent of the Mardi-Mangrove Creek Dam Pipeline, water from the Dam can be released via Boomerang Creek Tunnel and then the Pipeline to be transferred to Mardi Dam without requiring routing via the Wyong River as historically has been the case. Water harvested from Wyong River can also be pumped to the larger Mangrove Creek Dam. The Mardi-Mangrove Link can transfer up to 120 ML/d in either direction.

Proposed future development of the water supply system, described in 'WaterPlan 2050' (GWCWA, 2007) will progressively raise the annual system yield to 50,000 ML. These works are anticipated to provide sufficient water to satisfy demands until 2050. Figure 4 presents a schematic of the Gosford-Wyong water supply system.

Table 2 shows the average annual inflows to the water supply system, obtained from 'WaterPlan 2050' which indicates an average annual streamflow of 176,300 ML.

2.3.3 GWCWA Entitlements

GWCWA presently has the following water entitlements from the water supply system catchments under the relevant Water Sharing Plans (WSP):

- 34,600 ML/year from Wyong River and Jilliby Jilliby Creek;
- 8,400 ML/year from Ourimbah Creek;
- 47,900 ML/year from Mangrove Creek; and
- 17,900 ML/year from Mooney Mooney Creek.

Actual extractions by the water supply scheme are limited by the WSPs to a total of 36,750 ML/year from a combination of these sources.

A review of the historical rainfall and streamflow information in Wallarah Creek, Wyong River and Jilliby Jilliby Creek has enabled the volumetric runoff coefficients to be estimated to assist in investigating streamflow quantities. The estimated volumetric runoff coefficients for the Wyong River (17%) and Jilliby Jilliby Creek (24%) are relatively high. The estimated volumetric runoff coefficient of 36% for Wallarah Creek is very high for a catchment without significant impervious areas. It is possible that this high runoff coefficient is an artefact of the rating curve at the Wallarah Creek gauge. The period of available data (1966 to 1976) includes some very wet years.

Based on these results, the average annual streamflow from the Jilliby Jilliby Creek catchment is 248 mm, which is equivalent to 248 ML per km^2 per annum. The Jilliby Jilliby Creek catchment thus contributes, on average, approximately 24,800 ML of streamflow per annum to the catchment of the Gosford-Wyong Water Supply Scheme. This represents about 14% of total streamflow in the Gosford-Wyong Water Supply Scheme (WRM, 2012).

2.3.4 Baseflow

An analysis of baseflow in the Wyong River and Jilliby Jilliby Creek was undertaken as part of the 'Wyong Water Study' (SKM, 2010). The results of the analysis indicate that baseflow comprises 14% to 28% of measured streamflow across the region. During dry periods, the proportion of baseflow may increase to 100% of recorded streamflow (SKM, 2010).

An analysis of the impacts of subsidence on baseflow to surface drainage paths has been completed as part of the Groundwater Impact Assessment (MER, 2012). The results of these analyses are discussed in Section 7.2.

2.4 Land Use

The subregion containing the Project accommodates several land uses, ranging from light industrial, commercial and housing developments to small townships and acreages (see Figure 5).

Major transport routes traverse the area to the east of the Project Boundary, including the F3 Freeway, Motorway Link Road and the Main Northern Railway Line. The western extent of the area within the Project Boundary features heavily timbered steep hills, most of which are included in Wyong State Forest and Jilliby SCA.

2.4.1 Industrial and Commercial

The Wyong LGA supports three main industrial and/or commercial centres. Enterprise Drive (Tuggerah Business Park) straddles Ourimbah Creek and links the southern lake areas with Tuggerah. The Tuggerah Straight commercial area is also close to Tuggerah, whilst the North Wyong Industrial Area links Watanobbi to the newly developing Warnervale area. Development pressure is increasing for expanding industrial and commercial development in the Warnervale / Sparks Road area, Warner Industrial Park (the Precinct 14 area within the Wyong Employment Zone (WEZ)) and the Tooheys Road Site (see Figure 5).

The WEZ was created in order to meet employment requirements associated with the anticipated growth in the Central Coast population to 2031. The WEZ creates an opportunity to attract and accommodate the needs of large firms and new forms of industry to help respond to the need for significant local employment growth. It is anticipated that WEZ will help create around 6,000 jobs by attracting firms and industries including manufacturing, warehousing, storage and research.

Table 1 GWCWA Water Supply Scheme Storages

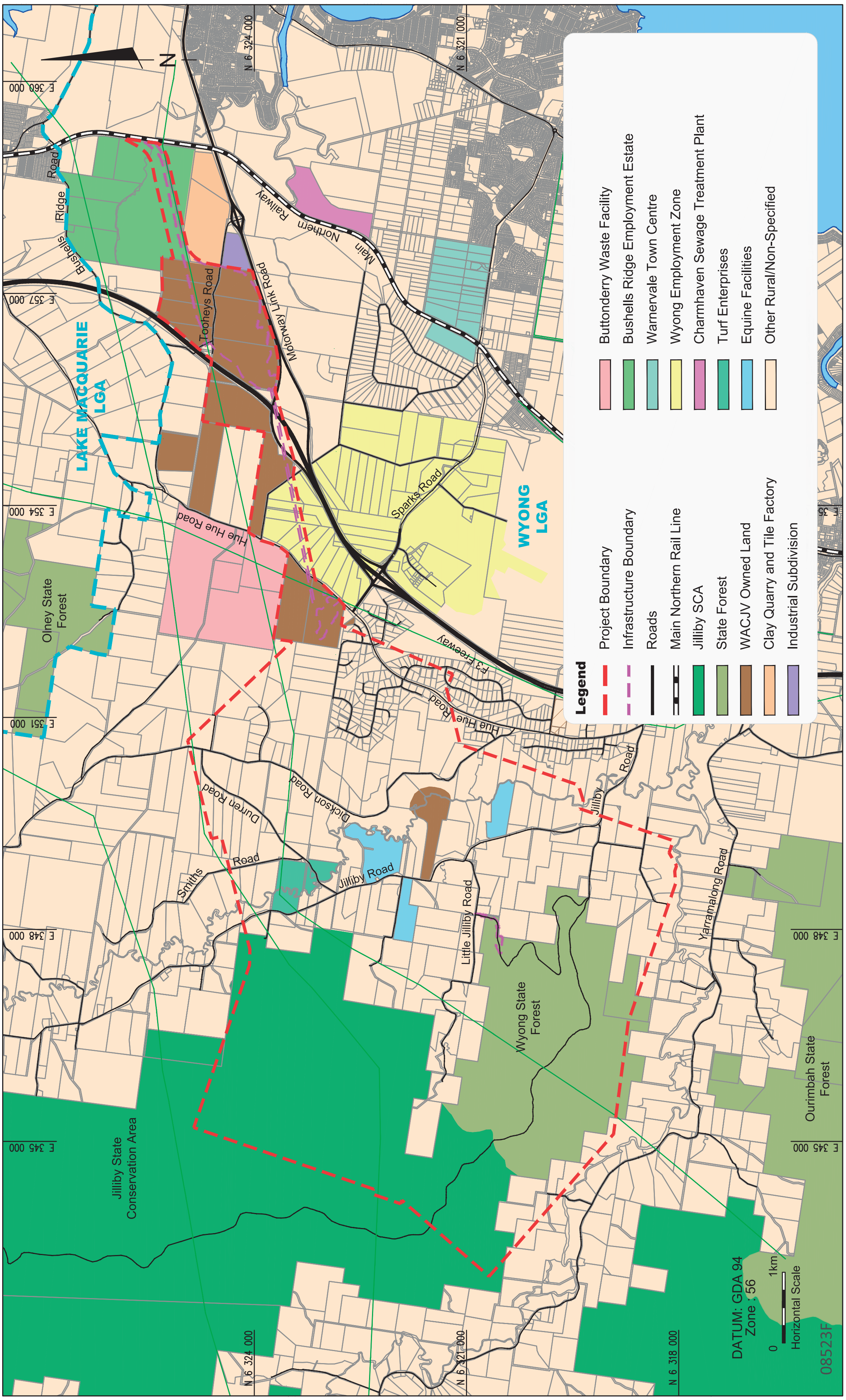
Catchment	Year Built	Catchment Area (km^2)	Maximum Capacity (ML)
Mangrove Creek Dam	1980	101	190,000
Mardi Dam	1962	2	7,400
Mooney Mooney Dam	1961	39	4,600
Lower Wyong River Weir	1968	355	300
Lower Mangrove Creek Weir	1975	140	100
Ourimbah Creek Weir	1978	88	45
Total		**725**	**202,700**

Source: SKM, 2010

Table 2 GWCWA Water Supply System Inflows

Catchment	Catchment Area (km^2)	Average Annual Streamflow (ML)	Average Annual Streamflow ($ML/km^2/year$)
Lower Wyong River Weir	355	84,500	238
Ourimbah Creek Weir	88	26,400	300
Mooney Dam	39	16,800	431
Mangrove Creek Dam	101	18,600	184
Mangrove Creek Weir (excluding Mangrove Creek Dam catchment)	140	30,000	214
Total	**725**	**176,300**	

Source: GWCWA, 2007



WALLARAH 2 COAL PROJECT

Significant Land Use within the Project Boundary

FIGURE 5

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The Tooheys Road Site and surrounds is designated for large industrial enterprises and has been zoned accordingly (see Figure 6). The Tooheys Road Site, which will contain the main surface infrastructure, is located within the Bushells Ridge Precinct noted in the 'North Wyong Structure Plan' (Department of Planning, 2012) and identified in the 'Central Coast Regional Strategy' (Department of Planning, 2008).

The Project will not have a direct impact on residential or industrial land in the main Wyong centre. There are a number of industrial and commercial developments surrounding the Tooheys Road and Buttonderry sites at varying stages of development, which have the potential to contribute to cumulative environmental impacts. These developments are shown on Figure 5 and are summarised below.

Warnervale Town Centre

The Warnervale Town centre is located in the vicinity of the intersection of Sparks Road with the Main Northern Railway Line (over 3 km south-east of the Tooheys Road Site). This proposed township development will provide commercial, residential housing and leisure components, including; a Big W Discount Department Store, Woolworths supermarket, specialty retail, entertainment, gym, commercial and car park. According to DP&I's major projects' website, the status of the Warnervale Town Centre Woolworths Retail Facility development (as at February 2013) is "Assessment" by DP&I.

Wyong Employment Zone

In order to meet the anticipated growth in population for the region and required employment opportunities, the WEZ resulted in the rezoning of approximately 340 hectares (ha) for general industrial purposes around the intersection of Sparks Road and the F3 Freeway. It is predicted that this development will generate employment for approximately 6,000 people. Development of the WEZ is well behind earlier planning schedules.

In addition to the rezoning for industrial purposes, the WEZ includes the rezoning for conservation purposes of a further 349 ha "for the protecting and enhancing significant vegetation and habitat".

The WEZ consists of Precincts 11, 13 and 14 and provides for a range of large scale industrial uses. Precincts 11 and 13 are divided into north and south sections by Sparks Road, between the F3 Freeway and the Main Northern Railway Line. Precinct 14 is located to the north of Sparks Road, between the F3 Freeway and Hue Hue Road and opposite the Buttonderry Site.

In November 2008, the WEZ proposal was approved. This amendment to the *Wyong Local Environmental Plan 1991* (Wyong LEP) established three land use zones within the WEZ land:

- IN1 General Industrial;
- SP2 Infrastructure; and
- E2 Environmental Conservation.

The increase in industrial land area for the WEZ recognises the value of the region to the State's ability to accommodate and provide employment for the growing population. The Buttonderry Site lies adjacent to the western boundary of the WEZ, while the Tooheys Road Site is approximately 1.2 km to the north-east.

Warner Industrial Park

The Warner Industrial Park (within Precinct 14 of the WEZ and located directly across the Hue Hue Road from the Buttonderry Site) is a 90 lot subdivision of a parcel of land to be used for industrial and ancillary uses. The development was approved in 2010 and is predicted to be operational in 2018.

Bluetongue Brewery

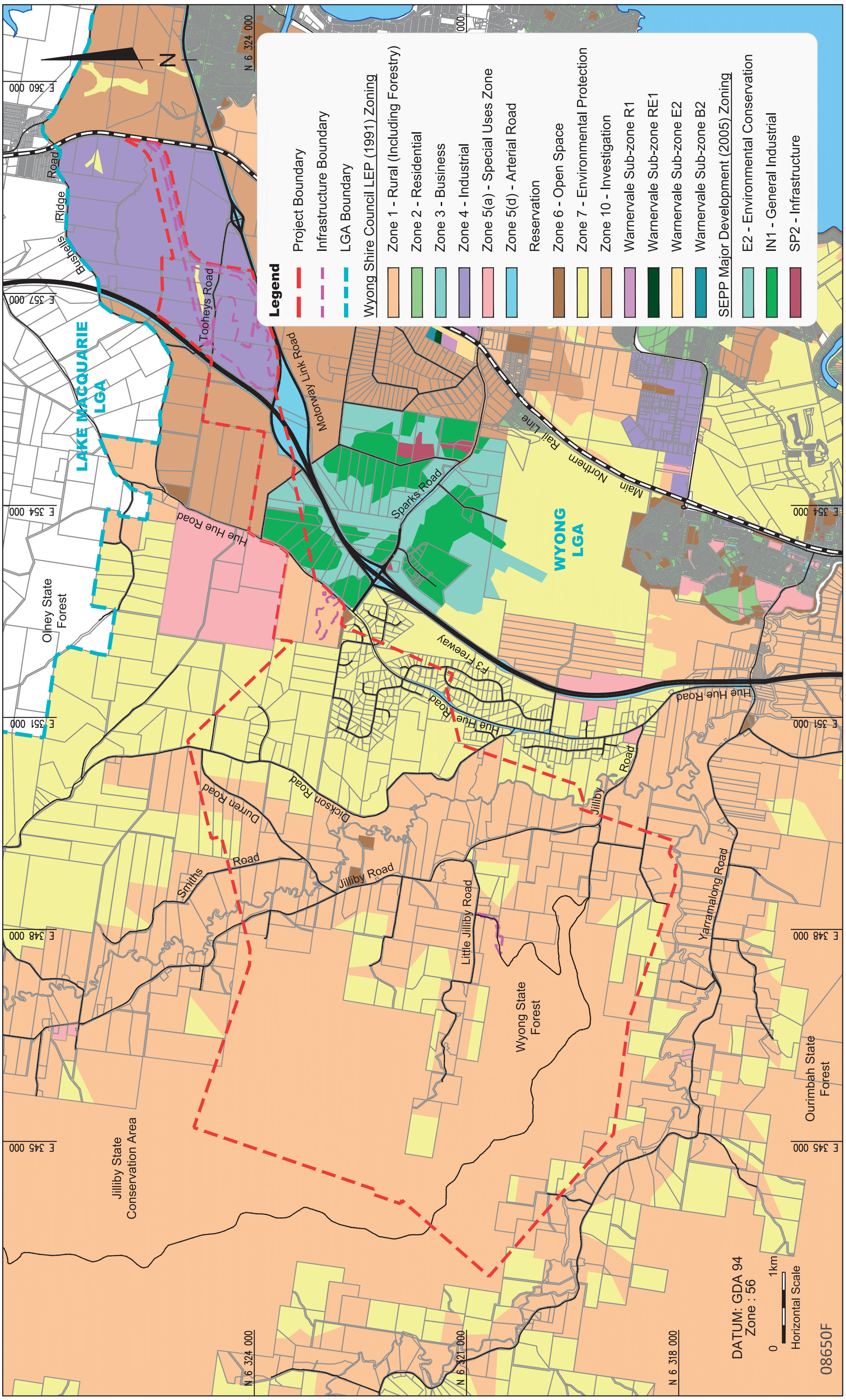
A brewery has been constructed at the south-western end of Burnet Road and within the WEZ. The brewery facilitates the production and packaging of a number of beer brands. The facility operates 24 hours per day, seven days per week and it is understood that a total of 140 full time staff are employed (GHD, 2008).

Warnervale Airport Industrial Subdivision

Also within the WEZ, WSC proposes a subdivision of the lot at 150 – 190 Sparks Road for industrial purposes. Based on Trehy, Ingold and Neate Land Development (2011) 'Section 96(1) Application to Modify Development Consent Development Application (DA) DA/3130/2004/A Proposing Subdivision of Land 150190 Sparks Road, Warnervale', this development will create two industrial lots (total land size 7.91 ha), one temporary conservation lot, one residue parcel, construction of a road and construction of an artificial wetland. WSC granted approval for this development in January 2012. In this vicinity is a proposed Chinese Theme Park which may be developed on 16 ha of land previously owned by WSC (WSC, 2012). The proposed development is yet to be subject to a formal development application.

Bushells Ridge Employment Estate

Located to the south of Bushells Ridge Road and north of Tooheys Road on approximately 260 ha of land, a previously proposed development was planned to provide approximately 150 allotments of new employment facilities for warehousing and distribution purposes.



WALLARAH 2 COAL PROJECT

Land Zoning

FIGURE 6

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Based on the JBA Planning (2010) 'Preliminary Assessment for Bushells Ridge Employment Estate Concept Plan', the developer (Darkinjung Local Aboriginal Land Council) sought shared road access with the Project to provide direct connection between the site off Tooheys Road and the Tooheys Road/Motorway Link interchange.

A Preliminary Environmental Assessment was submitted to DP&I and DGRs were issued in March 2011. However, this development application has since been withdrawn.

Buttonderry Waste Management Facility

The existing WSC owned and managed Buttonderry Waste Management Facility is located north of the Buttonderry Site. The recent upgrade works of the Buttonderry Waste Management Facility included a new transfer station, office and education centre, widening of the incoming access road to the weighbridge and a new car park at the existing site located off Hue Hue Road.

Tooheys Road 18 Lot Industrial Subdivision

This 18 lot industrial subdivision will provide industrial allotments off Tooheys Road, to the north-west of the Tooheys Road/ Motorway Link interchange. Based on ADW Johnson (2010) 'Statement of Environmental Effects for a Proposed 18 lot Industrial Subdivision', the developer proposed to upgrade Tooheys Road between its site access and the existing sealed section near the interchange. Road upgrade works including constructing kerb and gutter and pavement sealing along Tooheys Road are yet to be commenced.

The development involves the creation of 18 industrial allotments with an average allotment size of approximately 5,738 m^2. In addition, a separate allotment of 4.5 ha containing a riparian zone will be created and dedicated to Council. WSC approved this development in 2010 but no substantive site works have been completed at this time.

Clay Quarry and Tile Factory

Boral Montoro Pty Ltd (Boral) operates a clay quarry and roof tile manufacturing plant approximately 1.1 km and 1.8 km respectively to the east of the Tooheys Road Site. Boral holds a Mining Lease (ML) 554 which covers an area of approximately 57.2 ha and extends to a depth of 20 m. Following its renewal in December 2003, ML 554 remains valid until December 2023.

Charmhaven Sewage Treatment Plant

The operating Charmhaven Sewage Treatment Plant is located approximately 1.2 km south-east of the Tooheys Road Site. The Charmhaven Sewage Treatment Plant is one of six treatment plants located in the Wyong LGA and ultimately connects to the ocean outfall discharge off Norah Head.

2.4.2 Residential

In the Wyong LGA, 90% of urban development is consolidated into 56 km^2 of low density residential development around Tuggerah Lake (WSC, 1998). As shown in Figure 2, the major suburban clusters in the Wyong LGA are located to the east of the F3 Freeway.

A group of 30 rural landowners is seeking the rezoning of approximately 400 ha to enable a future subdivision of this land into 280 lots (approximately 1 ha each). The subdivision is located above the Extraction Area and extends west from the Buttonderry Site. As such, consultation has been carried out with the landowner group to discuss timing and consequences of potential impacts of the Project including subsidence. A DA has not yet been lodged with WSC and at the time of writing this EIS the proposed timing of such an application is unknown. Consultation is further discussed in Section 5.4.

2.4.3 Rural

The predominant land uses of the valley floor and near slopes are small scale beef grazing, horse enterprises and rural-residential lifestyle blocks. The beef grazing enterprises are predominantly low input, low intensive management operations with many being sub-commercial in scale.

Over the last 20 years, large holdings have been fragmented and converted to hobby farms, rural weekend retreats, market gardens, nurseries and horse properties. As a result, the character is more rural-residential than agricultural. Scattered rural dwellings follow the river flats and the small communities of Yarramalong and Dooralong are at the heads of their respective valleys. Further detail on the agricultural value in the vicinity of the Project is provided in Section 7.20.

2.4.4 Mining

Abundant natural resources in the Newcastle Coalfields have enabled a long history of coal mining with the establishment of a number of extractive industries in the vicinity of the Project. Current and recently closed mines in the vicinity of the Project are listed in Table 3.

In relation to the potential for cumulative impacts with other mining operations, the closest operating mines are at least 10 km from the Subsidence Impact Limit. The Mandalong Colliery and Mannering Colliery are the closest coal mining operations, located 15 km north and 10 km north-east respectively. Both of these mines are located in a different water catchment and thus the potential for cumulative impacts is negligible.

2.4.5 State Forests

Wyong State Forest and Jilliby SCA occur within the western portion of the Project Boundary. The connected Wyong and Olney State Forests (parts of which have been reserved as a SCA) continue north and west into the forested Watagan Mountains, which stretch towards Wollombi and the Hunter Region (see Figure 2).

To the west of the Yarramalong and Dooralong Valleys, the steep upland country continues through Dharug and Wollemi National Parks to merge with the Great Dividing Range to the west of the Project Boundary. Ourimbah State Forest is south of the Yarramalong Valley, and this area merges with the more gentle slopes of the Somersby Plateau.

Forests in the region have a long history of disturbance associated with forestry activities, including the selective logging and the construction of access trails which has occurred since the 1800s.

Beyond the Project Boundary, the Awaba, Heaton, Olney, Ourimbah, Watagan and Wyong State Forests (known as the Watagans) have been recognised in the Hunter and the Central Coast tourism awards (DP&I, 2012). The Watagans are popular for their camping sites, walking trails and picnic areas.

According to the National Parks and Wildlife Service (NPWS) website, the Jilliby SCA, which partly occurs within the Project Boundary, does not provide any recreational facilities.

2.5 Land Ownership

Land ownership within and surrounding the Infrastructure Boundary as utilised in the air quality and noise assessments is shown on Figure 7 and listed in Table 4.

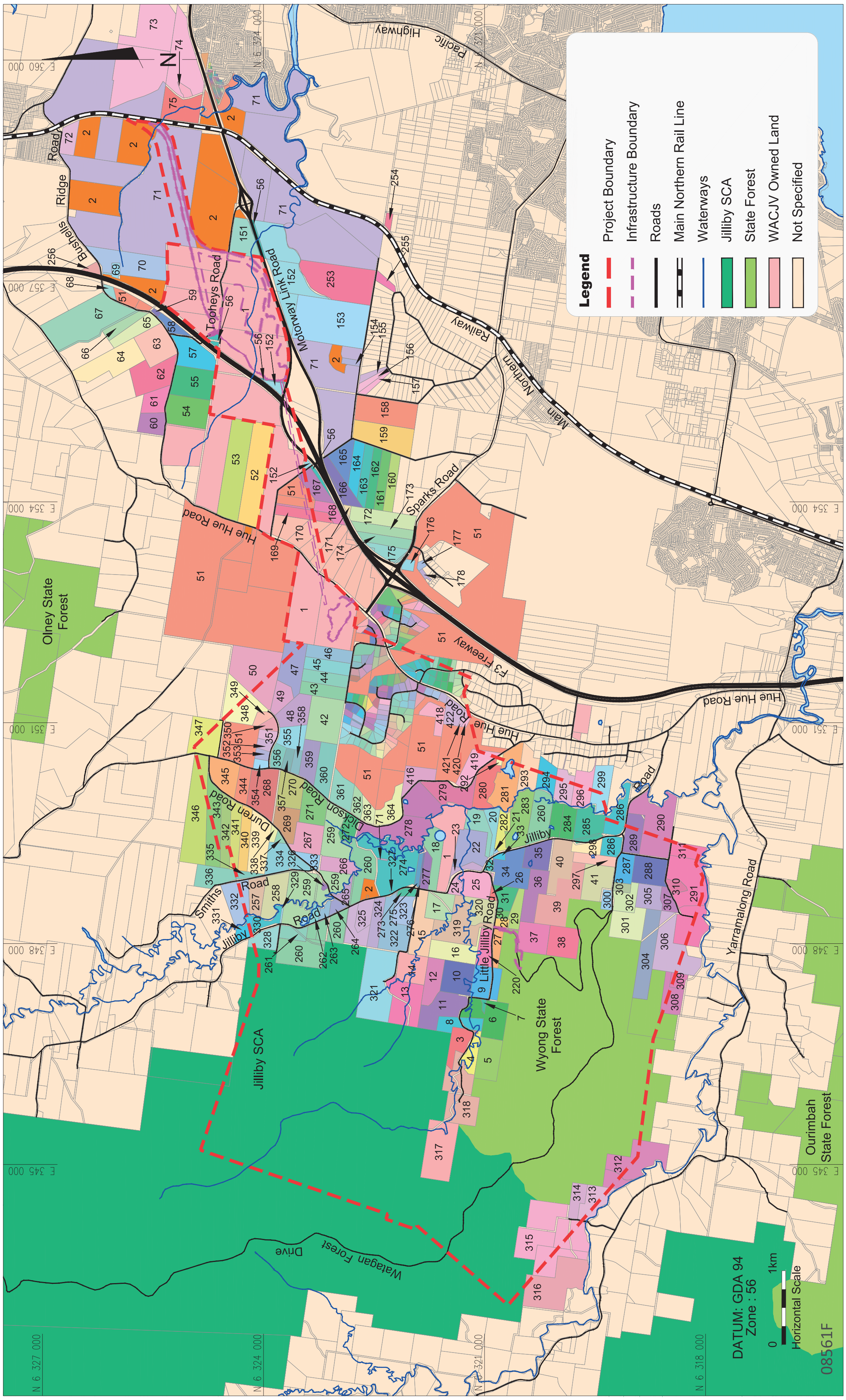
WACJV owns the majority of land to be directly disturbed by the development of the surface facilities at the Buttonderry Site and Tooheys Road Site. The exceptions are a portion of Crown land and Darkinjung Local Aboriginal Land Council (DLALC) lands to be traversed by the rail spur.

The Western Ventilation Shaft is located on land owned by State Forests. Private freehold landholders surround and occur within the Project Boundary.

Forests NSW manage land within and to the north, south and west of the Project Boundary. NPWS manages the Jilliby SCA within and to the north and west of the Project Boundary.

Table 3 Existing Surrounding Mining Operations

Name	Proximity to the Project / Status
Mandalong Colliery	Underground longwall mining operation with approval to operate at 5.5 Mtpa to 2028, located approximately 15 km to the north via the F3 freeway.
Mandalong Southern Extension Project	Continuation of underground mining at the Mandalong Colliery for an additional 21 years, extracting up to 6 Mtpa using continuous and longwall mining methods. Preliminary Environmental Assessment available only.
Cooranbong Colliery	Merged with Mandalong Colliery in 2004, located approximately 25 km north by road.
Newstan Colliery	Longwall and continuous miner underground mining operation with approval to operate at 4 Mtpa to 2020, located approximately 50 km north via the F3 freeway.
Newstan Extension Project	Continuation of underground mining at the Newstan Colliery, extracting up to 4.5 Mtpa using continuous and longwall mining methods. Preliminary Environmental Assessment available only.
Chain Valley Colliery	Bord and pillar underground mining operations with approval to operate at 1.2 Mtpa until 2016. Approximately 11 km north-east via the Pacific Highway.
Moonee Colliery	(Closed) Approximately 20 km to north-east via Pacific Highway.
Wallarah Colliery	(Closed) Approximately 20 km to north-east via Pacific Highway.
Endeavour Colliery	(Closed) Approximately 10 km to north-east via the Pacific Highway.
Myuna Colliery	Continuous miner and Bord and Pillar underground mine operation with approval to operate at 2 Mtpa to 2032, located approximately 30 km to the north by road.
Awaba Colliery	Bord and Pillar extraction underground mine approved to operate at 2 Mtpa until 2015 - ceased operation in April 2012. Approximately 35 km north by road.
Munmorah Coal Mine	(Closed) Approximately 10 km north-east via the Pacific Highway.
Wyee Colliery (Mannering)	Bord and Pillar underground operation with approval to operate at 1.1 Mtpa to 2018, approximately 10 km north-east via the Pacific Highway. The mine is currently under care and maintenance.
Boral Montoro	Clay quarry approved for extraction to a depth of 20 m to 2023, approximately 1.5 km east along Tooheys Road.



WALLARAH 2 COAL PROJECT

Land Ownership

FIGURE 7

Wallarah 2 COAL PROJECT

Hansen Bailey ENVIRONMENTAL CONSULTANTS

Table 4 Land Ownership

ID	Name	ID	Name	ID	Name
2	The State of New South Wales*	40	LP & PC Hirsch	79	CA & JI Hosking
3	IM Ghys*	41	KM & CD Broomfield	80	DJ & AF & R Lazzaroni*
4	IA & MAH Beveridge	42	AT Ethell	81	JA Swinfield & JC Phegan
5	KL Trevenar	43	ZS Muslu	82	KM & JT Scales
6	Govwell Pty Limited	44	C Tohamy & Muslim Community Co-Operative (Australia) Ltd	83	JC & DP Atkins
7	BD & SA Hardwick	45	S Wong & S Lin & PH Lee	84	EI Eddy
8	EM Nomme	46	LA & R Atchison	85	JD Maguire
9	DG & JM Suthers & KL Blunden	47	EM Dunn	86	WJ & KD Bourke
10	PB Chapman	48	KG & KA Macdonald	87	M Khoury
11	KC & J Phillips	49	MJ Baulch	88	MD & KA White*
12	CR & JA Scully	50	F & EM Mercieca	89	CL Taylor*
13	WM & EC Clark*	51	The Shire of Wyong*	90	I & JP Doherty
14	DC Adams & WM Brownlow	52	GB Arbolino	91	DPC & ML Cowell
15	PL & SH Adams	53	G & M Arbolino	92	AJ Pitcaithly
16	DM Akhurst	54	L Bywater	93	MJ O'Rourke
17	MJ McBride & WJ Bennett	55	BJ & KR Drake	94	TN & IM Pereira
18	Oakington Pty Limited	56	The Commissioner for Main Roads*	95	LT Cartwright
19	SJ & MM Olsen & RP & JO Johnson	57	KR Drake	96	RA & CA Johnstone
20	KG & CM Baker	58	KL Norman	97	MG & KL Solway
21	DJ & CA Noble	59	LM Ashcroft	98	AL & KS Heil
22	AW & MS Kirk	60	R Benvenuto	99	LJ & MJ Fenech*
23	BA & CL Huntley	61	RJ Stafford	100	CB & KL Derbyshire*
24	JRG Kavanagh	62	N & A Iordanidis	101	LJ Fuller
25	EJ Hastings	63	B & JM Cross	102	JJ Johnson & JE Mcfarland
26	GG & SF Baldwin	64	MBK & M Lambert*	103	LR Bell
27	JP & LD Morson	65	DJC Suarez	104	JD Moore
28	MA & NI Anderson	66	Granovu Pty Limited	105	SG & BJ Stanfield
29	H & H Christian	67	AR Marshall	106	EP & H Hunt
30	DB & JA Pritchard	68	DP Pemberton & AI Beggan	107	PE & SE Sue
31	MA & LM Campbell	69	Jemena Colongra Pty Ltd*	108	HK Callaghan
32	Minister for Education & Training*	70	Minister for Planning*	109	TA Moxey & BA Robins
33	B & CME Morgan	71	Darkinjung Local Aboriginal Land Council*	110	CA Mckenzie & PL Douglas
34	KS & R Matthews	73	Woodbury Park Estates Pty Limited*	111	N Hanley
35	GW & S Kitson	74	RW & LG Coles	112	TT & LYZ Lin*
36	SB Hemers & VA Lewis	75	Kerry Mountain Pty Limited	113	RK Cravero
37	RF & PJ Coafield	76	Jemby Corporation Pty Limited*	114	MML Hay
38	SM Dullard & SD Cuthbertson	77	RC & JP Holmes	115	M & P Naidu
39	IG Everitt	78	SSA Attia	116	RA & AM Jones

ID	Name	ID	Name	ID	Name
117	WG & JD Beehag	155	B Lees*	193	DP Hingerty
118	YA & V Nahal	156	AM & TJ Quennell	194	JL & JM Turner
119	JA Kemp*	157	SN & LL McIntyre	195	KJ & VJ Renwick
120	D Sundaram	158	G Silvio & A Ienna & G Cataldo & V Caronna*	196	JR & S Bucior
121	DJ Zancanaro	159	Kindimindo Investments Pty Limited	197	AA & SL Van Velzen
122	RD & VR Kershaw*	160	JF & JM Brooks	198	IW Hill
123	CAJ Ogg	161	LJ Gaut	199	PA & A Adams
124	JA Myers	162	G Radan*	200	J Keetley & SA Turtle
125	TA & IF Marshall	163	JN Cashin	201	GL Fletcher & HE Hunt
126	DJ Abbey & JC Sevester*	164	TR Williams	202	PW & NV Purches
127	SS & KL Christie	165	Standard Industries Pty Limited	203	DE & LF Brew
128	MM Miernik	166	R & A Ciccone*	204	KEJ & J Corless
129	GM Mckenzie	167	ID Malley & LJ Pine*	205	DJ & RJ Hall
130	S Karpowicz	168	LG Delahunty*	206	GR & RA Everett
131	R Scappatura	169	Delcare Constructions Pty Limited	207	AD & LM Sylvester
132	DA Abell & LJ Bell*	170	Warner Business Park Pty Limited*	208	FK McLeay
133	PL Cooper & MR Kidd*	171	D & FJ Troy*	209	NA Prest
134	RW & KM Skinner*	172	DN & DB Horton	210	DN Giteau
135	B Aldcroft	173	SR Judge*	211	IM Moyle
136	S Presland	174	KG & KA Macdonald & AD & CM Jameson*	212	AP & DG Jennings
137	TTQ Vo	175	LE & JA Waldon*	213	CJ & L Bauerhuit
138	MR & KM Short	176	AGL Gas Networks Limited*	214	JF & AP Ritchie
139	RD & YN Wilson	177	Pejr Pty Ltd	215	ME & JE Walters
140	SB & ML Eagleton	178	Amarcon Properties Pty Limited*	216	DKA & JA Moore
141	MT & CJ Anderson & CG & SL Fuller	179	BA McNaughton	217	N & M Pantsos
142	SM Swansborough	180	PA & RB Nagle	218	DM & RG Lutze
143	LM & KA Morris	181	JM & K Kent	219	GS & TL Armstrong
144	AN Hawknis & AN Donnelly*	182	RS & B Sandes	220	Marinus Franciscus Musters
145	Cam Moore & CL Watson	183	LB & AR Sparks	221	AM & AJ Morley
146	CP Baker & JP Glover	184	BA & SA Howard	222	RW & CP & BW Ikin
147	LJ Jackson & RC Sevester	185	Heli-Aust Land Holdings Pty Ltd	223	J Edington
148	GJ & JA Olsen	186	J Stekovic	224	CJ Campbell & EI Hinson
149	K Mcallister & J Andrews	187	TR & JA Field	225	MRG & JA Taylor
150	JJ Wain	188	JL & LJ Freeman	226	RW & MT Lovell
151	Hunter Land Holdings Pty Limited*	189	GFC & LF Thompson & IF Thorne	227	PM & MJ Vandenberg
152	Roads and Traffic Authority of New South Wales*	190	J & R Dimis	228	MWR & T Wade
153	JT & KE Hutchinson	191	B & B Mitrovic	229	RF & JM Fowle
154	FKI Ihlenburg	192	RO & AE Holland	230	AR & M Ballard

ID	Name	ID	Name	ID	Name
231	AF Zietsch & ME Roberts	269	AI & MM Coafield	307	RB & KA Farrell
232	PC & M Shadbolt	270	NT Pierce	308	LS Stone-Herbert
233	Invercairn Pty Ltd	271	SP Richards & PS & SL Abram	309	JL & KM Talbot
234	GW & VS Job	272	GW & J Isaacs	310	WH Daniel
235	G & J Caruana	273	PR & KE Phillips *	311	RJ & CD Murray
236	RJ & MA Price	274	CD Manuel & Lestat Pty Limited	312	Mervyn Salmon Pty Limited
237	SJ Kentwell & MP Hanson-Kentwell	275	TL Doust	313	MT & LC Moffett
238	CE & J Golding	276	Chittaway Pty Limited	314	W Christie & JB McElroy
239	AM & BM Evans & MP Church	277	DT & LI Lambeth	315	DI & JK Williams
240	MP & TL Pennycad	278	MK Jackson	316	SA Smith & LJ Sayer
241	LV McNamara & FI Coughran	279	WM McCauley & HL Sorby	317	North by North-West Pty Limited
242	PP & LAC Ball	280	K Higgins	318	PK Dind
243	IJ & CL Thomson	281	SB Jefferys & SL Langsford	319	DG & MC Devlin
244	JE & CR Bates	282	BL & CA Donaldson	320	DB & MJ Smith
245	MC & SG Byrnes	283	PC & VM Borg *	321	PB Farr
246	RJ & JM Smith	284	J & HB Davies *	322	PM & MJ Sinclair
247	DJ & L Clark	285	IP & LE Rich	323	WE Keegan (Junior)
248	PW & SA Gnauck	286	MT Mudie	324	DK Cornford
249	AB & CA Blyth	287	SO & LM Clayton	325	RJ & RG Davies
250	PJ & JA Vassallo	288	VD & RS Davenport	326	WE & G Keegan
251	PE & SG Cooke	289	TJ & AB Bowden	327	TA Pollock & CS Francis
252	C Farmakis*	290	Investasurance Pty Limited	328	DW & SG Johnson
253	IN Macleod*	291	RC & PJ Mansfield	329	A Fahey
254	Steven Barry Mckeogh & Siew Ting Mckeogh	292	PG & AK Murphy	330	PA & TM Hutcheson
255	Arthur Robert Munro & Susan Joan Munro	293	MJ Goddard	331	P & A Polito
256	Norman James Hawkins & Ada Marie Hawkins	294	HS & MA Campbell	332	CM French & KA & WL & RA Gale
257	KJ Randall	295	JW & KA Coombe	333	NL & JL & DL & M Smith
258	SW & PEA Wallis	296	PL & RA Reynolds	334	GF & MS Farram
259	WE Keegan	297	DM Brown & MN Subramany	335	DC Smith
260	NO Smith *	298	AR & SP Bowes	336	LW Morrison & TJ Walker
261	NO Smith & M Grant	299	SW & SJ Jeong	337	JR & SP Browne
262	GG & RM Gessey	300	JJ & L Burgess	338	K & N Bezwarchny
263	F & MJ Valenti	301	GO Clayton	339	CR & EB Freestone
264	JP & MA Batt	302	AE Quarmby	340	RJ & ET McVie
265	GLJ & NDP Korn	303	DJ & KL Asimus	341	GA & SM Dwyer
266	CR & KS & RD Audsley	304	Wicklow Properties Pty Ltd	342	PS & SL Edwards
267	MC & DG Anderson	305	SR Froggatt & SM Guildea	343	NB & YM & CP & BI Bullivant & K & CM Beaumont
268	T Charara & R Khoury & H Alamein & L Moussa	306	ME Williams	344	AF & DG Fookes

ID	Name	ID	Name	ID	Name
345	R & LA Atchison	381	DF & DJ Blaxell	417	TJ & CL Muldoon
346	DN & GM Roycroft	382	RT & RM Johnston	418	AL Morris
347	JA & CR Timp	383	JG & AL Bellwood	419	WJ & B & SJ Patterson
348	Y & O Shevket	384	AC & NE Coombs	420	JN & TMH Chandler
349	DR & PA Dewberry	385	TW & JM McCallum	421	AL & DF & VG & GC Desreaux
350	DG Brown	386	DF & NMM Bosch	422	SR Bishop
351	KJ & RL Currey	387	G & AA Slager	423	NJ Simak & M Sanders
352	SG & TM House	388	DT & ME Rathborne	424	AF & KM Dedera
353	AD & CM Jameson	389	KR & AM Kite	425	NL Stewart & DG O'Leary
354	RA & V Bourne	390	KA Dorman	426	CM & KL Stanford
355	MA & C Sciberras	391	HW & SC Lilley	427	DC & A Moulder
356	CJ & CJ Ware	392	JD & CE Eaton	428	PR Blanshard & TM Van Lierop
357	ID & JM Brown	393	CT & KL Scicluna	429	CJ & KL Ringuet
358	DK & JM Milligan	394	GJ & KA Hickey	430	MG & RL Lloyd
359	BD Hamester	395	PR & LP Gendle	431	GB & NC Brown
360	JJ & SM Durham	396	VA Lewis	432	IE & JA Christiansen
361	JR & GE Kirk	397	PJ & PM Robertson	433	TB Williams
362	CJ & LJ Downes	398	JJ & DR Lovell	434	TJ & DL Baxter
363	DR King	399	DS & TP Waugh	435	DW & AM Akhurst
364	LG Lapham	400	PR Bateman	436	SE & SP Cooper
365	GK & GA Young	401	CJ & KJ Fletcher	437	DC Constantine
366	DR & K-L Carroll	402	SM Bladwell	438	JR & KA Raterman
367	LN & DM Elliott	403	RK & SJ Aldrick	439	RWK & KL LI
368	RA Papallo	404	SN & SL Barr	440	CD & AE MacDonald & TL Bonnor
369	DJ & TL Hoolhan	405	BK & RC Sargent	441	DA & JL Wells
370	PR Gray	406	SM & CJ Heterick	442	RW & C T McClelland
371	MJ & AM Mortiss	407	DG & KA Simmons	443	KC & ST Barnfield
372	EE Garland	408	R & SK Stilo	444	KJ & B Mexted
373	GF & MK Smith	409	TC & SB Gardiner	445	PJ & TK O'Neill
374	SJ & AM Dashwood	410	BR & MK Park	446	CM Cole
375	AAR Sips	411	N & V Sotirios	447	CA Sawer
376	DC & LP Whiting	412	GR & RA White	448	D & JR O'Connor
377	GB & TA Ramsay	413	SA & DJ & MA Lewis	449	Arinya Investments Pty Ltd
378	RB Russell	414	PE & VS Baker	450	EL Moran
379	AL & SD Brown	415	NR & JL Spring	451	GA & PJ Cowham
380	SN & NV McIntyre	416	RJ & DA Squires	452	EK & KA & BL Royle

* denotes a lot with no residence, Landowner 1 is WACJV land.

2.6 Climate

Regional climatic conditions of the Central Coast region are characterised by seasonal variations of warm summer months giving way to mild winters. Rainfall is higher during the first half of the year when easterly winds dominate. The weather is moderated by proximity to the ocean.

The Bureau of Meteorology (BoM) collects climatic information in the vicinity of the Project. A range of climatic data was sourced from the Norah Head Automated Weather Station (Norah Head AWS) located approximately 10 km south-east of the Project, which has been in operation since 1989. The parameters recorded by the Norah Head AWS include:

- Humidity;
- Maximum and minimum temperature;
- Rainfall; and
- Rain days.

Evaporation data was obtained from the BoM station at Peats Ridge (Waratah Road), located approximately 11 km south-west of the Project Boundary. This station has been operational since 1981. Wind speed and direction data was obtained from the meteorological station established for the Project, which is located at the Tooheys Road Site. Baseline meteorological monitoring has been conducted continuously at this site since 2007 and for much of the period since 1996.

Table 5 provides meteorological data relevant to the Project with further discussion on key parameters provided below.

2.6.1 Temperature and Humidity

Temperature records from the Norah Head AWS indicate that February is the hottest month, with an average maximum temperature of 25.9°C. July is the coldest month with an average minimum temperature of 9.7°C. The average annual maximum and minimum temperatures are 22.1°C and 15.1°C respectively.

The warmer months generally experience higher humidity levels than the cooler months. Mean monthly humidity levels range from 63% to 78% for the morning (9:00 am) and from 56% to 72% for the afternoon (3:00 pm). The mean annual humidity levels for the morning and afternoon are 71% and 65% respectively. A summary of temperature and humidity data is provided in Table 5.

2.6.2 Rainfall

In the Central Coast region, rainfall is highest during the autumn months and is lowest during spring. The mean monthly rainfall ranges from 56.4 mm in October to 163 mm in May. The average number of wet days in a month correlates with the mean monthly rainfall. The highest number of wet days occurs in May (14.3 days) and the lowest number of wet days occurs in August (9.2 days).

The average annual rainfall is 1,154 mm over an average of 144 rain days. A summary of the rainfall data for the Central Coast region is provided in Table 5.

Table 5 Meteorological Data Summary

Month	Mean Daily Temperature (°C)		Mean Monthly Rainfall (mm)	Mean Monthly Rain Days	Mean Monthly Relative Humidity (%) *		Mean Monthly Evaporation (mm)*
	Min	Max			9:00 am	3:00 pm	
January	19.6	25.7	72.7	12.5	76	70	143
February	20.0	25.9	101.6	11.4	78	72	116
March	18.7	24.8	105.2	12.5	76	69	105
April	15.8	22.8	127.3	13.4	71	65	78
May	13.1	20.0	163.0	14.3	72	64	56
June	10.9	18.0	133.8	13.1	72	63	48
July	9.7	17.2	98.6	11.2	69	59	53
August	10.6	18.8	69.6	9.2	63	56	78
September	12.8	20.9	68.9	11.6	64	60	102
October	14.8	22.4	56.4	10.6	65	64	124
November	16.7	23.5	89.5	12.9	72	68	129
December	18.3	24.7	67.4	10.9	72	68	146
Total	-	-	**1,153.9**	**143.6**	-	-	1,178
Average	**15.1**	**22.1**	-	-	71	65	-

* Peats Ridge (Waratah Road) Meteorological Station. Source: BoM, 2012.

2.6.3 Evaporation

There is a direct correlation between temperature and evaporation. As a result, monthly evaporation is highest during the summer and lowest during the winter. Mean monthly evaporation levels range from 48 mm in June to 146 mm in December.

In the Central Coast Region, evaporation levels are similar to rainfall levels. The mean annual evaporation is 1,178 mm, compared to the mean annual rainfall of 1,154 mm. A summary of evaporation data is provided in Table 5.

2.6.4 Wind Speed and Direction

Wind speed and direction has been measured by the meteorological station at the Tooheys Road Site since 2007. The region experiences a high percentage (22%) of calm winds (speed less than 0.5 m/s). The annual average wind speed is 1.3 m/s.

In the autumn and winter months, the region experiences dominant winds from the west and west-southwest. Wind direction is more evenly distributed for the spring and summer months. Strong winds during these months generally originate from the north-east, south-east and south. Wind speeds are generally highest during the winter. Annual and seasonal windroses are provided in Figure 8.

2.7 Geology

2.7.1 Exploration

The presence of coal in the subsurface of the Wyong area has been recognised for more than 100 years. In the north-east of the area, the full sequence of coal resource utilisation comprising coal discovery, exploration, mining, and in some instances, reserve exhaustion, final mine closure and new land use succession (such as on the Wallarah Peninsula) has already occurred. These existing and former mining activities in the north-east extend southward to the boundary of the Tuggerah Lake area (which abuts WACJV's EL 4912) and Mandalong Mine in the north (which abuts WACJV's A 405 and EL 4911).

The mining and exploration titles held by WACJV and other mining companies are shown in Figure 9, along with the location of all key exploration boreholes undertaken in the region. Mining Lease Application (MLA) 342, MLA 343, MLA 346 and MLA 350 are also shown and described further in Section 4.4.3.

The Department of Mineral Resources (now Department of Trade and Investment, Regional Infrastructure and Services – Division of Resources & Energy (DTIRIS – DRE) drilled the earliest boreholes in the Wyong area in 1882. These boreholes confirmed the presence of coal at depth. No further drilling activities were recorded until 1957 when Australian Oil & Gas Corporation completed three boreholes.

At least 12 geological exploration programs were undertaken in the Wyong region between 1882 and 1987. Until about 1980, exploration objectives varied from determination of regional structure for coal, oil and gas, to regional coal resource assessment of the more southerly part of the Newcastle Coalfield. Subsequently, in the early to mid-1980s, more detailed drilling was undertaken to determine potential resources of energy coal for the then planned power stations.

In 1994, the NSW Government released two Coal Tender Areas in the Wyong area, with WACJV undertaking intensive field exploration from June 1996 until 2002. Results from 96 pre-existing boreholes formed part of an information package supplied to all companies that tendered for the right to explore the Wyong Coal Development Areas in 1994. A total of 352 HQ boreholes and five large diameter holes have been drilled by the WACJV (as shown on Figure 9).

2.7.2 Stratigraphy

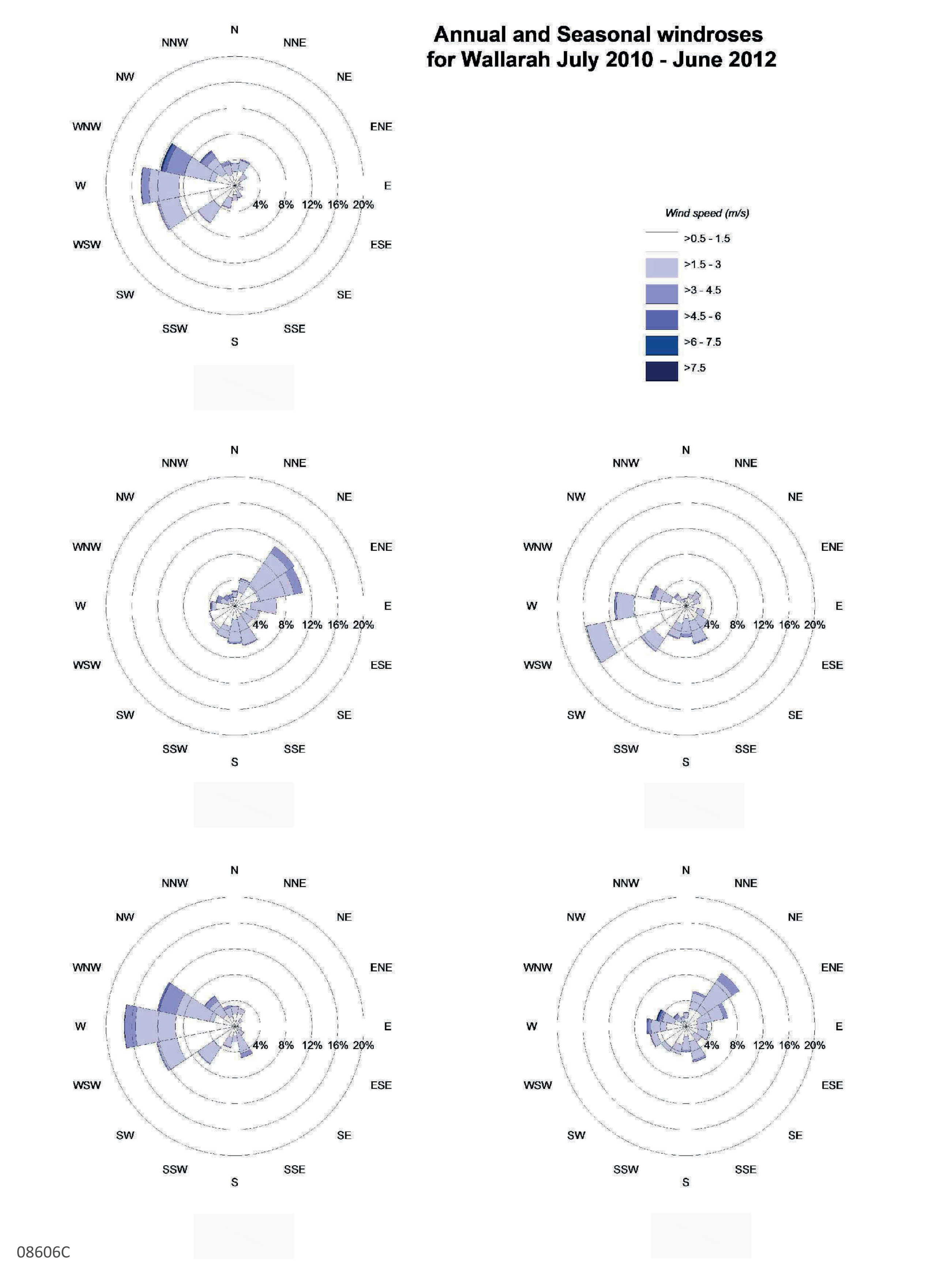
The Wyong area is located within the north-eastern margin of the Sydney Basin and in the southern part of the Newcastle Coalfield. An indicative stratigraphic column of the Project's geology is presented in Figure 10.

Economic coal resources in this region are contained within the upper part of the Permian Newcastle Coal Measures. These strata outcrop to the far north and north-east of the region and dip gently to the south-west beneath the area within the Project Boundary. The lowermost strata of the overlying Narrabeen Group comprise the Dooralong Shale which consists of between 50 m and 70 m of shales and laminites. This sequence coarsens upwards to contain beds of pebbly sandstone.

The overlying Munmorah Conglomerate is generally 70 m to 80 m thick and consists of coarse and pebbly sandstones with occasional green-grey shales. Neither of these sequences outcrops in the Extraction Area. Outcropping in the north-east of the area is a 200 m thick sequence of sandstones with minor siltstones and rare conglomerates known as the Tuggerah Formation.

The Patonga Claystone, which consists of 80 m to 110 m of interbedded grey-green and red-brown claystones and minor fine-grained sandstones, commonly outcrops in the lower elevation areas in (and immediately beneath) the Yarramalong and Dooralong Valleys. The uppermost strata of the Narrabeen Group in the area belong to the Terrigal Formation and consist of sandstones and minor siltstones. This sequence occurs through the more elevated zones of the south-western half of the area within the Project Boundary.

Unconsolidated Quaternary silts and sands of up to 50 m thickness occur as fill along the Yarramalong and Dooralong Valleys and beneath Tuggerah Lake.

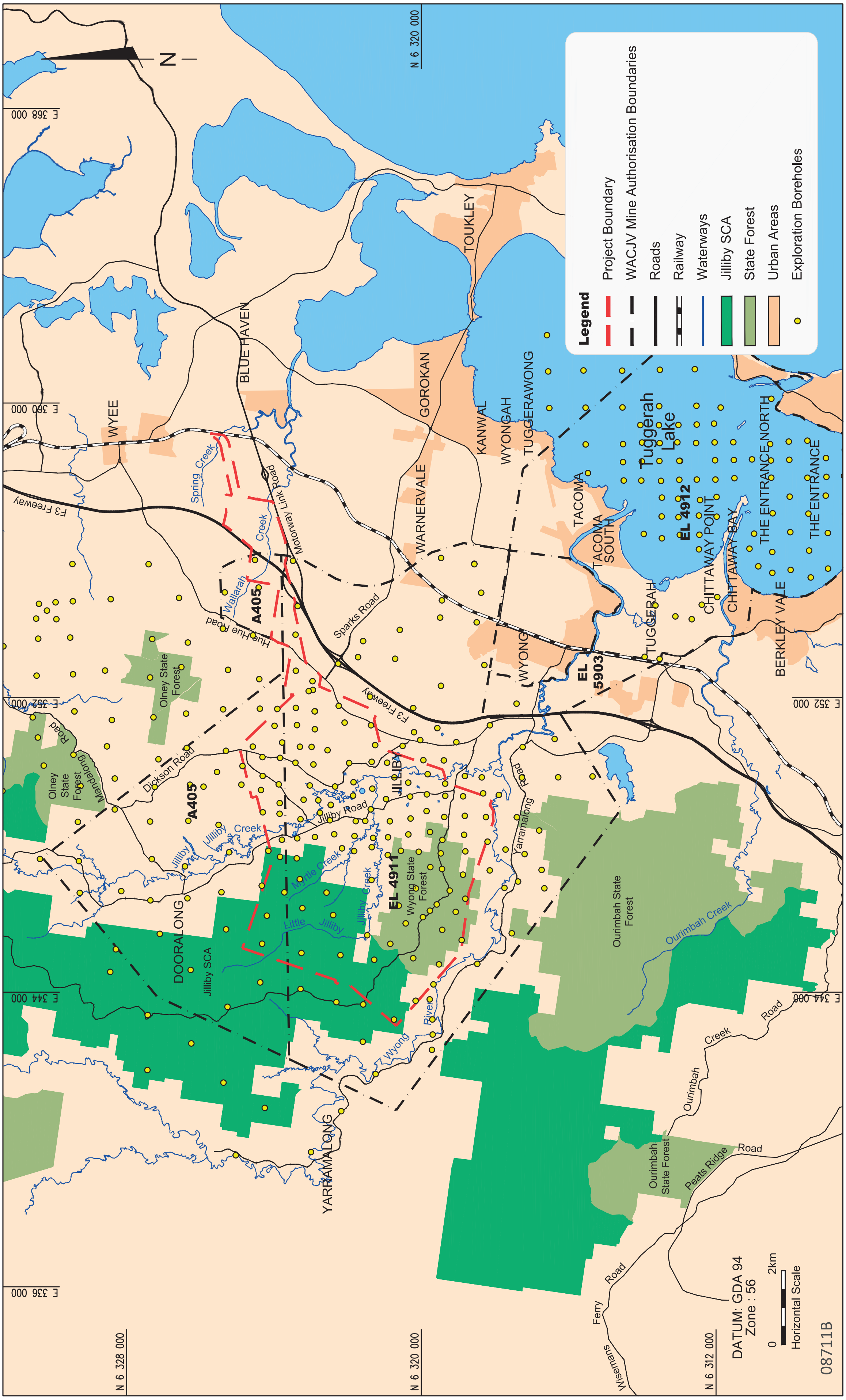


WALLARAH 2 COAL PROJECT

Wallarah 2 COAL PROJECT | Hansen Bailey ENVIRONMENTAL CONSULTANTS

Tooheys Road Site Weather Station Windroses

FIGURE 8



WALLARAH 2 COAL PROJECT

Wyong Regional Borehole Exploration

FIGURE 9

Wallarah 2 COAL PROJECT

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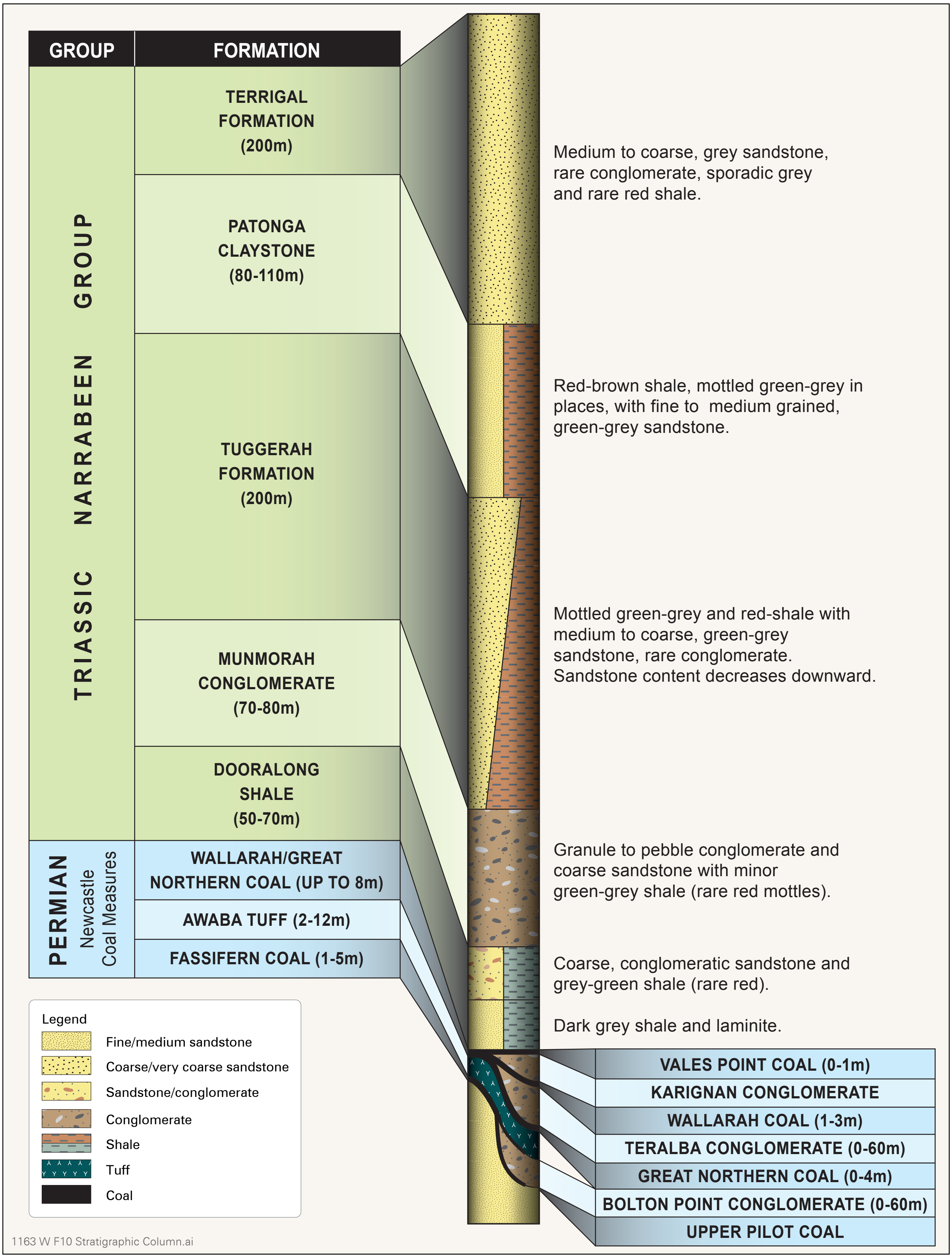

WALLARAH 2 COAL PROJECT

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Indicative Stratigraphic Column

FIGURE 10

Two regionally broad synclines traverse the area: the Macquarie Syncline on the western edge of Tuggerah Lake in a north-easterly direction, and the Yarramalong Syncline on the western edge of the Project Boundary in a similar orientation. Regional geology and the major structural features which provide physical constraints to the Extraction Area are shown in Figure 3.

2.7.3 Structural Geology

In the course of the stakeholder engagement program for this EIS, NOW raised a number of concerns regarding geological faulting. A detailed geological study was prepared to address these concerns with the results summarised below. This study is provided in full in Appendix C.

The South Newcastle Coalfield is typified by a dominant NW-SE structural trend with a secondary NE-SW grain as outlined in lineament analyses undertaken by Mauger et al (1984). These two major structural directions are well documented in mine workings around the southern reaches of Lake Macquarie and confirmed from magnetometer surveys undertaken in the vicinity of the Project, where dyke orientations are a reflection of the joint and fault directions that exist in the older sedimentary strata. These joint and fault directions become lines of least resistance along which the younger dykes intrude, as proposed by Creasey and Huntington (1985). Dykes in the vicinity of the Project are shown in Figure 11.

The location and orientation of features such as dykes and faults (as shown on Figure 12) are important considerations in modern day mine planning due to their potential to impact on the longwall extraction process. This disruption is usually in the form of challenging mining conditions and dilution of the coal by roof and floor material as the longwall must cut through the structure.

Members of the WACJV geology team found, with almost 20 years of underground experience in the South Newcastle Coalfield, that water make from these features was manageable and that traditional bord and pillar operations commonly negotiated 4-5 m faults at depths of less than 150 m beneath Lake Macquarie without experiencing significant inflows. Similarly, appropriately designed longwall extraction beneath Lake Macquarie did not result in connectivity with the overlying water body. This was also the case where the Boomerang Creek Tunnel, built to connect Mangrove Mountain Dam with Wyong Creek, intersected two major faults. While inflows of an estimated 2,000 L/min occurred when these faults were initially exposed, this rate dropped to only several litres per minute within a few hours (Milenko and Neville, 1991).

The Extraction Area has been chosen on the basis of approximately 450 drill holes (96 pre-existing and 352 drilled by WACJV) along with extensive surface seismic and airborne geophysical surveying. The locations of exploration boreholes in the vicinity of the Project are presented in Figure 9.

The extent and detail of the exploration program was able to identify an area free of major geological structures, bounded to the:

- North by a major dyke zone;
- East by seam splitting;
- West by seam thinning; and
- South by a further dyke zone and the Wyong River.

Specific assessments that were undertaken to help identify geological structures that may affect the mining operation and its environmental impacts included:

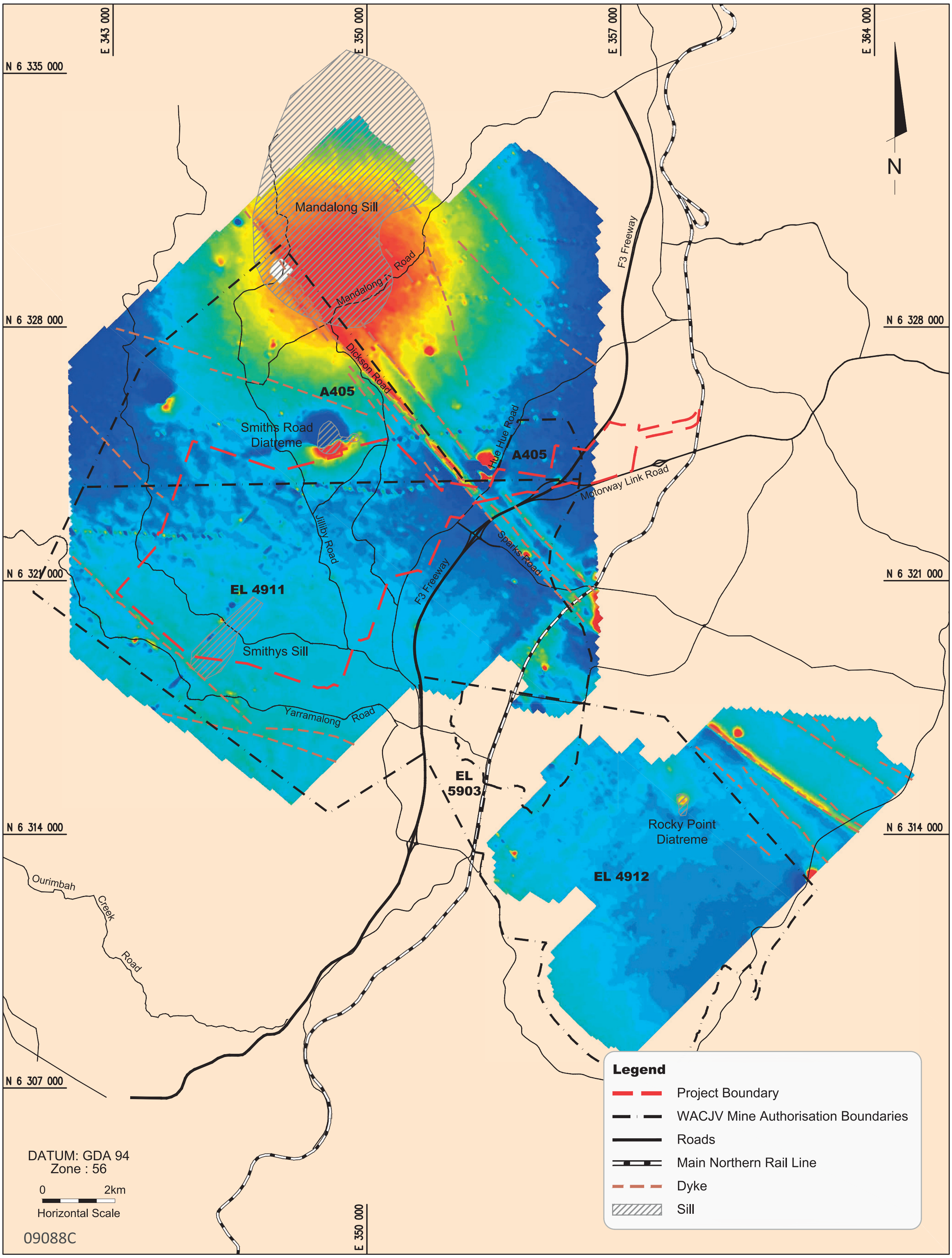
- A literature survey of available lineament analyses and relevant mine plans;
- Photo interpretation of non-alluvial sections of the project area;
- Airborne and surface magnetometer surveying;
- Approximately 32 km of 2-D seismic surveying;
- 3-D geological modelling of approximately 450 cored exploration holes; and
- Structural analysis of down-hole acoustic televiewer data.

At various stages of consultation for the Project, reference has been made by a number of agencies and Non-Government Organisations to purported "major geological structures" within the Project Boundary. Particular reference has been given to the "Coastal Lineament" proposed by Mauger et al (1985) and the "Northern Geosciences Faults" proposed by Jones (2005). Despite the intensity of the WACJV exploration program, no evidence to support either of these features has emerged.

Results do however suggest that the "Coastal Lineament" may have been misinterpreted from remote sensing data as a structure, when in fact it approximately corresponds with the west side of the massive conglomerate channel responsible for the seam splitting on the eastern flank of the deposit. The report by Jones (2005) on the other hand, was the subject of a review by the Department of Primary Industries - Mineral Resources (Barry, 2005) which states:

> *"DPI-MR Response (L):*
>
> *There is unlikely to be any real potential for connection between near-surface aquifers and the deeper coal seam aquifers on the Dooralong and Yarramalong Valleys. See DPI-MR responses (C), (F), (G) and (K)."*

A detailed discussion in relation to structural geology and lack of faulting is presented in Appendix C.



WALLARAH 2 COAL PROJECT

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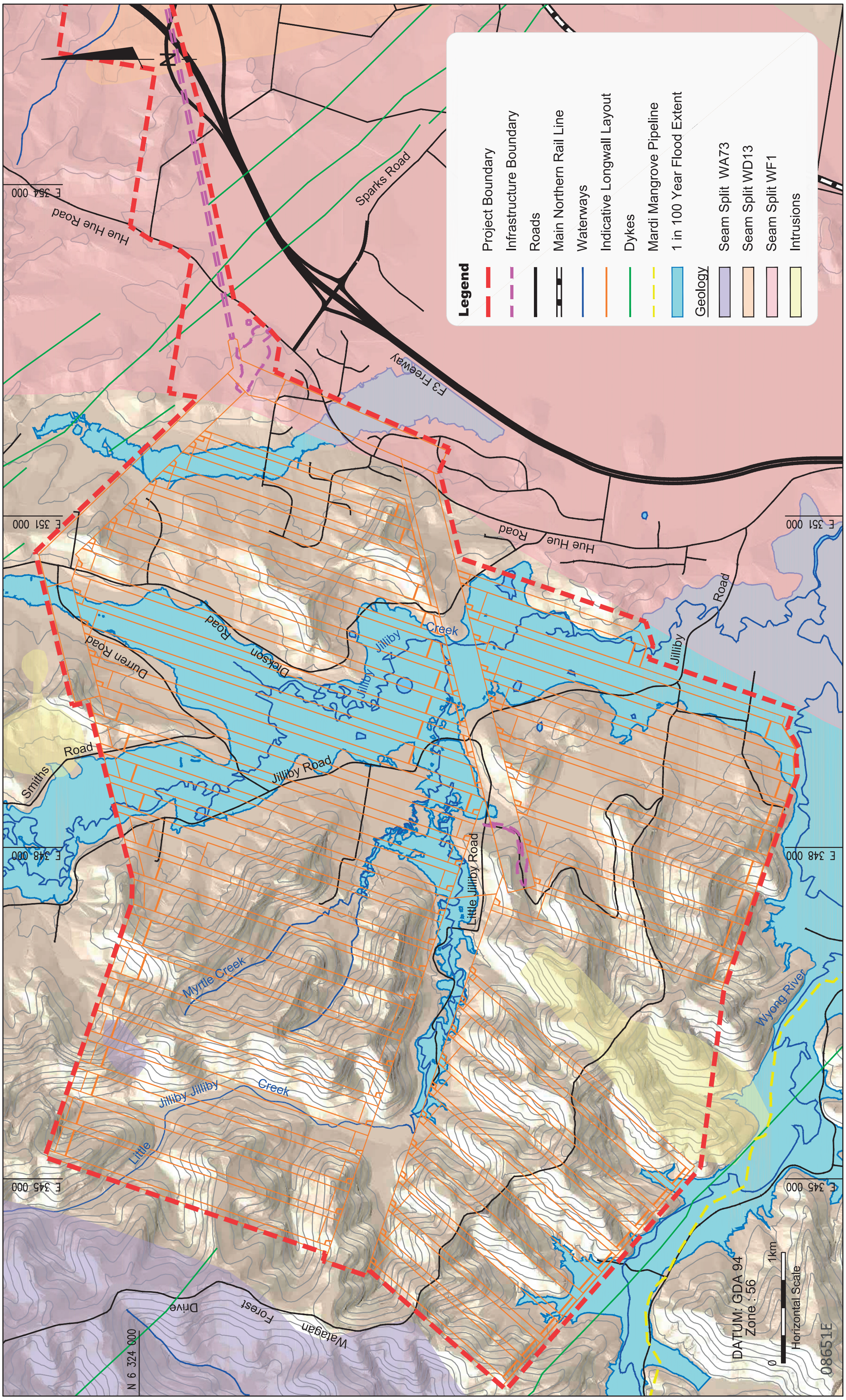
Igneous Intrusions

FIGURE 11



WALLARAH 2 COAL PROJECT

Key Mining Constraints

FIGURE 12

Wallarah 2 COAL PROJECT

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2.7.4 Hydrogeology

A total of 352 holes have been drilled by WACJV. All significant water make was recorded and tested for water quality. These observations indicated that there are no significant hard rock aquifers within the Extraction Area mine area and that any minor flows that do exist are saline. This is to be expected in tight rocks such as the Tuggerah Formation, which has entirely different permeability characteristics to those of the Hawkesbury Sandstone, which outcrops well to the south of the Project on the Somersby Plateau.

This lack of aquifers and the tight nature of the strata are also supported by the results of numerous packer tests conducted during exploration drilling, along with testing of oriented sub-samples from selected drill core, undertaken to provide a multi-directional porosity/permeability model. The results of geological investigations are detailed further in Appendix C. Further information on hydrogeology is included as part of the Groundwater Impact Assessment and is discussed in Section 7.2.

2.7.5 Reserves and Resources Utilisation

The target coal resources for the Project are the locally coalesced Wallarah and Great Northern Coal Seams. A resource of over 700 Mt has been identified within the WACJV's EL areas. The Project has identified an environmentally and economically feasible mineable coal resource of approximately 150 Mt.

This mineable coal resource will be sufficient to sustain mining at 5.0 Mtpa for at least the proposed 28 year period sought in this Development Application and as assessed in this EIS.

The Extraction Area is shown on Figure 3, and is a subset of the resources which exist within the WACJV's Mining Authorities. The Extraction Area is delineated to the north by a large north-west to south-east oriented dyke zone (a vertical geological feature containing igneous rock). The southern boundary is formed by a combination of the Wyong River and a separate dyke system (which was detected by airborne and ground-based magnetic surveys). Additional coal resources lie in the zone beyond the southern boundary of the Extraction Area, south of the Wyong River.

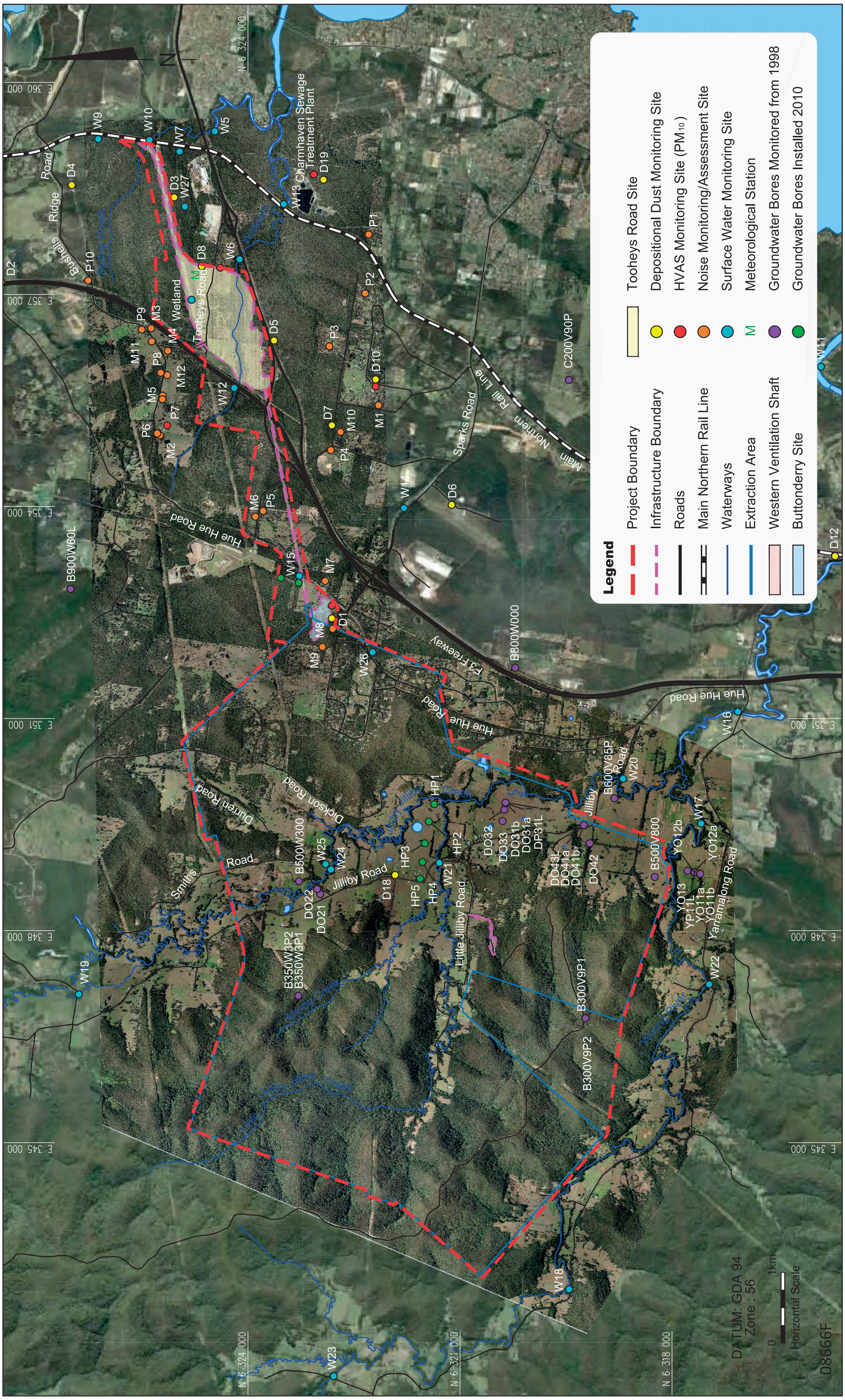
2.8 Environmental Management

WACJV has developed and implemented an Environmental Monitoring Program (EMP) for the Project which includes the regular collection of the following range of environmental monitoring data: meteorological, air quality (including depositional dust, Total Suspended Particulates (TSP) and Particulate Matter less than 10 microns (PM_{10}), noise, surface water quality, groundwater and aquatic ecology.

A summary of the components of the EMP is provided in Table 6 with monitoring locations shown on Figure 13. The EMP will continue to be enhanced and revised as required for the Project to ensure proactive and ongoing environmental management and monitoring as detailed in Section 8.

Table 6 Environmental Monitoring Program

Aspect	Mechanism	Monitoring Location	Parameters Monitored
Meteorology	Meteorological Station	Tooheys Road Site	Rainfall, Temperature, Relative Humidity, Solar Radiation, Wind Speed and Wind Direction
Air Quality – Depositional Dust	Depositional Dust Gauges	Six (formerly 18) locations onsite and offsite	Depositional Dust (g/m^2/month)
Air Quality – Suspended Particulates	High Volume Air Samplers (HVAS)	Buttonderry Site &Tooheys Road Site Formerly also south-east, south and north of Tooheys Road Site	TSP (µg/m^3) & PM_{10} (µg/m^3)
Noise	Noise Monitor	12 measurement locations onsite and offsite	Sound frequencies propagation and attenuation
Surface Water	Sample Collection	14 sampling sites (up to 25 previously) on Jilliby Jilliby, Wallarah, Spring and Buttonderry Creeks and Wyong River	Range of water quality parameters including electrical Conductivity (EC), pH, Total Dissolved Solids (TDS) and Total Suspended Solids (TSS)
Groundwater	Sample Collection and vibrating wire piezometers	17 dedicated bores including: Five multi-level alluvial bores in Dooralong Valley established 2010 Two monitoring bores at Buttonderry Site established 2010	Water Quality (range of parameters), depth and speciation analysis. Water level temporal and spatial analysis
Aquatic Ecology	Seasonal microfauna sampling	Multiple stream sites within the Project Boundary since Autumn 2011	Water quality, stream condition, microbenthic fauna, associated insects and other biodiversity features



WALLARAH 2 COAL PROJECT

Existing and Former Environmental Monitoring Program

FIGURE 13

Wallarah 2 COAL PROJECT

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Wallarah 2
COAL PROJECT

Wallarah 2 Coal Project

Environmental Impact Statement

April 2013

3

The Project

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This section contains a detailed description of the Project including the conceptual mine plan, its staging, equipment and employment requirements, infrastructure, management of waste and an indicative construction schedule. It also includes alternatives considered during the development of the Project for which approval is sought.

3.1 Overview

WACJV seeks a Development Consent under Division 4.1 of Part 4 of the EP&A Act to facilitate the development and operation of an underground coal mine within the Project Boundary on the land listed in Appendix A.

Development Consent is sought for a period of 28 years to facilitate the construction and operation of the Project. Construction will occur over an approximate three year period. Coal mining will commence after this period and continue for the duration of the Development Consent within the designated Extraction Area (as shown on Figure 3). Further mineable coal will remain in the Extraction Area at the completion of the Project mine life. A further planning approval will be required to enable the continuation of mining beyond Year 28.

The Project will involve the extraction of export quality thermal coal via underground longwall mining methods. The Project is generally comprised of an underground longwall mine, coal handling and storage facilities, rail loop and loading infrastructure, an underground drift entry, ventilation shafts, gas and water management facilities and administration buildings.

The Project surface facilities will be located on land zoned largely for industrial development and include:

- The Tooheys Road Site surface facilities between the Motorway Link Road and the F3 Freeway which will include (at least) a rail loop and spur, stockpiles, water and gas management facilities, workshop and offices;
- The Buttonderry Site surface facilities between Sparks Road and the Buttonderry Waste Management Facility. This facility will include (at least) the main personnel access to the mine, main ventilation facilities, offices and employee amenities; and
- The Western Ventilation Shaft located in the Wyong State Forest which is required for ventilation purposes by Year 13.

An inclined tunnel (or "drift") will be constructed from the surface at the Tooheys Road Site to the coal seam around 360 m beneath the Buttonderry Site.

The land which is the subject of the Development Application comprises the area within the Project Boundary (see Figure 14) and excludes the Jilliby SCA (defined as lands to a depth of 50 m from the surface). Areas below 50 m from the surface will be used for coal extraction and related underground mining activities. Existing roads and surface land access in the Jilliby SCA may be utilised during the Project for a variety of purposes (such as for monitoring, exploration and other surface activities).

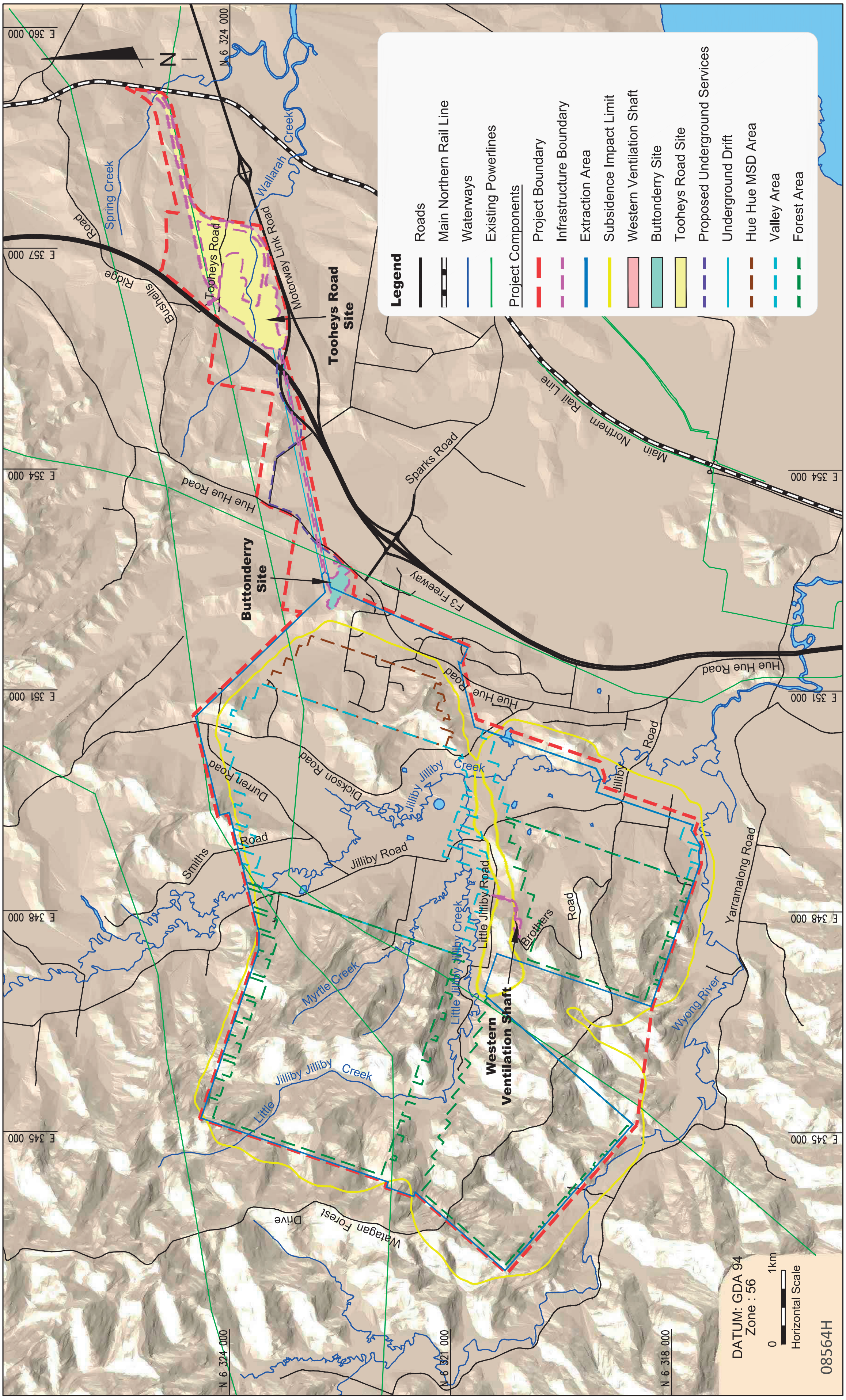
Outside the nominated Disturbance Area, additional minor disturbance associated with ancillary works may be required, including: firebreaks, water diversion structures, minor contour banks, pipelines and associated tracks and other services, power supply, powerlines, fences and sediment and erosion control structures. No such disturbance will occur prior to the completion of the Land Disturbance Protocol process as described in Section 7.9.

3.2 Conceptual Mine Plan

3.2.1 Mining Method

Longwall mining is a term given to a particular type of underground coal extraction. All underground mines use mechanised coal extraction equipment, often in combination with hydraulic roof supports in order to safely remove the coal. In the case of longwall mining, blocks of coal (or panels) are delineated by developing a series of parallel roadways (or tunnels which are also referred to as "headings") within the coal seam (see Figure 15). Once the headings delineating the panel are developed, a longwall mining system is installed which progressively extracts the panel as the longwall system retreats. The coal seam roof in the immediate longwall operating area is supported by a series of advancing hydraulic supports to protect both the workers at the face and the extraction equipment (Figure 16 and Figure 17 illustrate this process).

The coal is removed from the mine by a conveyor system which runs along the operating face of the panel being extracted, then down one side of the panel to the main roadways leading out of the mine (see Figure 16). The roadways are also used for equipment and personnel access and to draw fresh air into the mine to ventilate the mine workings. In contrast to the longwall panels, the roadways are mined using continuous miner equipment. These headings are either permanent tunnels for access and services throughout the mine life or temporary tunnels for access to the longwall panel. The permanent headings do not result in any surface subsidence.



WALLARAH 2 COAL PROJECT

Conceptual Project Layout

FIGURE 14

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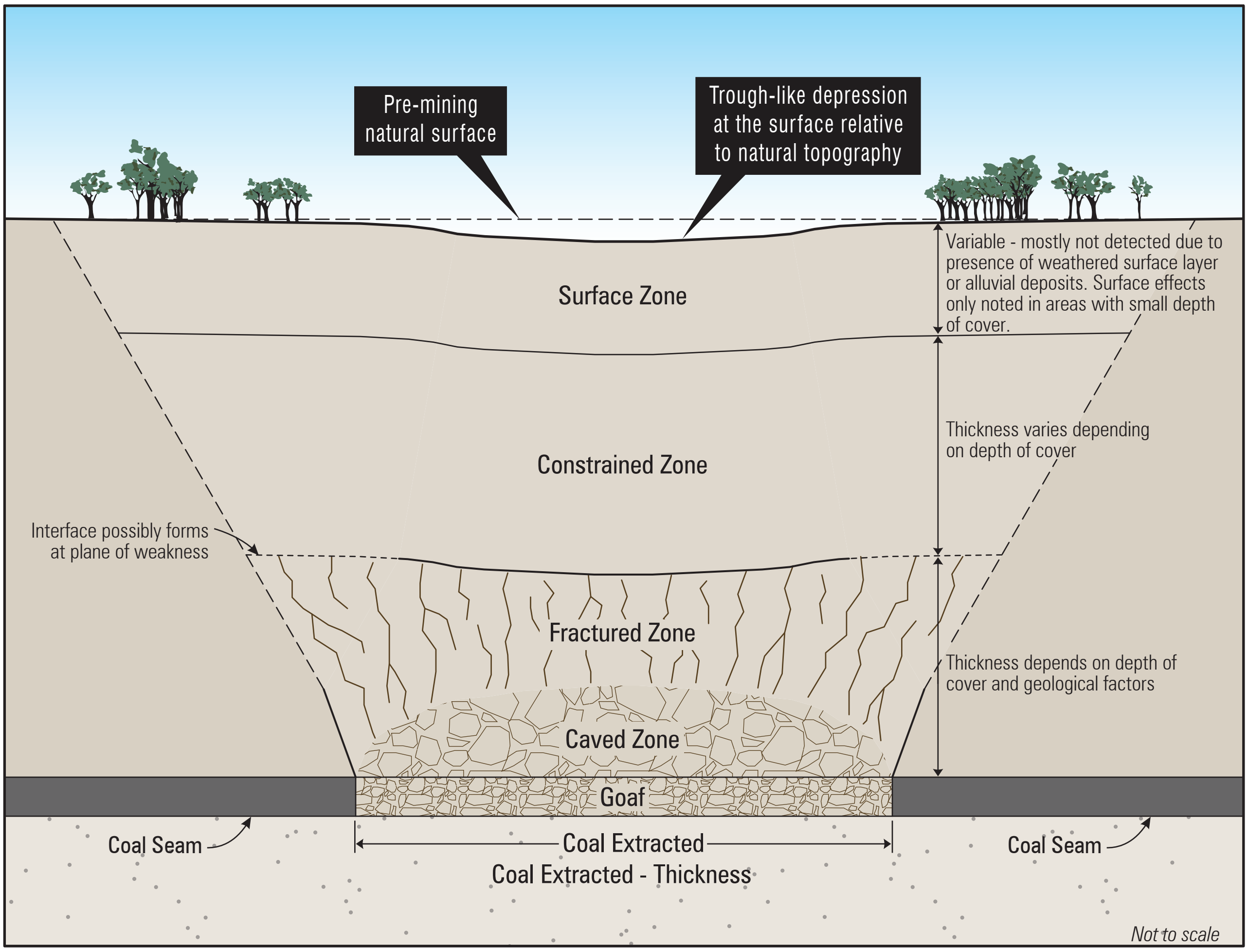
Wallarah 2 COAL PROJECT



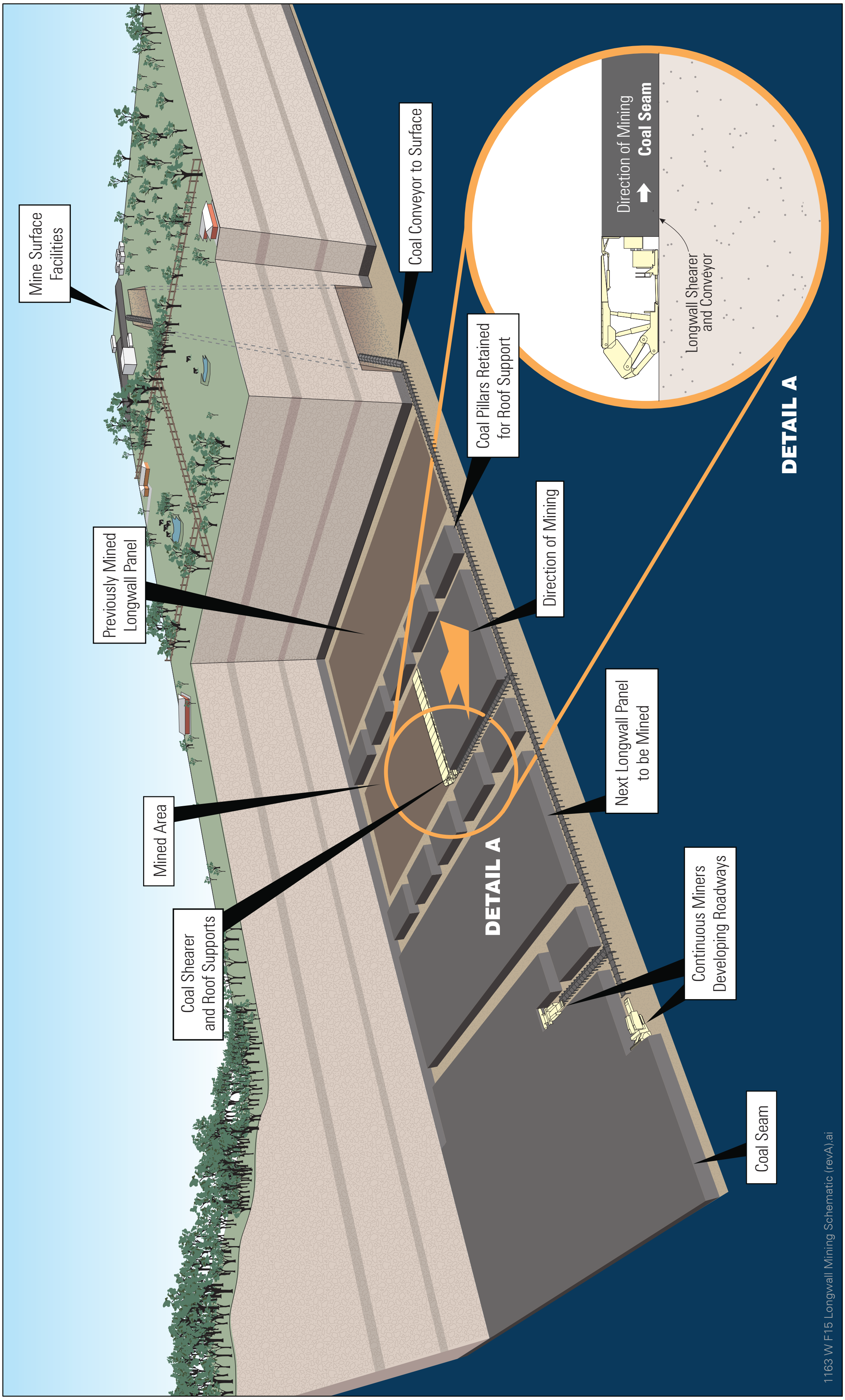
1163 W F14 - Subsidence Schematic (revA).ai

Plan based on MSEC Figure

WALLARAH 2 COAL PROJECT

Subsidence Schematic

FIGURE 15



WALLARAH 2 COAL PROJECT

Longwall Mining Schematic

FIGURE 16

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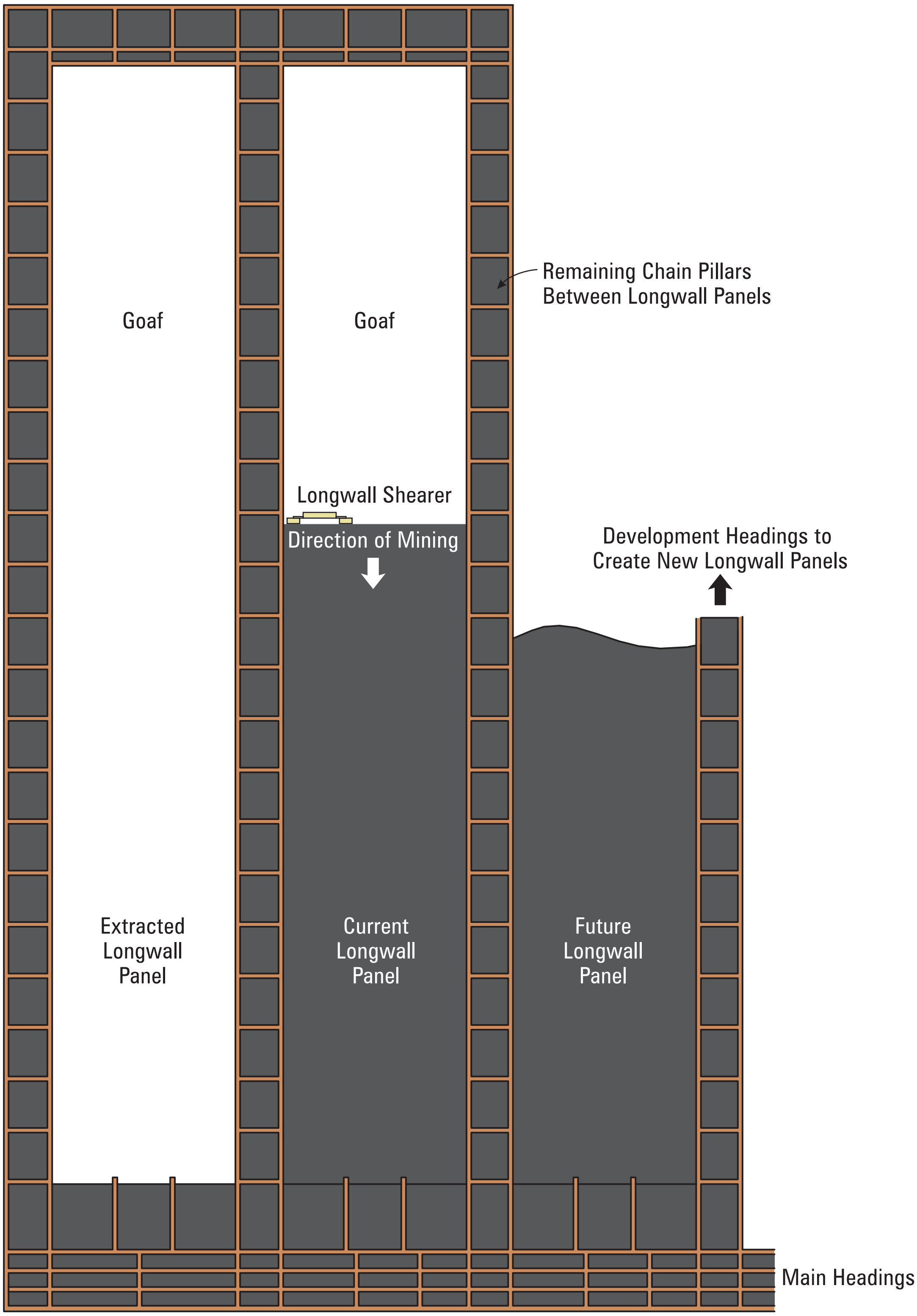
Wallarah 2 COAL PROJECT



1163 F16 Typical Longwall Layout (revA).ai

Plan based on MSEC Figure

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WALLARAH 2 COAL PROJECT

Typical Longwall Layout

FIGURE 17

3.2.2 Mine Plan Layout

The Project seeks to recover approximately 150 Mt of coal from within the Extraction Area. The target coal resources for the Project are the locally coalesced Wallarah and Great Northern Coal Seams. The identified coal resource will support mining at a rate of up to 5 Mtpa for at least the period sought by this Development Application.

The Extraction Area is shown in Figure 14 and the indicative longwall panel extraction sequence is shown on Figure 18. Evaluation of many alternative layouts has demonstrated that the proposed mine plan is the preferred layout (see Section 3.13). Some minor adjustments to final panel orientation and geometry may be required as a result of ongoing environmental and engineering studies as well as stakeholder consultation (Appendix D).

As well as variations in extraction height throughout the Extraction Area, the Project layout incorporates a variety of longwall panel widths in order to optimise economic resource recovery whilst considering environmental and known subsidence constraints as follows (see Figure 12 and Figure 14):

- Hue Hue Mine Subsidence District (MSD) Area: the use of 125 m and 175 m wide longwall panels below the north-eastern portion of the Hue Hue Mine Subsidence District;
- Valley Area: between 175 m to 205 m wide longwall panels depending on depth of cover (coal seam to the surface) below the 1-in-100 year flood zone; and
- Forest Area: less than 255 m wide elsewhere.

Panel widths can be varied along the length of a panel, as the panel moves from one zone to another zone of higher or lower permissible tilt levels. This element of the subsidence management process approach in mine design has been well demonstrated in other mining projects to ensure appropriate outcomes. Mining operations are proposed to commence beneath the Buttonderry Site in the north-eastern corner of the Extraction Area (see Figure 18). Due to design constraints imposed by the Hue Hue MSD, the initial longwall panels are relatively narrow.

To commence longwall extraction as early as possible, the first 11 longwall panels are to be extracted from a set of northern main headings, which run parallel and adjacent to the major dyke zone. A protection barrier of 120 m was applied to ensure adequate separation from the dyke zone (see Figure 12). The main headings terminate just east of an igneous geological intrusion under Smiths Road.

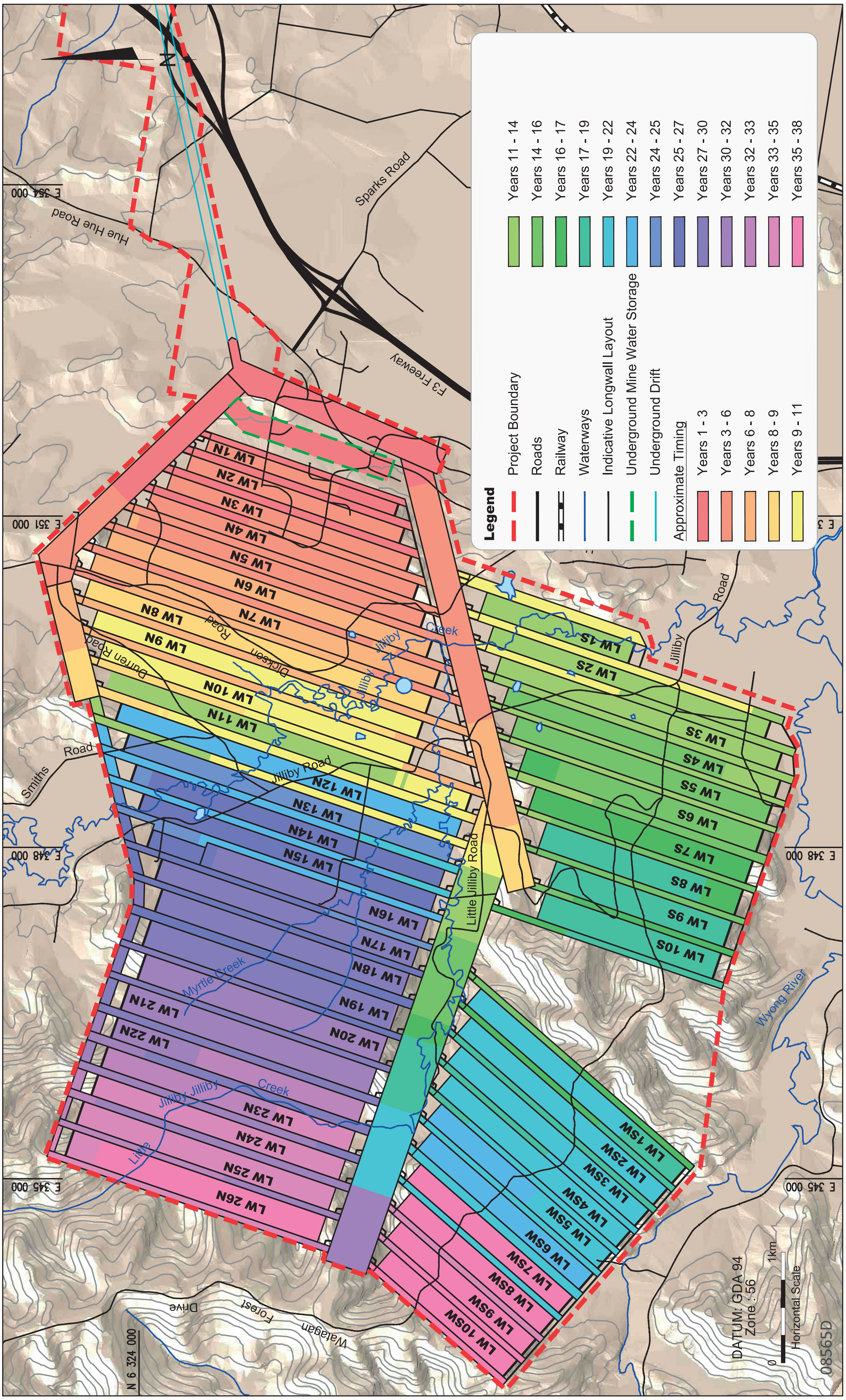
While these first 11 longwall panels are being developed and extracted, an additional development unit will drive the initial southern main headings, located east of and parallel to the first longwall panel. Subsequent headings will be developed in a west-southwest direction that crosses deep under the alluvial valley and the Wyong State Forest.

The western extremity of the west-southwest main headings is the planned location for an additional intake ventilation shaft known as the Western Ventilation Shaft and is shown in Figure 14. This shaft is required as the main shaft located at the Buttonderry Site will not have sufficient capacity to ventilate the entire Extraction Area.

Following extraction of LW1 North (LW1N) to LW11N, extraction of LW1S to LW6 South-West (LW6SW) will commence in the south-east area. LW12N to LW18N are located below the alluvial valley while LW19N to LW8SW are located below the western forested hills area.

Continuity of the southern longwall panels is interrupted by Smithys Sill (see Figure 12) to the west, a large igneous geological intrusion. Smithys Sill effectively splits the southern longwall panels into two discrete blocks. Again, the panels in the south-west area are designed to avoid the Wyong River system and the Mardi-Mangrove Pipeline water supply infrastructure (see Figure 12).

After the initial panels are extracted in the north-east area (LW1N to LW11N), mining relocates to the south-eastern panels, continuing until a deterioration in coal quality in the south-west of the Extraction Area requires relocation of LW mining to the north-western panels (LW12N to LW26N). It is proposed that only these north-western panels will be mined in a north to south direction. All other longwall panels will be mined from south to north.



WALLARAH 2 COAL PROJECT

Conceptual Mine Plan

FIGURE 18

3.3 Mining Equipment

Table 7 lists the indicative equipment utilised for modelling purposes for the Project. Actual equipment utilised for the Project may vary. Further to these items, there will be ancillary equipment required for the Project.

3.4 Tooheys Road Site

The proposed general layout of the Tooheys Road Site is shown in Figure 19 and includes (but is not limited to):

- Rail spur and loop with coal loader and two rail overbridges along Tooheys Road;
- Office facility (inclusive of administration offices, bathrooms and training facilities);
- Site access roads including at least partial closure and relocation of Tooheys Road;
- Mine access drift and portal;
- Gas extraction and treatment plant;
- Coal stockpiles and material handling facilities;
- Car parking;
- Surface workshop and secure store;
- Bulk dry goods store;
- Open yard storage;
- Air compressor installation;
- Vehicle wash down bay, incorporating water treatment plant;
- Fuel, oil and flammable goods storage area;
- Fire fighting water storage tanks and surface fire station;
- Electricity powerlines, switchyard and transformers;
- Environmental monitoring equipment;
- Mine operations dam and surface runoff settling dams;
- Gas engine and associated generator; and
- Water and brine treatment plant (RO plant) for treatment of mine water.

The Tooheys Road Site will be accessed off the Motorway Link Road via a sealed road. Tree screening and landscaping is proposed either side of the road up to the main administration building and adjoining car park.

Figure 20 provides a schematic illustrating coal handling sections for the Tooheys Road Site.

Detailed design as required under Schedule 1 of the EP&A Regulation is provided in Appendix E which will be revised and finalised upon seeking relevant additional approvals.

3.4.1 Office and Administration

The Tooheys Road Site administration building has been designed as a single storey structure. It will comprise separate male and female clean and dirty change rooms, shower facilities and toilets. The building will also comprise a reception area, male and female amenities, kitchen / meal room, first aid room, meeting room, private and open plan office areas, control room and general storage space.

The structure of the administration building (subject to gaining appropriate Building Certificates from WSC) will be steel framed, with a brick veneer and a Colorbond (or equivalent) roof, founded on a reinforced concrete ground slab. Internal walls will be plasterboard with suspended tile ceilings. External walls and ceiling space will have thermal and acoustic insulation.

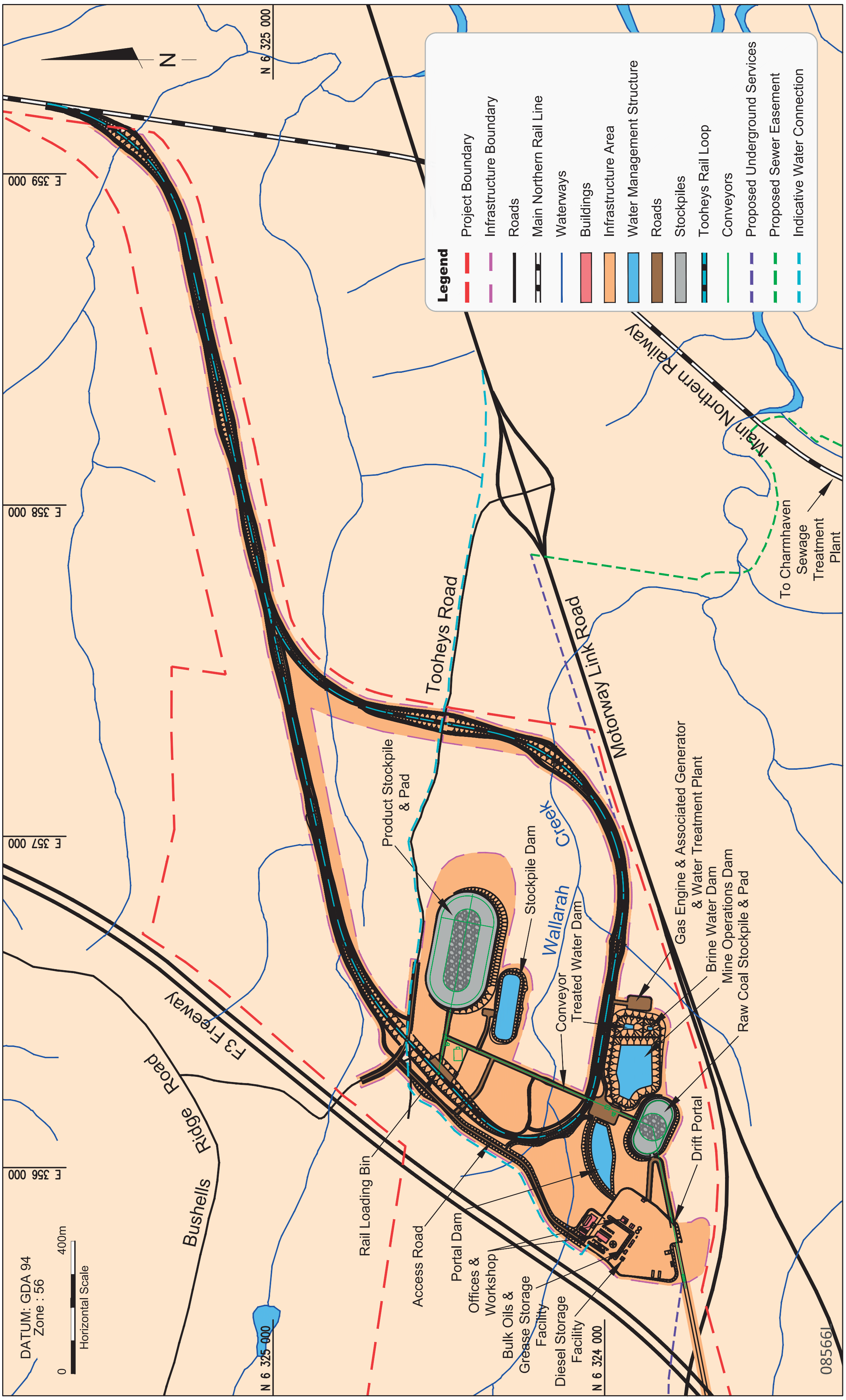
The workshop will feature drive-through bays with roller doors. The workshop floor area will be bunded and drained to a dirty water sump and oily water separator system. The workshop will be steel framed with Colorbond walls with a metal deck roof and a skillion roof extension along one side of the building.

The air compressor house will generally consist of a concrete ground slab, block wall construction, metal deck roof, all of which will be acoustically insulated. An oil containment and separation system will be provided for the compressors. All storage buildings (flammable goods, bulk dry goods, etc.) will consist of prefabricated, steel frame, metal clad structures founded on concrete slabs.

Table 7 Indicative Equipment List

Equipment	Quantity
Underground	
Longwall Mining System	1
Continuous Miner	3
Shuttle Car	6
Feeder Breaker	3
Eimcos	5
Drift-runners	6
Surface	
Bulldozer	2*

* Only one operating at Tooheys Road Site at any one time (when noise constraints apply).



WALLARAH 2 COAL PROJECT

Conceptual Layout Tooheys Road Site

FIGURE 19

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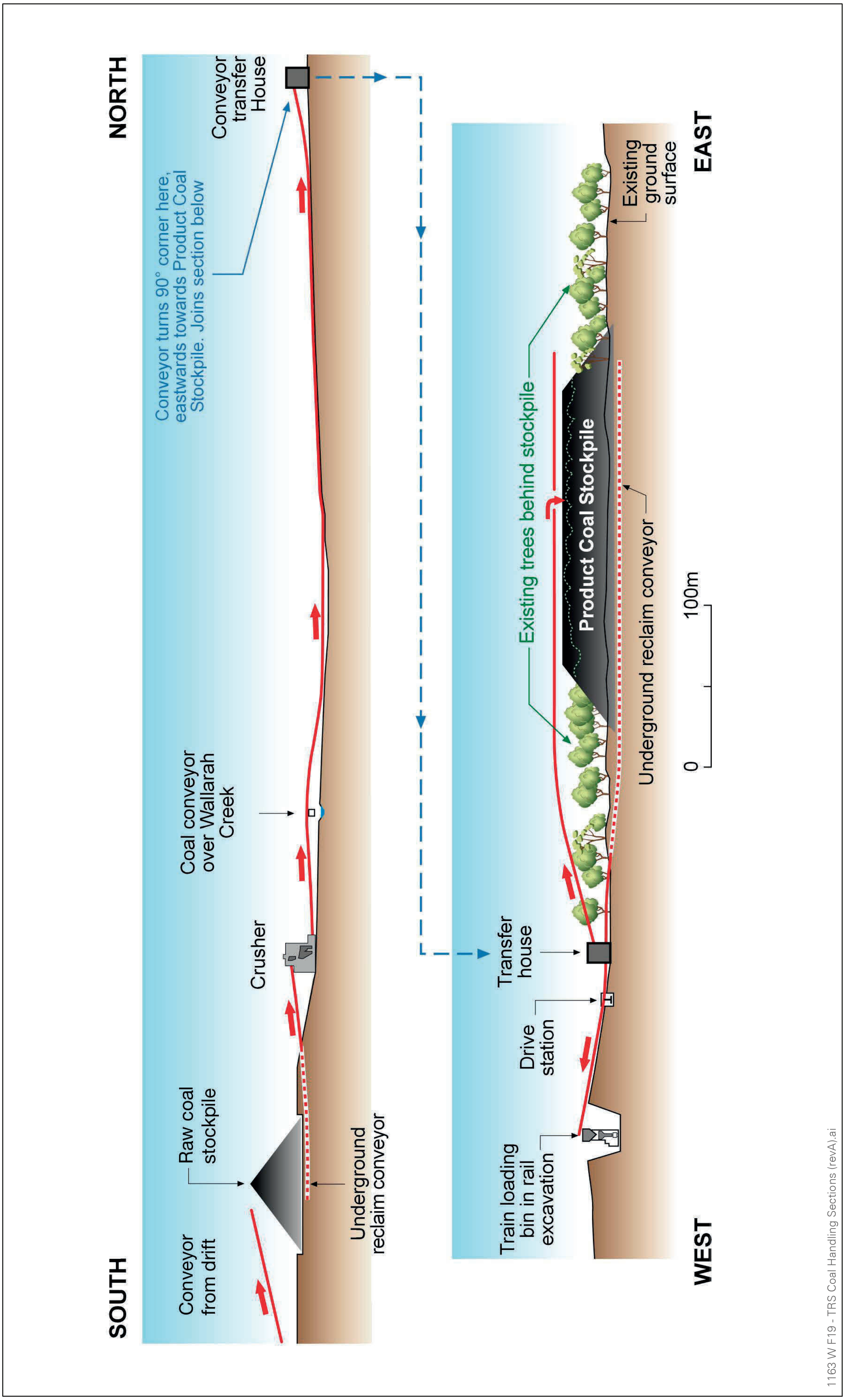
Wallarah 2 COAL PROJECT



WALLARAH 2 COAL PROJECT

Tooheys Road Site Coal Handling Sections

FIGURE 20

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Wallarah 2 COAL PROJECT

3.4.2 Ventilation and Underground Access

The drift will be an approximately 3,500 m long inclined mine access tunnel with a width of approximately 6.5 m and a height of approximately 6 m with a shallow curved roof. It will be used for transport of coal, vehicular and machinery access, secondary personnel and materials access, and general ventilation. The drift will lead from the surface of the south-western corner of the Tooheys Road Site down to the mine seam at a depth of over 350 m below ground level at the Buttonderry Site. The gradient of the decline will be approximately 1 in 10.

3.4.3 Water

A series of clean water catchment dams, diversions, sedimentation dams and culverts will be required throughout the life of the Project. Where necessary, culvert crossings will be provided beneath the Mine Access Road and proposed rail spur and loop to maintain surface flows.

Detailed requirements for various other mine water structures and erosion and sediment control devices for the Project are described in Section 7.3.

3.4.4 Coal Handling and Transport

Coal handling infrastructure and stockpiles will be located at the Tooheys Road Site. A 50,000 t Run of Mine (ROM) coal surge stockpile will be located at the end of the main drift conveyor, and a 250,000 t product stockpile will be located in the north of the site closer to Tooheys Road. The ROM and product stockpile pads will provide for additional temporary storage.

The facilities at the Tooheys Road Site for handling the ROM coal will generally consist of:

- 4,000 tonnes per hour (t/h) receival system from underground;
- 50,000 t raw coal surge stockpile;
- 2,000 t/h raw coal underground reclaim, crushing and stacking system;
- 2,000 t/h overhead tripper to stack crushed coal on the 250,000 t product stockpile with additional emergency stockpile capacity with dozer push out;
- Tunnel reclaim system under the product stockpile;
- Up to 4,500 t/h train loading system including a loading bin of approximately 250 t; and
- Spur and balloon loop off the main railway line with a capacity for holding three of the anticipated 3,400 t trains.

The main product coal stockpile will have a capacity of 250,000 t. The coal will be delivered by a 2,000 t/h overhead tripper conveyor which can progressively move to allow consistent stockpile shape and reclaim capacity. Additional emergency stockpile capacity will be achieved using dozer push out in the area of the formed coal stockpile pad.

Coal will be reclaimed via three feeders beneath the stockpile located in an underground tunnel. The tunnel reclaim system under the product stockpile will feed a 4,500 t/h train loading system including a loading bin of approximately 250 t. All coal stockpiles will be equipped with automated wind-activated watering systems for dust control. The sprays will cover the entire stockpile and will be activated when wind speed exceeds a designated trigger level.

A rail loop with train loading facilities with a capacity of 4,500 tph will be constructed to facilitate the loading of product coal onto trains at the Tooheys Road Site. The train load out facility will incorporate an automatic spray system capable of spraying water containing a dust suppressant over loaded coal wagons.

The Project will require a rail spur to connect the Tooheys Road Site to the Main Northern Railway Line for the transport of coal to the Port of Newcastle or local power stations.

To assist in reducing the regional transport of coal via road, the Project may also potentially facilitate the receipt, stockpiling and rail transport of product coal from other mines in the vicinity within the coal handling approval limits sought in this Development Application. The gaining of any required approvals associated with the transportation of coal to the Tooheys Road Site from other coal producers or for any additionally required infrastructure at the site is not part of this application and would be the responsibility of the proponent seeking to utilise this facility.

All product coal will be routinely transported from the site by rail. At peak production, it is anticipated that up to six trains will be loaded every 24 hours.

3.4.5 Ancillary Facilities

Both pre- and post-mining gas drainage operations are proposed. Pre-mining gas drainage will involve drilling of boreholes underground within the coal seam ahead of mining. Post-mining gas drainage will involve the capture of gas from sealed mining areas via underground pipelines.

Collected gas will be brought to the surface at the Tooheys Road Site for processing. In the initial years of operation it is unlikely that sufficient quantities of gas will be produced to allow commercialisation of the resource. The collected gas will be flared during this time generally as indicated on Figure 19. Flaring will occur as early as practicable during this interim period and will provide a major greenhouse emissions reduction as described in Section 7.6.

As the underground Extraction Area expands, commercial opportunities may become available for gas management and utilisation. A preferred gas management option is for up to a 10 MW on-site gas engine and associated generator to be constructed in order to utilise the power generation potential of the gas to be extracted.

The nearby Buttonderry Waste Disposal Facility owned by WSC has implemented landfill gas management measures to reduce its greenhouse emissions. WACJV will continue to evaluate the viability of co-ordinated gas management and usage opportunities with WSC and other stakeholders.

3.5 Buttonderry Site

The general site layout of the Buttonderry Site is shown in Figure 21. It will generally consist of:

- Upcast ventilation shaft and fan for mine ventilation;
- Downcast ventilation shaft for mine ventilation and man-riding;
- Main office (inclusive of administration offices and training rooms);
- Bathroom and shower facilities;
- Car parking;
- Small volume oil package and grease storage area;
- Fire fighting water storage tanks for surface fires;
- Easement for connection to WSC sewerage and mains water systems;
- Emergency services helicopter landing area;
- Air compressor installation;
- Environmental monitoring;
- Ballast borehole(s); and
- Electrical switchyard, hardstand and pollution control facilities.

The Buttonderry Site will be accessed off Hue Hue Road via a sealed road. Tree screening and landscaping is proposed alongside the road up to the main administration building and adjoining car park. Detailed design as required under Schedule 1 of the EP&A Regulation is provided in Appendix E. This design will be revised and finalised upon the determination of Development Consent in accordance with any required conditions of approval.

3.5.1 Office Administration and Bathhouse

The Buttonderry administration building has been designed as a single storey structure with an approximate overall plan dimension of 35 m x 40 m. The building will include a reception area, male and female amenities, kitchen / meal room, meeting rooms, training rooms, offices, store rooms, computing facilities and office equipment rooms.

The structure of the administration building (subject to gaining appropriate Building Certificates from WSC) will be steel framed with a brick veneer and Colorbond (or equivalent roof), founded on a reinforced concrete ground slab. External walls and ceiling spaces will have thermal and acoustic insulation.

The bathhouse / muster area will be a single storey building with an approximate plan area of approximately 70 m x 35 m, including the attached winder car room. It will comprise separate male and female clean and dirty change rooms, shower facilities and toilets. Adequate facilities will be provided to cater for the expected workforce on each shift roster. Additional features will include muster area, lamp room, offices and first aid facilities. The structure of the building (subject to gaining appropriate Building Certificates from WSC) will be steel framed with a brick veneer and Colorbond (or equivalent roof), founded on a reinforced concrete ground slab. External walls and ceiling space will have thermal and acoustic insulation.

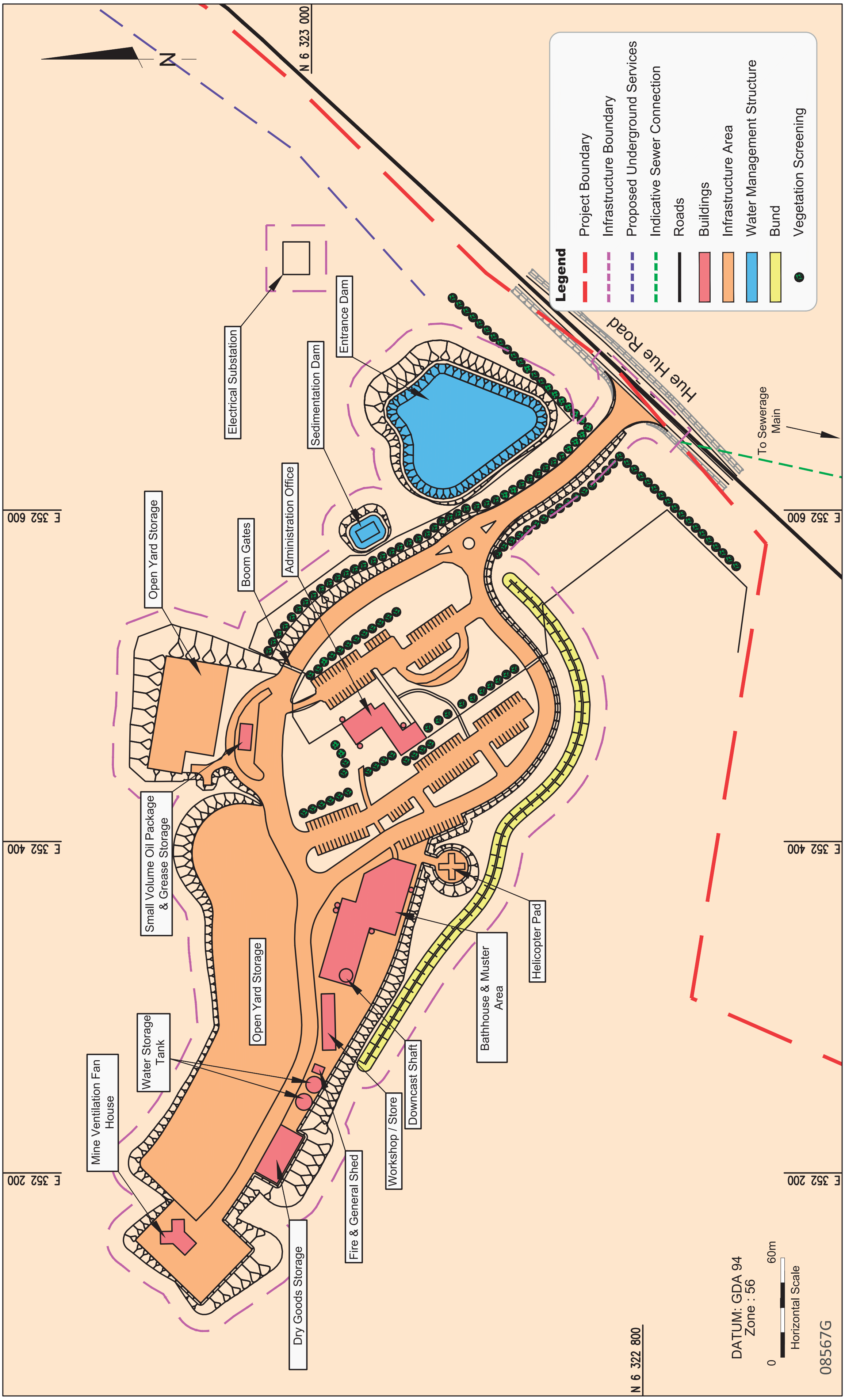
3.5.2 Ventilation and Underground Access

Two ventilation shafts are proposed at the Buttonderry Site.

- Downcast ventilation shaft – approximately 8 m in diameter and 350 m deep; and
- Upcast ventilation shaft – approximately 6 m in diameter and 350 m deep.

A winder car motor room and staging area will be constructed around the downcast ventilation shaft attached to the bathhouse. The mine ventilation fan house will accommodate ventilation fans, outlet silencers and air flow control dampers. The fans will be housed within an acoustic building to reduce noise emissions to design levels and face approximately north-west.

The mine ventilation fan house will consist of a 6 m x 6 m shaft cap, with Y branch connected structures each 10 m x 4 m, to accommodate axial flow vent fans, outlet silencers and air flow control dampers. The fans will be housed within an acoustic building to reduce noise emissions.



WALLARAH 2 COAL PROJECT

Conceptual Layout Buttonderry Site

FIGURE 21

The cavity block wall structure will be founded on a concrete ground slab. The air tight metal deck roof will include an overpressure relief structure in the design. All entry doors open out via air lock chambers. Acoustic insulation will be installed to the internal walls and roof for noise attenuation.

The above details of the proposed development at the Buttonderry Site are indicative and will be subject to refinement during final detail design.

3.5.3 Water

A series of clean water catchment dams, diversions, sedimentation dams and culverts will be required throughout the life of the Project. Where necessary, culvert crossings will be provided to maintain surface flows.

Detailed requirements for various other mine water structures and erosion and sediment control devices are described in Section 7.3.

3.5.4 Ancillary Facilities

The small volume oil package and grease storage facility will be a steel framed structure with Colorbond (or equivalent) cladding and a metal deck roof.

A fire and smoke alarm system and relevant fire suppression system will be installed.

3.6 Western Ventilation Shaft

A second (western) shaft site will be required by Year 13 as shown on Figure 22. This future western shaft facility will house a downcast shaft only (that is, air intake into the underground mine). Only limited facilities will be required at this site; however it will also serve as a secondary emergency access and egress point.

The Western Ventilation Shaft is expected to be 5 m in diameter and 485 m deep. Any required power reticulation infrastructure will be positioned within the Project Boundary and connect to an existing power supply within the Project Boundary.

3.7 Hours of Operation and Employment

During the three year construction period, the Project will employ up to 450 personnel on site. The Project will employ up to approximately 300 full time equivalent employees (including permanent contractors) during mining operations.

The majority of the mining employees will work from the Buttonderry Site while approximately 30 workers will be based at the Tooheys Road Site.

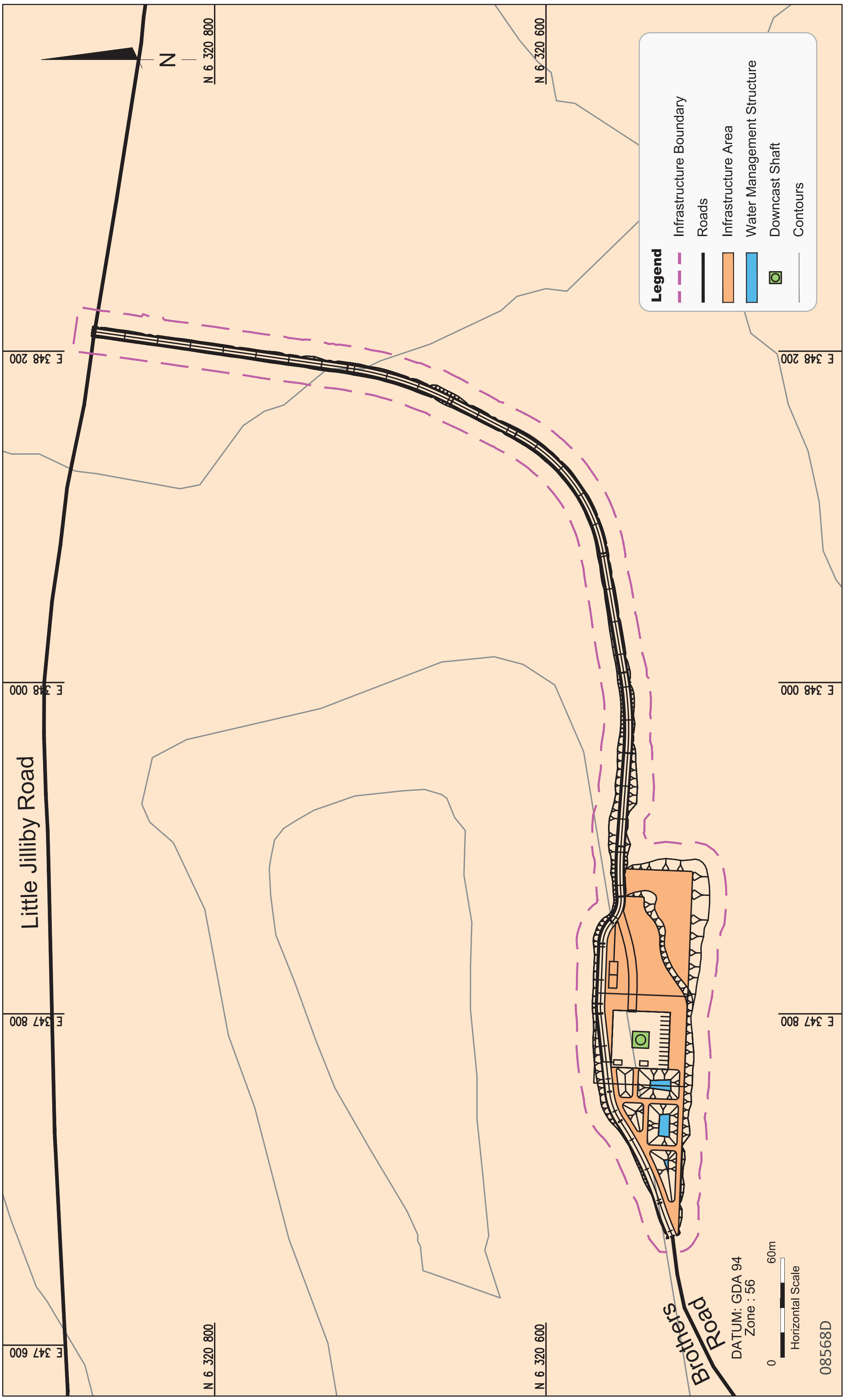
Some construction activities and maintenance activities, deliveries, coal processing, coal transport and mining operations will occur 24 hours per day, seven days per week.

3.8 Site Access

Table 8 nominates the preferred routes likely to be taken by construction vehicles, employee traffic and delivery and service vehicles travelling to the sites, during construction and operational phases (as shown on Figure 14). Further detail on intersection designs are provided in detail in Section 7.12.

Table 8 Site Access Points and Access Routes

Site	Access Point	Access To / From Via			
		North	South	East	West
Tooheys Road Site	Off Tooheys Road, south of F3 overpass	F3 Freeway, turn back via Sparks Road, Motorway Link Road, Tooheys Road	F3 Freeway, Motorway Link Road, Tooheys Road	Sparks Road, F3 Freeway and/or Motorway Link Road, Tooheys Road	Wyee Road, Hue Hue Road, Bushells Ridge Road and Tooheys Road
Buttonderry Site	Off Hue Hue Road, north of the Hue Hue Road / Sparks Road intersection	F3 Freeway, Sparks Road, Hue Hue Road	F3 Freeway, Sparks Road, Hue Hue Road, Old Maitland Road or Alison Road, Hue Hue Road	Motorway Link Road, Sparks Road, Hue Hue Road	Wyee Road, Hue Hue Road
Western Ventilation Shaft	Off Brothers Road	F3 Freeway, Sparks Road, Hue Hue Road, Jilliby Road, Little Jilliby Road, Brothers Road	F3 Freeway, Sparks Road, Hue Hue Road, Jilliby Road, Little Jilliby Road, Brothers Road, Old Maitland Road or Alison Road, Hue Hue Road, Jilliby Road, Little Jilliby Road, Brothers Road	Sparks Road, Hue Hue Road, Jilliby Road, Little Jilliby Road, Brothers Road	Wyee Road, Hue Hue Road, Jilliby Road, Little Jilliby Road, Brothers Road



WALLARAH 2 COAL PROJECT

Conceptual Layout Western Ventilation Shaft

FIGURE 22

3.9 Water Management

The key objective of the water management system is to minimise the impact of the Project on the adjacent creek systems. The Tooheys Road site will intercept catchment runoff within the Wallarah Creek catchment. In order to replace this water, treated mine water will be discharged into a tributary of Wallarah Creek at a similar quality to the existing water quality of the creek.

The onsite water management for the Project entails a number of separate, though inter-related components including:

- At the Tooheys Road Site:
  - Connection to WSC water and wastewater reticulation systems;
  - A Stockpile Dam which collects runoff from the product coal stockpile;
  - A Portal Dam which collects runoff from the raw coal stockpile, offices and workshop area;
  - A Mine Operations Dam to store water pumped out of the underground. The Mine Operations Dam will also store runoff water pumped from the Portal Dam and Stockpile Dam;
  - Water Treatment Plant (RO or similar) to treat excess mine water from the Mine Operations Dam and supply treated water to the site surface and underground demands;
  - A Treated Water Dam to store Water Treatment Plant outflows for reuse. This storage is likely to be a cell in the Mine Operations Dam (separate from the higher salinity mine water);
  - A Brine Water Dam (or cell) to store brine extract produced by the Water Treatment Plant;
  - Sediment traps and drainage channels to collect and treat runoff from the rail loop and access road;
  - Clean water drains to divert runoff from undisturbed catchments around areas disturbed by mining/ infrastructure; and
  - Discharge infrastructure for treated water releases to Wallarah Creek.
- At the Buttonderry Site:
  - Connection to WSC water and wastewater reticulation systems;
  - An Entrance Dam to store water for the Buttonderry Site demands; and
  - A sediment dam to collect and treat runoff from the buildings, paved and hardstand areas at the Buttonderry Site.
- The underground mine:
  - An underground mine water storage sump;
  - Underground water pumping systems; and
  - Mine void spaces that become available after longwall panels are completed for permanent mine water storage.

The main components of the water management system are shown in Figure 19 and Figure 21.

A series of clean water catchment dams, diversions, sedimentation dams and culverts will be required throughout the life of the Project and will be constructed generally within the Infrastructure Boundary. Where necessary, culvert crossings will be provided beneath the Mine Access Road and proposed rail spur and loop to maintain surface flows. Detailed requirements for various other mine water structures and erosion and sediment control devices will be developed during the detailed design phase.

The final design and operation of the water management system will be agreed in consideration of WSC's advice of the most appropriate connection to regional potable water supply and sewerage systems. The construction of water and sewer connection infrastructure will be undertaken in consultation with WSC and in accordance with relevant regulations and guidelines. An indicative alignment for the Project to access the town water supply and sewerage system is shown on Figure 3, Figure 19 and Figure 21.

Most water from the underground workings will be pumped to the surface for treatment. Whilst a proportion of mine water inflows will become involuntarily retained in previous workings, some underground mine water will be pumped directly to voids in completed longwall panels for permanent storage, depending on relevant triggers in the Water Management Plan. Saline groundwater is of no value for potential agricultural or industrial uses due to its poor water quality.

The water collected by the Project will be primarily due to groundwater inflows; however it will also include some surface water runoff. All water collected by the Project will be treated to meet the appropriate water quality criteria. The treated water will be used to satisfy operational demands, with surplus treated water to be discharged into Wallarah Creek in accordance with the conditions of an Environmental Protection Licence (EPL). The water being discharged to Wallarah Creek will be treated to a quality that is similar to the existing water quality in the creek.

In the future, it may become environmentally, operationally and commercially feasible to dispose of brine extract and/or excess mine water by directing it to the municipal sewerage system for ultimate discharge from WSC's ocean outfall.

Although current licensing, design and operation of the sewage system do not immediately enable such arrangements, such an approach would reduce the volumes of water that will be treated and discharged into Wallarah Creek.

Initial consultations on this issue have been undertaken with WSC and State government agencies and will continue as the Project progresses. Should this approach be pursued in the future, WACJV will seek the necessary agreement with the appropriate authorities and will obtain any additional development approvals required.

Further detail on the water management system (including a schematic of the system) is detailed in Section 7.3.

3.9.1 Water Treatment Plant

The mine water (groundwater in the coal seam and adjacent deep strata) is anticipated to range in salinity from 1,800 to 7,500 mg/L Total Dissolved Solids (TDS) (see Section 7.2). Mine water will be treated at a combined Water Treatment Plant and Brine Treatment Plant to substantially reduce the TDS concentration.

The Water Treatment Plant will utilise various processes and technologies to reduce salinity levels, TSS and concentrations of metals in the water. Mine water will initially be pre-treated using the Dissolved Air Floatation process to remove suspended solids and dissolved organic matter. The water will then undergo membrane filtration (microfiltration or ultrafiltration) to further reduce the TSS concentration. Membrane filtration will also remove algae and larger bacteria.

The next treatment process is ion exchange, which reduces the hardness of the water. The ion exchange removes undesirable ions in the water and replaces these with more acceptable ions. The ion exchange process also improves the effectiveness of the RO process to follow. To ensure the barium content meets the existing water quality of Wallarah Creek, additional resins will be utilised at the Water Treatment Plant in the ion exchange process.

Finally, the mine water will be treated using the RO process to significantly reduce salinity. The RO process involves the passing of the water through a membrane under high pressure which will produce a filtrate (treated water for re-use) and a brine extract requiring disposal. The brine extract may be further treated in a brine treatment plant to produce a semi-solid salt mixture for disposal. RO has been proven to be the most cost effective method for the desalination of brackish water. The RO and ion exchange processes are also responsible for the removal of heavy metals.

The Water Treatment Plant has been designed so that it will treat water to a similar quality to that of the background water quality of Wallarah Creek, having regard to key water quality parameters such as pH, salinity (EC and TDS) and concentrations of various metals.

A detailed comparison of treated water quality and the background quality of Wallarah Creek is provided in Appendix J.

A similar practice of discharging treated water is currently being utilised at the Austar Coal Mine in the lower Hunter Valley, the impacts from which are regulated and authorised by EPL 416.

The Water Treatment Plant will have the capacity to treat 3 ML/day (2.7 ML/day excluding backwash). The plant has been designed specifically for the Project with the capacity determined using predicted volumes of groundwater inflows and runoff from hardstand areas.

The clean water filtrate produced from the water treatment plant will be used firstly to satisfy the mine's operational water demand. Any surplus treated water will be released into a tributary of Wallarah Creek as environmental flows. The Water Treatment Plant has been designed to treat water to a quality that is appropriate for beneficial use and environmental discharge.

Should the demand arise in the future, this clean water may be re-directed to the Gosford / Wyong water supply system or to other potential users. If this option is deemed viable in the future, additional relevant approvals would be sought in this regard in consultation with WSC and other relevant regulators.

3.9.2 Sewage and Potable Water

Sewage and routine site generated waste water will be discharged to the municipal sewerage system. Sewage from the Tooheys Road Site will be pumped directly to the Charmhaven Sewage Treatment Plant to the south-east. Sewage from the Buttonderry Site will be discharged into the municipal sewerage system via a connection to the sewer mains near the intersection of Sparks Road and Hue Hue Road. The indicative sewer connections are shown on Figure 3, Figure 19 and Figure 21.

Potable water required during construction will be trucked onsite prior to the completion of a connection to the town supply. An indicative connection alignment to the Gosford - Wyong Councils' Water Authority potable water supply system from the Tooheys Road Site is shown in Figure 19. Connection details will be confirmed once the Water Authority is commissioned to undertake this work.

WACJV will continue to consult with WSC with respect to the alignments of the potable water and sewerage connections. WACJV will obtain any necessary approvals prior to the commencement of these works.

3.9.3 Regulated Discharge

Mine water will be managed via the following methods:

- Treated and used for mine operational needs; and
- Treated and discharged into Wallarah Creek.

Discharge of water into Wallarah Creek will be managed. Control measures will include real time monitoring of the water quality stored in the discharge dam. The water treatment process has been designed to ensure that the quality of discharge water is similar the existing receiving water quality in Wallarah Creek. Further detail in relation to water quality parameters under which discharge will occur are provided in Section 7.3.

An automated water discharge system will be utilised which is able to be controlled remotely and will include:

- Sensors to monitor water quality (EC, TSS, pH) and quantity of water to be discharged;
- Emergency shut off valves which relate to quality of water; and
- Protocol to ensure water discharge is undertaken in accordance with regulatory requirements.

This operation will be undertaken in accordance with an EPL for the Project.

3.9.4 Brine and Salt Disposal

The Water Treatment Plant will be designed to comprise a two stage treatment process. The Water Treatment Plant will generate clean water that is either suitable for reuse within the operation of the mine or release into Wallarah Creek in accordance with conditions of any EPL. Brine will be generated as a by-product of the primary treatment process. The brine will either be fed into the Brine Treatment Plant or disposed of in the underground workings (later in the Project life).

The Brine Treatment Plant will be used for the second stage of the treatment process. It will be operated for at least the first 14 years of the Project life. The Brine Treatment Plant will be used to dewater the brine and produce a partly-dried salt mixture which will enable the efficient disposal of this by-product in dedicated underground workings. This secondary treatment process significantly reduces the volumes of material that will need to be disposed of in the underground workings. The salt mixture from the secondary treatment process will be stored in a dedicated underground sump comprised of five headings. The indicative location of this sump is illustrated in Figure 18.

The Brine Treatment Plant will produce distilled water as a result of the dewatering process. The distilled water will be mixed with the treated water produced by the Water Treatment Plant. The resulting mixture of treated water will be similar in quality to the existing water quality in Wallarah Creek. Distilled water will not be discharged directly into the creek.

During the first 14 years of the Project life, the Brine Treatment Plant is predicted to produce a total of 52,590 m^3 of salt mixture that will need to be stored underground. Two of the five headings in the underground sump will be used for salt storage. The two headings provide a storage capacity of approximately 72,000 m^3. The salt mixture produced by the Brine Treatment Plant has a salinity of 707,500 mg/L and a density of 1,697 g/cm^3.

As the underground mine develops and completes the extraction of LW 11N (approximately Year 14), WACJV will have the option of bypassing the Brine Treatment Plant. The brine from the Water Treatment Plant will be disposed in the subsided goaf areas of the longwall panels completed in the earlier years of the Project. The Water Treatment Plant is predicted to generate 246 ML of brine over the second 14 years in the Project life. This brine will be disposed of in the goaves of longwalls LW1N to LW11N and LW1S to LW10S (refer to Figure 18). The brine produced by the Water Treatment Plant has a salinity of 290,500 mg/L and a density of 1,237 g/cm^3.

If WACJV elects to operate the Brine Treatment Plant for the entire 28 year Project life, an additional 71,400 m^3 of semi-solid salt will be generated over the second 14 years of the Project life. If brine treatment is undertaken for the entire 28 year period, a total of 123,990 m^3 of salt will be stored underground.

WACJV has adopted the strategy of underground brine and salt disposal to avoid the need to discharge saline by-products off site. The adopted strategy ensures that the only substance discharged from the site will be treated water. WACJV considered an alternative underground disposal strategy where only brine would be produced for the entire 28 year Project life (i.e. no brine treatment process).

Due to the lack of mine goaves in the early stages of mining, it was determined that storage requirements needed to be minimised. The Brine Treatment Plant will concentrate the salts in the groundwater in the first 14 years of the Project life to reduce the volume of storage area needed underground.

The proposed underground storage is located at a depth of greater than 350 m below the natural surface. The underground storage is overlain by the low permeability geological units forming the Narrabeen Group. The salts in the brine largely originated mainly from the coal seam situated below the Narrabeen Group. Hence these salts are being returned to their original location.

A RO plant is operated and the underground disposal of brine currently occurs at the Austar Coal Mine in the lower Hunter Valley.

3.10 Power Supply and Communications

High voltage electricity is available at the Buttonderry Site (see Figure 14) which will also be utilised for the Tooheys Road Site. The 132 kV supply will be provided by Ausgrid from the 132 kV feeder 957, near Hue Hue Road. Whilst the exact nature of the network connection works are still subject to negotiation, this supply may include the requirement for an outdoor switching station (maximum footprint 50 m x 50 m). Ausgrid will require a specific construction environmental management plan for agreed electrical works and will gain all necessary approvals for any required off Lease electrical works.

Power supply for the coal handling plant and surface infrastructure at the Tooheys Road Site will be provided by a private electrical feeder from the 132 kV / 11 kV Substation at the Buttonderry Site. This feeder will be via an easement from the Buttonderry Site to Tooheys Road Site within the Project Boundary. Onsite communications facilities and an optic fibre network connection will also be required and will be located within the Infrastructure Boundary. Any work required to be undertaken outside the Disturbance Area will be in accordance with a Land Disturbance Protocol.

3.11 Reject and Tailings

The Project does not require a Coal Handling and Preparation Plant (CHPP) due to the high quality of the resource. Therefore coarse rejects or fine tailings that are normal by-products of a CHPP are not produced and coal tailings dam storage facilities for these by-products are not required. The Project's water consumption and power demands are substantially reduced because a CHPP is not required.

Clean excavated waste rock will be created during the construction of the drift and shafts. This amounts to approximately 160,000 m^3 for the Tooheys Road Site and approximately 20,000 m^3 for the Buttonderry Site. It is intended to use this material for site earthworks including the creation of perimeter bunding and landscaping features on the two sites.

3.12 Construction

The current Project schedule contains a three year construction period. Table 9 provides an indicative construction schedule for the Project. The Project will require approximately 450 on site construction employees. Some construction activity (such as subsurface excavation for the drift) may be undertaken 24 hours per day.

Table 9 Indicative Construction Schedule

	Year 1				Year 2				Year 3				Year 4				Year 5			
Action	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Gas Management				■																
PROCUREMENT / MOBILISATION		■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	
Site Establishment		■	■																	
Construction Power		■	■																	
Water Supply		■	■																	
Portal			■																	
Drift			■	■																
Shafts				■	■															
Materials Handling					■	■	■													
Rail Track Materials					■	■	■													
Ventilation Equipment			■	■	■	■	■													
Development Equipment			■	■	■	■	■													
Rail Signalling Equipment					■	■	■	■												
Transformers		■	■	■	■	■	■	■	■	■										
Longwall														■	■	■	■	■	■	
CONSTRUCTION AND UNDERGROUND DEVELOPMENT		■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
TOOHEYS ROAD SITE		■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Site Establishment		■																		
Construction Power			■																	
Portal			■																	

	Year 1				Year 2				Year 3				Year 4				Year 5			
Action	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Power Supply – HV Transmission Line			■	■	■															
Power Supply – Sub Stations				■	■															
Power Supply – Reticulation				■	■															
Buildings, Services and Facilities			■	■	■	■	■	■												
Water Supply			■	■	■	■	■	■	■											
Materials Handling – ROM Coal							■	■	■											
Rail Loop and Spur – Civil Works					■	■	■	■	■											
Drift				■	■	■	■	■	■	■										
Rail Loop and Spur – Track work									■	■										
Materials Handling – Train Loader										■	■									
Rail Loop and Spur – Signalling and Services										■	■									
Materials Handling							■	■	■	■	■									
Materials Handling – Product Coal							■	■	■	■	■									
Rail Loop and Spur					■	■	■	■	■	■	■									
Gas Plant																		■	■	■
BUTTONDERRY SITE			■	■	■	■	■	■	■	■	■									
Site Establishment			■																	
Construction Power			■																	
Water Supply			■	■																
Buildings and Facilities					■	■	■													
Upcast Shaft						■	■	■	■	■										
Power Supply									■	■										
Downcast Shaft (Materials and Equipment)						■	■	■	■	■	■									
UNDERGROUND DEVELOPMENT											■	■	■	■	■	■	■	■	■	■
LONGWALL EXTRACTION																				■

The overall duration for the construction works at the Tooheys Road Site is anticipated to be approximately two years with the gas plant to be developed later. The overall duration for the construction works at the Buttonderry Site is anticipated to be approximately two years.

The Western Ventilation Shaft will be constructed around Year 13. Construction will be conducted over approximately 14 months.

Clean excavated soil and rock material will be brought to the surface and the majority of it will be stockpiled and trucked off site in order to reduce the disturbed area and manage impacts at this location. Some material will be used for fill in earthworks around the site.

The material represents virgin excavated natural material and can be used as clean fill for local earthworks, safely disposed of or productively used as a clean cover or fill material at any licensed landfill or approved quarry.

3.13 Project Alternatives

Since the granting of the WACJV Mining Authorities in 1995, an extensive exploration program and detailed feasibility studies have been carried out in order to identify the most efficient and environmentally responsible mining operation for extraction of the coal reserves. This process has included the consideration and refinement of numerous mine plans and operational alternatives.

The objective of these studies was to develop a mine plan that considered financial viability, the principles of Ecologically Sustainable Development (ESD) and minimised the potential environmental and social impacts, whilst maximising coal recovery and retaining operational flexibilities. From the outset of Project planning, open cut mining options were discarded due to the substantial depth of the resource and are not further detailed in this review process. The various Project alternatives that were considered are described below.

3.13.1 Option 1 – Do Nothing

The 'do nothing' approach would result in the termination of the WACJV Mining Authorities. This would result locally in a loss of employment opportunities, as well as socio-economic benefits and royalties or other payments to the Federal, NSW State and Local Governments. This alternative would fail to maximise resource recovery and not considered to meet the Objects of the EP&A Act, in particular that of encouraging the proper development of natural resources for the purpose of promoting the social and economic welfare of the community.

In addition, the 'do nothing' option would result in significant financial loss to WACJV as a result of the substantial investment in exploration, mine planning and environmental studies carried out to date.

It would also potentially result in the permanent sterilisation of the resource and the resultant break-up of the land package that would be difficult to reassemble for any future project development purposes.

3.13.2 Option 2 – Underground Operation (Bord and Pillar)

Option 2 involved the development of an underground mining operation utilising the bord and pillar underground mining method. This method, which generally results in a lower level of surface subsidence above the mine Extraction Area, was investigated and deemed unviable for extraction of a large resource at significant depth. This was due to safety implications and economic considerations (high initial capital cost and higher operating costs). The application of this mining method would result in the Project not being developed and the resource being sterilised.

3.13.3 Option 3 – The Project

The Project comprising an underground longwall mining operation is the preferred alternative and was the culmination of assessing at least 15 different mine designs. It will maximise the social and economic benefits from the Project while minimising impacts on environmental aspects such as surface water regimes, water supply, ecology, Aboriginal archaeology and soils.

This option was considered to be the best alternative in terms of meeting the principles of ESD and the Objects of the EP&A Act.

3.13.4 Review of Detailed Project Options

The review process for alternative Project options considered a range of underground mining layouts, mine production scenarios, surface facilities locations and layouts, coal processing alternatives and transport and infrastructure options. These alternatives were evaluated against geotechnical, commercial, social and environmental criteria.

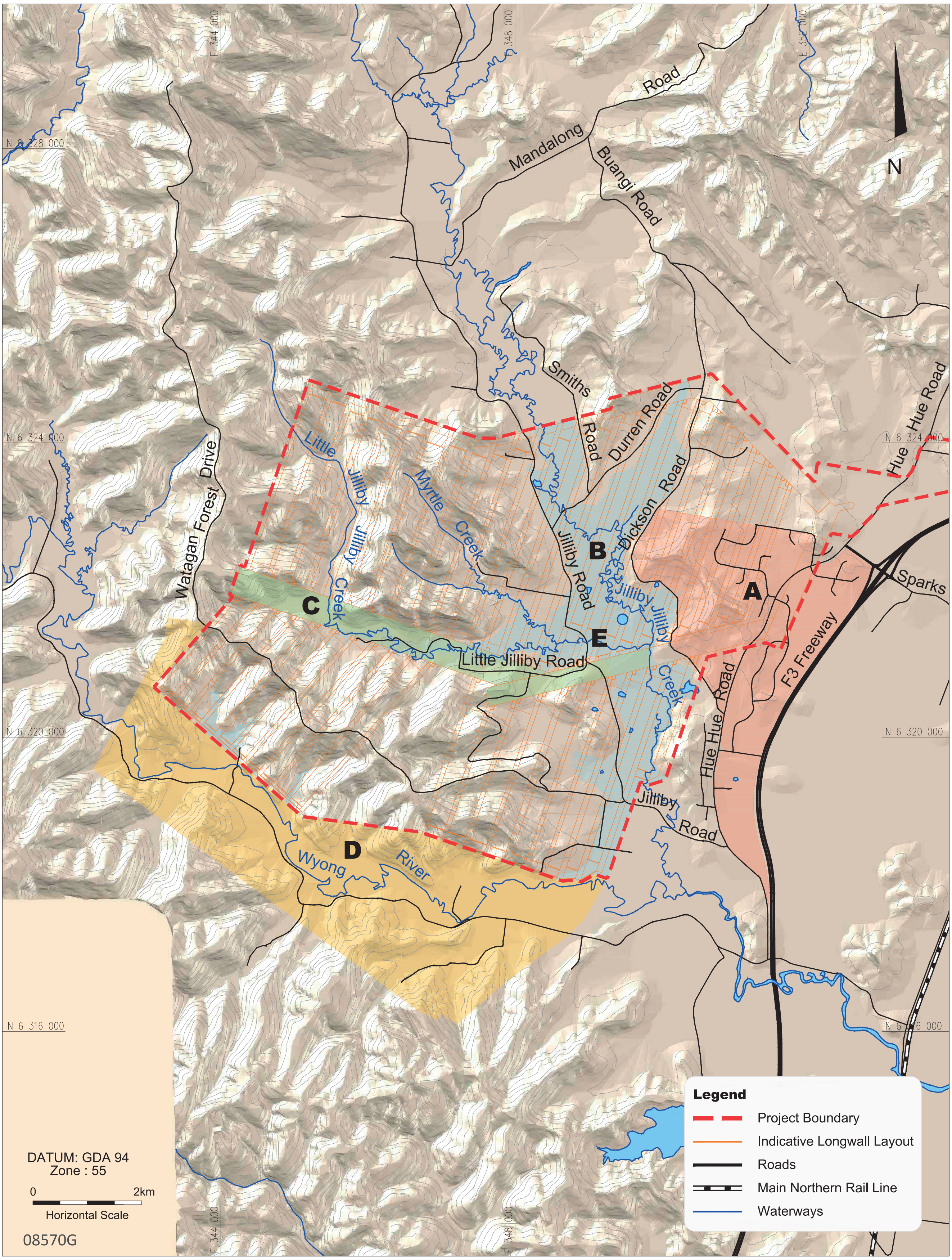
Underground Mine Layout

Key geological constraints such as regional linear dyke patterns, igneous intrusions and coal seam thickness, seam splitting and coal quality conditions were closely studied throughout the extensive exploration process enabling a target mining area to be delineated.

A seam thickness of up to 6.8 m occurs in the target area. The general range of extraction thickness within the 6.8 m seam will vary from 3.0 m to 4.5 m, in order to best balance the need for subsidence protection and maximum extraction efficiency. Within this target mining area, the conceptual mine plan has continued to evolve as information has progressively become available on the geological, operational, environmental and socio-economic constraints throughout the feasibility study and environmental assessment process.

During the mine planning review process, a number of areas that were initially proposed to be mined were removed from the mine plan on environmental grounds to prevent impacts to specific surface features of the natural or built environment (see Figure 23).

Specific subsidence management zones were used by WACJV to guide mine planning. The detailed configuration of proposed extraction in all areas of the mine plan has been modified to ensure that risks and impacts have been reduced to demonstrably low and manageable levels. An outline of the key areas where mining was modified or reduced to minimise environmental and social impacts is provided in Table 10.



WALLARAH 2 COAL PROJECT

Mine Plan Revisions to Reduce Impacts

FIGURE 23

Wallarah 2 COAL PROJECT | Hansen Bailey ENVIRONMENTAL CONSULTANTS

Surface Facilities Planning

The Project planning process also included numerous conceptual plans for surface facilities which were assessed on economic, environmental and social grounds. Rail access from the Main Northern Railway Line has been a consistent design factor since the inception of the Project.

The initial conceptual layout at the time of the 1995 tender for the Wyong Coal Development Areas involved surface rail facilities east of the F3 Freeway but north of their current location in a former Crown land area now owned by DLALC. The opportunities for siting a rail loop and train loading facilities were considered in the Bushells Ridge area both east and west of the F3 Freeway and north and south of the Motorway Link Road. The option for a rail loop south of the Motorway Link Road was discarded due to the technical difficulty in providing a rail crossing over the Motorway Link Road and the likely impact on high value ecological land in this area.

The initial layout alternatives also assessed the viability of locating facilities west of the F3 Freeway, including underground access via a drift from that location. While some land purchases were made to facilitate this option, it was discarded following advice from WSC that this area contained high ecological values that were a priority for conservation under the emerging Wyong Conservation Strategy. There were also significant complexities of providing rail access west of the F3 Freeway.

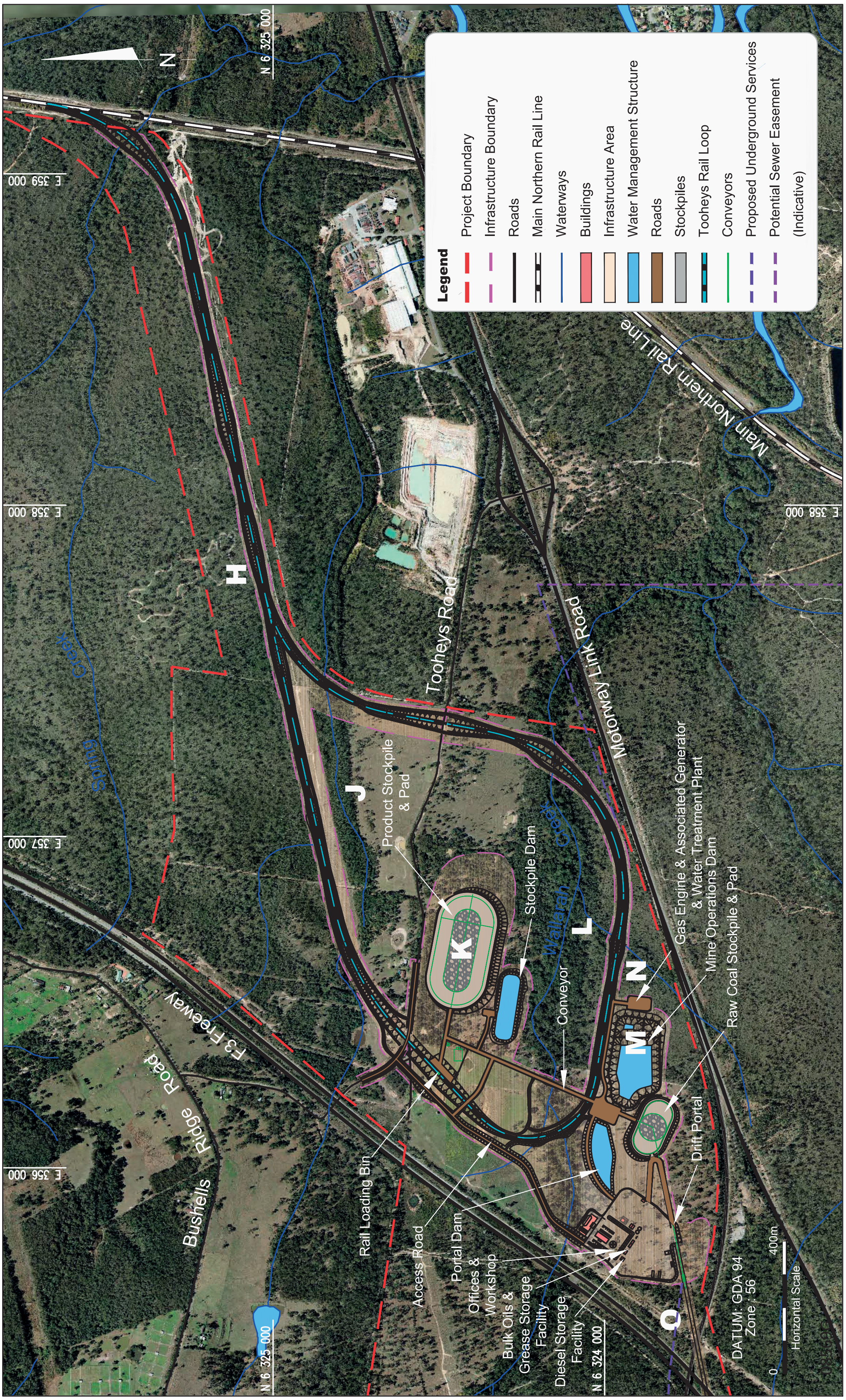
Further evaluation eventuated in the current option for coal handling facilities located east of the F3 Freeway and adjacent to the intersection of the Motorway Link Road and the F3 Freeway with a separate administration facilities site at Buttonderry, immediately south of WSC's waste facility. This option requires a 3.5 km long drift (inclined tunnel) to link the Tooheys Road Site with the underground mine beneath the Buttonderry Site. This enables coal to be conveyed from the underground mine to the surface stockpiles at Tooheys Road Site as well as provide for large machinery access to the underground mine. This drift will avoid the need for long surface conveyors across private property or high conservation lands west of the F3 Freeway.

The detailed planning for surface facilities focused on minimising impacts. An outline of the key environmental features of the surface facilities as proposed is shown in Figure 24 and described in Table 10.

Table 10 Reduced Impacts and Socio-Economic Implications of Project Design

Ref	Description	Environmental Impact Reduction	Socio-Economic Costs
Underground Mine Layout and Extraction Plan			
A	Mine layout and panel configuration in Hue Hue MSD	Ensured that there would be conformance with the local mining subsidence criteria in the Hue Hue area and adjacent areas of potential future development. MSB procedures also apply in this and all of the areas within the Project Boundary for appropriate management of buildings and improvements	Sterilisation of approximately 2.4 Mt of coal due to narrow longwall and reduced extraction height
B	Restricted extraction plan in the Jilliby Jilliby Creek alluvial zone	Longwall panels are restricted to a maximum of 175 m width and variable extraction heights (3.5 m to 4.5 m) to ensure protection of stream system and alluvial and hardrock groundwater regimes	Approximately 0.6 Mt of coal sterilised based on 4.5 m target extraction height (excludes coal from restricted panel widths)
C	Subsidence protection zone at Little Jilliby Jilliby Valley	The alignment of permanent main underground headings provides major subsidence mitigation or avoidance for Little Jilliby Jilliby Creek alluvial valley area, stream alignment and flows, as well as Jilliby Primary School and houses	No coal loss value applied as nearly all mine design alternatives included this or similar design feature. Subsidence repair costs avoided
D	Removal from mine plan of longwall panels under Wyong River	Very minor actual reduction in environmental risk to river, adjacent alluvial lands and Mardi-Mangrove Pipeline. However, significant perceived impact reduction due to heightened community concerns regarding Wyong River and the assumed threat to water supply and integrity of key water infrastructure	Potential reduced degree of community concern on impacts to water supply. Significant coal sterilisation of up to 15 Mt
E	Shortened longwall panels for protection of creeks confluence	Risks avoided to Little Jilliby Jilliby Creek channel alignment, channel morphology, landscape stability (erosion risk avoided) and flow continuity	Coal sterilisation of up to 1.75 Mt. Avoids risk of any potential stream remediation or of any local channel realignment affecting land production and property value

Ref	Description	Environmental Impact Reduction	Socio-Economic Costs
Surface Facilities Location and Design			
F	Tooheys Rd and Buttonderry sites selection	Reduced impacts on land zoning and land use due to development compatibility with current and future adjacent lands. Reduced land and ecological disturbance from avoiding rail and surface facilities in north (DLALC land) or other high value ecological lands west of F3 or south of Motorway Link Road. Drift will avoid coal handling risk in water catchment and avoid land use and visual impacts from overland conveyor between surface sites	Potential for WACJV to facilitate water and sewerage connections to sites which will benefit adjacent land owners. Redundant land purchases
G	No CHPP, coarse reject emplacements or tailings dams	Major reduction in development footprint (no CHPP and associated tailings dams). Significant reduction in water consumption and reduced noise, vibration, visual and dust emissions and respective zones of affectation/visibility	Reduced capital and operating costs, and reduced monitoring costs
H	Rail spur alignment alongside 330 kV transmission line easement	Reduced ecological fragmentation impact due to proposal to utilise existing corridor	Reduced land use (sterilisation) impact on adjacent land
I	Rail, coal handling and surface facility overall layout at current Tooheys Road Site	Reduced ecological impacts due to maximising development in cleared and disturbed areas. Reduced amenity impacts on nearest residences due to separation from Tooheys Road Site, local acoustic environment of existing freeways and proposed Project noise, dust and visual impact mitigation strategies. WACJV will facilitate infrastructure connections to the surface facilities which will assist future nearby developments. Ability for WACJV to establish vegetation protection areas as part of broader biodiversity offsets strategy	Conservation benefits by WACJV biodiversity offset strategy
J	Protection of zoned wetland	Protection of Swamp Mahogany swamp forest (approximately 6 ha) from direct disturbance. Water quality protection and continuation of flow regime	None
K	Coal stockpile design	Stockpile design and operation results in minimised dust, noise and visual impacts. Single dozer operation gives noise reduction to nearest receivers	None
Surface Facilities Location and Design cont.			
L	Vegetation protection strategy for Wallarah Creek	Minimal direct impacts on ecology and morphology of the creek area by necessary rail crossings and siting of major infrastructure	None
M	Dams	Dams sited in partially cleared and disturbed areas to reduce ecological impacts	None
N	Water and gas management systems	Water treatment strategy enables water reuse and recycling and reduction of fresh water consumption. Gas management strategy will reduce greenhouse emissions	Cost of plant
O	Drift development	Use of a 3.5 km long drift will reduce land use and visual impacts compared to overland conveyor alternative	Cost differential compared to alternative coal transport option



WALLARAH 2 COAL PROJECT

Infrastructure Layout Revisions to Reduce Impacts

FIGURE 24

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Wallarah 2 COAL PROJECT

Wallarah 2
COAL PROJECT

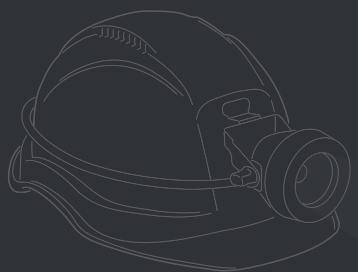
Wallarah 2 Coal Project

Environmental Impact Statement

April 2013

4

Regulatory Framework



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This section describes the environmental regulatory framework applicable to the Project and considers both NSW and Commonwealth legislation. It further considers relevant environmental planning instruments including the identification of any inconsistencies with these instruments. The Project will require approvals under additional State and Commonwealth Acts which are also discussed in this Section.

Figure 25 illustrates the EIS and stakeholder consultation process that applies to the Project.

4.1 Environmental Planning and Assessment Act 1979

4.1.1 Application of Division 4.1 of Part 4

The *Environmental Planning and Assessment Amendment (Part 3A Repeal) Act 2011* inserted a new Division 4.1 in Part 4 of the EP&A Act. This Division provides for a new planning assessment and determination regime for State Significant Development (SSD) in NSW.

Under section 89C of the EP&A Act, development is SSD if it is declared to be such by the *State Environmental Planning Policy (State and Regional Development) 2011* (SRD SEPP). Clause 8(1) of the SRD SEPP provides:

> *"8 Declaration of State Significant Development: Section 89C*
>
> *(1) Development is declared to be State significant development for the purposes of the Act if:*
>
> *(a) the development on the land concerned is, by the operation of an environmental planning instrument, not permissible without development consent under Part 4 of the Act, and*
>
> *(b) the development is specified in Schedule 1 or 2."*

The Project is SSD as it meets each of the two limbs in clause 8(1) of the SRD SEPP – that is:

- The Project is not permissible without Development Consent on the land on which the Project will be carried out; and
- The Project is development that is specified in Schedule 1 to the SRD SEPP.

Each is briefly discussed below.

Permissibility

Activities at the Buttonderry Site, Tooheys Road Site and Western Ventilation Shaft Site are permissible with development consent under the Wyong LEP.

Although the Project's underground Extraction Area is largely zoned 1(a) Rural, 1(c) Non Urban Constrained Lands or 1(f) Forestry in respect of which mining is permissible with development consent, there are several areas within the underground Extraction Area which are zoned 7(a) Conservation, 7(b) Scenic Protection, 7(c) Scenic Protection: Small Holdings, 6(a) Open Space and Recreation where mining is prohibited (see **Figure 6**). However, these provisions are subject to the application of the *State Environmental Planning Policy (Mining, Petroleum Production and Extractive Industries) 2007* (Mining SEPP) as discussed below.

Clause 7(1) of the Mining SEPP provides:

> *"7 Development Permissible with Consent*
>
> *(1) Mining*
>
> *Development for any of the following purposes may be carried out only with development consent:*
>
> *(a) underground mining carried out on any land …"*

The Mining SEPP applies to the whole of NSW and, pursuant to clause 5(3) of the Mining SEPP, it prevails over any other Environmental Planning Instrument (EPI) to the extent of any inconsistency. The practical effect of clause 5(3) is that if there is any inconsistency between the provisions in the Mining SEPP and those contained in any other EPI, including relevantly the Wyong LEP, the provisions of the Mining SEPP will prevail.

"Underground mining" is defined for the purposes of the Mining SEPP as follows:

> *"**underground mining** means:*
>
> *(b) mining carried out beneath the earth's surface, including bord and pillar mining, longwall mining, top-level caving, sub-level caving and auger mining, and*
>
> *(c) shafts, drill holes, gas and water drainage works, surface rehabilitation works and access pits associated with that mining (whether carried out on or beneath the earth's surface), but does not include open cut mining."*

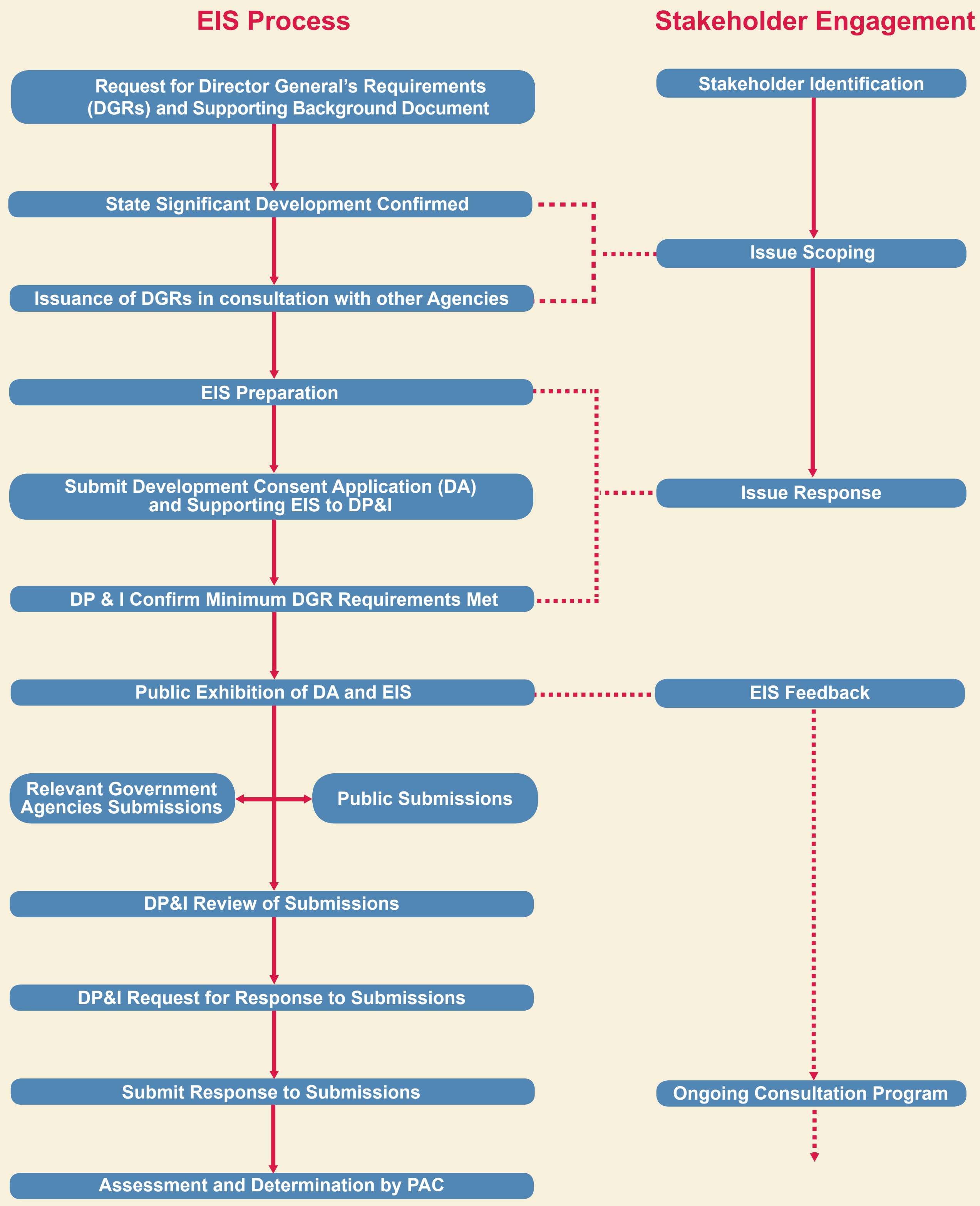

Figure 24 EIS Process and Stakeholder Engagement .ai

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WALLARAH 2 COAL PROJECT

EIS Process and Stakeholder Engagement

FIGURE 25

And further, *"mining"* is defined for the purposes of the Mining SEPP as follows:

> *"mining means the winning or removal of materials by methods such as excavating, dredging, or tunnelling for the purpose of obtaining minerals, and includes:*
>
> *(a) the construction, operation and decommissioning of associated works, and*
>
> *(b) the stockpiling, processing, treatment and transportation of materials extracted, and*
>
> *(c) the rehabilitation of land affected by mining."*

Accordingly, as the Project in its entirety can be characterised as development for the purpose of *"underground mining"* (which incorporates in its definition the defined term *"mining"*), the Project is permissible with Development Consent on the land on which the Project will be carried out.

Schedule 1 to the SRD SEPP

The Project is development specified in Schedule 1 to the SRD SEPP.

Clause 5(1)(a) in Schedule 1 to the SRD SEPP specifies the following development:

> *"5 Mining*
>
> *(1) Development for the purpose of mining that:*
>
> *(a) is coal … mining, or …"*

Given that the Project in its entirety is development for the purpose of coal mining, the Project is development specified in Schedule 1 to the SRD SEPP.

4.1.2 State Significant Development

As each of the two limbs in clause 8(1) of the SRD SEPP can be satisfied as described in Section 4.1.1, the Project is declared to be SSD. As a consequence of this declaration, the Minister for Planning and Infrastructure (Minister) is the consent authority for the Project (EP&A Act, section 89D(1)).

The Minister has delegated his consent authority function for certain SSD, relevantly:

- To the NSW Planning Assessment Commission (PAC) for development applications made by private proponents for SSD; and
- To officers of the DP&I for development applications which have attracted less than 25 public submissions objecting to the development and where the local council, in this case WSC, has not objected.

Objects of the EP&A Act

The objects described in Section 5 of the EP&A Act are:

> *"(a) to encourage:*
>
> *(i) the proper management, development and conservation of natural and artificial resources, including agricultural land, natural areas, forests, minerals, water, cities, towns and villages for the purpose of promoting the social and economic welfare of the community and a better environment,*
>
> *(ii) the promotion and co-ordination of the orderly and economic use and development of land,*
>
> *(iii) the protection, provision and co-ordination of communication and utility services,*
>
> *(iv) the provision of land for public purposes,*
>
> *(v) the provision and co-ordination of community services and facilities, and*
>
> *(vi) the protection of the environment, including the protection and conservation of native animals and plants, including threatened species, populations and ecological communities, and their habitats, and*
>
> *(vii) ecologically sustainable development, and*
>
> *(viii) the provision and maintenance of affordable housing, and*
>
> *(b) to promote the sharing of the responsibility for environmental planning between the different levels of government in the State, and*
>
> *(c) to provide increased opportunity for public involvement and participation in environmental planning and assessment."*

Section 9 describes how this EIS has addressed each in relation to the Project.

4.1.3 Development Contributions

Divisions 6 and 6A of Part 4 of the EP&A Act relate to contributions and affordable housing provisions. Section 94 enables the Minister to apply a condition to a Development Consent which requires the payment of money or dedication of land to the local Council (WSC) with regard to the increased demand on public facilities due to the Project. Section 94A enables to Minister to apply a condition to a Development Consent which requires the payment of a fixed development consent levy.

Section 93F enables a Voluntary Planning Agreement (VPA) to be established which may replace the imposition of a condition under Section 94 or Section 94A. WACJV has commenced discussions with WSC in relation to entering into a VPA to meet the required contributions in relation to the Project under Division 6 of Part 4 of the EP&A Act.

The VPA is being developed in consideration of WSC's policy on VPAs as described in Section 4.2.8.

4.1.4 Environmental Assessment Requirements

WACJV sought DGRs for the environmental assessment of the Project on 13 October 2011 supported by the 'Wallarah 2 Coal Project Background Document' (dated October 2011).

DGRs were issued for the Project under Part 2 of Schedule 2 of the EP&A Regulation on 12 January 2012. Section 5.4.2 lists each DGR and indicates where each is addressed in this EIS. DGRs were reissued on 11 July 2012 to incorporate Department of Sustainability, Environment, Water, Population and Communities (SEWPaC) requirements as described in Section 4.6.1.

4.1.5 Evaluation

Section 79C(1) of the EP&A Act stipulates matters for consideration by the Minister (or delegate) in determining a development application. The consent authority is to take into consideration the following matters as are of relevance to the development:

"(a) *the provision of:*

(i) *any environmental planning instrument, and*

(ii) *any proposed instrument that is or has been the subject of public consultation under this Act and that has been notified to the consent authority (unless the Director-General has notified the consent authority that the making of the proposed instrument has been deferred indefinitely or has not been approved), and*

(iii) *any development control plan, and*

(iiia) *any planning agreement that has been entered into under section 93F, or any draft planning agreement that a developer has offered to enter into under section 93F, and*

(iv) *the regulations (to the extent that they prescribe matters for the purposes of this paragraph), and*

(v) *any coastal zone management plan (within the meaning of the Coastal Protection Act 1979), that apply to the land to which the development application relates,*

(b) *the likely impacts of that development, including environmental impacts on both the natural and built environments, and social and economic impacts in the locality,*

(c) *the suitability of the site for the development,*

(d) *any submissions made in accordance with this Act or the regulations,*

(e) *the public interest."*

Section 9 describes how this EIS has addressed each in relation to the Project.

4.1.6 Planning Assessment Commission

The Minister has the option of referring a Project to the PAC for its review and report to the Minister. Section 23D(1) states the functions of the PAC including:

"(a) *any function delegated to the Commission under this Act,*

(b) *if requested to do so by the Minister or the Director-General:*

(i) *to advise the Minister or the Director-General as to planning or development matters, environmental planning instruments or the administration or implementation of the provisions of this Act, or any related matter, and*

(ii) *to review any (or any aspect or part of any) development, activity, infrastructure or project to which this Act applies, and*

(iii) *to hold a public hearing into any matter the subject of any such advice or review, and*

(iv) *(Repealed)*

(v) *to review a proposal to constitute, alter or abolish a development area under section 132 or 133,*

(c) *any function of a regional panel, an independent hearing and assessment panel or a planning assessment panel conferred on it by order in writing by the Minister,*

(d) *if a regional panel has not been appointed for any part of the State, any function that is conferred on a regional panel under an environmental planning instrument applicable to that part or that is otherwise conferred on a regional panel under this Act …"*

4.1.7 Wyong Local Environment Plan 1991

The Project is wholly located within the Wyong LGA. The local EPI governing land use in the Wyong LGA is the Wyong LEP. Figure 6 shows the Wyong LGA boundary in relation to key Project features.

The Tooheys Road Site, containing the rail loop and spur line and the coal handling facilities is primarily zoned 4(e) Regional Industrial and Employment Development, with a small area zoned 7(g) Wetlands Management. Under the Wyong LEP, mining is permissible in the 4(e) zone with Development Consent.

The Buttonderry Site will provide the main ventilation fans, and access for personnel and services. This site is zoned 1(c) Rural Holdings where development ancillary to mining is permitted with Development Consent. This site is bordered by land zoned: to the north by 5(a) Waste Disposal, 10(a) Investigation Zone to the east (in the process of being zoned industrial), to the west by rural residential areas zoned 7(b) Scenic Protection, and to the south by areas zoned 6(a) Open Space Recreation, 7(a) Conservation and 7(c) Scenic Protection: Small Holdings.

The Project's underground Extraction Area is largely zoned 1(a) Rural, 1(c) Non Urban Constrained Lands or 1(f) Forestry in respect of which mining is permissible with development consent.

There are several areas within the Extraction Area which are zoned 7(a) Conservation, 7(b) Scenic Protection, 7(c) Scenic Protection: Small Holdings or 6(a) Open Space and Recreation where mining is prohibited.

The Wyong LEP also contains the following provisions:

- WSC must not grant consent to the carrying out of development on land to which the Wyong LEP applies unless, in the opinion of WSC, the proposed development is compatible with the objectives of the zone within which the development is proposed to be carried out; and
- Part 3 of the Wyong LEP contains a number of special provisions which apply to the decision-making function of WSC under the Wyong LEP.

Further, the provisions will be considered having regard to the application of clause 8 of the Mining SEPP which provides:

> *"8 Determination of permissibility under local environmental plans*
>
> *(1) If a local environmental plan provides that development for the purposes of mining, petroleum production or extractive industry may be carried out on land with development consent if provisions of the plan are satisfied:*
>
> *(a) development for that purpose may be carried out on that land with development consent without those provisions having to be satisfied, and*
>
> *(b) those provisions have no effect in determining whether or not development for that purpose may be carried out on that land or on the determination of a development application for consent to carry out development for that purpose on that land.*
>
> *(2) Without limiting subclause (1), if a local environmental plan provides that development for the purposes of mining, petroleum production or extractive industry may be carried out on land with development consent if the consent authority is satisfied as to certain matters specified in the plan, development for that purpose may be carried out on that land with development consent without the consent authority having to be satisfied as to those specified matters."*

As discussed in Section 4.1.1 above, due to the application of the Mining SEPP, to the extent that the Project is prohibited under the Wyong LEP, the Mining SEPP will prevail such that the Project in those areas is in fact permissible with consent.

In addition, Section 89E(3) of the EP&A Act provides that, in respect of SSD:

> *"(3) Development consent may be granted despite the development being partly prohibited by an environmental planning instrument."*

It follows that, even if the Mining SEPP did not prevail over the provisions of the Wyong LEP which provide that minor parts of the Project are prohibited, Section 89E(3) still provides that Development Consent may be granted in respect of these parts.

4.1.8 Draft Wyong Local Environmental Plan 2012

WSC has prepared the draft *Wyong Local Environmental Plan 2012* (Draft Wyong LEP), with the objective of superseding the Wyong LEP. The Draft Wyong LEP was placed on public exhibition from 9 January 2013 to 20 February 2013. The Draft Wyong LEP is accompanied by new land zoning maps and contains provisions determining permissibility of developments.

When determining the Project under the EP&A Act, the Minister's delegate is required to have regard to the provisions of the Draft Wyong LEP in so far as they are of relevance to the Project. This is required under sections 89H and 79C(a)(ii) of the EP&A Act.

The Project Boundary contains land within the following zonings of the Draft Wyong LEP:

- RU1 Primary Production;
- RU2 Rural Landscape;
- RU6 Transition;
- R5 Large Lot Residential;
- IN1 General Industrial;
- RE1 Public Recreation;
- E1 National Parks and Nature Reserves;
- E2 Environmental Conservation; and
- E3 Environmental Management.

In a fact sheet that accompanied the exhibition of the Draft Wyong LEP, WSC explained the new zones as follows:

> *"In 2006, the NSW Government created a common structure and language for LEPs by adopting a 'Standard Instrument'. The new zones in draft Wyong LEP 2012 are consistent with the Standard Instrument and are primarily a conversion of the existing zones described by Wyong LEP 1991. There will be changes to zone descriptions, objectives and permissible and prohibited land uses. However, Council has used a 'best-fit' for the conversion of existing zones."*

The list of permissible developments in various zonings has been drafted in harmony with clause 7(1)(a) of the Mining SEPP. This is the clause which provides that development for the purpose of underground mining may be carried out on any land with development consent. The existence of clause 7(1)(a) of the Mining SEPP explains the superficial anomaly in the RU1 Primary Production and RU2 Rural Landscape zones under the Draft Wyong LEP where "open cut mining" is permissible with development consent in those zones, but development for "underground mining" is prohibited.

Even if the Draft Wyong LEP was to be gazetted, in the form in which it was publicly exhibited, the Project would be permissible with development consent by reason of clause 7 of the Mining SEPP and section 89E(3) of the EP&A Act.

Clause 7.13 of the Draft Wyong LEP identifies an area of land as a potential site for a Type 3 airport. The land identified in clause 7.13 encompasses an area of 900 ha and includes the Tooheys Road Site. Clause 7.13 does not prohibit the 900ha site from being used for any purpose other than an airport. There has been no multi-disciplinary expert study which recommends the site for a Type 3 airport, nor has either the Federal or State government endorsed this site for an airport.

WACJV has provided a submission on the Draft Wyong LEP for WSC's consideration.

4.1.9 Regional Environmental Plans

The only Regional Environmental Plan applicable to the Project is the *Sydney Regional Environmental Plan No 9 – Extractive Industry (No 2 – 1995)* (SREP No. 9) which is deemed to be a State Environmental Planning Policy. Division 1 of Schedule 1 of SREP No. 9 lists clay / shale extraction areas of regional significance and includes "Land covered by Mining Lease 554 and Special Lease 84/7 Wyee. Boral, Wyee". This land contains Boral's clay resources in the vicinity of the Tooheys Road Site.

Clause 16 of SREP No. 9 provides that a proposed development within the vicinity of an extraction area of regional significance can only be granted consent where:

- The proposed development will not be affected by noise, dust, vibration and visual amenity impacts caused by extractive industries; and
- The proposed development will not adversely affect any existing extractive industries.

The Boral Montoro Clay Quarry is located 3 km to the east of the Project's Tooheys Road Site. As the Project is industrial in nature; noise, dust, vibration and visual amenity impacts from the quarry are not predicted to adversely affect the Project. Relevant cumulative impact assessments in Section 7 have considered impacts from the existing Boral Montoro Clay Quarry. The Project is not predicted to adversely affect the existing industry.

4.1.10 State Environmental Planning Policies

Mining SEPP

Some of the relevant provisions of the Mining SEPP have been discussed in Sections 4.1.1 and 4.1.7.

The other provisions which are required to be considered by the PAC when assessing the Project are:

- Clause 12

"12 Compatibility of proposed mine, petroleum production or extractive industry with other land uses

Before determining an application for consent for development for the purposes of mining, petroleum production or extractive industry, the consent authority must:

(a) consider:

(i) the existing uses and approved uses of land in the vicinity of the development, and

(ii) whether or not the development is likely to have a significant impact on the uses that, in the opinion of the consent authority having regard to land use trends, are likely to be the preferred uses of land in the vicinity of the development, and

(iii) any ways in which the development may be incompatible with any of those existing, approved or likely preferred uses, and

(b) evaluate and compare the respective public benefits of the development and the land uses referred to in paragraph (a) (i) and (ii), and

(c) evaluate any measures proposed by the applicant to avoid or minimise any incompatibility, as referred to in paragraph (a) (iii)."

Land zoning within and adjacent to the Tooheys Road Site is categorised as '*Industrial*' or '*Investigation*' which allows for mining under the objects of those zones. Although the Buttonderry Site is located on land zoned rural, it is adjacent to the WSC Buttonderry Waste Management Facility and the approved Warner Industrial Park, leading to a commercial and / or industrial character in the area.

As such, the Infrastructure Boundary is consistent with the existing or proposed uses of the land. The Project is not likely to have a significant impact regarding land use trends or be incompatible with any of those existing, approved or likely preferred uses of land surrounding the Infrastructure Boundary.

The Project will not impact on the existing or proposed uses of the land above the Extraction Area. The Project is not likely to have a significant impact regarding land use trends or be incompatible with any of those existing, approved or likely preferred uses of land above the Extraction Area.

- Clause 13

"13 Compatibility of proposed development with mining, petroleum production or extractive industry

(1) This clause applies to an application for consent for development on land that is, immediately before the application is determined:

(a) in the vicinity of an existing mine, petroleum production facility or extractive industry, or

(b) identified on a map (being a map that is approved and signed by the Minister and copies of which are deposited in the head office of the Department and publicly available on the Department's website) as being the location of State or regionally significant resources of minerals, petroleum or extractive materials, or

Note. At the commencement of this Policy, no land was identified as referred to in paragraph (b).

(c) identified by an environmental planning instrument as being the location of significant resources of minerals, petroleum or extractive materials.

(2) Before determining an application to which this clause applies, the consent authority must:

(a) consider:

(i) the existing uses and approved uses of land in the vicinity of the development, and

(ii) whether or not the development is likely to have a significant impact on current or future extraction or recovery of minerals, petroleum or extractive materials (including by limiting access to, or impeding assessment of, those resources), and

(iii) any ways in which the development may be incompatible with any of those existing or approved uses or that current or future extraction or recovery, and

(b) evaluate and compare the respective public benefits of the development and the uses, extraction and recovery referred to in paragraph (a) (i) and (ii), and

(c) evaluate any measures proposed by the applicant to avoid or minimise any incompatibility, as referred to in paragraph (a) (iii)."

The Project is located within the vicinity of existing mining operations and is located within existing mining authority boundaries (see Figure 2). The Project is a mining operation and as such is consistent with this clause.

As discussed above, the Project will not unduly impact on the intended use of the land within the Project Boundary. The Project has been designed to maximise the social and economic benefits that it will realise while minimising any environmental impacts it will cause.

- Clause 14

"14 Natural resource management and environmental management

(1) Before granting consent for development for the purposes of mining, petroleum production or extractive industry, the consent authority must consider whether or not the consent should be issued subject to conditions aimed at ensuring that the development is undertaken in an environmentally responsible manner, including conditions to ensure the following:

(a) that impacts on significant water resources, including surface and groundwater resources, are avoided, or are minimised to the greatest extent practicable,

(b) that impacts on threatened species and biodiversity, are avoided, or are minimised to the greatest extent practicable,

(c) that greenhouse gas emissions are minimised to the greatest extent practicable.

(2) Without limiting subclause (1), in determining a development application for development for the purposes of mining, petroleum production or extractive industry, the consent authority must consider an assessment of the greenhouse gas emissions (including downstream emissions) of the development, and must do so having regard to any applicable State or national policies, programs or guidelines concerning greenhouse gas emissions."

The Project has been designed to minimise, as far as practical, its impacts on water resources, global warming and biodiversity. Impact minimisation is addressed in Sections 7.1, 7.2, 7.3, 7.4, 7.6 and 7.9 of this EIS.

Further, a summary of management and mitigation measures incorporated into the Project design are included in Section 8. Applicable State and national policies, programs and guidelines in relation to greenhouse gas abatement are addressed in Section 7.6.

- Clause 15

"15 Resource recovery

(1) Before granting consent for development for the purposes of mining, petroleum production or extractive industry, the consent authority must consider the efficiency or otherwise of the development in terms of resource recovery.

(2) Before granting consent for the development, the consent authority must consider whether or not the consent should be issued subject to conditions aimed at optimising the efficiency of resource recovery and the reuse or recycling of material.

(3) The consent authority may refuse to grant consent to development if it is not satisfied that the development will be carried out in such a way as to optimise the efficiency of recovery of minerals, petroleum or extractive materials and to minimise the creation of waste in association with the extraction, recovery or processing of minerals, petroleum or extractive materials."

The Project has been designed to balance resource recovery against minimising impacts on the natural and manmade environment. Section 3.11 describes consideration of resource recovery. The reuse and recycling of Project consumables is considered in Section 7.24.

- Clause 16

"16 Transport

(1) Before granting consent for development for the purposes of mining or extractive industry that involves the transport of materials, the consent authority must consider whether or not the consent should be issued subject to conditions that do any one or more of the following:

(a) require that some or all of the transport of materials in connection with the development is not to be by public road,

(b) limit or preclude truck movements, in connection with the development, that occur on roads in residential areas or on roads near to schools,

(c) require the preparation and implementation, in relation to the development, of a code of conduct relating to the transport of materials on public roads.

(2) If the consent authority considers that the development involves the transport of materials on a public road, the consent authority must, within 7 days after receiving the development application, provide a copy of the application to:

(a) each roads authority for the road, and

(b) the Roads and Traffic Authority (if it is not a roads authority for the road).

Note. Section 7 of the Roads Act 1993 specifies who the roads authority is for different types of roads. Some roads have more than one roads authority.

(3) The consent authority:

(a) must not determine the application until it has taken into consideration any submissions that it receives in response from any roads authority or the Roads and Traffic Authority within 21 days after they were provided with a copy of the application, and

(b) must provide them with a copy of the determination.

(4) In circumstances where the consent authority is a roads authority for a public road to which subclause (2) applies, the references in subclauses (2) and (3) to a roads authority for that road do not include the consent authority."

Transport of coal from the Project will only be by rail as described in Section 3.4.

- Clause 17

"17 Rehabilitation

(1) Before granting consent for development for the purposes of mining, petroleum production or extractive industry, the consent authority must consider whether or not the consent should be issued subject to conditions aimed at ensuring the rehabilitation of land that will be affected by the development.

(2) In particular, the consent authority must consider whether conditions of the consent should:

(a) require the preparation of a plan that identifies the proposed end use and landform of the land once rehabilitated, or

(b) require waste generated by the development or the rehabilitation to be dealt with appropriately, or

(c) require any soil contaminated as a result of the development to be remediated in accordance with relevant guidelines (including guidelines under section 145C of the Act and the Contaminated Land Management Act 1997), or

(d) require steps to be taken to ensure that the state of the land, while being rehabilitated and at the completion of the rehabilitation, does not jeopardize public safety."

The rehabilitation and potential final land use for the mine will be documented in a Mine Closure Plan to be developed for the Project and approved by relevant regulators as assessed and described in Section 7.25 of this EIS. Waste generation and any pre-existing soil contamination issues are assessed in Section 7.24 and Section 7.19 of this EIS respectively.

SRD SEPP

The application of the SRD SEPP to the Project is discussed in Section 4.1.1 and Section 4.1.2.

State Environmental Planning Policy (Infrastructure) 2007

Clause 45 of the *State Environmental Planning Policy (Infrastructure) 2007* (Infrastructure SEPP) is relevant if the Project involves the penetration of ground within 2 m of an underground electricity power line or an electricity distribution pole, or within 10 m of any part of an electricity tower. It is also relevant if a Project is within or immediately adjacent to an easement for electricity purposes, an electricity substation or within 5 m of an overhead electricity power line.

If clause 45 applies, the Minister must give written notice to the electricity supply authority for the area in which the development is to be carried out, inviting comments about potential safety risks and take into consideration any response to the notice that is received within 21 days of the notice being given.

Electricity easements and powerlines occur within the Project Boundary and have a potential to be affected by the Project (see Figure 14) and as such, the Minister must give written notice to the electricity supply authority in accordance with clause 45.

State Environmental Planning Policy No 14 – Coastal Wetlands

State Environmental Planning Policy No 14 – Coastal Wetlands (Wetlands SEPP) applies to the Wyong LGA, however its provisions which require the concurrence of the Director-General of the DP&I is not applicable to the Project as it is "State significant development" (EP&A Act, section 79B(2A)). Further, no SEPP 14 wetlands occur within the Project Boundary.

State Environmental Planning Policy No 33 (Hazardous and Offensive Development)

For development that is a "potentially hazardous industry", clause 12 of *State Environmental Planning Policy No 33 (Hazardous and Offensive Development)* (Hazardous SEPP) requires the preparation of a Preliminary Hazard Analysis. Further, for development that is a "potentially hazardous industry" or "potentially offensive industry", clause 13 of the Hazardous SEPP sets out matters that the Minister must consider in determining the development application for the Project.

The Hazardous SEPP requires the consent authority to consider the merits of proposed activities, including the location of the development and the way in which it is to be carried out.

A review of the relevant components of this Project in Section 7.23 has confirmed that the Project is potentially hazardous. As such, a preliminary hazardous analysis has been prepared (see Section 7.23).

State Environmental Planning Policy No 44 - Koala Habitat Protection

State Environmental Planning Policy No 44 - Koala Habitat Protection (Koala SEPP) applies to the Project because Wyong is a LGA specified in Schedule 1 to the Koala SEPP as being land subject to the Koala SEPP. The Koala SEPP requires a council (WSC), before determining a development application, to consider whether the land is *"potential koala habitat"*, and if so, whether it is *"core koala habitat"*.

If the land is *"core koala habitat"*, then the council must not grant consent unless a *"plan of management"* has been prepared and must also take into account the guidelines made under the Koala SEPP. The Ecological Impact Assessment conducted for the Project did not identify a population of Koalas, however it did identify potential suitable habitat for Koalas within or surrounding the Project Boundary (see Section 7.9).

State Environmental Planning Policy No 55 (Remediation of Land)

State Environmental Planning Policy No 55 (Remediation of Land) (Contamination SEPP) provides that the Minister must not consent to the carrying out of the Project unless it has considered certain matters relating to whether or not the Project land is contaminated.

Further, given that the Project will involve a "*change of use*" of the Project land, the Minister may need to consider a "*preliminary investigation*" of the Project land as to whether it satisfies certain criteria set out in clause 7(4) of the Contamination SEPP.

As discussed in Section 7.22, contaminated land does not occur within the Disturbance Area and therefore the Contamination SEPP does not apply to the Project.

State Environmental Planning Policy No 71 – Coastal Protection

A small part of the Project (comprising part of the Tooheys Road Site) is within the coastal zone to which *State Environmental Planning Policy No 71 – Coastal Protection* (Coastal Protection SEPP) applies.

Clause 8 of the Coastal Protection SEPP sets out matters that the Minister is to take into account when determining the development application for a Project in respect of that part of the Project within the coastal zone.

Under clause 15 of the Coastal Protection SEPP, a consent authority must not consent to a development that proposes to dispose of effluent using a non-reticulated system, where such disposal would negatively impact coastal water bodies. The Project will dispose of effluent via a connection to the municipal sewerage system. Therefore, clause 15 of the Coastal Protection SEPP does not preclude the granting of Development Consent for the Project.

Under clause 16 of the Coastal Protection SEPP, a consent authority must not grant Development Consent to a development that is likely to discharge untreated stormwater into coastal water bodies. The Project will implement the water management system described in Section 3.9 and Section 7.3.1.

At the Buttonderry Site, runoff will be captured in the Entrance Dam. Since this is a sediment dam, only treated stormwater will overflow from the Buttonderry Site. At the Tooheys Road Site, runoff will be captured in the Portal Dam and Stockpile Dam. This water will be treated using RO (or a similar process) prior to being discharged into a tributary of Wallarah Creek. Therefore, clause 16 does not preclude the granting of Development Consent for the Project.

4.2 Strategic Planning Documents

4.2.1 Central Coast Regional Strategy 2008 and the North Wyong Structure Plan 2012

The Project is demonstrably consistent with the NSW Government's Central Coast Regional Strategy (CCRS) and the North Wyong Structure Plan (NWSP).

The CCRS was developed by the State government to assist in planning for an anticipated population growth in the region of 100,000 people by 2031, increased from 64,250 expected in the Draft CCRS. The majority of the population growth will occur in the Wyong Shire. The Strategy supports creating the capacity for over 45,000 jobs in the region over the next 25 years. Some 12,000 jobs are expected to occur in the NWSP area which includes the WEZ and Warnervale Town Centre, both designated as SSD Projects.

The NWSP area will be the focus of future employment land releases, including in the Tooheys Road - Bushells Ridge precinct which is designated for development in the short term (including the Tooheys Road Site) in DP&I's NWSP report of October 2012.

The Tooheys Road Site was zoned industrial more than 15 years ago by the NSW State Government as a significant regional employment precinct. The CCRS retains and promotes this location as key employment land, although with some constraints. These constraints include the management of vegetation and surface drainage systems and other environmental protection measures.

The Project has been specifically designed in consideration of these constraints. The Project is consistent with the aims of the CCRS and NWSP in providing additional employment in the region. It will generate approximately 300 new jobs directly and provide additional employment opportunities for up to 505 people through increased expenditure and well understood flow-on effects in the local and regional economies.

4.2.2 Central Coast Regional Action Plan 2012

To complement NSW 2021 and other existing long term initiatives, Regional Action Plans identify immediate actions the NSW Government will prioritise over the next few years. These plans are an initial response to key actions raised by communities across NSW (http://www.2021.nsw.gov.au/regions/central-coast).

The Central Coast Regional Action Plan (CCRAP) (NSW Department of Premier and Cabinet, 2012) capitalises on the region's strong identity, supporting improved local employment opportunities, education facilities and investment opportunities. The NSW Government in partnership with communities will focus on:

- A prosperous and sustainable economy, with education and employment opportunities that draw people to the region to live, learn, work, visit and invest;
- Liveable communities, supported by well serviced centres, housing, employment and education opportunities which are complemented by a sustainable environment; and
- Well-coordinated human services and infrastructure, with efficient and regular transport services and world-standard broadband connections.

The socio-economic benefits of the Project will contribute to the CCRAP's goals of: "*a prosperous and sustainable economy, provide employment opportunities, along with training opportunities*" as described in detail in Section 7.17 and Section 7.18.

The significant environmental management and mitigation measures proposed for the Project as described in Section 8 will also contribute to maintaining the liveability of local communities. The VPA being negotiated with WSC will assist in providing funds which may be utilised to contribute to relevant human servces and infrastructure.

4.2.3 NSW Coastal Policy 1997

The *NSW Coastal Policy 1997* (Coastal Policy) establishes a framework for providing for population growth and economic development while at the same time protecting the natural, cultural, spiritual and heritage values of the coastal environment.

As stated in Section 4.1.10, a small part of the Project (comprising part of the Tooheys Road Site) is within the coastal zone to which the Coastal Protection SEPP also applies. Clause 8 of the Coastal Protection SEPP sets out the matters which must be taken into consideration when determining development applications in respect of land within the coastal zone. These matters are similar to those described in the Coastal Policy and have all been addressed in this EIS.

4.2.4 Strategic Review into the Impacts of Potential Underground Coal Mining in the Wyong LGA

On 5 February 2007, the Minister appointed members to an independent strategic panel to inquire into potential coal mining development in the Wyong LGA (Wyong Coal Inquiry), including the Dooralong and Yarramalong Valleys. The panel's terms of reference were to examine and report on:

"(3) Whether coal mining under the catchment for the Mardi Dam, would compromise, in any significant way, the water supply of the Central Coast;

(4) Environmental impacts of any underground coal mining, with a particular emphasis on:

- *surface and groundwater resources, especially on drinking water supply and flooding;*
- *hazards and risks of subsidence impacts; and*
- *the amenity of the community, including dust and noise impacts;*

(5) Social and economic significance of any underground coal mining to the local community, the region and State; and

(6) Areas where mining should not be permitted, or if permitted the conditions under which it may proceed, having regard to the matters listed above and the NSW Government's strategic planning policies that apply to the area."

The panel's final report was released on 17 December 2008. The findings and recommendations in the panel's report are listed in Table 11.

Table 11 also illustrates where each matter identified has been addressed in this EIS.

Table 11 Key Recommendations from the Wyong Coal Inquiry and Where Addressed in this EIS

Ref	Requirement	Where Addressed in EIS
General Recommendations		
1.	Increased focus should be given to risk assessment in the environmental impact assessment process, and that a rigorous, standardised risk assessment process be developed and implemented by relevant government agencies in consultation with affected mining companies, representative bodies and the community.	**Section 6** and **Appendix F**
2.	Future coal mine proponents in the Wyong LGA should be required to demonstrate a strong commitment and systematic approach to keeping the community informed and responding to community concerns. Particular issues that need to be addressed by future mine proponents include: a) developing a trust relationship between the mine proponent and the local community; b) investing in relationships and an information sharing process with other companies and government agencies in order to gather accurate and consistent baseline data; c) providing the community with accurate, high quality information; and d) establishing processes to respond to and review community concerns or complaints.	**Section 5** and **Appendix D**
3.	The Department of Planning and other relevant approval agencies should require future coal mine proponents to provide evidence of a clear, transparent and accessible community consultation process through the preparation of communications and engagement plans. In keeping with a high quality, transparent process, these plans should specify the type and frequency of consultation activities and the resources allocated to enhancing community relationships and information across the various phases of the project, from the concept stage, through pre-lodgement, lodgement, assessment, post-approval and delivery.	**Section 5** and **Appendix B** and **D**
4.	Any new coal mine project application should include comprehensive information concerning both the above-mentioned consultation and the potential social and economic impacts identified as part of the social and economic impact assessments.	**Section 5, 7.17** and **7.18**
5.	In relation to groundwater and surface water resources: a) all groundwater bores, other than low yield domestic and stock bores, should be metered; b) for non-metered bores, annual reports of estimated usage should be a requirement of the access licence; c) State Government funding should be allocated for development of a systematic monitoring network with automatic data logging; d) the Wyong River Water Sharing Plan should be completed and issued as soon as possible; e) macro water sharing plans for groundwater should be completed and issued as soon as possible; and f) a flow gauging station should be installed at the downstream end of Porter's Creek.	**Section 7.2** and **7.3**
6.	Subsidence impacts from new underground coal mines within the Wyong LGA should be mitigated such that affected privately-owned dwellings will be in accordance with WSC's Flood Prone Land Development Policy after mining is completed (either by impact minimisation or rectification), or otherwise subject to appropriate compensation.	**Section 7.1** and **7.4**
7.	That because of the significant environmental, social and cultural values of Tuggerah Lake and the potential for mining subsidence to impact on these values, no mining causing subsidence of the Lake should be approved unless a high level of knowledge about the Lake's ecology and hydrology (including seagrasses, tidal flows, currents, water quality and mixing) has been demonstrated and sufficient certainty and assurance provided to ensure that there would be no unacceptable adverse impacts on the Lake or its key values.	N/A as there is no mining proposed within or in close proximity to the Lake
8.	Any new coal mining proposal that would impact on wetlands in the Wyong LGA should provide appropriate offsets to meet the 'maintain or improve' principle. Such offsets could include the creation of new wetlands where impacts on natural wetlands are unavoidable or unforeseen. The development of these strategies should be undertaken in conjunction with Department of Environment and Climate Change and WSC, in the context of their requirements for constructed wetlands and the broader restoration and development programs that are underway within the LGA.	**Section 7.9** and **7.10**
9.	The Department of Environment and Climate Change should consider reviewing its current air quality standards, particularly the existing deposited dust standard, and establish new standards for smaller particulates to ensure that such standards are consistent with current scientific knowledge and community expectations.	**Section 7.5**
10.	Any coal mine surface facility which is near residences should be required to comply with world's best practice in relation to coal stockpiling, storage and dust emissions.	**Section 7.5**
11.	Further mining in the Wyong LGA should be subject to a comprehensive socio-economic cost/benefit analysis which takes into account the direct and indirect cost and benefits, including likely employment gains from mining and risks to residential growth, current and future employment and property prices.	**Section 7.17** and **7.18**

Ref	Requirement	Where Addressed in EIS
General Recommendations cont.		
12.	Given that the shallower coal resources in the North eastern Area appear to have been largely exhausted and that there are apparently no current plans to mine deeper seams in this area, there is potential to relax or remove some of the current constraints on new developments east of the F3 freeway in the Wyong LGA. There may also be potential to relax mine subsidence related restrictions on building codes in some parts of declared mine subsidence districts west of the F3 Freeway. A planning forum involving all relevant government agencies and other key stakeholders should evaluate options for future mining-related development controls in the Wyong LGA.	N/A
Wallarah 2 Coal Project Recommendations		
a.	Subject to the recommendations contained within this report, the Wallarah 2 proposal should be assessed under Part 3A of the *Environmental Planning & Assessment Act 1979*	**Section 4**
b.	Consideration should be given to an independent review of the final Wallarah 2 proposal as part of the Department of Planning's assessment process	**Section 4**
c.	Given the proximity of the proposed Wallarah 2 surface facility to residential areas, noise and dust emissions from the proposed surface facilities should be minimised as recommended in this report	**Section 7.5** and **7.8**
d.	If these emissions are unable to be satisfactorily minimised, the Wallarah 2 proponent should review the proposed location and size of its coal stockpile, including the potential for it to be moved west of the F3 Freeway	**Section 3**
e.	The Wallarah 2 proposal should apply best practice community consultation, engagement and participation (e.g. NSWMC and DoP guidelines)	**Section 5** and **Appendix D**
f.	WSC and the community should be encouraged to allow water monitoring stations to be installed and accessed to allow for better collection of baseline and monitoring data	**Section 2.8** and **5**

Source: Section 4.2 of *Impacts of Potential Underground Coal Mining in the Wyong Local Government Area Strategic Review* (July, 2008)

4.2.5 Hunter-Central Rivers Catchment Management Authority Action Plan

The Catchment Action Plan (CAP) for the Hunter-Central Rivers Catchment Management Authority (CMA) region has been prepared under the *Catchment Management Authorities Act 2003*. The CAP addresses mining and extractive industries and includes a number of policy statements with regard to the impacts of these activities on natural resources within the Hunter-Central Rivers CMA region.

Key targets of the CAP to be achieved by 2015 are listed in Table 12. This table also illustrates which are relevant to the Project and how and where each is considered in this EIS.

4.2.6 Strategic Regional Land Use Policy

The NSW Government's *Draft Strategic Regional Land Use Policy* (SRLUP) was released prior to the March 2011 State election and has as its focus the prioritisation of "strategic agricultural land" and "associated water" to guarantee food security. The NSW Government is developing Strategic Regional Land Use Plans intended to identify, on a regional basis, the areas suitable for agriculture, mining, coal seam gas extraction, conservation, urban development and other types of land use.

No draft plan for the Project's region was available as at the drafting of this EIS, however the Agricultural Impact Statement presented in Section 7.20 generally addresses some of the principles of this latest NSW Government strategic planning initiative.

4.2.7 Wyong Development Control Plan 2005

Chapters 13, 28, 30 and 75 of the 'Wyong Development Control Plan 2005' (DCP) potentially apply to the area within the Project Boundary.

Chapter 13 indicates that the eastern part of the Project Boundary is within an area identified with a potential for conservation lands and as such a conservation assessment is required to be submitted with any DA. Section 7.9 of this EIS addresses this requirement.

Chapter 28 describes controls for Hue Hue Road, Warnervale on which an eastern section of the Project Boundary occurs. It requires where land is zoned 7(c) or 7(a) to consider protection of natural features, landscape and scenic properties, bush fire protection, consideration of freeway noise, allow for buffers to F3 Freeway, ensure road access and intersections for residences, indicate limitations placed on development by the MSB, identify reticulated water supply areas, and allow for conservation areas. Section 7 of this EIS addresses these requirements.

Chapter 30 applies to land zoned 7(g), including wetlands and buffer lands as indicated on the map in that chapter of the Wyong DCP. It aims to protect wetlands and maintain ecological sustainability. This applies to a portion of the Tooheys Road Site. This is considered in Section 7.9 of this EIS.

Table 12 Hunter-Central Rivers CMA CAP 2015 Targets and Where Addressed in this EIS

Ref	Requirement	Where Addressed in this EIS
1.	Protect an additional 31,000 ha of native vegetation	**Section 7.10**
2.	Regenerate 25,500 ha of native vegetation	**Section 7.10**
3.	Treat 2,400 ha of weed affected lands	**Section 7.10, 7.20** and **7.25**
4.	Implement priority recovery actions on 800 ha	N/A
5.	Manage an additional 52,000 ha of landscapes having physical, cultural or spiritual significance to Aboriginal people	**Section 7.14**
6.	Protect an additional 4,600 ha of wetlands	**Section 7.10**
7.	Enhance 2,600 ha of wetlands	**Section 7.10**
8.	Treat animal pests over 31,000 ha	**Section 7.10, 7.20** and **7.25**
9.	Manage 200 km of roads that affect sensitive areas using current best practice erosion and sediment control	**Section 7.19**
10.	Revegetate 8,400 ha of highly erodible soils	**Section 7.19**
11.	Stabilise 800 ha of actively eroding soils	**Section 7.19**
12.	Revegetate 1,200 ha of salinity recharge areas with deep-rooted vegetation	**Section 7.10, 7.20** and **7.25**
13.	Improve nutrient management on 500 ha of land	N/A
14.	Stabilise 150 ha of salt affected areas	N/A
15.	Implement sustainable grazing management practices on an additional 19,000 ha of grazing land	**Section 7.20**
16.	Develop and implement property plans for an additional 25,000 ha	**Section 7.1**
17.	Protect an additional 1,100 km of native riparian vegetation	**Section 7.10**
18.	Regenerate 550 km of degraded native riparian vegetation	**Section 7.10**
19.	Restore native fish passage to 60 instream barriers	N/A
20.	Stabilise 125 km of unstable or degraded stream channels and estuarine shorelines	**Section 7.10**
21.	Improve habitat to 200 km of stream channels	**Section 7.10**
22.	Maintain 420 Lower Hunter Valley Flood Mitigation Scheme structures	N/A
23.	Retrofit 620 ha of existing developed areas with current best practice urban storm water	N/A
24.	Improve the management of 120 sewage management systems	N/A
25.	Manage 75 estuarine floodgates to increase tidal movement	N/A
26.	Treat an additional 5,000 ha of acid sulphate soils	N/A
27.	Revegetate 240 ha of degraded dune systems	N/A
28.	Protect an additional 21,000 ha of priority marine habitat	N/A
29.	60 industry groups develop, adopt and audit an Environmental Management System	N/A
30.	Enhance 130 km of vegetation along coastal lake shorelines	N/A
31.	Enhance 250 km of marine shorelines	N/A

Chapter 75 relates to industrial development and its objectives are to:

- Encourage employment generating developments;
- Promote quality industrial development in Wyong Shire;
- Control environmental impacts arising from industrial development;
- Provide guidance to people seeking to develop land and buildings for industrial purposes in Wyong Shire; and
- Identify Council's expectations and requirements relating to:
  - Information required for a development application; and
  - Standards of design and construction for industrial development.

The Project as described in **Section 3** will provide significant employment and flow on effects, provide a quality, long term industrial development and provides relevant controls on the impacts predicted in **Section 7.**

4.2.8 Wyong Shire Council Planning Agreements Policy

The Planning Agreements Policy (WSC, 2010) sets out WSC's policy, principles and procedures relating to the use of VPAs under the EP&A Act. WSC's objectives with respect to the use of VPAs include:

"(a) To provide an enhanced and more flexible development contributions system for Council, which achieves net Planning benefits from Development;

(b) To supplement or replace, as appropriate, the application of Section 94 and Section 94A of the Act to Development;

(c) To give all stakeholders in Development greater involvement in determining the type, standard and location of Public facilities and other Public benefits;

(d) To allow the community, through the public participation process under the Act, to gain an understanding as to the redistribution of the costs and benefits of Development in order to realise community preferences for the provision of Public benefits;

(e) To adopt innovative and flexible approaches to the provision of Public facilities in a manner that is consistent with relevant controls, policies and circumstances legally recognised as relevant under Section 79C of the Act;

(f) To provide or upgrade Public facilities to appropriate levels that reflect and balance environmental standards (including, without limitation, the principles of ecologically sustainable development), community expectations and funding priorities;

(g) To ensure that Developers make appropriate contributions towards the cost of the provision and management of Public facilities within Council's area;

(h) To provide certainty for the community, Developers and Council in respect to Public facilities and development outcomes; and

(i) Where applicable, to achieve outcomes from Development which ensure that the public has full access to the Shire's natural public assets including the Tuggerah Lakes foreshore and other waterways within Council's area."

WSC's use of VPAs will be governed by the following principles:

"(a) Planning decisions may not be bought or sold through Planning Agreements;

(b) Development that is unacceptable on planning grounds (including, without limitation, environmental, sustainability or financial grounds) will not be permitted because of Planning benefits offered by Developers that do not make the Development acceptable in planning terms;

(c) Council will not allow Planning Agreements to improperly fetter the exercise of its functions under the Act, Regulation or any other Act or Law.

(d) Council will not use Planning Agreements for any purpose other than a proper planning purpose.

(e) Council will not allow the interests of individuals or interest groups to outweigh the public interest when considering a proposed Planning Agreement;

(f) Council will not improperly rely on its statutory position, or otherwise act improperly, in order to extract unreasonable Public benefits from Developers under Planning Agreements, and will ensure that all Parties involved in the Planning Agreement process are dealt with fairly; and

(g) If Council has a commercial stake in Development the subject of a Planning Agreement, it will take appropriate steps to ensure that it avoids a conflict of interest between its role as a planning authority and its interest in the Development."

As discussed in Section 4.1.3, WACJV has commenced discussions with WSC in relation to entering into a VPA consistent with WSC's Planning Agreement Policy and Division 6 of Part 4 of the EP&A Act. These discussions have also taken place in consideration of the findings of the Social Impact Assessment undertaken for the Project (see Section 7.17).

4.2.9 Aquifer Interference Policy

The NSW Aquifer Interference Policy (AI Policy) was released in September 2012. The AI Policy defines the requirements for obtaining aquifer interference approvals under the *Water Management Act 2000* (WM Act).

The AI Policy provides that an aquifer interference approval can only be granted if the Minister is satisfied that the activity will not cause more than minimal harm to any water source. The "minimal impact considerations" are listed in Table 1 of the AI Policy.

Groundwater sources are classified as either "highly productive groundwater" or "less productive groundwater". There are different "minimal impact considerations" for the two categories of groundwater sources. An assessment of the Project's impacts against the "minimal impact considerations" is provided in Section 7.2.

4.3 Approvals Exempted with Development Consent

Pursuant to Section 89J of the EP&A Act, there are a number of authorisations that will not be required for the Project, should Development Consent be granted by the Minister for Planning and Infrastructure under Part 4, Division 4.1 of the EP&A Act. These include the following authorisations:

- The concurrence of the Minister administering Part 3 of the *Coastal Protection Act 1979* (CP Act);
- A permit under Sections 201, 205 or 219 of the *Fisheries Management Act 1994* (FM Act);
- An Aboriginal heritage impact permit under Section 90 of the *National Parks and Wildlife Act 1974* (NP&W Act);
- An approval under Part 4, or an excavation permit under Section 139 of the *Heritage Act 1977* (Heritage Act);
- An authorisation under Section 12 of the *Native Vegetation Act 2003* (NV Act);
- A bushfire safety authority under Section 100B of the *Rural Fires Act 1997* (Rural Fires Act); and
- A water use approval under Section 89, a water management work approval under Section 90 or an activity approval (other than an aquifer interference approval) under Section 91 of the WM Act.

Further discussion on key acts is provided below.

4.3.1 Coastal Protection Act 1979

The Coastal Protection Act provides that, in some circumstances, development carried out by a public authority within the coastal zone requires concurrence from the Minister.

This requirement relevantly does not apply, by virtue of Section 89J of the EP&A Act, to any development for which a Development Consent is held under Part 4 Division 4.1 of the EP&A Act.

4.3.2 Fisheries Management Act 1994

A permit under sections 201, 205 or 219 of the FM Act is not required for the Project by virtue of Section 89J of the EP&A Act.

4.3.3 National Parks and Wildlife Act 1974

Under section 90 of the NP&W Act, it is an offence to harm or desecrate an Aboriginal place or object without an Aboriginal Heritage Impact Permit (AHIP).

By virtue of Section 89J of the EP&A Act, an AHIP under Section 90 is not required for the destruction or desecration of an Aboriginal object or place arising from a project if a Development Consent is held under Division 4.1 of Part 4 of the EP&A Act.

4.3.4 Heritage Act 1977

The Heritage Act makes provision for control over the manner in which items of European heritage significance (*relics*) are managed and prevents their uncontrolled destruction or change without an excavation permit under Section 139.

By virtue of Section 89J of the EP&A Act, an excavation permit under Section 139 of the Heritage Act is not required if a Development Consent is held under Part 4, Division 4.1 of the EP&A Act.

4.3.5 Native Vegetation Act 2003

Under the NV Act it is an offence to clear native vegetation without authorisation under Section 12 (subject to certain exceptions).

By virtue of Section 89J of the EP&A Act, an authorisation under Section 12 of the NV Act is not required to clear vegetation if a Development Consent is issued under Division 4.1 of Part 4 of the EP&A Act.

4.3.6 Rural Fires Act 1997

The Rural Fires Act provides the statutory framework to prevent, mitigate and suppress bush fires in rural districts, and to coordinate bush fire fighting and prevention.

By virtue of Section 89J of the EP&A Act, a bush fire safety authority under Section 100B of the Rural Fires Act is not required for the Project should a Development Consent be granted under Division 4.1 of Part 4 of the EP&A Act.

4.3.7 Water Management Act 2000

Section 89J of the EP&A Act provides that it is not necessary to obtain a water use approval under Section 89, a water management work approval under Section 90 or an activity approval (other than an aquifer interference approval) under Section 91 of the WM Act as described in Section 4.5.7.

The requirement to obtain an approval under Section 89, 90 and/or 91 of the WM Act is triggered only where a proclamation has been made under Section 88A of the WM Act specifying that the particular type of approval is required in the specified part of the State. To date, no proclamation has been made, specifying that an aquifer interference approval is required in any part of the State.

Other approvals under the WM Act or Water Act which are required for the Project are described in Section 7.2 and 7.3.

4.4 Approvals to be Granted with Development Consent

Pursuant to Section 89K of the EP&A Act, there are a number of authorisations that must be issued "substantially consistent with" a Division 4.1 of Part 4, Development Consent if such an approval is required for the conduct of the approved project. These include the following authorisations:

- An aquaculture permit under section 144 of the FM Act;
- An approval under section 15 of the *Mine Subsidence Compensation Act 1961* (MSC Act);
- A mining lease under the *Mining Act 1992* (Mining Act);
- A production lease under the *Petroleum (Onshore) Act 1991*;
- An EPL under the Protection of the *Environment Operations Act 1997* (POEO Act);
- A consent under section 138 of the *Roads Act 1993* (Roads Act); and
- A licence under the *Pipelines Act 1967.*

Further discussion on key Acts is provided below.

4.4.1 Fisheries Management Act 1994

An aquaculture permit under section 144 of the Fisheries Act is not required for the Project.

4.4.2 Mine Subsidence Compensation Act 1961

The MSC Act provides that approval is required under Section 15 of the Act for the erection or alteration of an improvement within a declared mine subsidence district. Such an approval, if required, cannot be refused and must be substantially consistent with any development consent granted.

4.4.3 Mining Act 1992

In order to carry out mining activities associated with the Project, WACJV will require various mining leases to be granted by the Minister for Resources and Energy. Sections 5 and 6 of the *Mining Act 1992* (Mining Act) provides that a person must not conduct mining or certain stipulated mining purposes without an appropriate authorisation.

Applications have been lodged with the DTIRIS – DRE for mining leases for the Extraction Area and the surface facilities within the Project Boundary. These are MLA 342, MLA 343, MLA 346 and MLA 350 as are shown on Figure 26.

Section 89K of the EP&A Act provides that if a Development Consent is granted for the Project, then an application for a mining lease cannot be refused if it is necessary for the carrying out the approved project and must be granted substantially consistent with the approval.

The mining leases for the Project will impose the requirement for a Mining Operations Plan (MOP) (or equivalent) to be prepared to the satisfaction and approval of the Director-General of DTIRIS.

4.4.4 Protection of the Environment Operations Act 1997

The Project is deemed to be a scheduled activity under Schedule 1 of the POEO Act. Accordingly, under Chapter 3 of the POEO Act, an EPL is required for the Project.

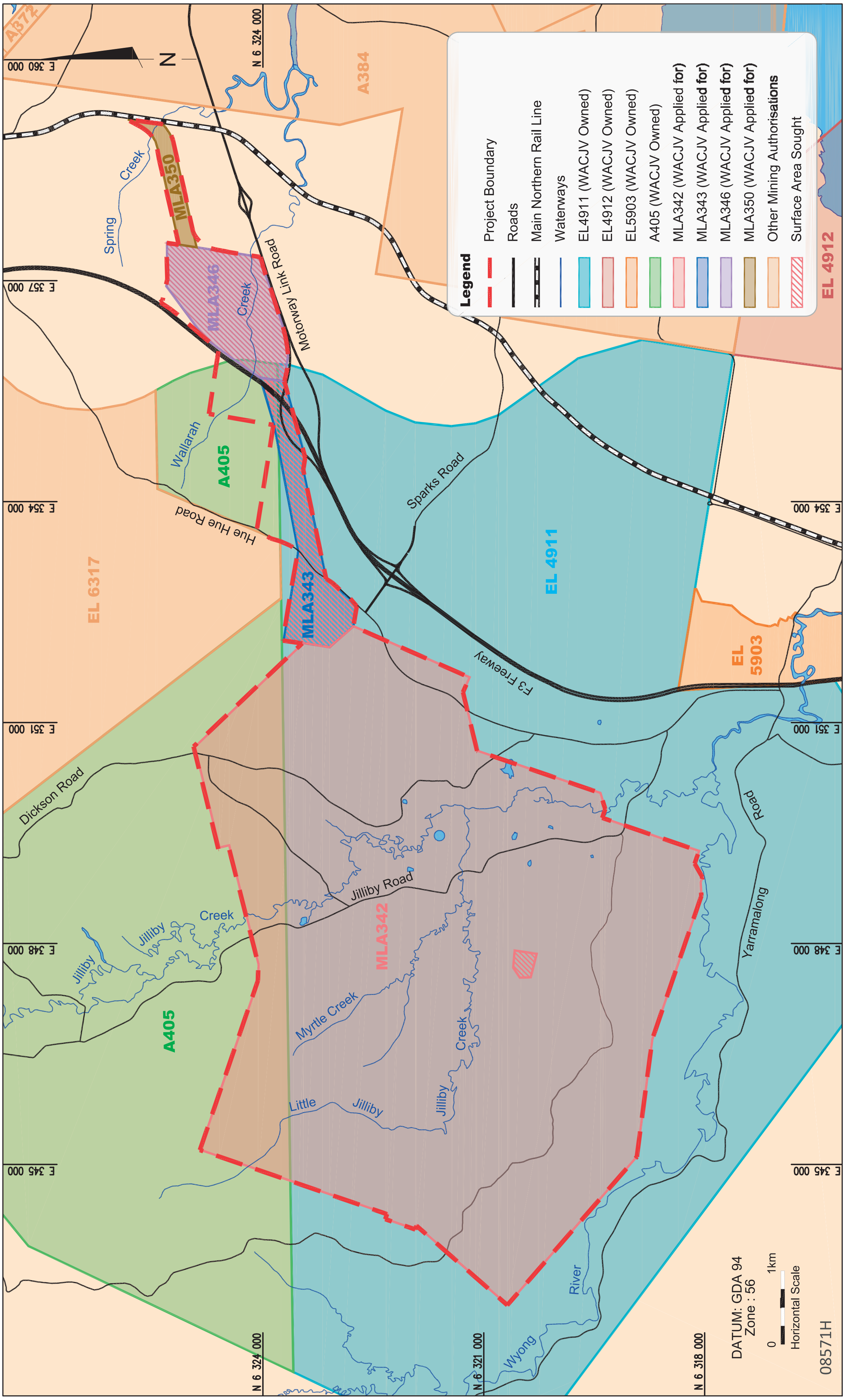
An application for an EPL will be made by WACJV to the Environment Protection Authority (the appropriate regulatory authority by virtue of section 6 of the POEO Act) should Development Consent be granted.

Section 89K of the EP&A Act requires that such an application cannot be refused if it is necessary for carrying out an approved project and is to be granted substantially consistent with the approval.

4.4.5 Roads Act 1993

The Project proposes the relocation of some sections of roads which will be affected by the Infrastructure Boundary. Interactions (upgrades and intersections) with various WSC owned and RMS owned roads will also be required as described in Section 7.12.

Consent under Section 138 of the Roads Act from the appropriate roads authority (WSC and / or RMS) will be required for any work in or over the surface of any road which has not been closed. Section 89K of the EP&A Act requires that such an application cannot be refused if it is necessary for carrying out of an approved project, and it must be granted substantially consistent with the Development Consent.



WALLARAH 2 COAL PROJECT

Project Mining Authorisations

FIGURE 26

Wallarah 2 COAL PROJECT

Hansen Bailey ENVIRONMENTAL CONSULTANTS

4.5 Other Relevant NSW Legislation

In additional to those described in Section 4.3 and Section 4.4, the Project will require approvals under one or more of the following additional NSW legislation:

- EP&A Regulation;
- *Contaminated Land Management Act 1997* (CLM Act);
- *Crown Lands Act 1989*;
- *Dams Safety Act 1978* (DS Act);
- *Dangerous Goods (Road and Rail Transport) Act 2008*;
- *Forestry Act 1916* (Forestry Act);
- *Noxious Weeds Act 1993*; and
- Water Act and WM Act.

The application of each is briefly described below.

4.5.1 Environmental Planning & Assessment Regulation 2000

Relevant plans, architectural drawings, diagrams and relevant documentation as required under Schedule 1 of the EP&A Regulation are shown in Appendix E.

Should Development Consent be granted, these conceptual drawings will be revised and amended in consultation with relevant regulators when seeking construction and building certificates under section 109C and section 149A of the EP&A Act, respectively.

This EIS has been developed to meet the form and content requirements in Clauses 6 and 7 of Schedule 2 of the EP&A Regulation.

Table 13 indicates where each has been addressed in this EIS.

Table 13 EP&A Regulations EIS Requirements and Where Addressed in this EIS

Section	Requirement	Where Addressed in this EIS
6(a)	the name, address and professional qualifications of the person by whom the statement is prepared	**Page i**
(b)	the name and address of the responsible person	**Page i**
(c)	the address of the land: (i) in respect of which the development application is to be made, or (ii) on which the activity or infrastructure to which the statement relates is to be carried out	**Section 2.5**
(d)	a description of the development, activity or infrastructure to which the statement relates	**Section 3**
(e)	an assessment by the person by whom the statement is prepared of the environmental impact of the development, activity or infrastructure to which the statement relates, dealing with the matters referred to in this Schedule	**Page i**
(f)	a declaration by the person by whom the statement is prepared to the effect that: (i) the statement has been prepared in accordance with this Schedule, and (ii) the statement contains all available information that is relevant to the environmental assessment of the development, activity or infrastructure to which the statement relates, and (iii) that the information contained in the statement is neither false nor misleading	**Page i**
7(1) (a)	An EIS must also include each of the following: a summary of the EIS	**Page iii**
(b)	a statement of the objectives of the development, activity or infrastructure	**Section 3**
(c)	an analysis of any feasible alternatives to the carrying out of the development, activity or infrastructure, having regard to its objectives, including the consequences of not carrying out the development, activity or infrastructure	**Section 3.11**
(d)	an analysis of the development, activity or infrastructure, including: (i) a full description of the development, activity or infrastructure, and	**Section 3**
	(ii) a general description of the environment likely to be affected by the development, activity or infrastructure, together with a detailed description of those aspects of the environment that are likely to be significantly affected, and	**Section 2**
	(iii) the likely impact on the environment of the development, activity or infrastructure, and	**Section 7**
	(iv) a full description of the measures proposed to mitigate any adverse effects of the development, activity or infrastructure on the environment, and	**Section 7**
	(v) a list of any approvals that must be obtained under any other Act or law before the development, activity or infrastructure may lawfully be carried out	**Section 4.7**
(e)	a compilation (in a single section of the EIS) of the measures referred to in item (d) (iv),	**Section 8**

Section	Requirement	Where Addressed in this EIS
(f)	the reasons justifying the carrying out of the development, activity or infrastructure in the manner proposed, having regard to biophysical, economic and social considerations, including the principles of ecologically sustainable development set out in subclause (4)	**Section 9**
(2)	Subclause (1) is subject to the environmental assessment requirements that relate to the EIS	This EIS
(3) (a)	Subclause (1) does not apply if: the Director-General has waived (under clause 3 (9)) the need for an application for environmental assessment requirements in relation to an EIS in respect of State significant development, and	N/A
(b)	the conditions of that waiver specify that the EIS must instead comply with requirements set out or referred to in those conditions	N/A
(4)	The principles of ecologically sustainable development are as follows:	-
(a)	the precautionary principle, namely, that if there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation	**Section 9**
	In the application of the precautionary principle, public and private decisions should be guided by: (i) careful evaluation to avoid, wherever practicable, serious or irreversible damage to the environment, and (ii) an assessment of the risk-weighted consequences of various options	**Section 9**
(b)	inter-generational equity, namely, that the present generation should ensure that the health, diversity and productivity of the environment are maintained or enhanced for the benefit of future generations	**Section 9**
(c)	conservation of biological diversity and ecological integrity, namely, that conservation of biological diversity and ecological integrity should be a fundamental consideration	**Section 9**
(d)	improved valuation, pricing and incentive mechanisms, namely, that environmental factors should be included in the valuation of assets and services, such as: (i) polluter pays, that is, those who generate pollution and waste should bear the cost of containment, avoidance or abatement, (ii) the users of goods and services should pay prices based on the full life cycle of costs of providing goods and services, including the use of natural resources and assets and the ultimate disposal of any waste, (iii) environmental goals, having been established, should be pursued in the most cost effective way, by establishing incentive structures, including market mechanisms, that enable those best placed to maximise benefits or minimise costs to develop their own solutions and responses to environmental problems	**Section 9**

4.5.2 Contaminated Land Management Act 1997

A level 1 contaminated lands assessment has been undertaken in accordance with the CLM Act 1997 for the Project and is presented in Section 7.2.2. No contaminated lands exist within the Infrastructure Boundary and as such, further approvals are not required.

4.5.3 Crown Lands Act 1989

The approval of the Department of Lands (DoL) will be required under the Crown Lands Act for any works within Crown road reserves or on Crown land for the Project. Figure 7 indicates the location of Crown land in relation to the Project.

Should Development Consent be granted, further approval from the DoL will be sought for the construction of the Western Ventilation Shaft and any other mining related activities required to be carried out on Crown lands.

4.5.4 Dams Safety Act 1978

The *Dams Safety Act 1978* (Dams Safety Act) requires the NSW Dams Safety Committee (DSC) to "*formulate measures to ensure the safety of dams*" and to "*maintain a surveillance of prescribed dams*". A "prescribed dam" is any dam listed under Schedule 1 of the Dams Safety Act.

Under section 369 of the Mining Act, the DSC may declare certain land under or surrounding a prescribed dam to be a "Notification Area" for that dam. The DSC must be notified of all proposals to grant an Assessment Lease or Mining Lease within a Notification Area.

The Project is located over 1.75 km north-east of the Notification Area for the Mardi Dam. Therefore, the notification requirement under section 369 of the Mining Act does not apply for the Mardi Dam.

Section 7.3.1 describes the water management system to be implemented for the Project. WACJV will consult with the Dams Safety Committee (DSC) regarding the construction and operation of the proposed onsite dams. If one or more of the proposed dams are deemed to be prescribed dams, those dams will be regulated by the Dams Safety Act and the DSC.

4.5.5 Forestry Act 1916

For any component of the Project that will occur within the Wyong State Forest, the WACJV will apply for an occupation permit under section 31 of the Forestry Act.

The Forestry Act provides the statutory framework for the dedication, reservation, control and use of State forests, timber reserves, and Crown lands for forestry and other purposes. The Forestry Act is governed by the Forestry Commission of NSW, trading as Forests NSW (a division of DTIRIS).

Part 4 of the Forestry Act applies to issuance of Permits and Forest Leases that are required for any person wishing to occupy and utilise the land for certain activities. WACJV has a current Occupation Permit in place with Forests NSW for any required access associated with exploration and other mining related activities.

Should a Development Consent be granted for the Project, WACJV will enter into a revised Occupation Permit with Forests NSW to facilitate its future exploration and mining activities in the Wyong State Forest and Jilliby SCA.

4.5.6 Noxious Weeds Act 1993

Weed management for the Project is described in Section 7.9 and Section 7.24.

No approvals are required for the Project under the *Noxious Weeds Act 1993*.

4.5.7 Water Act 1912 and Water Management Act 2000

The Project's potential requirement for Water Access Licences (WALs) under Part 2 of Chapter 3 of the WM Act depends on whether a WSP has commenced in respect of the water sources within the Project Boundary. The following surface WSPs apply to the Project:

- *The Water Sharing Plan for the Jilliby Jilliby Creek Water Source 2003* (JJCW WSP) – which commenced on 1 July 2004; and
- *The Water Sharing Plan for the Central Coast Unregulated Water Sources 2009* (CCUWS WSP) – which commenced on 1 August 2009.

Clause 5 of the JJCW WSP provides that it applies to all water occurring on the land surface shown on the map in Schedule 2 to the JJCW WSP, including all rivers, lakes and wetlands, but excludes all water contained within the aquifers underlying this water source.

Clause 4 of the CCUWS WSP provides that it applies to a range of water sources (relevant to the Project is the Wyong River Water Source). Those water sources include all water occurring naturally on the surface of the ground shown on the registered plan for the water sources and all water in rivers, lakes and wetlands in these water sources. They do not include water contained in alluvial sediments, coastal sands, fractured rock aquifers and basement rocks.

Accordingly, as no WSP has commenced in respect of the groundwater within the Project Boundary, the Water Act remains the relevant legislation in respect of the licensing of groundwater extraction within the Project Boundary.

Appropriate WALs for the Project's taking of water from the water sources the subject of the abovementioned WSPs will be obtained under the WM Act and appropriate bore licences under the Water Act will be obtained for the Project's extraction of any groundwater, as required.

It is noted that pursuant to section 113A of the Water Act, part of the Project Boundary is the subject of an embargo on applications for bore licences under Part 5 of the Water Act. The embargo, known as the *Coastal Floodplain Alluvial Groundwater Sources and Highly Connected Alluvial Groundwater Sources of Coastal Catchments – Regional NSW embargo*, was gazetted on 11 April 2008. It applies to:

- All the groundwater found in alluvial aquifers located upstream of the tidal limit, and within 500 m of a 3rd order stream or greater, in the relevant part of the Project Boundary to which the embargo applies; and
- All the groundwater found in alluvial aquifers located downstream of the tidal limit in the relevant part of the Project Boundary to which the embargo applies.

As discussed in Section 4.3.7, if the Project is granted Development Consent, by the operation of section 89J of the EP&A Act, it will not require water use approvals under section 89 of the WM Act, water management approvals under section 90 of the WM Act or a controlled activity approval (except for an aquifer interference approval) under section 91 of the WM Act.

4.6 Commonwealth Legislation

4.6.1 Environment Protection & Biodiversity Conservation Act 1999

The *Environment Protection & Biodiversity Conservation Act 1999* (EPBC Act) prescribes the Commonwealth's role in environmental assessment, biodiversity conservation and the management of protected areas of national significance. It also provides a mechanism for national environment protection and biodiversity conservation.

The EPBC Act is administered by SEWPaC and provides protection for listed Matters of National Environmental Significance (MNES) including:

- Listed species and communities (e.g. listed Threatened species and ecological communities and migratory species);
- Protected areas (e.g. World heritage properties, Ramsar wetlands of international significance, conservation zones); and
- National and Indigenous Heritage.

The EPBC Act contains an assessment and approval process for proposed actions which are a "*controlled action*" because it will have, or is likely to have, a significant impact on a MNES.

A delegate of the Federal Minister for SEWPaC decided on 15 June 2012 that the Project is a "*controlled action*" as it is likely to have a significant impact on listed Threatened species and communities (sections 18 and 18A). A detailed assessment of EPBC Act issues is provided in Section 7.9.

On 15 June 2012, the Federal Minister's delegate confirmed that the Project's assessment under Division 4.1 of Part 4 of the EP&A Act was an accredited assessment process under the EPBC Act given the repeal of Part 3A. Assessment requirements were subsequently provided to DP&I on 11 July 2012 for the Project. Appendix B includes a copy of the DGRs.

4.6.2 Native Title Act 1993

The Commonwealth *Native Title Act 1993* (NT Act) was enacted on 1 January 1994 to provide for the recognition of Native Title and a statutory mechanism for its protection. The NT Act considers the possible acts that may affect Native Title, provides a process to determine if Native Title exists and how compensation for acts affecting Native Title should be managed.

Applications have been lodged with the DTIRIS – DRE for mining leases for the Extraction Area and the surface facilities within the Project Boundary. These are MLA 342, MLA 343, MLA 346 and MLA 350.

DTIRIS confirmed on 22 October 2010, that in the case of MLA 342, MLA 343 and MLA 346 the National Native Title Tribunal had received no native title claims within the statutory period triggered by the issue of notices under Section 29 of the NT Act.

DTIRIS also confirmed on 22 October 2010, that in the case of MLA 350, the National Native Title Tribunal had received no native title claims within the statutory period. The processing of the MLAs may therefore continue without further reference to the NT Act.

4.7 Summary of Required Approvals

Table 14 provides a summary of the key licences, leases and approvals which will be required under NSW and Commonwealth legislation following Development Consent to enable the construction and operation of the Project.

Table 14 Licences and Approvals Required for the Project

Approval	Legislation	Authority	Comments
Development Consent for the construction and operation of the Project	Section 89E of Part 4 of the EP&A Act provides the Minister for DP&I the power to grant a Development Consent	Minister for DP&I	The Minister has delegated his approval function with respect to most SSD to the PAC
Grant of mining leases for MLA 342, MLA 343, MLA 346 and MLA 350	Part 5, Division 3, Clause 63 of the Mining Act provides the Minister for Resources and Energy the power to grant or not grant a mining lease	Minister for DRE	Section 89K EP&A Act provides the granting of a mining lease must be approved substantially consistent with the Development Consent
Preparation of a MOP (or equivalent)	Condition of a Mining Lease issued under the Mining Act	DRE	Separate approval
Preparation of a Subsidence Management Plan (SMP) and Property Subsidence Management Plans (PSMP)	Condition of a Mining Lease issued under the Mining Act	DRE	Separate approval

Approval	Legislation	Authority	Comments
Preparation of the Extraction Plan	Condition of Development Consent issued under the EP&A Act	DP&I	Post-approval
Approval for the carrying out of a Controlled Action	EPBC Act	SEWPaC	Separate approval, adopting Part 4, Division 4.1 assessment process as determined by SEWPaC under Section 87 of the EPBC Act
EPL	Chapter 3 of the POEO Act	OEH	Section 89K EP&A Act provides the granting of this approval must be approved substantially consistent with the Part 4, Division 4.1 approval
Section 90 AHIP	Section 90 of the NPW Act	EPA	Section 89J EP&A Act provides that a permit of this type is not required for an approved project
Authorisation to clear Native Vegetation	Section 12 of the NV Act	OEH	Section 89J EP&A Act provides that an authorisation of this type is not required for an approved project
Water Use Approval	Section 89 of the WM Act	NSW Office of Water (NOW)	Section 89J EP&A Act provides that an approval of this type is not required where Development Consent is granted
Water Management Work Approval	Section 90 of the WM Act	NOW	Section 89J EP&A Act provides that an approval of this type is not required for an approved project
Controlled Activity Approval	Section 91 of the WM Act	NOW	Section 89J EP&A Act provides that an approval of this type (except for an aquifer interference approval) is not required for an approved project.
Water Access Licence(s)	Parts 2 and 3 of Chapter 3 of the WM Act	NOW	Separate Approval
Bore Licence	Part 5 of the Water Act	NOW	Licence to be sought separately
Licence Under Threatened Species Conservation Act	Threatened Species Conservation Act 1995 (TSC Act) & NP&W Act	OEH	A licence under the TSC Act provides a defence to the offence provisions contained in Sections 118A and 118C of the NP&W Act (regarding damage or harm to threatened species or habitat)
Consent to carry out a work in on or over a public road	Section 138 of the Roads Act	RMS / NSW	Section 89K EP&A Act provides the granting of this approval must be approved substantially consistent with the Part 4, Division 4.1 approval
Construction and Building Certificates	EP&A Act	WSC	Separate Approval
Approval for works over Crown land	Crown Lands Act	DoL	Separate Approval
Agreement with Forests NSW	Forestry Act	Forests NSW	Separate Approval
Notification of Dangerous Goods	OH&S Regulation	WorkCover	Separate Approval
Environment Management Plans	Conditions of Development Consent	DP&I	Separate Approval

Wallarah 2
COAL PROJECT

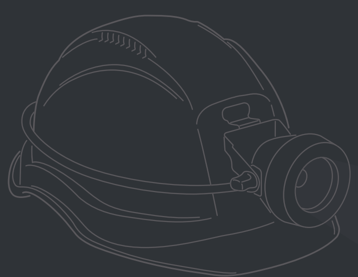
Wallarah 2 Coal Project

Environmental Impact Statement

April 2013

5

Stakeholder Engagement



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ENVIRONMENTAL CONSULTANTS

This section of the EIS provides a summary of the stakeholder engagement program undertaken for the Project, which included engagement with near neighbours and the surrounding community, Local, State and Federal Government, industry regulators and other interested stakeholders. This section provides an overview of the engagement process applied for the Project, its objectives, a description of the various engagement phases, the engagement activities undertaken, and findings that have been incorporated in the impact assessments undertaken for this EIS.

A Social Impact Assessment was also undertaken as a component of this EIS and is discussed further in Section 7.17.

5.1 Existing Stakeholder Engagement

WACJV has actively participated in formal engagement activities utilising regular Wallarah Coal 2 Project Community Representative Group (CRG) meetings. WACJV also continues to explore further opportunities for its community engagement processes through the development of stakeholder relationships with neighbouring landholders, Government and surrounding industry.

Current stakeholder engagement methods employed by WACJV that will continue for the Project are provided in Table 15.

5.2 Stakeholder Identification

A range of stakeholders were identified for the Project based on approaches to WACJV, regulatory requirements for the Project and this EIS. Confirmation of near neighbour contact details occurred through cadastral analysis and background research into the area.

The key stakeholders relevant to the Project and the engagement methods employed for each are listed in Table 16.

Table 15 WACJV Existing Stakeholder Engagement

Activity	Details
Community Engagement and Communications	• Newsletters • Project Information Days • Community Reference Group • Presence at local fairs and trade shows • Letters and personal invitations to key near neighbour stakeholders • Website • State and local Government briefings and meetings • Presentations to Local Government
Community Issues Management	• Community contact line and website • Near neighbour engagement • Issue response procedures
Community Support	• Financial contributions to local community groups and sporting teams • The Wallarah 2 Foundation Apprenticeships Scheme (Four Apprenticeships sponsored in 2013)
Environmental Monitoring and Management	• Environmental impact monitoring • Environmental management procedures

Table 16 Project Stakeholders and Methods of Engagement

Stakeholders	Method of Engagement
Community Stakeholders	
Individual landholders / near neighbours	• Personal briefings with near neighbours from October 2011 to October 2012 who requested follow up information or discussion • Project Newsletters (see **Appendix D**) • Project Information Days (26 April 2012, 10 May 2012, 24 May 2012, 7 June 2012) • Individual letter delivered (4 July 2012) • Discussions with Jilliby Stage 2 Landowners Action Group 27 May 2010 and 8 June 2010
Central Coast Community	• Project Newsletters • Project Information Days (26 April 2012, 10 May 2012, 24 May 2012, 7 June 2012) • Buy Local Trade Fair (19 & 20 May 2012) • Briefing to Wyong Regional Chamber of Commerce on 25 September 2012 • Memoradum of Understanding with TAFE NSW (December 2012) • Memorandum of Understanding with Central Coast Group Training (December 2012)
Central Coast Business Community	• Briefing to Central Coast NSW Business Chamber on 2 April 2012 • Buy Local Trade Fair (19 & 20 May 2012) • Briefing to Wyong Regional Chamber of Commerce on 25 September 2012 • Project Newsletters
Neighbouring Mines and Industry	• Project Newsletters to Centennial Coal (Mandalong, Mannering) and LD Operations (Chain Valley) • Briefing on two occasions with Centennial Coal on 15 February 2012 and 20 June 2012 • Briefing on two occasions with LDO on 15 November 2011 and 19 July 2012 • Offer of briefing with Blue Tongue Brewery 17 July 2012 • Offer of briefing with Woolworths on 17 July 2012 • Offer of briefing with Boral on 17 July 2012
Aboriginal Community	• Consultation in accordance with OEH Guidelines as described in **Section 5.6** • Briefing with DLALC on 7 March and through CRG
Community Reference Group	• Bi-Monthly meetings held on 19 April, 14 June, 23 August and 31 October 2012 • Project Newsletters
Australian Coal Alliance	• Five offers of a meeting on 20 February 2012, 29 February 2012, 7 June 2012, 14 June 2012 and 25 September 2012 • Project Newsletters
Regulatory Stakeholders	
DP&I	• Project Briefings on 17 January, 24 April and 5 July 2012 • Background Document review • Project Newsletters
SEWPaC	• Project Briefing and potential offset strategy discussion on 19 June 2012 • Background Document review • Withdrawal of previous EPBC Referral 2007/3881 on 21 February 2012 and Submission of EPBC Referral 2012/6388 on 15 June 2012 • Project Newsletters
WSC Mayor, General Manager and Officers	• Project Briefing on 10 November 2011 • Background Document review • Project Newsletters • Project update briefing 14 March 2012 • Meetings on the proposed water and sewerage connections 23 April 2012, 11 September 2012 and follow up phone calls • Meeting on the proposed VPA on 9 July 2012 and follow up phone calls • Meeting on 20 December 2012 to discuss water management strategy
Lake Macquarie City Council (LMCC) Mayor, General Manager and Officers	• Project Briefing on 16 April 2012 • Social Impact Assessment discussion 12 April 2012 • Project Newsletters
Gosford City Council (GCC) Mayor, General Manager and Officers	• Project Briefing on 27 March 2012 • Project Newsletters
DTIRIS – DRE	• Project Briefings on 23 February, 13 March and 23 April 2012 (and various phone discussions) • Background Document review • Project Newsletters

Stakeholders	Method of Engagement
NOW	• Background Document review • Project Newsletters • Letter to obtain DGR clarification 22 March 2012 • Project briefing and meeting to groundwater impact assessments on 31 August 2012 • Meeting/discussion on EIS Process 13 September 2012 • Meeting on 10 January 2013 to discuss surface water and groundwater issues • Meeting on 25 January 2013 to discuss additional requirements for the groundwater impact assessment
OEH	• Telephone discussion on 31 August 2012, no meeting required • Background Document review • Project Newsletters • Meeting on 19 November 2012 to discuss ecology impact assessment • Meeting on 27 November 2012 to discuss the flood impact assessment • Telephone enquiry on 24 January 2013 regarding general water management strategy and site discharge opportunities
EPA	• Telephone discussion on 31 August 2012, no meeting required • Background Document review • Project Newsletters
NSW Transport and Roads & Maritime Services (RMS)	• Background Document review • Project Newsletters • Meeting with RMS to discuss Traffic Impact Assessment methodology 13 March 2012 • Meeting with Transport NSW Freight and Regional Development Division – Discussions regarding modelling and rail impact report 17 December 2012
Forests NSW	• Background Document review • Project Newsletters • Offer of briefing
Department of Agriculture and Fisheries	• Background Document review • Project Newsletters • Meeting to discuss Agriculture Impact Assessment methodology 5 June 2012
Catchments and Lands (Crown Lands Division)	• Background Document review • Project Newsletters • Telephone conversation 7 September 2012, no meeting required
Hunter Central Rivers CMA	• Background Document review • Project Newsletters • Offer of briefing
Australian Rail Track Corporation (ARTC)	• Background Document review • Project Newsletters • Project Briefing on 2 May 2012
RailCorp	• Project Newsletters • Project briefings on 23 February 2012 and 27 March 2012
Newcastle Ports Corporation	• Project Newsletters • Project briefing on 19 June 2012
Hunter Valley Coal Chain Co-ordinator	• Project Newsletters • Project briefing on 2 May 2012
Port Waratah Coal Services	• Project Newsletters • Project briefings on 19 June 2012 and 17 July 2012
Mine Subsidence Board	• Project Newsletters • Project Briefing on 23 July 2012
Gosford-Wyong Councils Water Authority (Central Coast Water Corporation)	• Background Document review • Project Newsletters • Project Briefings on 12 March 2012 and 10 April 2012
NSW Health	• Background Document review • Project Newsletters • Telephone conversation 27 September and 3 October 2012, no meeting required

5.3 Issue Scoping

Engagement with community and regulatory stakeholders to assist in the identification of key Project issues is outlined below. Community and regulatory stakeholder engagement for the Project was undertaken in accordance with the following key objectives:

- To identify potential stakeholders;
- To engage with relevant stakeholders to understand and discuss stakeholder / community issues and concerns;
- To assess the compatibility of the Project with existing land uses in the local area and the values of the local community;
- To identify the primary and higher order social impacts (direct and indirect) associated with the Project, particularly on those communities within WSC, LMCC and GCC LGAs;
- To maintain a process for consistent, ongoing consultation and communication with key stakeholders and the local community;
- To enable stakeholders to have input into this EIS and Project planning (especially in relation to any VPA funds); and
- To proactively respond to and work to address the issues of relevant stakeholders to develop appropriate solutions and mitigation strategies to minimise the potential impacts of the Project.

Various methods were employed to engage with the local community including personal briefings, the distribution of newsletters, Project information days and presentations as discussed below.

5.3.1 Local Community Meetings

During the issue scoping phase for this EIS which commenced in October 2011, consultation was undertaken with local landholders. Follow up to the issues raised during this consultation was undertaken where requested to further discuss their concerns in relation to the Project and to ensure that these were considered as appropriate in this EIS.

5.3.2 Focus Group and Telephone Survey

UMR Research carried out a telephone survey with 400 respondents from the Wyong and Gosford LGAs over 31 March and 1 April 2012. The telephone survey followed on from Focus Groups interviews previously completed by UMR Research on 14 November 2011.

The purpose of this research was to both canvas community attitudes towards the Project and also understand community views on the preferred means for communication or contact with WACJV. Key findings from this survey are presented in the Social Impact Assessment referred to in Section 7.17.

5.3.3 Newsletters and Direct Correspondence

Engagement with WACJV's near neighbours and the wider local community was complemented by the distribution of several Project newsletters during the preparation of this EIS. Approximately 5,200 copies of each newsletter were distributed to the local community, regulators and other interested stakeholders over October 2011 (Spring 2011), February 2012 (Summer 2012), April 2012 (Autumn 2012), June 2012 (Winter 2012) and November 2012 (Spring 2012).

A further newsletter is proposed to be distributed prior to this EIS being placed on public exhibition notifying stakeholders of the key findings from the assessment and where they will be able to view a copy of this EIS.

Further, a letter was sent to over 900 individual neighbours on 4 July 2012 offering further consultation opportunities (see Appendix D). As at 20 September 2012, two responses had been received, requesting information about the location of the property owner's residence with respect to the mine plan, inquiring about employment opportunities and commenting on the Project.

5.3.4 Community Reference Group

The CRG was formed in February 2012 and is currently holding bi-monthly meetings. These have occurred on 19 April 2012, 14 June 2012, 23 August 2012 and 31 October 2012. The group is comprised of six representatives (nominated in response to a newspaper advertisement) from a cross section of the community as well as representatives from the Australian Coal Alliance, WSC, DLALC and local business. Minutes are posted on the WACJV website.

5.3.5 Project Information Days

Following notification being provided to the local community via five newspaper advertisements and in the Project newsletter, Community Information Days were held at the WACJV Office in Tuggerah (26 April, 10 May, 24 May and 7 June 2012). The Project Information Days were initiated by WACJV to provide the local community an opportunity to gain additional information on the Project and to seek face to face feedback from Project staff.

Nine members of the local community attended the information days to discuss issues in relation to the Project. WACJV representatives fielded a number of questions from attendees covering a range of issues. The matters raised were discussed at the time with additional follow up information provided as required. The issues raised were also recorded to be considered for assessment within this EIS. The community issues raised during the information days are included below in Section 5.4.4.

On 19 and 20 May 2012, WACJV manned an information booth at the Wyong Buy Local Trade Fair. WACJV representatives spoke with approximately 150 people over the two days of the Fair, with issues raised described in Section 5.4.4.

5.3.6 Regulatory Engagement

A series of Project briefings and presentations were provided to relevant regulators throughout the preparation of this EIS (see Table 16).

This consultation included providing briefings on the current Project description, updates on the findings of environmental assessments and outlining the progress of the planning approvals process. This level of engagement assisted with the identification of regulatory stakeholder issues in relation to the Project that were required to be addressed within this EIS.

Responses to issues raised by regulatory stakeholders (including the DGRs) are discussed further below in Section 5.4.2.

5.4 Issue Response

The objective of this stage of stakeholder engagement was to ensure that appropriate responses were provided to stakeholder issues raised in relation to the Project and that relevant strategies for their management and mitigation were considered in this EIS.

5.4.1 Project Feedback

Following the completion of the initial community and regulatory stakeholder engagement processes, all relevant issues raised were addressed by either WACJV or the relevant specialists for inclusion in the technical studies undertaken for this EIS.

Feedback on the issues raised was provided via personal meetings with those affected land owners or near neighbours who noted they were interested in follow-up briefings.

5.4.2 Director-General's Requirements

In response to the stakeholder engagement undertaken for the Project, DP&I issued DGRs for the Project on 12 January 2012 which incorporated responses from other regulators (and revised on 11 July 2012 to incorporate SEWPaC's requirements). The DGRs are provided in full in Appendix B while Table 17 lists each requirement and where it is addressed in this EIS.

5.4.3 Regulatory Consultation Feedback

Following the completion of initial regulatory consultation and discussions on the Project as outlined above in Sections 5.2 and 5.4, relevant specialists preparing each of the environmental assessments for this EIS were briefed on the issues raised to ensure that these were appropriately considered in this EIS. A summary of these issues and where these have been addressed in this EIS is included in Table 18.

5.4.4 Community Stakeholders Feedback

Table 19 provides a summary of the issues raised by near neighbours and other stakeholders and where each is addressed in this EIS. The findings of the stakeholder engagement program were also incorporated in the risk assessment outlined in Section 6 to ensure that they were adequately assessed.

Table 17 Director-General's Environmental Assessment Requirements

Description	EIS Section
General Requirements	
The Environmental Impact Statement (EIS) for the development must meet the form and content requirements in Clauses 6 and 7 of Schedule 2 of the *Environmental Planning & Assessment Regulation 2000*	**Executive Summary**
• In addition, the EIS must include a: – Detailed description of the development, including: – Need for the proposed development; – Justification for the proposed mine plan, including efficiency of coal resource recovery, mine safety, and environmental protection; – Likely staging of the development - including construction, operational stage/s and rehabilitation; – Likely interactions between the development and existing, approved and proposed mining operations in the vicinity of the site; – Plans of any proposed building works;	**3 and Appendix E**
• Consideration of all relevant environmental planning instruments, including identification and justification of any inconsistencies with these instruments;	**4**
• Risk assessment of the potential environmental impacts of the development, identifying the key issues for further assessment;	**6**

Description	EIS Section
General Requirements cont.	
• Detailed assessment of the key issues specified below, and any other significant issues identified in this risk assessment, which includes: – A description of the existing environment, using sufficient baseline data; – An assessment of the potential impacts of all stages of the development, including any cumulative impacts, taking into consideration relevant guidelines, policies, plans and statutes; and – A description of the measures that would be implemented to avoid, minimise and if necessary, offset the potential impacts of the development, including proposals for adaptive management and/or contingency plans to manage any significant risks to the environment.	**2** and **7**
Key Issues	
• **Subsidence** – Including a detailed quantitative and qualitative assessment of the potential conventional and non-conventional subsidence impacts of the development that includes: – The identification of the natural and built features (both surface and subsurface) within the area that could be affected by subsidence, and an assessment of the respective values of these features using any relevant statutory or policy documents; – Accurate predictions of the potential subsidence effects and impacts of the development, including a robust sensitivity analysis of these predictions; – A detailed assessment of the potential environmental consequences of these effects and impacts on both the natural and built environment, paying particular attention to those features that are considered to have significant economic, social, cultural or environmental values; and – A detailed description of the measures that would be implemented to avoid, minimise, remediate and/or offset subsidence impacts and environmental consequences (including adaptive management and proposed performance measures);	**7.1**
• **Land Resources** – including a detailed assessment of the potential impacts on: – Soils and land capability (including contamination); – Landforms and topography, including cliffs, rock formations, steep slopes, etc; – Land use, including forestry, conservation and recreational use, with particular reference to Wyong State Forest - including impacts on forestry resources and forestry activities and consideration of appropriate compensation in relation to forestry production; and - agricultural resources and/or enterprises in the local area, including: • Any change in land-use arising from requirements for biodiversity offsets; • A detailed description of the measures that would be implemented to avoid and/or minimise the potential impacts of the project on agricultural resources and/or enterprises; and • Justification for any significant long term changes to agricultural resources, particularly if highly productive agricultural resources (e.g. alluvial lands) are proposed to be affected by the project;	**7.19, 7.21, 7.22** and **7.25**
• **Water Resources** – including: – Detailed assessment of potential impacts on the quality and quantity of existing surface and ground water resources, including: • Detailed modelling of potential groundwater impacts; • Impacts on riparian, ecological, geo-morphological and hydrological values of watercourses, including environmental flows; – A detailed assessment of the potential impacts of the project on: • The quantity and quality of regional water supplies, and in particular the supply of water to the Gosford-Wyong Water Supply Scheme; • Regional water supply infrastructure; and • Affected licensed water users and basic landholder rights (including downstream water users); – A detailed site water balance, including a description of site water demands, water disposal methods (inclusive of volume and frequency of any water discharges), water supply infrastructure and water storage structures; – Identification of any licensing requirements or other approvals under the *Water Act 1912* and/or *Water Management Act 2000;* – Demonstration that water for the construction and operation of the development can be obtained from an appropriately authorised and reliable supply in accordance with the operating rules of any relevant Water Sharing Plan (WSP) or water source embargo; – A description of the measures proposed to ensure the development can operate in accordance with the requirements of any relevant WSP; – A detailed description of the proposed water management system (including sewage), water monitoring program and other measures to mitigate surface and groundwater impacts; and – A detailed flood impact assessment, which identifies impacts on local and regional flood regimes and resultant impacts on agricultural land use, transport, services, habitability and public safety, including any measures proposed to mitigate potential flood impacts;	**7.2, 7.3** and **7.4**

Description	EIS Section
Key Issues cont.	
• **Biodiversity** – including: – Measures taken to avoid, reduce or mitigate impacts on biodiversity; – Accurate estimates of proposed vegetation clearing; – A detailed assessment of potential impacts of the development on any: • Terrestrial or aquatic threatened species or populations and their habitats, endangered ecological communities and groundwater dependent ecosystems (including the following threatened species: *Angophora inopina*, *Cryptostylis hunteriana*, *Mixophyes iterates* - the Giant Barred Frog, *Mixophyes balbus* - the Stuttering Frog, *Litoria littlejohni* - the Littlejohns Tree Frog); • Migratory bird species listed under CAMBA, JAMBA and/or ROKAMBA; and • Regionally significant remnant vegetation, or vegetation corridors; – Impacts on Jilliby SCA - including impacts on the conservation and recreational values of the reserve and landowner consent issues; and – A comprehensive offset strategy to ensure the development maintains or improves the terrestrial and aquatic biodiversity values of the region in the medium to long term;	**7.9, 7.10** and **7.11**
• **Heritage** – including: – An Aboriginal cultural heritage assessment (including both cultural and archaeological significance) which must: • Demonstrate effective consultation with Aboriginal communities in determining and assessing impacts, and developing and selecting mitigation options and measures; • Outline any proposed impact mitigation and management measures (including an evaluation of the effectiveness and reliability of the measures); and – A Historic heritage assessment (including archaeology) which must: • Include a statement of heritage impact (including significance assessment) for any State significant or locally significant historic heritage items; and • Outline any proposed mitigation and management measures (including an evaluation of the effectiveness and reliability of the measures);	**7.14** and **7.15**
• **Air Quality** – including a quantitative assessment of potential: – Construction and operational impacts, with a particular focus on dust emissions including $PM_{2.5}$ and PM_{10} emissions and the dust generation from coal transport; – Reasonable and feasible mitigation measures to minimise dust emissions, including evidence that there are no such measures available other than those proposed; and – Monitoring and management measures, in particular real-time air quality monitoring;	**7.5**
• **Greenhouse Gases** – including: – A quantitative assessment of potential Scope 1, 2 and 3 greenhouse gas emissions; – A qualitative assessment of the potential impacts of these emissions on the environment; and – An assessment of reasonable and feasible measures to minimise greenhouse gas emissions and ensure energy efficiency;	**7.6**
• **Noise** – including a quantitative assessment of potential: – Construction, operational and transport noise impacts; – Offsite road noise impacts; and – Reasonable and feasible mitigation measures, including evidence that there are no such measures available other than those proposed; and - monitoring and management measures, in particular real-time and attended noise monitoring;	**7.8**
• **Human Health** – including a detailed Human Health Risk Assessment addressing how the project's environmental impacts (particularly in relation to air quality, noise and drinking water quality) may impact on the health of the local community. The assessment should address both direct and indirect impacts, such as may result from additional rail and road movements;	**7.7**
• **Visual** – including: – A detailed assessment of the: • Changing landforms on site during the various stages of the project; and • Potential visual impacts of the project on private landowners in the surrounding area as well as key vantage points in the public domain, and particularly the proposed Warnervale Town Centre, Wyong Employment Zone, and the major elements of the public domain linking these two areas; – A detailed description of the measures that would be implemented to minimise the potential visual impacts of the project;	**7.16**
• **Waste** – including: – Accurate estimates of the quantity and nature of the potential waste streams of the development, including tailings and coarse reject; – A tailings and coarse reject disposal strategy; and – A description of measures that would be implemented to minimise production of other waste, and ensure that that waste is appropriately managed;	**7.24**

Description	EIS Section
Key Issues cont.	
• **Social & Economic** – including an assessment of the: – Potential direct and indirect economic benefits of the project for local and regional communities and the State; – Potential impacts on local and regional communities, including: • increased demand for local and regional infrastructure and services (such as housing, childcare, health, education and emergency services); and • impacts on social amenity; – A detailed description of the measures that would be implemented to minimise the adverse social and economic impacts of the project, including any infrastructure improvements or contributions and/or voluntary planning agreement or similar mechanism; and – A detailed assessment of the costs and benefits of the development as a whole, and whether it would result in a net benefit for the NSW community; and	**7.17** and **7.18**
• **Rehabilitation** – including: – Rehabilitation objectives, methodology, monitoring programs, performance standards and proposed completion criteria; – Nominated final land use, having regard to any relevant strategic land use planning or resource management plans or policies; and – The potential for integrating this strategy with any other rehabilitation and/or offset strategies in the region	**7.25**
The EIS must include all relevant plans, architectural drawings, diagrams and relevant documentation required under Schedule 1 of the *Environmental Planning & Assessment Regulation 2000*. These documents should be included as part of the EIS rather than as separate documents	**Appendix E**
References	
The Environmental Impact Statement (EIS) for the development must meet the form and content requirements in Clauses 6 and 7 of Schedule 2 of the *Environmental Planning & Assessment Regulation 2000*.	**4.5.1**

Table 18 Regulatory Stakeholder Issues Raised

Ref	Details	Issue Raised	EIS Section
1.	Letter sent to DP&I on 29 March 2012 Reply sent to WACJV on 7 June 2012	Groundwater	**7.1**
		Surface water	**7.3**
2.	Presentation to Gosford Council 27 March 2012	Economic and social	**7.17** and **7.18**
		Surface water	**7.3**
		Groundwater	**7.2**
3.	Presentation to LMCC 16 April 2012	Subsidence	**7.1**
		Groundwater	**7.2**
		Surface water	**7.3**
		Rail	**7.13**
4.	Letter to NOW 22 March 2012 and meeting with NOW 31 August 2012	Groundwater	**7.2**
5.	Meeting with WSC 9 July 2012	Social	**7.18**
		Traffic and transport	**7.12**
6.	Meeting with WSC 20 December 2012	Water Management	**3.9** and **7.3.1**
7.	Meeting with OEH 19 and 27 November 2012	Ecology	**7.9**
		Flooding	**7.4**
8.	Meeting with NOW 10 and 25 January 2013	Surface Water	**7.3**
		Groundwater	**7.2**
		Geology	**2.7**

Table 19 Community Stakeholder Issues Raised

Ref	Issue Raised	EIS Section
1	***Air Quality***	**7.5**
	Dust impacts from Tooheys Road facility on Blue Haven suburb	
	Dust impacts from Tooheys Road facility on local neighbours	
	Dust monitoring including monitoring locations and availability of data	
2	***Noise***	**7.8**
	Operational noise and minimisation techniques	
	Noise impact created by rail traffic on Wyee township	
	Traffic generated noise	
3	***Social and Economic***	**7.17** and **7.18**
	Employment opportunities in Wyong, Central Coast and Lake Macquarie	
	Benefits to region during construction period	
	Economic benefits to local community	
	Specific company contributions to local community	
	Land zoning for surface facilities	
4	***Water and water management***	**7.2, 7.3** and **7.4**
	Protection of local and regionally significant surface water regimes	
	Protection of sub-surface water regimes	
	Protection of regional water supply infrastructure	
	Protection of individual property water systems/private bores	
	Impact on flooding	
	Water management at surface facilities	
5	***Subsidence***	**7.1**
	Impact on built environment	
	Impact on natural environment	
	Impact on water regimes	
	Impact on regional infrastructure	
6	***Visual***	**7.16**
	Impact from F3 Freeway	
	Impact from Motorway Link Road	
	Impact from neighbouring residential areas	
7	***Heritage***	
	Impact on Aboriginal heritage	**7.14**
	Impact on European heritage	**7.15**
8	***Ecology***	**7.9** and **7.10**
	Impact on State Forest	
9	***Traffic***	**7.12**
	Impact on road network	
10	***Other***	
	Consultation with community throughout EIS process	**5**
	Understanding of refusal of earlier related W2CP EA	**1.2**

5.5 Ongoing Stakeholder Engagement

WACJV is committed to continuing its stakeholder engagement program throughout the life of the Project, in accordance with leading practice.

Ongoing stakeholder engagement will include regular contact with neighbouring land owners, representatives of key Local and State regulatory authorities and industry bodies, and the release of information on the status of the Project, key Project issues and environmental performance.

Project information sheets will be distributed upon the submission of this EIS to provide an update on this EIS process and where this EIS may be viewed by the public.

Mechanisms that will be employed by WACJV to ensure effective ongoing engagement and communication with Project stakeholders will include:

- Regular engagement with individual near neighbours;
- Project Community Consultative Committee (CCC) to be continued or re-established in accordance with the conditions of Development Consent;
- Company representation on appropriate environmental and community groups;
- Distribution of regular community newsletters;
- Regular updates and documentation available on the Company website;
- Participation at relevant key community events; and
- Community surveys.

Training of employees and contractors will be undertaken commensurate with each job description in relation to the commitments in this EIS and as part of the commitment to ongoing stakeholder consultation.

In addition, an Annual Review that summarises company activities and performance in the areas of environment and community will be prepared and made available to the public on the WACJV website.

5.6 Aboriginal Community Consultation

Aboriginal community consultation for the Project was undertaken in two phases due to delays in the approval process and changes to the legislation and guidelines for heritage management and consultation.

The first phase was conducted according to the Department of Environment & Conservation (DEC 2004) *Interim Community Consultation Requirements* (ICCRs) as recommended in the DEC 2005 *Guidelines for Aboriginal Cultural Heritage Impact Assessment and Community Consultation* (for Part 3A assessments).

The revised Department of Environment, Climate Change & Water (DECCW) 2010 *Aboriginal Cultural Heritage Consultation Requirements* (ACHCRs) were followed for consultation carried out since 2011.

5.6.1 2006: Survey Infrastructure Boundary and other WACJV owned land

An advertisement appeared in the local print media on the 23 August 2006 seeking expressions of interest from Indigenous groups and organisations in the Wyong area to participate in a Heritage Assessment for the then proposed Wallarah No 2 Coal Project. Letters were also sent to the then Department of Environment & Climate Change (DECC), WSC and Native Title Service Corporation (NTSCORP) seeking knowledge of any indigenous stakeholder groups to contact for inclusion in the consultation process. The DLALC and Guringai Tribal Link Aboriginal Corporation (GTLAC) formally registered interest.

Representatives from DLALC and GTLAC were invited to participate in the field assessment and sent details describing the proposed Aboriginal Archaeology and Cultural Heritage Assessment methodology. A request was extended for any specific cultural information (should any be available), as well as inviting comment / input on the methodology proposed.

A copy of the draft report was issued to registered stakeholders in December 2009. Responses were received from both DLALC and GTLAC. Both organisations were verbally supportive of the methodology proposed, however DLALC requested an extension on their feedback until after the additional survey in the western area potential subsidence district.

5.6.2 2010: Survey Subsidence Impact Limit

The OzArk survey team was accompanied in the field during the survey of the Wyong State Forest/Jilliby SCA and Honeysuckle Park by representatives from both DLALC and GTLAC over the five day period 25 – 29 January 2010. Subsequent to this survey, GTLAC submitted a report supporting the development of an Aboriginal Cultural Heritage Management Plan which they recommended be prepared in partnership with the GTLAC and the DLALC. The DLALC indicated they will submit a report following the test excavation of areas along Wallarah Creek scheduled for March 2010.

5.6.3 2010: Test Excavation at Tooheys Road Site

The test excavation program took place from 15 March – 19 March 2010 with representatives from DLALC and GTLAC both present. Primarily, the community representatives were involved with the wet-sieving of deposits and in providing feedback on the excavation methodology. Discussions were held in the field at the location of excavation areas between archaeologists and the representatives to define the type and nature of each impact and assessed requirements for mitigation or management measures.

5.6.4 2011: Survey Subsidence Impact Limit

Additional site surveys were undertaken in the Wyong State Forest/Jilliby SCA and Honeysuckle Park Study Areas in September 2011. Community consultation was continued under the existing arrangements and the methodology for the survey, and an invitation to participate, was extended to DLALC and GTLAC. Each stakeholder group was represented in the field.

5.6.5 Consultation Since 2011

The second phase of consultation commenced in November 2011, undertaken according to the "Aboriginal Cultural Heritage Consultation Requirements 2010" (DECCW, 2010). Both DLALC and GTLAC were contacted and their previous input in the Project was acknowledged. Each organisation was advised they will continue to be consulted as a Registered Aboriginal Party (RAP).

An expression of interest advertisement was placed in the Central Coast Express on 30 November 2011. In order to establish a broad base of Aboriginal people and organisations who may hold cultural knowledge relevant to the Project and area within the Project Boundary, contact details were sought from OEH, WSC, NTSCORP, Hunter Central Rivers CMA, National Native Title Tribunal, DLALC, GTLAC, and the Register of Aboriginal Owners. Two new Aboriginal groups registered an interest: Awabakal Traditional Owners Aboriginal Corporation (ATOAC) and Awabakal Descendants Traditional Owners Aboriginal Corporation (ADTOAC).

Letters presenting information about the sites recorded as part of the previous surveys were sent to all stakeholders. This correspondence included an invitation to RAPs wishing to meet, discuss the Project and share their views and cultural knowledge regarding the sites within and surrounding the Project Boundary. Both DLALC and GTLAC advised that they did not feel the need to attend further meetings as they were aware of all aspects of the Project and had shared their substantial knowledge to this point.

Each of the new stakeholder groups expressed an interest in attending a Project briefing session to discuss their cultural knowledge in relation to the area within the Project Boundary. Due to their close association, both ADTOAC and ATOAC agreed to attend a joint meeting which was scheduled for 16 May 2012. Due to unexpected issues, neither organisation was able to attend on this day. Further meetings have not as yet been able to be scheduled. A phone discussion was held with ATOAC on 10 September 2012 to discuss cultural knowledge and concerns relating to the Project.

5.6.6 Consultation on this Report

The draft Aboriginal Heritage Impact Assessment was sent to all registered RAPs for review and comment. Responses are discussed in Section 7.14 and were received from DLALC, ATOAC and ADTOAC.

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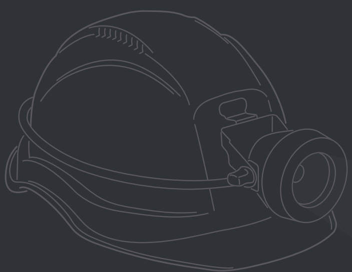
Risk Assessment



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Risk Assessment 6

The Background Document which supported the request for DGRs to DP&I included a preliminary risk assessment which identified potential environmental issues associated with the Project. The primary purpose of the Risk Assessment process was to prioritise and focus the required environmental assessments for the Project.

Each of the environmental issues has now been assessed and addressed to a relevant extent, and where appropriate, management and mitigation options were developed. Following stakeholder engagement and the receipt of the DGRs, a revision of this preliminary risk assessment was undertaken to incorporate additional requirements. The revised risk assessment is summarised in Table 20 and presented in full in Appendix F.

The key risks identified for the Project were analysed in accordance with the WACJV Risk Assessment Matrix which is based on the probability of the impact occurring and potential consequences of the impact. Under this matrix, each potential environmental issue was ranked as either being of extreme, high, moderate or low risk to the environment. Risk rankings identified for each aspect of the Project were further evaluated based on the outcomes of the stakeholder engagement program, as required.

Findings from the revised risk assessment indicated several aspects associated with the Project which, in the absence of controls, potentially posed a high to moderate environmental risk, whilst many of the aspects were rated as low risk. No extreme risks were identified as part of the risk assessment process. Aspects identified throughout the risk assessment process as high, moderate and low have each been assessed as part of this EIS.

Aspects identified as having a higher environmental impact risk formed the primary focus of this EIS and were more intensively assessed. Aspects which have been identified as having a moderate to low risk were also assessed however a lesser scope of work was conducted for these secondary issues, based on their lower risk rating. The detailed assessment undertaken within the EIS has assessed the potential environmental impacts as a result of the Project and developed relevant management and mitigation measures to reduce the risks shown below.

Table 20 Environmental Risk Rating

Extreme Risk	High Risk	Moderate Risk	Low Risk
None	Subsidence	Noise	Soils and Land Capability
	Groundwater	Air Quality (including dust and health risk)	Contamination
	Surface Water Management	Greenhouse gas	Hazards
	Flooding	Visual	Waste
	Ecology (Biodiversity)	Agriculture	Land Management (Rehabilitation, Final Land use and Closure)
	Aboriginal Cultural Heritage	Economics	Forestry
		Land Resources (soils and land use)	Traffic and Transport
			Historic Heritage
			Rail

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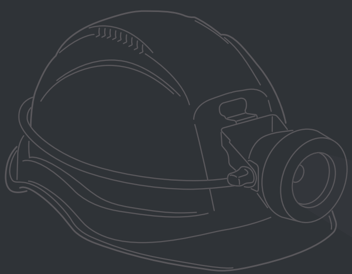
Impacts, Management and Mitigation



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This section provides a summary of potential environmental and social impacts from the Project and discusses the management and mitigation measures to be implemented, as appropriate. The issues have been prioritised in accordance with the DGRs and the risk assessment (in consideration of stakeholder engagement) described in Section 6.

7.1 Subsidence

7.1.1 Background

Introduction

A Subsidence Impact Assessment has been completed for the Project by WACJV and the relevant technical experts, SCT Operations Pty Ltd (SCT) and Mine Subsidence Engineering Consultants Pty Ltd (MSEC). The purpose of this Subsidence Impact Assessment is to predict the likely subsidence related ground movements resulting from the Project and then to assess the impacts of this predicted subsidence on the natural and built environments.

The Subsidence Impact Assessment includes a Subsidence Modelling Study (SMS) and a Subsidence Impact Report (SIR). The SMS was prepared by WACJV and SCT and is provided in Appendix G. The SIR was prepared by MSEC and is provided in Appendix H.

Subsidence predictions for mine geometries relevant to the Project were prepared by SCT using numerical modelling techniques. The results of these predictions were then utilised by MSEC to calibrate the Incremental Profile Method (IPM) empirical subsidence model. The calibrated IPM empirical subsidence model was then used to generate subsidence contours across the entire mining area and site specific subsidence predictions were then used to undertake impact assessments for each natural feature and built structure located over or near the Project.

Terminology

This Subsidence Impact Assessment has adopted the terms and definitions in relation to mine subsidence that were first published in an Independent Inquiry report entitled 'Strategic Review of Impacts of Underground Coal Mining on Natural Features in the Southern Coalfield' (Independent Expert Panel, 2008). These terms were also utilised in the 'Strategic Review of Impacts on Underground Coal Mining in the Wyong Local Government Area' (Department of Planning, 2008).

The term "subsidence effects" refers to the physical ground movements induced by underground mining. This encompasses all movements, including vertical subsidence, horizontal displacement, tilt, curvature and strain. Conventional subsidence effects are illustrated in Figure 27.

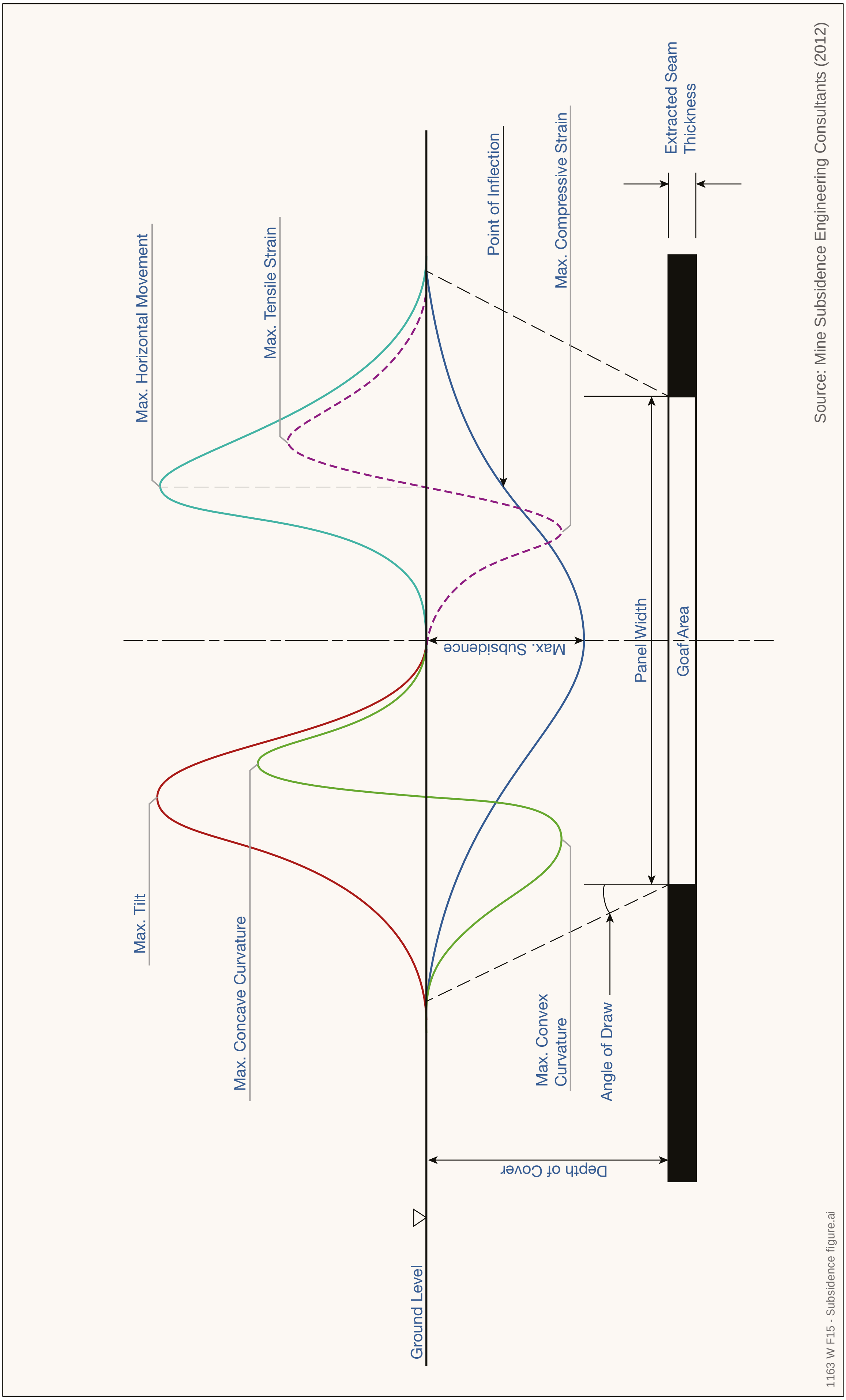
The term "subsidence impacts" refers to the physical changes to the rock mass and surface. Subsidence impacts can include tensile and shear failure of the rock mass, bedding shear and localised buckling of the strata. "Environment consequences" refers to the changes to the environment arising from the subsidence impacts. The term is used broadly to include changes to both the natural and built environments.

For the purposes of this assessment, the term "subsidence impact limit" refers to the boundary of the region within which the predicted vertical subsidence exceeds 20 mm. Outside of the subsidence impact limit, the conventional subsidence effects are considered negligible. It is noted, that valley related upsidence and closure movements, as well as far-field horizontal movements that are greater than 20 mm can occur outside this vertical subsidence limit. Therefore, the potential impacts on the natural and built features located outside this limit have also been considered in this study. Some of the remote surface features and infrastructure items that were included in the impact assessments for this Subsidence Impact Assessment included those that are located outside of the subsidence impact limit and up to 5 km from the nearest edge of the mined panels.

Identification of Surface Features

The Subsidence Impact Assessment has comprehensively considered the potential impacts and environmental consequences for surface features in the vicinity of the Project. Natural features and surface infrastructure with the potential to be affected by subsidence due to the Project are indicated in Table 21.

The 'status' column in Table 21 indicates whether the natural feature or other item of surface infrastructure has been identified within the subsidence impact limit. Where a natural feature and item of surface infrastructure has been marked with a tick then it could potentially be impacted by the Project. A description and impact assessment of those items potentially impacted by the Project have been provided in the Subsidence Impact Assessment. The locations of these features within and in the vicinity of the Subsidence Impact Limit are shown on Figure 28.



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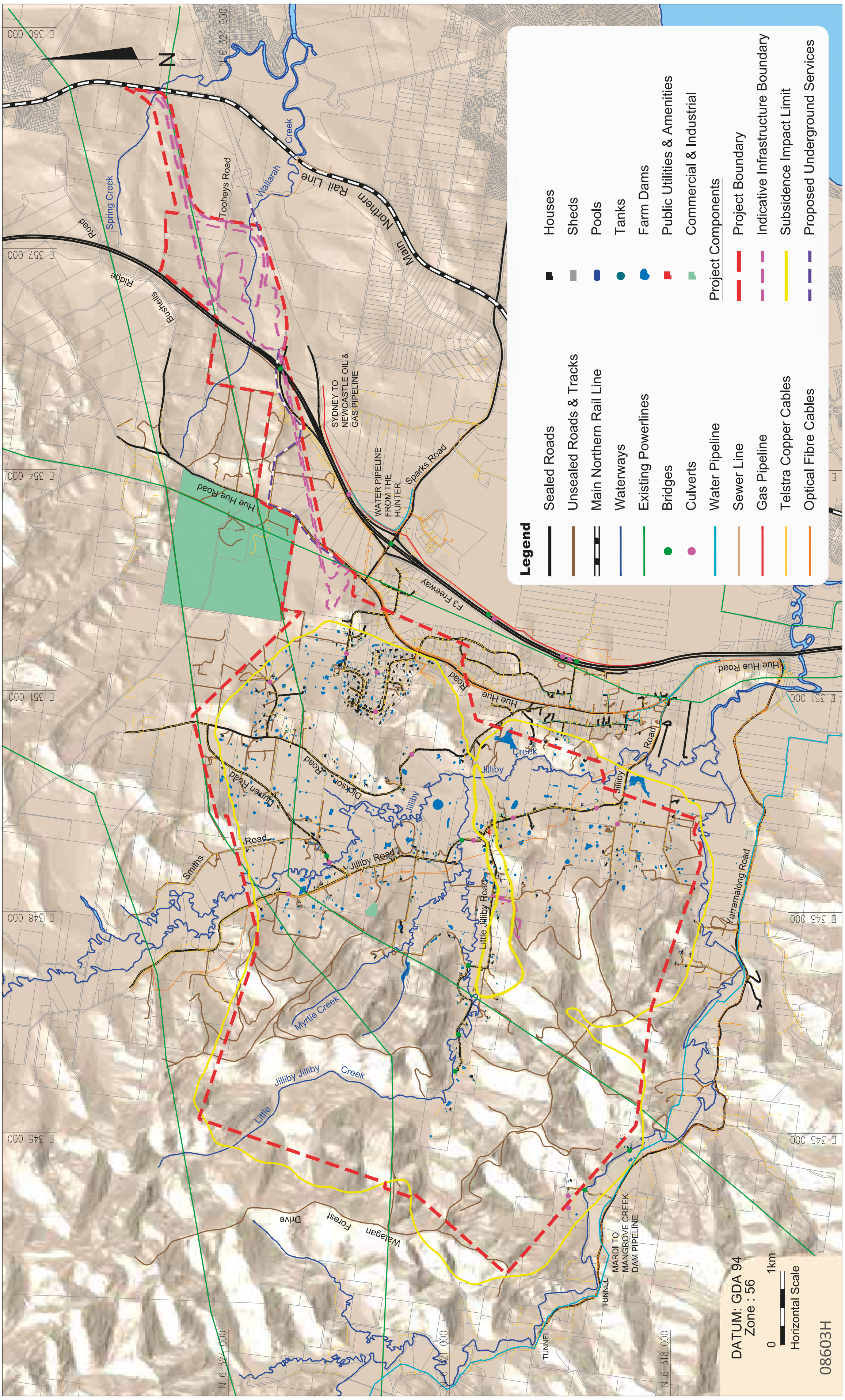
Conventional Subsidence Effects Diagram

FIGURE 27

Table 21 Natural Features and Infrastructure in the Vicinity of the Subsidence Impact Limit

Item	Status
Natural Features	
Catchment Areas or Declared Special Areas	✓
Rivers or Creeks	✓
Aquifers or Known Groundwater Resources	✓
Springs	✓
Sea or Lakes	×
Shorelines	×
Natural Dams	×
Cliffs or Natural Rock Formations	✓
Steep Slopes	✓
Escarpments	×
Land Prone to Flooding or Inundation	✓
Swamps, Wetlands or Water Related Ecosystems	✓
Threatened, Protected Species or Critical Habitats	✓
National Parks or Wilderness Areas	×
State Recreational or Conservation Areas	✓
State Forests	✓
Natural Vegetation	✓
Areas of Significant Geological Interest	×
Any Other Natural Feature Considered Significant	×
Public Utilities	
Railways	×
Roads (All Types)	✓
Bridges	✓
Tunnels	×
Culverts	✓
Water, Gas or Sewerage Pipelines	✓
Liquid Fuel Pipelines	×
Electricity Transmission Lines or Associated Plants	✓
Telecommunication Lines or Associated Plants	✓
Water Tanks, Water or Sewage Treatment Works	✓
Dams, Reservoirs or Associated Works	✓
Air Strips	×
Any Other Public Utilities	×
Public Amenities	
Hospitals	×
Places of Worship	×
Schools	✓
Shopping Centres	×
Community Centres	✓
Office Buildings	×
Swimming Pools	×
Bowling Greens	×

Item	Status
Public Amenities cont.	
Ovals or Cricket Grounds	×
Racecourses	×
Golf Courses	×
Tennis Courts	×
Any Other Public Amenities	×
Farm Land and Facilities	
Agricultural Utilisation, Agricultural Improvements or Agricultural Suitability of Farm Land	✓
Farm Buildings or Sheds	✓
Gas or Fuel Storages	✓
Poultry Sheds	×
Glass Houses or Green Houses	×
Hydroponic Systems	×
Irrigation Systems	✓
Fences	✓
Farm Dams	✓
Wells or Bores	✓
Any Other Farm Features	×
Industrial, Commercial and Business Establishments	
Factories	×
Workshops	×
Business or Commercial Establishments or Improvements	✓
Gas or Fuel Storages or Associated Plants	×
Waste Storages and Associated Plants	×
Buildings, Equipment or Operations that are Sensitive to Surface Movements	×
Surface Mining Voids and Rehabilitated Areas	✓
Mine Infrastructure Including Tailings Dams or Emplacement Areas	×
Other Industrial, Commercial or Business Features	×
Areas of Archaeological or Heritage Significance	✓
Permanent Survey Control Marks	✓
Residential Establishments	
Houses	✓
Flats or Units	×
Caravan Parks	×
Retirement or Aged Care Villages	×
Associated Structures such as Workshops, Garages, On-Site Waste Water Systems, Water or Gas Tanks, Swimming Pools or Tennis Courts	✓
Any Other Residential Features	✓
Any Other Item Of Significance	✓



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Indicative Surface Infrastructure in Vicinity of Project

FIGURE 28

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Peer Review

Professor Bruce Hebblewhite, Head of School of Mining - University of NSW was engaged to provide an independent peer review of the mine subsidence predictions and impact assessments that were carried out for the Project (see Appendix G and Appendix H respectively).

Bruce Hebblewhite's report is appended to Appendix H and concludes "I am of the opinion that 'best-practice' subsidence prediction techniques have been adopted using innovative hybrid empirical and numerical techniques. These techniques have been rigorously evaluated, and validated as far as possible against available databases.

However, it will be essential that some Wallarah site-based validation is carried out once data is collected from subsidence associated with the initial longwall panels to provide an even better level of confidence in the prediction techniques and findings". These commitments are included in Section 7.1.4 below.

7.1.2 Methodology

Subsidence Prediction Methodology

Subsidence from underground mining can be predicted using various methods, including empirical, analytical and numerical modelling. Empirical modelling methods predict subsidence using parameters derived from actual subsidence data measured over previously mined areas. These methods are most appropriate for mine plans where the geology of the site and mining geometry being assessed are similar to those where empirical data is available.

There is a considerable amount of monitored subsidence data available for the Southern and Newcastle Coalfields, due to the history of mining activities within these areas. However, there are critical differences between the Project and previous underground mining activities in these coalfields, which limit the ability to utilise the available monitored subsidence data for making empirical predictions for the Project.

These include:

- The Project involves the longwall extraction of coal at depths of cover of up 690 m, which considerably exceeds the depths of cover for mines in the Newcastle Coalfield and Southern Coalfield, where depths of cover typically extend up to 550 m;
- Southern Coalfield collieries usually mine at an extraction thickness of approximately 3.0 m, whereas the Project includes plans to operate at extraction thicknesses of between 3.0 m and 4.5 m;
- Southern Coalfield seams are usually bounded above and below by reasonably strong strata, whereas the near-seam strata for the Project are comparatively weak; and
- Overburden in the Newcastle Coalfields often contain thick, strong conglomerate units which tend to reduce surface subsidence, whereas overburden in the vicinity of the Project consists of finer gained sandstones and shales with minor conglomerates which will behave more like the overburden within the Southern Coalfield.

Consequently, there is limited empirical subsidence data available that can be applied to the Project. Therefore, it was necessary to utilise a numerical model to provide appropriate mine subsidence predictions for a range of sites across the Project. A hybrid approach was then adopted by using the results from the numerical model to calibrate an empirical model. This calibrated empirical model was then used to predict the subsidence parameters at all natural features and surface developments across the Extraction Area.

Numerical Modelling

SCT undertook numerical modelling to develop subsidence profiles at three sites over the Extraction Area. Subsidence profiles were produced using the modified Fast Lagrangian Analysis of Continua (FLAC) model, a two-dimensional, explicit-finite-difference program developed specifically for solving mining and geotechnical engineering problems. The rock failure and permeability routines have been developed by SCT to offer a more realistic representation of the rock fracture mechanics than is available in the standard FLAC codes. It incorporates a coupled rock failure and fluid flow system to simulate the behaviour of the strata as well as the fluid pressure/flow effects as it models the behaviour of a representative cross section through the central zone of the series of longwall panels.

Model Validation

Prior to being applied to the Project, the FLAC model was validated through back analysis of a number of historical subsidence data sets. The purpose of this exercise was to exhaustively test the adequacy of the model in simulating the deformation mechanics of the strata associated with a number of different geological environments and extraction geometries.

The validation process involved:

- Modelling of a series of extracted panels with a typical Hunter Valley geology to assess FLAC's ability to model varying width / depth ratios. Comparison of the results to data within the regional database of the Hunter and Western Coalfields indicated that FLAC was found to adequately simulate the effects of panel geometry and depth on subsidence;
- Modelling of Longwalls 1 – 3 at the Ellalong Colliery as an example to test the model's ability to predict caving mechanics. Results showed that there was a strong correlation between the model results and the caving mechanics monitored using a surface-to-seam, borehole extensometer; and

- Modelling of a series of longwall panels for the South Bulli Colliery was also undertaken to test the ability of the model to accurately predict the subsidence associated with the extraction of sub-critical width panels in the Southern Coalfield. The predicted subsidence profiles were very similar to the actual measured subsidence.

This validation process demonstrated that the FLAC model was capable of accurately predicting the subsidence effects for a range of geological conditions and panel geometries. As such, the FLAC model was adopted for this assessment.

FLAC Modelling

The geological parameters used in the FLAC model were sourced from the exploration program for the Project (as explained in Section 2.7.1). Detailed rock strength data were obtained from three fully cored geotechnical boreholes and extrapolated across the Extraction Area by applying sonic-UCS relationships developed between the laboratory data and the sonic logs that had been produced for each individual drill hole. Stress field data was obtained from the interpretation of acoustic scanner results from a number of exploration boreholes, while the permeability of the strata was determined using packer testing. Goaf loading characteristics were interpreted from field extensometer data from other longwall sites.

The Extraction Area was divided into three areas, representing the three main surface environments as shown on Figure 14, including:

- The “Hue Hue MSD Area” – which is the shallower, urbanised area where longwall panels have been narrowed to minimise subsidence impacts on built structures;
- The “Valley Area” – which is the deeper, relatively flat lying rural areas in the base of the valley where potential surface water, flooding and groundwater impacts were closely examined; and
- The “Forest Area” – which is the hilly, forested terrain comprising most of the western half of the Extraction Area, where increased levels of subsidence are expected in association with the wider longwall panels that have been adopted for this less-developed region of the Project Boundary. In this area, particular emphasis was placed on the assessment of upsidence and closure movements in the steeper terrain.

Separate FLAC models were then generated for the mining geometries and strata conditions occurring in each of these three case study areas.

Since FLAC is a two-dimensional model, it assumes that the pillars are continuous, whereas the Project proposes to develop 65 m wide pillars with cut-throughs at 100 m intervals. From their long experience in numerical modelling pillar behaviour, SCT determined that a 65 m pillar with cut-throughs at 100 m intervals is approximately equal in strength to a 55 m continuous pillar. As a result, the three models adopted a pillar width of 55 m so as to provide a more realistic and conservative result.

Calibration of IPM Empirical Modelling

Subsidence predictions for the Project were initially made using the “standard” IPM model. These initial, uncalibrated predictions were considered to be non-conservative, given that the geological conditions and seam extraction heights for the Project were beyond those of the IPM empirical database.

In order to provide more appropriate subsidence predictions at the Project, the IPM model was first compared with and calibrated against the magnitude and shape of the predicted mine subsidence results that were obtained from the FLAC model. It was found from these comparisons that the predictions obtained using the IPM model could be made to reasonably match those from the FLAC model, by simply increasing the magnitudes of the standard empirical predictions curves for the Southern Coalfield. These factors, referred to in this case as geological factors, are those that the standard IPM curves were multiplied by to match the subsidence curves predicted using the FLAC model for the three cases. The geological factors used to calibrate the “standard” IPM model are presented in Table 22.

Subsidence Predictions

Once the necessary adjustments to the “standard” IPM curves were made, the calibrated model was used to predict subsidence ground movements across the Extraction Area reflecting the site conditions, and thereby incorporating a higher level of conservatism into the overall Subsidence Impact Assessment. Reviews of these calibrated subsidence predictions indicate that the resultant predictions are much higher than predictions developed using standard “Newcastle” empirical prediction curves. Consequently, it is considered that these calibrated subsidence predictions are regarded as “upper-bound” and will exceed the actual subsidence that will be observed following mining operations.

Table 22 Geological Factors Applied to the Incremental Profile Method

Longwall Series Number	Hue Hue MSD Case	Valley Case	Forest Case
1st longwall in a series	1.0	1.0	1.0
2nd longwall in a series	1.0	2.0	2.0
3rd (and subsequent) longwalls in a series	1.5	1.5	1.5

MSEC then used the subsidence contours that had been generated across the Extraction Area to assess the potential impacts of predicted levels of subsidence on the natural and build environment, in conjunction with the other specialist consultants. These assessments also incorporated extensive past experience and knowledge from other longwall mining operations in the NSW Coalfields.

7.1.3 Impact Assessment

Subsidence Impacts

Subsidence related issues, particularly with their potential effect on residential structures, water catchments and groundwater regimes within the Project Boundary were recognised from the outset as being a key factor for consideration in the mine design process. Similarly, any disruption to the water regime that will result in water ingress into the proposed mine workings was identified as a major safety risk that must also be addressed through appropriate mine design.

As discussed in Section 3.11, a number of iterations of the mine design were undertaken to address potential subsidence related issues before a final draft layout was then subjected to detailed scrutiny by way of state-of-the-art modelling.

As part of the development of the Project mine plan, the chain pillars have been designed so that they will yield when isolated in the goaf. The benefit of this is to minimise the risk of delayed pillar failure, which has the potential to result in unplanned subsidence events at some point in the future. This design also serves to reduce the differential subsidence that will otherwise occur between the troughs above the extracted longwall panels and the peaks that would exist above chain pillars that were not designed to fail. The numerical modelling undertaken by SCT (see Appendix G) indicates that both of these objectives have been achieved in the final design.

The modelling also demonstrated that caving related fracturing will only extend to approximately 200 m above the seam, while the minimum depth of cover is approximately 400 m. Since fracturing in the upper portion of the rock mass is generally limited to bedding plane shear, which exhibits very low vertical conductivity, the modelling further indicates that the design has effectively limited the potential for hydraulic connection between the surface waters to the underground mining areas as discussed in Section 7.2.

Subsidence Effects

Conventional Subsidence Effects

Conventional subsidence effects were predicted by MSEC using the calibrated IPM model. The conventional subsidence parameters vary across the Extraction Area according to the depth of cover, panel width, chain pillar width, and surface topography and extraction heights. The predicted maximum subsidence, tilt and curvatures for the Project are presented in Table 23.

The predicted subsidence contours are presented in Figure 29.

The values shown in Table 23 are localised, peak maxima with more typical predicted subsidence figures being:

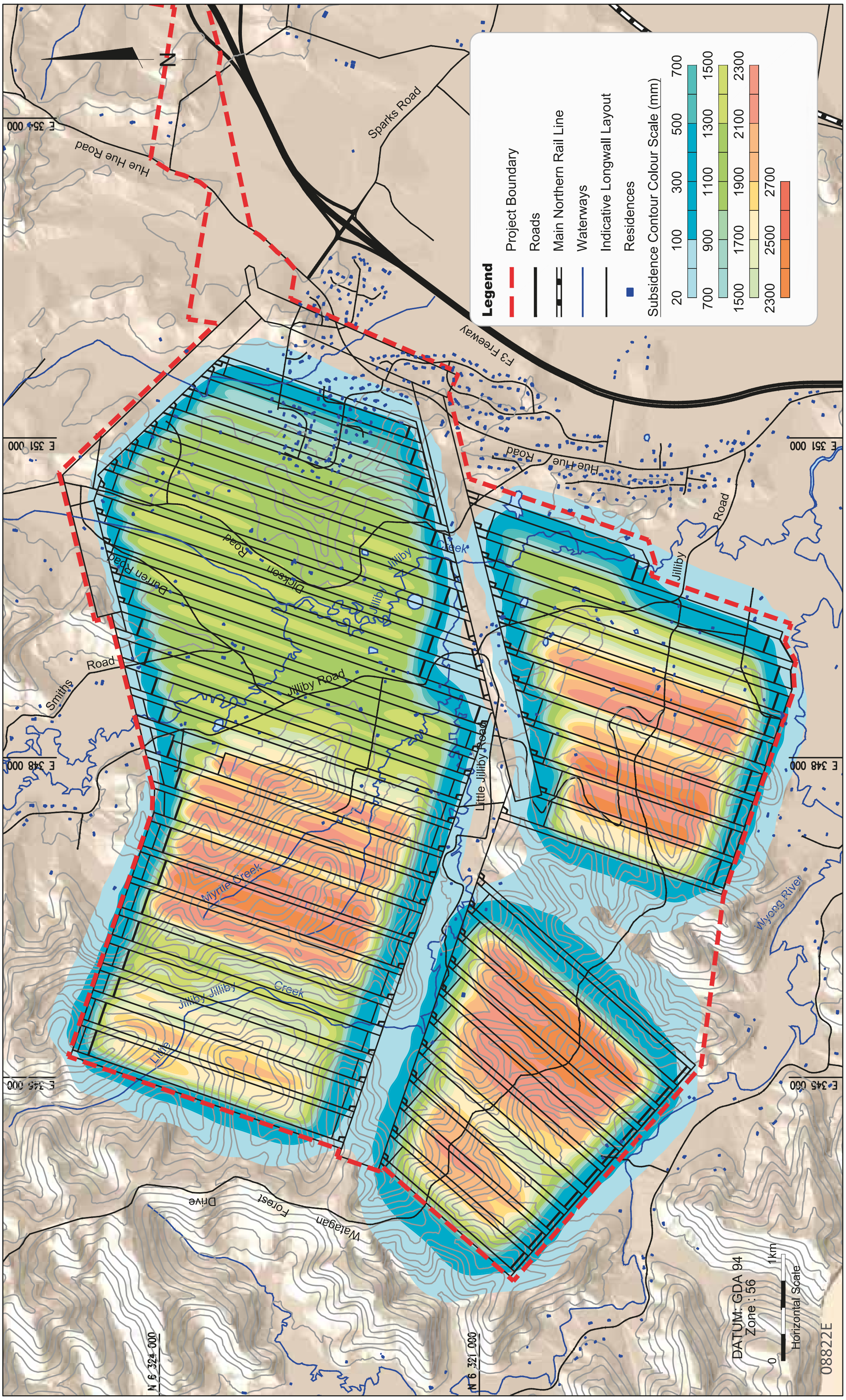
- Hue Hue MSD Area: 600-1,000 mm;
- Valley Area: 1,200-1,400 mm; and
- Forest Area: 1,500-2,000 mm.

There are two major streams passing through or in the vicinity of the Extraction Area: Jilliby Jilliby Creek and Wyong River. There are also numerous minor, intermittent streams including Little Jilliby Jilliby Creek, Armstrong Creek, Myrtle Creek, Hue Hue Creek, Calmans Gully, Hughes Gully, Splash Gully, Youngs Gully and a number of unnamed tributaries. The conventional subsidence effects for these watercourses are presented in Table 24.

The prediction of ground strain is more difficult than the prediction of subsidence, tilt and curvature. The conventional strains can be estimated using a linear relationship between curvature and strain. However, these horizontal strain predictions are not as accurate as the vertical predictions of subsidence and a statistical approach has also been used for the Project to predict the magnitudes of strains for the assessment of impacts. The locations that are predicted to experience hogging or convex curvature are expected to be net tensile strain zones. Conversely, the locations that are predicted to experience sagging or concave curvature are generally expected to be net compressive strain zones.

Table 23 Maximum Conventional Subsidence Effects for Extraction Area

Domains	Maximum Predicted Total Conventional Subsidence (mm)	Maximum Predicted Total Conventional Tilt (mm/m)	Maximum Predicted Total Conventional Hogging Curvature (km^{-1})	Maximum Predicted Total Conventional Sagging Curvature (km^{-1})
Hue Hue MSD	1,000	4	0.12	0.15
Valley	2,000	10	0.28	0.30
Forest	2,600	15	0.28	0.37
Study Area	2,600	15	0.28	0.37



WALLARAH 2 COAL PROJECT

Predicted Subsidence Contours

FIGURE 29

Hansen Bailey ENVIRONMENTAL CONSULTANTS

Wallarah 2 COAL PROJECT

Table 25 provides the maximum conventional tensile and compressive strains, which were obtained by applying a factor of 15 to the maximum hogging and sagging curvatures. Similarly, there is generally a linear relationship between maximum conventional tilt and the maximum conventional horizontal movement of the ground above the longwall and these horizontal movement predictions are not as accurate as the vertical predictions of subsidence. For mines within the Southern Coalfield, the maximum horizontal movement can be predicted approximately by multiplying the maximum conventional tilt by a factor of 15. Since the subsidence profile for the Project is very similar to the profiles for the Southern Coalfield, this factor has been also adopted for this assessment. With the maximum conventional tilt being 15 mm/m, the maximum predicted horizontal movement is 225 mm.

Non-conventional Subsidence Effects

The Project also has the potential to generate far-field horizontal movements which can potentially impact on certain surface features, such as bridges and other large built features. Far-field horizontal movements refer to movements outside of the area directly overlying the longwalls. These are small bodily movements towards the extracted area. Far-field horizontal movements monitored at other mining sites have not been associated with any adverse impacts, in all but one rectified circumstance. The far-field horizontal movements resulting from the Project are not expected to result in any adverse impacts.

Non-conventional strains due to mining can also occur which could exceed the maximum predicted conventional strains provided in Table 25 particularly in the base of narrow valleys. A statistical approach has been used to assess the magnitudes of strains which could result from these non-conventional ground movements.

The data used in the statistical analysis was sourced from 21 monitoring lines over five existing mines. For 16 of the 21 monitoring lines (76%), the maximum tensile strain was 2 mm/m or less. Thirteen of the 21 monitoring lines (62%) recorded a maximum compressive strain of 2 mm/m or less. The maximum tensile and compressive strains across the entire data set were 3.6 mm/m and 4.6 mm/m, respectively.

The maximum non-conventional tensile strain, predicted at the 99% confidence level, is 2.5 mm/m for land overlying the goaf and 1.6 mm/m for land overlying solid coal. The maximum non-conventional compressive strain, predicted at the 99% confidence level, is 3.3 mm/m for land overlying the goaf and 1.3 mm/m for land overlying solid coal.

Similarly, shear deformation was predicted using existing monitoring data from other mines within NSW. Shear deformation is the movement of the ground perpendicular to the monitoring line and, in this case, has been defined using “horizontal mid-ordinate deviation”. Based on the available data, the maximum horizontal mid-ordinate deviation is predicted at the 99% confidence level to be 42 mm.

Table 24 Maximum Conventional Subsidence Effects for Streams

Location	Maximum Predicted Conventional Subsidence (mm)	Maximum Predicted Conventional Tilt (mm/m)	Maximum Predicted Conventional Hogging Curvature (km^{-1})	Maximum Predicted Conventional Sagging Curvature (km^{-1})
Wyong River	150	1	0.01	0.01
Jilliby Jilliby Creek	1,500	10	0.15	0.20
Little Jilliby Jilliby Creek headwaters	2,000	12	0.20	0.25
Armstrong Creek headwaters	2,600	13	0.25	0.30
Myrtle Creek headwaters	2,500	15	0.28	0.37
Remaining Streams	2,600	15	0.28	0.37

Table 25 Maximum Conventional Strain

Domains	Maximum Conventional Tensile Strain (mm/m)	Maximum Conventional Compressive Strain (mm/m)
Hue Hue MSD	3	3
Valley	3	3
Forest	3.5	5

The valleys within and in the vicinity of the Subsidence Impact Limit are likely to experience measurable upsidence and valley closure ground movements. The predicted magnitude of these movements was determined using the Australian Coal Association Research Program (ACARP) upsidence and closure prediction method (Waddington and Kay, 2002), which relies on empirical databases for the Southern Coalfield. The maximum predicted valley related movements for the Project are shown in Table 26.

The ACARP upsidence and closure prediction method is based on measured data from the Southern Coalfield, predominately from large and steeply incised valleys including the Cataract, Nepean, Bargo and Georges Rivers. The method has been designed to be conservative for these types of valleys and is expected to be even more conservative for the wide, alluvial filled valleys within the Project Boundary.

Environmental Consequences

Water Resources

The Extraction Area is mainly located within one of the catchments feeding the water supply scheme for the Gosford City Council (GCC) and WSC. The report of the Independent Expert Panel (2008) for the 'Strategic Inquiry into potential coal mining in the Wyong LGA' concluded that proposed longwall mining within the area was not anticipated to have a significant impact on the region's catchment area and water supply infrastructure. The subsidence impact assessment for the Project has further assessed the impacts upon these water resources.

The streams within the Extraction Area are expected to experience ground tilt as a result of longwall mining. Increased levels of flooding and scouring of the stream banks can potentially occur where longwall mining induces a considerable increase in the natural stream gradients, while a decrease in the natural stream gradient can potentially lead to increased ponding.

Mining is not proposed under the Wyong River and only small levels of subsidence have been predicted along the river alignment. Since the predicted maximum subsidence at the Wyong River is only 175 mm it will experience a change in gradient in the order of 1 mm/m (1 in 1,000).

Table 26 Maximum Predicted Valley Movements

Location	Maximum Predicted Upsidence (mm)	Maximum Predicted Closure (mm)
Wyong River	150	100
Jilliby Jilliby Creek	150	75
Little Jilliby Jilliby Creek	650	775
Armstrong Creek	650	775
Myrtle Creek	800	1,000
Other Streams	800	1,000

Small levels of upsidence of up to 150 mm have also been predicted to occur and this will result in a net subsidence along the Wyong River of 25 mm. Consequently, the change in stream gradient along the river will be negligible. Since these levels of movement are so small, no significant changes in the levels of ponding, flooding or scouring are predicted for Wyong River.

The other streams within the Subsidence Impact Limit are predicted to experience greater tilts, generally in the order of 1% (1 in 100). These tilts are not expected to significantly increase scouring of the stream banks, although there may be localised scouring in sections where the tilt is the greatest (up to 1.5%). The potential for increased ponding is expected to occur in sections of Jilliby Jilliby Creek that overlie longwall panels LW1S and LW6N. The potential for increased flooding has been assessed in the Flood Impact Assessment as described in Section 7.4. Further, the ability of the stream system to equilibrate under natural geomorphic processes is discussed in the Surface Water Assessment as described in Section 7.3.

Cross-bed tilts induced by longwall mining can potentially cause changes in stream alignment. However, the predicted cross-bed tilt for the Wyong River is minimal (0.1%), and will not result in any noticeable changes to the stream alignment. The cross-bed tilts for Jilliby Jilliby Creek (1%), Little Jilliby Jilliby Creek (1.2%) and the minor streams (up to 1.5%) are an order of magnitude lower than the natural gradient across the stream widths. As a result, the changes to stream alignment from longwall mining are expected to be minor and within the range of existing natural variability.

Subsidence induced fracturing of the bedrock can affect overlying or adjacent streams where the mining occurs at shallow depths of cover resulting in connective fracturing of rock between the seam and the surface.

The numerical modelling undertaken by SCT demonstrates that due to the high depths of cover of underground mining operations within the Extraction Area and the characteristics of the rock strata that are present at the Project, there will be no connectivity between the mining induced fracture system and the surface. The proposed mine layout has been specifically designed to avoid such connectivity to minimise the impact on surface water resources and avoid the potential for flooding of the mine.

Upsidence and closure can generate fracturing of bedrock beneath streams, dilating the immediate strata down to a depth of several metres, and potentially resulting in subterranean flows which can reduce the normal environmental flow of the stream. While this phenomenon may affect localised sections of the headwaters of some of the minor ephemeral streams, it is not predicted to occur in the major streams within the Extraction Area as these streams exist within saturated alluvium up to 30 m thick.

Consequently, any fractures that may develop in the bedrock beneath this alluvium will immediately become charged with groundwater as they form, resulting in an imperceptible diversion of surface water flow. This is discussed further within Section 7.2.

Section 7.3 describes the impacts to surface water from the MSEC (2013) predictions and the close interrelationship between the subsidence, groundwater, flooding and subsidence studies.

Topographic Features

There are no cliffs located within the Subsidence Impact Limit, although there are some isolated rock outcrops and benches in the Forest Area. The topography within the Project Boundary is distinctly different to the Illawarra area where subsidence impacts on cliff lines have been closely studied. As outlined in Appendix H, the predicted curvatures are relatively low and generally less than those experienced in the Southern Coalfields further reducing the likelihood of rock falls. The maximum predicted tilt for the steep slopes is 15 mm/m (1 in 65). This change in gradient is not significant when compared to the natural gradient of steep slopes, which exceeds 1 in 3. Therefore, the Project is unlikely to alter the stability of steep slopes.

The incidence and scale of subsidence-induced surface cracking in the Extraction Area is likely to be minor and notably less than in the Southern Coalfields due to lower subsidence effects, greater cover depth, and a thicker alluvial cover in both the valleys and on the hill sides. These factors provide an elastic medium that tends to absorb cracks that may occur within the bedrock.

Transport Infrastructure

There are a number of roads, both sealed and unsealed, passing over the Extraction Area. Changes in grade due to ground tilt can potentially affect the drainage and serviceability of roads, while curvature and strain can potentially result in cracking, spalling and heaving of the pavement. Predicted subsidence effects for the sealed roads within the Extraction Area are shown in Table 27.

The maximum predicted tilt for the sealed local roads is 9 mm/m. This represents a change in grade of 0.9% (1 in 110) which is much less than typical road cross fall design for drainage. The change in grade for unsealed roads is equivalent to the tilt for the landform (see Table 23). The maximum change in grade will be 1.5% (1 in 65). The predicted changes in grade for both sealed and unsealed roads are minor, and are unlikely to significantly affect the drainage or serviceability of the roads.

The maximum curvatures for the main roads are 0.12 km^{-1} hogging and 0.17 km^{-1} sagging. These are similar to the curvatures induced by mining at the Tahmoor Colliery in the Southern Coalfield. The impacts of longwalls at the Tahmoor Colliery included cracking and heaving of road surfaces and impacts to concrete kerbs and guttering. Impacts on sealed roads will be of a nature that can be remediated using normal road maintenance techniques. With appropriate monitoring and management, the impacts on roads will be minor and will not pose a significant risk to public safety.

The maximum predicted curvatures for the unsealed roads are 0.28 km^{-1} and 0.37 km^{-1}. As a result, unsealed roads may experience cracking and heaving however it is expected that these unsealed roads can be maintained in serviceable conditions using normal road maintenance techniques.

There are a number of local road bridges crossing the streams and lower lying areas within the Extraction Area. The predicted maximum tilts for the local road bridges vary from 0.2 mm/m (<0.1%) and 2 mm/m (0.2%). These changes in grade are negligible and are unlikely to affect the drainage and serviceability of these bridges. The maximum predicted curvatures are 0.05 km^{-1} hogging and 0.04 km^{-1} sagging. These curvatures are unlikely to result in any adverse impacts on local road bridges.

Road bridges could also experience valley effects. The maximum predicted upsidence at the bridges varies from 25 mm to 100 mm, and maximum predicted valley closure also varies from less than 20 mm to 100 mm. Concrete bridges can become affected by valley closure if the movement exceeds the capacity of movement joints in these structures. All other road bridges are constructed from timber or steel.

Table 27 Predicted Subsidence Effects for Public Roads

Location	Maximum Predicted Conventional Subsidence (mm)	Maximum Predicted Conventional Tilt (mm/m)	Maximum Predicted Conventional Hogging Curvature (km^{-1})	Maximum Predicted Conventional Sagging Curvature (km^{-1})
Dickson Road	1,350	9.0	0.12	0.17
Durren Road	1,400	6.5	0.08	0.10
Jilliby Road	1,750	7.5	0.09	0.09
Little Jilliby Road	175	1.0	0.01	0.01
Parkridge Drive Crestwood Road Sandra Street	1,050	7.0	0.11	0.15

Timber and steel bridges are flexible structures, and are likely to be able to withstand the predicted closure movements.

The F3 Freeway is located approximately 1.1 km from the nearest longwall. In the Southern Coalfield, horizontal mid-ordinate deviations of up to 5 mm have been observed at distances of over 1 km from extracted longwalls. Far-field movements tend to be bodily movements rather than differential movements (i.e. strains). As a result, the F3 Freeway pavement is unlikely to be impacted by far-field horizontal movements. However, the freeway bridges could be sensitive to far-field horizontal movements. These bridges may only be adversely impacted if the differential horizontal movements exceed the distances that the movement joints in the bridges can accommodate.

There are numerous drainage culverts associated with the local road network that are located within the Subsidence Impact Limit. The maximum predicted tilt in the Extraction Area is 15 mm/m. This change in grade is unlikely to significantly affect the serviceability of these culverts. Drainage culverts are orientated along the alignments of drainage lines and are therefore unlikely to be significantly affected by subsidence-induced, valley related movements.

Water Infrastructure

The Treelands Drive Reservoir is located 300 m from the nearest longwall panel proposed. Due to its distance from the mining area, the reservoir is predicted to experience less than 50 mm of conventional subsidence and the corresponding tilts and curvatures are unlikely to significantly impact upon the reservoir.

The Mardi to Mangrove Creek Dam pipeline is predicted to experience less than 20 mm of conventional subsidence. Since this pipeline is located within the valley of the Wyong River, the pipeline could experience minor upsidence, which is predicted to peak at 80 mm, or experience horizontal movement which is predicted to peak at 145 mm. The subsidence and upsidence predictions from the Project were provided to the designers of the water pipeline so that the pipeline could be designed to withstand these subsidence effects.

There are other pipelines located to the east and well outside of the Extraction Area. Due to the considerable distances of these pipelines from the proposed longwalls, the maximum conventional subsidence is predicted to be less than 20 mm.

The conventional tilts and curvatures are small in magnitude, resulting in a low likelihood of significant impacts on these pipelines.

Electricity Infrastructure

There are two 330 kV transmission lines (Lines 21 and 22) passing through the Extraction Area. These transmission lines consist of single circuit steel towers, with the top earth wires being connected to the towers at a height of approximately 28 m. There are 29 towers in total, comprising 14 tension towers and 15 suspension towers. The maximum predicted subsidence effects along the alignments of Line 21 and Line 22 are shown in Table 28.

WACJV has consulted with TransGrid about potential impacts caused by subsidence. Three key impacts were identified:

- Increases in conductor tensions, which can possibly overload the support towers;
- Deformation of the tower bases due to ground curvature and strain; and
- Reduction in cable heights to below the statutory minimum clearances.

There is an additional 330 kV transmission line (Line 25) located outside of the Extraction Area, but still in the vicinity of the Project. There is also a 132 kV transmission line near the Project. Neither transmission line is predicted to experience conventional subsidence greater than 20 mm. The subsidence effects are too minor to have any material impact on these transmission lines.

There are numerous powerlines within and in close proximity to the Extraction Area. The maximum predicted tilt of 1.5 mm/m generates a horizontal ground movement of 200 mm. This translates to a movement of approximately 400 mm at the top of the 12 m poles. Based on the experience at other NSW longwall mines at similar depths of cover, the impacts to powerlines as a result of subsidence are uncommon and generally of a minor nature. Impacts that do arise can be remedied through minor adjustments to the cables or poles.

Discussions between WACJV and TransGrid will continue so that preventive measures can be developed to allow the undermining of all TransGrid towers. These discussions will concentrate on investigating each of the possible options that could provide for the continued safe operation of the transmission lines and avoid the sterilisation of such large quantities of coal resources.

Table 28 Subsidence Predictions for Transmission Lines

Line	Maximum Predicted Conventional Subsidence (mm)	Maximum Predicted Conventional Tilt Along Alignment (mm/m)	Maximum Predicted Conventional Tilt Across Alignment (mm/m)	Maximum Predicted Conventional Hogging Curvature (km^{-1})	Maximum Predicted Conventional Sagging Curvature (km^{-1})
Line 21	2,100	11	13	0.30	0.30
Line 22	2,500	12	13	0.15	0.30

To this end, WACJV will seek to establish a subsidence management committee, with officers from the WACJV, TransGrid and the MSB, so that the appropriate management strategies can be developed. Since at least 20 years of monitoring data will be available before longwall extraction approaches the first high angled tension tower above Longwall 14N, ample data will exist upon which appropriate management strategies can be based. The local substation is located approximately 250 m from the nearest longwall. The conventional subsidence at this location is less than 20 mm. As a result, the substation is not predicted to experience any significant impacts.

Telecommunications Infrastructure

There are two types of copper telecommunications cables occurring in the Extraction Area: direct buried cables and aerial cables suspended on poles. The direct buried cables are unlikely to be affected by tilt and curvature due to their flexibility. Impacts to buried cables, if any, will be caused by ground strain - particularly tensile strain. Experience from other NSW operations indicates that the incidence of impacts on direct buried cables is low when the depth of cover exceeds 350 m, as will be the case for the Project.

Aerial cables can potentially be affected by changes in bay length, which can be induced by differing horizontal movements and / or tilts at consecutive support poles. Impacts to aerial cables at other mines in NSW where the depths of cover are similar to the Project, are uncommon and generally of a minor nature. As such, impacts to aerial cables are not predicted to be a concern for the Project and can readily be rectified through adjustments to the poles or cables if necessary.

A Telstra optical fibre cable passes directly over Longwalls 11N to 15N and Longwalls 1S to 5S. Since this cable is direct buried, potential impacts are more likely to be caused by ground strain. The predicted strains are similar to observed strains at other NSW operations, where the optical fibre cables have been maintained in serviceable conditions with the implementation of the necessary management strategies.

There is a Cellular Mobile Telephone Service (CMTS) site located directly above Longwall 1N. The tilts and curvatures are unlikely to affect the structural integrity of the building, while any impacts on the antennae can be remedied by adjustment. The optical fibre cable associated with the CMTS site will experience the same movements as the CMTS structure.

There are other optical fibre cables located beyond the Extraction Area however, due to the distances from the longwalls, these cables are not expected to experience any significant subsidence impacts.

Management strategies will be developed, in consultation with the infrastructure owners, such that all aerial and buried cables will be maintained in serviceable conditions throughout the mining period.

Public Amenities

Jilliby Public School and a scout camp are located on land overlying the main development headings which separate the northern and south-eastern series of longwalls. Neither of these facilities is expected to experience more than 20 mm of subsidence. Therefore, the tilts, strains and curvatures are unlikely to cause any significant impacts on these structures.

Commercial Sites

There is a disused quarry site directly above Longwalls 14N and 15N. While subsidence related ground movements are unlikely to cause significant instabilities the potential to dislodge loose or marginally stable rocks will be assessed prior to mining as part of the Extraction Plan or SMP (hereafter referred to as the Extraction Plan) process.

The Linton Park and Parkview horse studs are located within the Extraction Area. Given that the depth of cover is approximately 400 m in these locations, any surface cracking that may occur is expected to be minor and can easily be remedied by infilling or ploughing if necessary.

The Extraction Area also contains the Moonpar Nursery and the Dooralong Valley Turf Farm. These premises may be impacted by temporary water table adjustments. These groundwater impacts are further discussed in Section 7.2.

Rural Infrastructure

There are a large number of rural buildings within the Subsidence Impact Limit that have been assessed in the SIR (see Appendix H). The maximum predicted tilt will be less than 7 mm/m for 722 structures, between 7 mm/m and 10 mm/m for 27 structures, and greater than 10 mm/m for 6 structures. The maximum tilt predicted to be experienced by any rural structure is 13 mm/m, which represents a change in gradient of 1 in 75. Based on experience from other NSW mines, tilts of this magnitude could require remedial works but are unlikely to result in any significant structural damage to buildings of this type.

At 635 of the 755 rural structures, the maximum curvatures will be less than 0.15 km^{-1}. The remaining 120 structures will experience curvatures of up to 0.25 km^{-1} hogging and 0.30 km^{-1} sagging. Extensive data from the Southern, Newcastle and Hunter Coalfields indicate that the incidence of impacts on rural structures is very low, particularly when the depth of cover exceeds 200 m. This is because these structures are generally able to cope well with ground movements due to their small size and lightweight construction. Consequently any impacts that do occur are usually minor and can be repaired using conventional building techniques.

Farm fences are potentially affected by tilting of fence posts and changes in wire tension due to ground strain. Wire fences can typically tolerate strains of up to 5 mm/m and tilts of up to 10 mm/m. Colorbond and timber paling fences are more rigid, and therefore more susceptible to strain and tilt.

It is possible that fences will be impacted by the Project. However, these impacts can easily be overcome by repairing or replacing damaged sections of fence as required.

There are 420 farm dams located in the Extraction Area. Since dams are typically constructed within drainage lines, they may be subject to valley related movements, however upsidence and closure movements at the dam walls are predicted to be much lower than conventional subsidence movements, and are therefore not critical. Conventional tilt causes freeboard to increase on one side of the dam and decrease on the other. This change can affect the water storage capacity of the dam. The maximum predicted change in freeboard is 500 mm, occurring at a dam near Longwall 2N. The change in freeboard is not predicted to exceed 400 mm at any other farm dams.

At 341 of the 420 farm dams, the maximum predicted curvature will be less than 0.15 km^{-1}. The remaining 79 dams are predicted to experience curvatures of up to 0.25 km^{-1} hogging and 0.35 km^{-1} sagging. These latter values are higher than typical curvatures for the Southern Coalfield, but lower than curvatures at mines in the Newcastle and Hunter Coalfields. Observations for these operations indicate that the incidence of impacts on farm dams is low when the depth of cover exceeds 200 m, while any cracking that may occur in these dam walls can be readily repaired. Potential impacts on groundwater wells and bores are discussed in Section 7.2. Management strategies will be developed as part of Property Subsidence Management Plans or the Extraction Plans, to manage the potential impacts on rural infrastructure.

Residences

There are 245 residences within the Extraction Area. Vertical subsidence alone does not generally impact on the stability or serviceability of buildings. However, vertical subsidence could affect the heights of houses above the flood level. These impacts are discussed further in Section 7.4.3.

Of the 245 residences, 88 are situated within the Hue Hue Mine Subsidence District. The maximum predicted tilt for these residences is 4 mm/m which meets the Hue Hue Mine Subsidence District criteria of 4 mm/m. As a result, impacts on these residences are expected to be limited to minor serviceability impacts. The remaining 157 residences are situated within the Wyong Mine Subsidence District. The maximum tilt is not expected to exceed 7 mm/m at 144 of these residences.

The maximum tilt will be between 7 mm/m and 10 mm/m at 8 residences, and greater than 10 mm/m at 5 residences. These 13 residences may require more substantial remediation works.

For 226 of the 245 residences, the maximum hogging and sagging curvatures will be less than 0.2 km^{-1} and 0.25 km^{-1} respectively. Experience from the Southern and Newcastle Coalfields suggests that, at these curvatures, approximately 16% of residences may experience material impacts with significant repairs potentially required at approximately 5% of residences. The risk to public health is low because "sudden and immediate" impacts are very rare since the majority of impacts will arise gradually, providing ample time in extreme cases for residents to be temporarily relocated. A summary of impacts for residences in the Subsidence Study Area over the life of the Project is presented in Table 29.

Downslope movements can affect residences which are situated on steep slopes. Residences are generally located on slopes of less than 1 in 5, with the maximum slope for a residence within the Project Boundary being 1 in 3. Since a gradient of 1 in 3 is considered stable there are no predicted impacts due to downslope movements.

Subsidence movements can affect the serviceability of water tanks by altering the horizontal level of structures. The maximum predicted tilt for the water tanks is 1.1 mm/m, which equates to a change in grade of 1 in 90. This change in grade is small and considered unlikely to significantly impact the serviceability of water tanks. Since water tanks are usually constructed above ground level, mining induced strains and curvatures are unlikely to have an impact.

Some of the residences are equipped with waste water systems. These systems are typically constructed from reinforced concrete and bedded in sand. As a result, curvatures and strains are not expected to cause any impacts to the structural integrity of these systems. The change in grade due to tilt is expected to be 1 – 2%. This is not likely to significantly affect the serviceability of waste water systems.

There is the potential for damage to buried pipelines associated with these systems though these impacts can usually be mitigated through the installation of flexible couplings. Any leaks caused by ground strain are expected to be minor and easily remediable. Management strategies will be developed as part of Property Subsidence Management Plans or the Extraction Plans, to manage the potential impacts on the residential and non-residential building structures.

Table 29 Assessed Impacts for the Houses within the Subsidence Study Area

Group	Repair Category			
	No Claim or R0 Adjustment	R1 or R2 Very Minor - Minor Repair	R3 or R4 Substantial – Extensive Repair	R5 Rebuild
All houses (total of 245)	202 (83%)	30 (12%)	12 (5%)	≈ 1 (<0.5%)

Recreational Facilities

There are 107 swimming pools situated within the Extraction Area. Subsidence induced tilts will alter the water level in swimming pools. Australian Standard (AS) 2783-1992 requires that pools are level (± 15 mm) from one end to the other. As a result, the maximum permissible tilt for a 10 m long pool is 3.3 mm/m. For 82 of the 107 pools, the maximum predict tilt is less than 3 mm/m. The other 25 pools will experience tilt exceeding AS 2783-1992 and will therefore require remediation measures.

Maximum curvatures of less than 0.1 km^{-1} hogging and 0.15 km^{-1} sagging are predicted to be experienced at 82 pools in the vicinity of the Project. Experience has indicated that around 15% of such pools may be impacted, requiring repair or even replacement in some cases.

There are 11 tennis courts located within the Extraction Area. The maximum predicted tilt for the tennis courts is 9 mm/m, which represents a change in grade of 1 in 110. This is a minor change in gradient and is unlikely to significantly impact the serviceability of tennis courts. The maximum predicted curvatures are 0.15 km^{-1} hogging and 0.20 km^{-1} sagging. The curvatures can result in minor cracking of grass or clay courts however cracking of this nature can be easily repaired.

Other Consequences

MSEC predicted the subsidence effects at sites possessing Aboriginal or historic heritage significance. Using these subsidence predictions, OzArk Environmental & Heritage Management Pty Ltd (OzArk) assessed the consequences for Aboriginal and historic heritage items. The subsidence consequences for items of Aboriginal heritage significance are discussed in Section 7.14. Consequences for historic heritage structures are discussed in Section 7.15.

Gas and fuel storage tanks are unlikely to be affected by tilt, curvature and strain because these tanks are generally supported above the ground. Buried pipelines associated with these storages may be impacted by ground strain. These impacts are expected to be minor and easily remediable.

State survey control marks within the Extraction Area and in the vicinity of the Project will experience subsidence. It will be necessary to re-establish these survey marks once the ground has stabilised after the completion of longwall mining.

Sensitivity Analysis

A sensitivity analysis was conducted to determine the consequences that may occur if actual subsidence exceeded the predicted subsidence.

A conservative approach was adopted whereby the predicted subsidence was doubled. Table 30 outlines the possible impacts if actual subsidence effects are double the predicted values.

Table 30 Subsidence Effects Sensitivity Analysis

Aspect	Consequences
Rock formations and steep slopes	The increased tilt is still relatively minor compared to the natural gradient. As a result, slope failure is unlikely, and no known rock formations are at risk. Tension cracking on steep slopes may occur, but will still be lower than the cracking observed elsewhere at shallower depths of cover.
Roads	The change in grade will increase to 1 – 3 %. This is still unlikely to significantly affect the drainage of roads. The extent of cracking will increase but such cracking can still be remedied using standard road maintenance techniques.
Road bridges	Tilts and curvatures remain very low and are unlikely to cause any impacts. Bridges will need to be able to tolerate the higher valley movements. The movement joints may need to be modified if they cannot withstand the higher closure movements.
Water Infrastructure	Subsidence effects are too low to cause impacts on Treelands Drive Reservoir and pipelines, including Mardi - Mangrove Creek Dam Pipeline.
Transmission lines	Stresses on the 330 kV transmission line towers will increase. Appropriate factors of safety need to be taken into account when designing mitigation measures for these towers. Subsidence effects are still too low to materially impact the 132 kV transmission line. Maximum tilts for powerlines will increase to 30 mm/m (3%). Longwall mining under powerlines has been successfully conducted in other NSW mines where the tilt exceeds 3%. Preventative measures such as roller sheaves and intermediate poles may be necessary. Subsidence effects are too low to materially affect the local substation.
Telecommunications cables	The maximum tilt increases to 30 mm/m, which is still considerably lower than tilts at other NSW mines where longwall mining has been conducted without significant impacts to telecommunications cables, with the implementation of suitable management strategies. The conventional ground strain will increase to 4 mm/m tension and 6 mm/m compression. Significant impacts are unlikely given that longwall operations have been successfully conducted with strains of up to 26 mm at other NSW operations with the implementation of suitable management strategies. The tilt and curvature at the CMTS site remain very low and are unlikely to affect the stability and integrity of the structure.
Rural buildings	Tilts are still unlikely to impact on the stability and integrity of structures. Increased curvatures will increase the incidence of impacts on structures. However, these impacts will be minor in nature and could be repaired using normal building maintenance techniques.

Aspect	Consequences
Farm Dams	Change in freeboard will increase to a maximum of 500 mm. This is unlikely to affect dam stability, but may alter the dam storage capacity. Doubling strain and curvature will increase the incidence of cracking in farm dams. Cracking is not expected to be significant and can be repaired where necessary.
Residences	Increased tilts and curvatures will result in a higher incidence of impacts and more significant impacts. Residences are expected to remain safe (i.e. unlikely to experience "sudden and immediate" impacts).
Water Tanks	Increased tilts will result in a higher incidence of serviceability impacts. These can be rectified by re-levelling the tanks. Increased curvatures and strains are unlikely to affect water tanks because they are raised above the ground.
Recreational facilities	The number of pools experiencing tilt of less than 3 mm/m will be reduced from 82 to 44. Increases in curvatures will result in a greater number of pools suffering damage. Consequently, more pools will require remediation work. The maximum tilt experienced by tennis courts will increase to 18 mm/m, which is still not likely to affect the serviceability of the courts. Doubling the curvature will result in a higher incidence of cracking, but the cracking will remain minor in nature.

7.1.4 Mitigation and Management

Mitigation

The mine plan for the Project has been designed so that environmental consequences are minimised wherever practicable. Various iterations have been made to the plan to minimise the extent and severity of subsidence impacts, including changes to the longwall panel layout, panel geometry and location of development headings. The chain pillars have been designed to yield once isolated in the goaf so as to reduce the effect of differential subsidence as well as mitigate the risk of future unplanned subsidence events.

Section 3.11 of this EIS describes the various mine plan options that were considered and discounted as a result of predicted subsidence impacts.

Subsidence predictions for the Project have been based on the empirical IPM which has been calibrated by numerical modelling to account for differences between the geology of the Extraction Area and the geologies of the Newcastle and Southern Coalfields. While resultant predictions are considered to be conservative, they have been chosen as appropriate to ensure that all management plans will be based on worst-case scenarios.

Field monitoring data will be used as it becomes available to further validate these predictions and underpin the final subsidence management process. The subsidence management process requires the preparation of a Subsidence Management Plan prior to the extraction of each longwall block or series of longwall blocks. It is a statutory requirement that these plans be assessed and approved by DTIRIS – DRE to ensure that the proposed extraction is consistent with community and government expectations for responsible mining, optimal resource recovery and effective land use and environmental management.

The subsidence predictions in this study are conservative and as such the degree of subsidence that will actually result from future mining is likely to be less than those upon which the current management strategies have been formulated.

Detailed monitoring of actual subsidence behaviour will be undertaken to further validate and refine the model predictions and underpin modifications to the mine plan if necessary. Any modifications to the longwall layout (other than minor in nature) will be subject to further comprehensive assessment to the satisfaction of DP&I. Quarterly reporting of predicted versus measured subsidence to DRE and other relevant regulators until such time as the subsidence methodology has been adequately developed (or 5 years, whichever is longer) will be carried out.

The following key mitigation will be undertaken for the Project:

- Develop and implement a detailed program for detecting and recording significant geological structures and assess the potential impacts of these structures on subsurface and surface structures;
- Modify the mine plan if it is likely to result in unacceptable environmental impacts;
- Contingency plans for longwall mining under steep rocky catchments to manage any unexpected seepages featuring release of soluble oxidized metals due to fracturing and localised redirection of drainage pathways; and
- Include measures to manage or mitigate any unexpected effects of subsidence leading to the creation of new wetland / depressions or increased potential for channel avulsion.

Extraction Plan

WACJV will prepare an Extraction Plan (as required by conditions of Development Consent) to manage the Project's subsidence impacts. Mitigation and management measures including those discussed above will be proactively undertaken in conjunction with MSB to minimise the extent of impacts and the potential cost of remediation, as well as to enable timely and appropriate adaptive management to occur in response to any subsidence impacts.

Such measures will include:

- Consultation with WSC or RMS to develop management strategies for local roads and bridges;
- Consultation with TransGrid to develop management strategies for electricity transmission lines;
- Consultation with relevant telecommunication companies to develop management strategies for telecommunications infrastructure;
- Identification of natural and built features that may be at risk and develop appropriate management strategies;
- Preparation of 'End of Longwall Panel Report' within 6 months of the completion of extraction of each longwall panel and provided to relevant regulators;
- Annual reporting of subsidence monitoring processes and outcomes compared to EIS predictions;
- Detailed assessment of structures and improvements prior to mining;
- Development of a Trigger Action Response Plan (TARP) by WACJV which will identify potential issues that may occur, develop appropriate monitoring measures and respond to impacts as they arise; and
- Liaise with government agencies, landowners and special interest groups to ensure that regulatory, legislative and community expectations are maintained.

Property Subsidence Management Plans

A key component of the Extraction Plan process will be the development of Property Subsidence Management Plans in conjunction with property owners. These property-specific PSMPs will be progressively prepared throughout the mine life as longwall mining progresses across the Extraction Area and will outline, for example, the agreed management arrangements for mitigation and remediation of property improvements potentially affected by subsidence.

The management of subsidence consequences for dwellings generally involves:

- Identification of structures and their forms of construction prior to mining;
- Identification of any structures or structural elements that may be potentially unstable prior to mining, to be conducted by a suitably qualified building inspector;
- Implementation of mitigation measures, where necessary, to address specific identified risks to public safety;
- Detailed monitoring of ground movements at or around structures to address specific identified risks to public safety,
- Periodic inspections of structures that are considered to be at higher risk
- Visual Inspections of houses during extraction of the longwalls; and
- Co-ordination and communication with landowners and the Mine Subsidence Board during mining.

7.2 Groundwater

7.2.1 Background

A Groundwater Impact Assessment for the Project was completed by Mackie Environmental Research (MER) and is provided in Appendix I. The objectives of the assessment were to assess the impacts of the Project on the groundwater regime and water users, and to quantify predicted inflows into the mine workings throughout the life of the Project.

Previous Groundwater Studies

A literature review of historical groundwater studies was undertaken to obtain an understanding of the groundwater system in the vicinity of the Project.

A study of groundwater systems in the region was previously conducted by Coffey Partners International (1998). This study included the identification of existing bore locations, geophysical profiling of the Jilliby Jilliby Creek alluvial aquifers and establishment of a regional groundwater monitoring network. This study also conducted hydraulic conductivity tests for exploration boreholes using packer-injection techniques.

Using data from the Coffey Partners International study, ERM developed a simplified groundwater model (ERM, 2002) for a preliminary assessment of the impacts of mining on the regional groundwater system. Other groundwater studies have been undertaken over the years by Hydroilex Pty Ltd, L. Cook and Associates and EcoEngineers.

In 2008, the Minister for Planning appointed an Independent Expert Panel to conduct a strategic inquiry into potential coal mining development in the Wyong LGA. With regard to groundwater impacts, the Independent Expert Panel reached the following conclusion:

> *"Both the WACJV and DPI agree that there are dense, almost impermeable rock strata between the shallow alluvial aquifer and deeper hard rock aquifers of the region. Subsidence cracks in the hard rocks at the base of the alluvium are likely to be limited in number and depth, and to quickly fill with both groundwater and sediment. Accordingly, the Panel concludes that, even if cracks do occur at the base of the alluvium, they are unlikely to allow significant mixing of water from the hard rock aquifers and the alluvial aquifers."*

Existing Groundwater Systems

The regional groundwater system in the vicinity of the Project consists of three aquifer systems:

- Unconsolidated alluvial aquifers within the Yarramalong and Dooralong Valley and coastal areas where unconfined conditions prevail;
- Aquifers within the shallow weathered rock zone where unconfined conditions prevail; and
- Hard rock aquifers within the Clifton Subgroup of the Narrabeen Group of sedimentary rocks, including the Wallarah/Great Northern (WGN) Coal seam.

Unconsolidated and variably saturated alluvial sediments occur within the Yarramalong Valley and Dooralong Valley. The alluvium varies in thickness from 10 m to over 30 m, and is comprised of mixed sequences of sands, silts and clays. Clean permeable sand and gravel zones can occur at the surface and at depth, but are uncommon in the Dooralong Valley. Groundwater monitoring data collected between February 1998 and December 2001 indicate that the saturated thickness ranges from 2 m to over 30 m. Although there has been restricted access to the previous groundwater monitoring sites in recent years, additional alluvial monitoring data has been collected from a number of multi-level bores across the floodplain of Jilliby Jilliby Creek. The continued groundwater monitoring has been undertaken at a property owned by WACJV in the alluvial sediments adjacent to the confluence of Jilliby Jilliby Creek and Little Jilliby Jilliby Creek.

The available Total Dissolved Solids (TDS) monitoring data indicate that there is significant variability in the salinity of groundwater in the locality, including in the alluvial aquifers. The water quality varies from fresh to saline in upland areas (200 to 9,100 mg/L), and from moderately fresh to highly saline in coastal areas (500 to 20,000 mg/L). The pH ranges from 5.5 to 7.5 for coastal locations and from 5.2 to 11.8 for inland locations.

Hydraulic conductivities within the alluvial deposits will vary depending on the nature of the unconsolidated materials and the depositional environment. The alluvium is generally characterised by low hydraulic conductivities, due to the silty and clayey constitution of the deposits. Based on rising head and falling head tests undertaken in previous studies, the average hydraulic conductivity for alluvial areas was determined to be 0.18 m/day. The median hydraulic conductivity was determined to be between 0.22 m/day and 0.24 m/day.

The unconfined quaternary alluvial deposits are underlain by the sedimentary rocks of the Narrabeen Group. The Clifton Subgroup (within the Narrabeen Group) consists of the Terrigal Formation, Patonga Claystone, Tuggerah Formation, Munmorah Formation and Dooralong Shale. In the strata of the Narrabeen Group, groundwater exists predominantly within pore spaces. The very fine-textured Patonga Claystone directly underlies the alluvial sediments of the Jilliby Jilliby Creek floodplain in the Dooralong Valley.

Strata within the Narrabeen Group are generally considered to be aquitards (very poor groundwater transmission characteristics) or aquicludes (impermeable). The Narrabeen Group is only regarded as an aquifer in the shallow weathered zone or areas where secondary permeability has been introduced through jointing and stress relief at shallower depths.

Secondary permeability is more pronounced in areas where the Terrigal Formation outcrops above the floodplain. This occurs in the western forested hills of the Wyong State Forest and Jilliby SCA. As part of this assessment, core inspections and borehole testing were undertaken to determine the matrix and bulk permeabilities in the Narrabeen Group strata. It was observed that fractures were clean and did not exhibit alteration or secondary mineralisation. This indicates that groundwater movement through these cracks is negligible. Fracturing of the rock strata is uncommon in the Narrabeen Group.

Groundwater quality data for the Narrabeen Group strata were obtained from monitoring data between 1998 and 2002. The TDS for the hard rock aquifers ranges from fresh to brackish (1,800 to 7,500 mg/L) and pH ranges from 6.3 to 7.6.

The shape of the groundwater table generally reflects the topography. That is, the groundwater table is elevated where the topographical relief is higher. Groundwater generally flows from topographic highs towards the Yarramalong and Dooralong Valleys and the coast.

Existing Groundwater Users

A search of the NOW database was conducted to determine the location of wells and bores in the vicinity of the Project. As shown on Figure 30, there are 12 registered bores and wells located within the Extraction Area. There are an additional 49 bores located within 5 km of the Extraction Area. The registered bores include both pumping bores and monitoring bores which are largely used for domestic, stock, farm, irrigation, waste disposal and poultry purposes. Details of the registered bores located within the Extraction Area are provided in Table 31.

A review of bore construction information indicates that most of the bores draw groundwater from the hard rock strata (Narrabeen Group) rather than the alluvial zone. Yields are generally low and water qualities vary from fresh to brackish.

7.2.2 Methodology

Regional Piezometric Surface

As a result of limited land access, sufficient monitoring data was not available across the region to plot a regional piezometric surface. Instead, an indicative water table plot was generated using the computer model. The water levels predicted by the model were calibrated against the available monitoring data for the region.

Table 31 Registered Bores within the Mine Footprint

Bore (Purpose)	Coordinates (AMG)		Depth (m)	Aquifers/ Yield (L/s)	Water Depth (m)	Water Quality	Bore Geology
	E	N					
GW028035 20BL021424 (P)	348750	6318275	30.5	19.8-25.2/1.26	7.60	good	0.0-4.8 clay 4.8-6.7 s/s 6.7-18.3 clay 18.3-20.4 s/s 20.4-24.4 sh 24.4-30.5 s/s
GW033297 20BL026199 (W,D)	348930	6321110	19.8	17.6-19.7/0.25	4.60	nil	0.0-10.66 clay 10.66-11.88 s/s 11.88-17.67 sh 17.67-19.81 s/s
GW051560 20BL111424 (F,S)	348160	6322940	33.0	28.0/5.0	13.0	nil	0.0-19.0 clay 19.0-33.0 s/s
GW056521 20BL122843 (D,S)	345687	6321210	45.0	nil	nil	nil	0.0-8.0 clay 8.0-25.0 s/s 8.0-25.0 sh 25.0-44.0 s/s 44.0-45.0 sh
GW058390 20BL127954 (D)	345575	6321050	0.00	nil	nil	nil	Nil
GW059092 20BL135236 (D,S)	349070	6320630	38.0	24.0-25.0/1.26	15.0	salty	0.0-16.0 clay 16.0-38.0 sh s/s
GW078221 20BL166822 (I)	349022	6319270	60.0	28.9-30.0/0.13	26.0	fresh	0.0-16.5 clay 16.5-28.9 mud 28.9-42.6 cong 42.6-53.0 mud 53.0-60.0 cong
GW080608 20BL169008 (D,S)	349520	6321281	48.0	41.0-45.0/0.40	3.20	nil	0.0-36.0 sands 36.0-48.0 sh

Bore (Purpose)	Coordinates (AMG)		Depth (m)	Aquifers/ Yield (L/s)	Water Depth (m)	Water Quality	Bore Geology
	E	N					
GW078609(D)	348866	6323656	32.0	nil	nil	nil	0.0-6.0 soil/clay 6.0-30.0 s/s 30.0-32.0 mudstone
GW200505 (D,S)	350914	6322022	54.0	26.4-26.9 48.5-49.3	nil	fresh	0.4-4.9 clay 4.9-6.5 gravel 6.5-26.4 clay 26.4-26.9 clayey gravel 26.9-31.4 clay 31.4-49.3 cong 49.3-50.1 clay 50.1-54.0 cong
GW058391 (D)	345728	6321244	nil	nil	nil	nil	nil
GW058392(D)	345802	6321461	nil	nil	nil	nil	nil

Bore Geology denoted by:'nil' = no recorded data, s/s = sandstone, sh = shale/claystone, cong = conglomerate
Purpose of licence denoted by: D-Domestic, S-Stock, F-Farm, I-Irrigation, W-Waste disposal, and P-Poultry.

The rate of groundwater flow is determined by the piezometric surface and the hydraulic properties of the geology. The rate of flow in the hard rock aquifers is predicted to be in the range of 10^{-7} m/day to 10^{-4} m/day, which is considered very low. This is due to the low hydraulic conductivities of the strata. The alluvial aquifers in the Yarramalong Valley and Dooralong Valley are more dynamic flow systems due to the higher permeability of the alluvial deposits. The flow rate in the alluvial aquifers is predicted to range from 10^{-4} m/day to 10^{-2} m/day.

Modelling

A computer based mathematical model (MODFLOW SURFACT) has been developed to simulate the regional extent of depressurisation and to predict mine water influx. The model employs a numerical finite difference scheme for solving the differential equations that govern groundwater flow.

Previous groundwater models, known as W1 and W2, were developed in 2009 and 2010 respectively. These models have been superseded by models W3 and W4 for this assessment. Models W3 and W4 have incorporated some minor changes to the hydraulic conductivity distributions and the way the subsidence zone is represented. Model W3 uses a hard rock permeability distribution derived from measured hydraulic conductivities. Model W4 takes the subsidence zone permeabilities developed for model W3 and imposes randomised distributions.

The necessary data for the modelling was obtained from previous groundwater studies undertaken in the vicinity of the Project as described in Section 7.2.1. Additional data was provided by exploration activities undertaken for the Project.

Peer Review

A peer review of the MER Groundwater Impact Assessment was undertaken by Kalf and Associates in accordance with the Murray-Darling Basin Commission's (MDBC's) 'Australian Flow Modelling Guideline' (MDBC 2001). A copy of the Peer Review report is included within Appendix I.

The Peer Review was completed following a number of meetings to discuss the methodology and findings of the assessment and after a thorough review of the draft and final MER Groundwater Impact Assessment report (incorporating peer review comments).

7.2.3 Impact Assessment

Depressurisation of Aquifers

Coal Seam Aquifer

The extraction of coal from the WGN seam will result in the depressurisation of the coal seam and the strata above and below the seam. Depressurisation of the overlying strata will be accelerated through caving and subsidence.

Model W3 predicts significant depressurisation of the WGN seam, with the greatest hydraulic head loss occurring near the access drift. The region where head loss exceeds 2 m extends approximately 2 km beyond the mine footprint in the east (near the access drift). In contrast, this region only extends 400 m beyond the mine footprint in the western extent of the longwall panels.

The head loss propagates slowly outwards from the extracted longwalls due to the low permeability of the coal seam. As a result, the head loss is lowest in the westernmost longwalls, since these are extracted later in the Project life. The predicted depressurisation of the WGN seam is illustrated in Figure 30. The drawdowns within the coal seam aquifer predicted using model W4 are almost identical to the values predicted using model W3.

Other Hard Rock Strata and Water Table Drawdown

Depressurisation of hard rock strata above the coal seam has been modelled and is discussed in detail in Appendix I. The depressurisation zone expands over time, extending upwards from the extracted coal seam as mining progresses. However, major depressurisation effects featuring relatively free drainage only extend upwards through the strata to the limit of connective cracking in the zone known as the fractured zone (refer Figure 15). The overlying strata in the constrained zone do not feature connected vertical fracturing and depressurisation effects are relatively insignificant.

The generally low permeabilities of the strata in this zone further limit the potential for water movement and depressurisation. The total leakage from the shallow hardrock aquifer is estimated to be 0.04 ML/day. Given the significant depths at which coal extraction occurs, the constrained zone will be very thick and acts as a safeguard protecting and separating the surface water system from the effects of the caving and fracturing zones associated with subsidence.

The only water table drawdown within the shallow zone is predicted to occur near the Tooheys Road Site due to the access drift development through the Tuggerah Formation. This drawdown effect is not predicted to exceed a few metres. The predicted water table drawdown after 28 years is illustrated in Figure 31, which indicates that only a very small area of affectation is predicted in the area immediately surrounding the access drift.

Alluvial Aquifer

The modelling predicts only minimal depressurisation of the alluvial aquifers. The groundwater in the alluvial lands in the Yarramalong Valley and Dooralong Valley is predicted to be only minimally impacted by the Project. The negligible impact on alluvial lands is due to the very low permeability of the underlying Patonga Claystone and Tuggerah Formation, and the high storage capacity and sustained rainfall recharge in the alluvial aquifers.

The level of the groundwater table within the alluvial areas is not predicted to change measurably as a result of the Project. Downward leakage is predicted to be minimal, and rainfall recharge will be sufficient to sustain water levels. It is predicted that the loss of baseflow from alluvial aquifers to creek catchments will be negligible. The leakage loss has been calculated to be 2 millilitres/day for each square metre of alluvial land surface.

Given that recharge from rainfall is estimated at 130 millilitres/day (assumed 4% of rainfall), the loss of water can easily be restored by natural hydrological functions. The leakage from the alluvial aquifer is estimated to be 0.02 ML/day.

Inflows to Mining Areas

The predicted depressurisation of the hard rock strata will induce seepage into the mine workings and goaf areas. The depressurisation will migrate upwards from the WGN seam due to cracking, bedding parting and pores in the rock induced by subsidence. This depressurisation has been predicted to extend up to 220 m above the WGN seam and includes the lower portion of the Tuggerah Formation.

The loss of pressure within the strata will induce seepage into the mine workings and goaf. The 220 m above the WGN seam is more than three times the previously reported conditions in the region (Forster, 1995). It is also greater than the height suggested by geo-mechanical modelling of the subsidence zone (SCT, 1999 and SCT, 2011) and is therefore considered to be conservative.

Model W3 predicts a total influx to mining areas of 26,500 ML over the 38 year simulation period. The daily influx is predicted to increase from 0 ML/day in Year 1 reaching the maximum rate in Year 19 of 2.5 ML/day under model W3.

Table 32 provides the predicted groundwater inflow rates for each year of the Project based on the model W3.

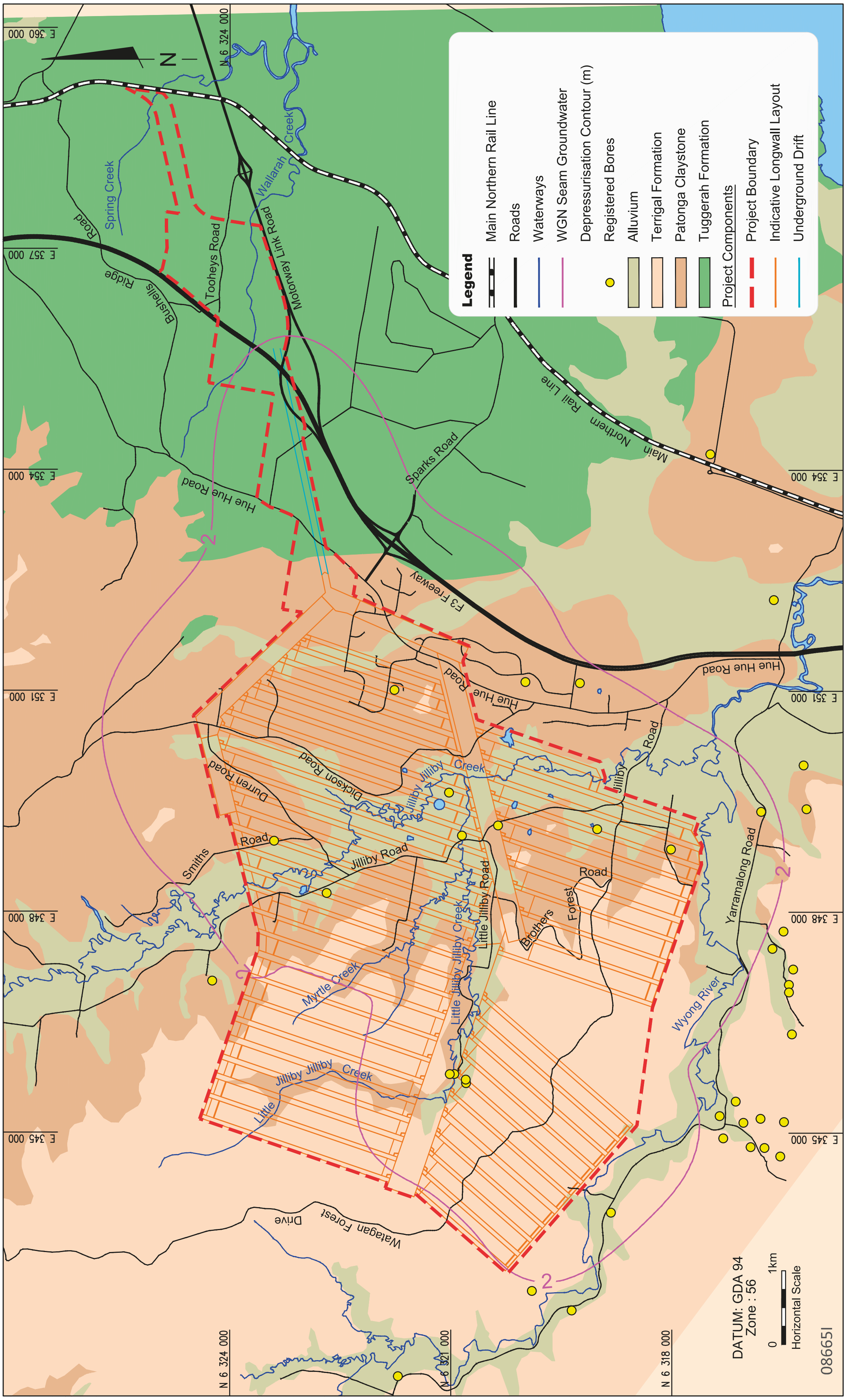
These predictions do not consider the contribution of storages within fractures that are intercepted by mining. Analyses of fractures identified in drill cores suggest that fractures are either discrete or moderately clustered, and do not experience water movement. Fracture related storages are likely to be micro-cracks with hydraulic apertures of less than 50 µm. If deep fracture storages are intercepted by mining, inflows may increase by up to 0.5 ML/day for a short period of time.

Post Mining Recovery

Regional aquifer pressures within the hard rock strata will begin to recover upon the completion of mining. The rate of recovery is dependent upon the remaining water stored within the hard rock strata, the hydraulic properties of the goaf, and the sustained gravity drainage of strata above extracted panels. The rate of recovery is expected to be slow due to the increase in storage caused by the creation of underground workings and goaf, as well as the low permeability of the hard rock strata.

Changes in Groundwater Storage Due to Subsidence

Mining induced subsidence can alter the volume of groundwater storages in two ways. The first is by inducing cracks at the base of the alluvium (in the surface zone of the bedrock below the alluvium), which can act as minor storages. The second is by causing a lowering of the water table in subsided areas relative to the surrounding topography.



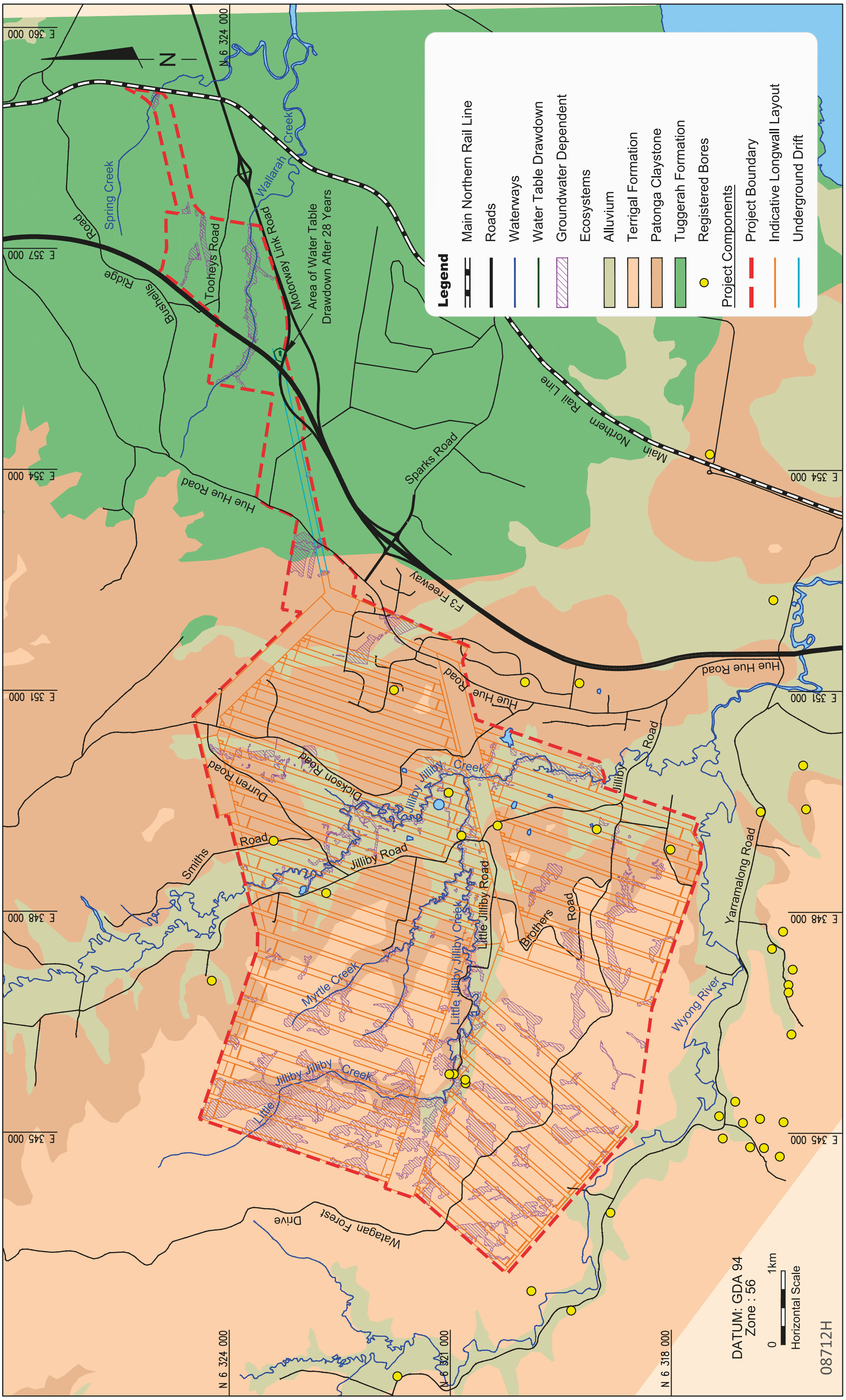
WALLARAH 2 COAL PROJECT

Predicted Wallarah/Great Northern Coal Seam Depressurisation

FIGURE 30

Hansen Bailey ENVIRONMENTAL CONSULTANTS

Wallarah 2 COAL PROJECT



WALLARAH 2 COAL PROJECT

Predicted Water Table Drawdown

FIGURE 31

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Wallarah 2 COAL PROJECT

Table 32 Predicted Groundwater Inflows

Year	Predicted Inflow Rate (ML/Day)	Year	Predicted Inflow Rate (ML/Day)
1	0.0	15	1.9
2	0.2	16	1.9
3	0.4	17	2.1
4	0.8	18	2.2
5	1.1	19	2.4
6	1.3	20	2.4
7	1.5	21	2.4
8	1.5	22	2.5
9	1.6	23	2.4
10	1.7	24	2.3
11	1.8	25	2.3
12	1.8	26	2.3
13	1.8	27	2.3
14	1.9	28	2.2

Water will potentially accumulate in subsidence induced shallow cracks in the bedrock, thereby increasing the groundwater storage of the alluvial strata. Subsidence induced cracking is predicted to increase the storage volume within the alluvium by 0.9 kL/m of panel length. In comparison, the average storage in the unsubsided alluvium is approximately 1,560 kL/m of panel length. Therefore, the increase in storage generated by subsidence is negligible, being in the order of 0.05%.

The elevation of the water table within the alluvial aquifer is likely to change due to subsidence. In subsided areas, the water table will fall with the surface topography. Subsidence is not uniform across the Extraction Area, due to the progression of subsidence across the area with advancing longwall extraction. As a result, hydraulic gradients will be generated from unsubsided areas to subsided areas. As a result, groundwater will migrate from the higher unsubsided areas to the lower subsided areas. The unsubsided areas will therefore experience a lowering of the water table and subsided areas will experience a raising of the water table. This behaviour is only expected to occur in the alluvial areas. In the elevated hard rock areas, the subsidence related tilt is relatively minor when compared to the existing topography. As a result, there will be no significant effects on the hydraulic gradients in these areas.

After the initial lowering of the water table, the aquifer is recharged by rainfall and surface flows. Separate modelling was undertaken to determine the rate of recovery for the water table. Since the alluvial materials exhibit inhomogeneous hydraulic properties, modelling was undertaken for four separate scenarios, with hydraulic conductivity ranging from 0.1 to 0.5 m/day.

It was found that a hydraulic conductivity of 0.1 m/day resulted in a 55% recovery after 200 days, whereas a hydraulic conductivity of 0.5 m/day produced a 75% recovery of the water table within the same timeframe. These results are very conservative due to the low rates of rainfall recharge that have been assumed (1 mm/year). Recent monitoring of water table fluctuations indicates response times of only a few days. It is expected that the water table will rapidly reach a state of quasi-equilibrium. The water table will re-establish at a depth similar to pre-mining levels, although water table variation in the alluvium will continue to occur in response to individual rainfall events and longer term climatic cycles.

Mining induced subsidence will result in an increase in the alluvial groundwater storage. This increase in storage results in an increased demand on rainfall recharge. The increases in groundwater storage caused by each longwall within the expected hydrogeological response timeframes are listed in Table 33.

The increase in alluvial groundwater storage is temporary, as the water level is expected to re-equilibrate after the extraction of each longwall. As a result, the increases in storage caused by the various longwalls are not expected to accumulate. Therefore, the maximum increase in storage that will be experienced at any one time is 181 ML, which will be experienced during the extraction of longwall LW 9N. This effect is expected to be fully replenished over an 8 to 10 month period before the adjacent panel (LW 10N) is subsided. The actual storage increase will be dependent upon the permeability and effective porosity of alluvial materials at a specific location.

Table 33 Increases in Groundwater Storage Due to Subsidence

Panel	Mine year commenced	Mine year completed	Increase in storage (ML)	Drainage Catchment
LW 1N	3.0	3.5	11	Hue Hue Creek
LW 2N	3.5	4.0	4	Hue Hue Creek
LW 3N	4.1	4.6	2	Hue Hue Creek
LW 4N	4.9	5.5	0	Hue Hue Creek + Jilliby Jilliby Creek
LW 5N	5.6	6.3	29	Hue Hue Creek + Jilliby Jilliby Creek
LW 6N	6.5	7.2	55	Jilliby Jilliby Creek
LW 7N	7.3	8.2	92	Jilliby Jilliby Creek
LW 8N	.4	9.2	136	Jilliby Jilliby Creek
LW 9N	9.3	10.1	181	Jilliby Jilliby Creek
LW 10N	10.2	11.0	173	Jilliby Jilliby Creek
LW 11N	11.1	12.0	163	Jilliby Jilliby Creek + Little Jilliby Creek
LW 1S	12.1	12.5	83	Jilliby Jilliby Creek
LW 2S	12.5	13.2	119	Jilliby Jilliby Creek + Armstrongs Creek
LW 3S	13.3	14.0	92	Jilliby Jilliby Creek + Armstrongs Creek
LW 4S	14.1	14.8	62	Jilliby Jilliby Creek + Armstrongs Creek
LW 5S	14.9	15.6	37	Armstrongs Creek
LW 6S	15.7	16.3	19	Armstrongs Creek
LW 7S	16.4	17.0	24	Armstrongs Creek
LW 8S	17.1	17.7	12	Armstrongs Creek
LW 9S	17.8	18.3	0	Armstrongs Creek
LW 10S	18.4	19.0	5	Armstrongs Creek
LW 1SW	19.1	19.8	7	Little Jilliby Creek + Wyong River
LW 2SW	19.8	20.5	5	Little Jilliby Creek + Wyong River
LW 3SW	20.6	21.2	5	Little Jilliby Creek + Wyong River
LW 4SW	21.3	21.9	5	Little Jilliby Creek + Wyong River
LW 5SW	22.0	22.6	6	Little Jilliby Creek + Wyong River
LW 6SW	22.7	23.2	8	Little Jilliby Creek + Wyong River
LW 12N	23.3	24.2	114	Jilliby Jilliby Creek + Little Jilliby Creek
LW 13N	24.3	25.1	116	Jilliby Jilliby Creek + Little Jilliby Creek
LW 14N	25.2	26.0	88	Jilliby Jilliby Creek + Little Jilliby Creek
LW 15N	26.2	26.9	44	Jilliby Jilliby Creek + Little Jilliby Creek
LW 16N	27.0	27.8	5	Jilliby Jilliby Creek + Little Jilliby Creek
LW 17N	27.9	28.6	0	Jilliby Jilliby Creek + Little Jilliby Creek
LW 18N	28.7	29.4	0	Jilliby Jilliby Creek + Little Jilliby Creek
LW 19N	29.5	30.2	0	Little Jilliby Creek
LW 20N	30.4	31.0	0	Little Jilliby Creek
LW 21N	31.2	31.9	0	Little Jilliby Creek
LW 22N	32.0	32.7	0	Little Jilliby Creek
LW 23N	32.8	33.4	0	Little Jilliby Creek
LW 24N	33.6	34.2	0	Little Jilliby Creek
LW 25N	34.3	35.0	0	Little Jilliby Creek

Panel	Mine year commenced	Mine year completed	Increase in storage (ML)	Drainage Catchment
LW 26N	35.2	35.9	0	Little Jilliby Creek
LW 7SW	36.0	36.5	0	Little Jilliby Creek + Wyong River
LW 8SW	36.6	37.1	0	Little Jilliby Creek + Wyong River
LW 9SW	37.2	37.7	0	Little Jilliby Creek + Wyong River
LW 10SW	37.8	38.1	0	Little Jilliby Creek + Wyong River

Due to the effect of increasing alluvial groundwater storage, a slightly greater proportion of rainfall is needed to recharge groundwater storages. As a consequence, the quantity of runoff to streams is slightly reduced, resulting in marginally lower flows in local streams.

Compared to the pre-subsidence water table, the shallower post-subsidence water table has the potential to saturate the soil profile for longer periods during rainfall events. Saturation may occur until stream bed elevations re-equilibrate through stream bed erosion. Final re-equilibrium is expected to occur after the final longwall is completed.

In areas where the water table is less than 1 m below the surface, and where predicted subsidence is in the order of 1 m, the water table is expected to be close to the subsided surface. As a result, the soil profile may reach field capacity more frequently during prolonged rainfall periods. The water table is expected to re-equilibriate at about the same depth as pre-mining conditions.

Increased Seepage Due to Cracking

Seepage from the alluvial aquifers to deeper hard rock aquifers ordinarily occurs via intergranular permeability in the rock strata. The rate of seepage can become magnified by subsidence induced cracking, which creates additional flow paths. However, the subsidence modelling study completed by SCT (2012) indicates that cracking above the goaf will not exhibit continuity to the surface. The subsidence model predicts that there will be a 100 m – 400 m thick zone of rock that will be free of connected cracking. As a result, there is unlikely to be a significant increase in the rate of downward seepage from the alluvial aquifers to the deeper hard rock aquifers.

Existing Registered Bores

Due to the lack of connected cracking, there will not be a significant loss of water through downward leakage. Consequently, the yields of existing bores and wells are not predicted to be significantly affected in this regard.

There are 12 registered bores located within the Subsidence Impact Limit as shown on Figure 31. The alluvial water table will initially drop as a result of subsidence, but will undergo a 55% – 75% recovery within 200 days (in the absence of significant rainfall recharge events). As a result, these bores will temporarily experience a minor reduction in yield but longer term yields are likely to be unaffected.

The yields of bores constructed in the hard rock strata are unlikely to be affected because there will be no significant depressurisation due to the very low leakage rates as estimated by the numerical modelling of the aquifer systems.

Subsidence effects also have the potential to cause structural damage to these existing bores which may require the bores to be extended or re-drilled.

Changes to Groundwater Quality

The depressurisation of hard rock strata is not expected to have any significant impacts on the quality of groundwater in the hard rock aquifers. There may be localised changes in salinity where groundwater mixes with fragmented materials in the goaf. Water that is dewatered from the underground workings will be managed within the mine water management system as discussed in Section 7.3.1.

There is unlikely to be any measurable change in the quality of groundwater within the alluvial aquifer systems. The changes to the water table caused by subsidence are not expected to impact groundwater quality. Active flushing of salts by recharge processes will not be interrupted.

Within the shallow hardrock domain, there are a number of naturally occurring, ephemeral ferruginous springs in the upper reaches of the Jilliby Jilliby Creek and Little Jilliby Jilliby Creek catchments. Work completed by EcoEngineers has confirmed that the presence of iron is attributed to the presence of siderite (iron carbonate) in the Terrigal Formation. Although marcasite-pyrite (iron sulphide) may also be present, analyses of core samples suggest that the presence of these minerals is likely to be minor. The presence of ferruginous springs has resulted in bacterially mediated matting and localised iron staining. The matting and dissolved iron can be transported downstream during during wet periods. However, most of these streams are ephemeral, allowing iron staining and matting to dissipate during periods of no flow. The subsidence induced cracking of the hardrock strata in elevated areas is likely to result in a localised redirection of runoff into these cracks. This induces water-rock hydrochemical interactions, which may result in the formation of new ephemeral ferruginous springs.

Storage of Salt and Brine

The salt and brine disposal strategy adopted for the Project is described in Section 3.9.4. The semi-solid salt mixture produced by the water treatment process will be stored in the underground sump during the first 14 years of operation. Although the coal seam and surrounding strata will become re-saturated following the completion of mining, the stored salt is expected to remain immobile. This is due to the significantly higher density of the salt mixture compared to groundwater.

After year 14, waste brine will be stored within the goaves of completed longwalls. The post-mining recovery of water levels and pore pressures is predicted to be extremely slow. As a result, the underground mine is predicted to behave as a groundwater sink for at least 500 years after mining. As a groundwater sink, the mine will induce the inward flow of groundwater. This inhibits the highly saline brine from migrating outwards from the mine workings.

Due to the high density of the salt mixture and the very slow rate of groundwater recovery, the storage of brine and salt is not predicted to have any measurable impacts on water quality.

Groundwater Dependent Ecosystems

GDEs have been identified along surface drainage channels within the Project Boundary (see Section 7.9). The GDEs that have been identified include Paperbark, Coachwood, Blackbutt and other species that rely on the shallow water table. Subsidence has the potential to alter the level of the water table. Water will naturally migrate from unsubsided areas to subsided areas as a result of differences in elevation. However, the migration of water is limited by the low permeabilities of the alluvial materials. Accordingly, the changes in the depth of the water table will be minimal. The system is expected to be rapidly recharged by rainfall, resulting in only minimal impacts on GDEs.

In elevated and forested areas, the water table is generally predicted to be deep. GDEs in these areas rely on soil moisture within the unsaturated zone. This moisture is provided by rainfall and runoff. Subsidence will not affect these processes, and will therefore have no impact on GDEs in these areas.

Aquifer Interference Policy

The alluvial groundwater systems within the Yarramalong and Dooralong Valleys are characterised by low hydraulic conductivities and increasing salinity with depth. As a result, these groundwater systems fall within the category of “less productive groundwater” under the AI Policy. The low productivity of these groundwater systems is reflected in the low number of boreholes that are present.

The minimal impact considerations for less productive groundwater are addressed below and should be read in conjunction with the groundwater impact assessment in Section 7.2.

- *Less than or equal to a 10% cumulative variation in the water table, allowing for typical climatic “post-water sharing plan” variations, 40 m from any high priority groundwater dependent ecosystem or high priority culturally significant site listed in the schedule of the relevant water sharing plan.*

The relevant Water Sharing Plans (WSP) are the JJCW WSP and CCUWS WSP. Neither of these WSPs identifies any high priority groundwater dependent ecosystems or high priority culturally significant sites.

- *A maximum of a 2 m decline cumulatively at any water supply work.*

The water table will drop due to subsidence. The maximum subsidence in the alluvium is 1.4 m, which is less than the maximum prescribed decline of 2 m.

- *A cumulative pressure head decline of not more than 40% of the “post-water sharing plan” pressure head above the base of the water source to a maximum of a 2 m decline, at any water supply work.*

The maximum subsidence within the alluvium is lower than the maximum allowable decline of 2 m. However, the pressure head decline may exceed 40% in some subsided areas where the alluvium pinches out along the valley sides. This is due to the saturated thickness of the alluvium decreasing rapidly in these areas. Since the groundwater system will re-equilibriate, the long term viability of the water source in these peripheral areas is not expected to be affected.

- *Any change in the groundwater quality should not lower the beneficial use category of the groundwater source beyond 40 m from the activity.*

No long term change in water quality is predicted since subsided areas will essentially reflect unsubsided conditions with respect to aquifer material properties, rainfall recharge and surface drainage systems.

- *No increase of more than 1% per activity in long-term average salinity in a highly connected surface water source at the nearest point to the activity.*

No long term change in water quality is predicted since subsided areas will essentially reflect unsubsided conditions with respect to aquifer material properties, rainfall recharge and surface drainage systems.

- *No mining activity to be below the natural ground surface within 200 m laterally from the top of high bank or 100 m vertically beneath (or the three dimensional extent of the alluvial water source – whichever is the lesser distance) of a highly connected surface water source that is defined as a “reliable water supply”.*

No mining activity will be undertaken within these prescribed limits. Although mining induced subsidence will impact the alluvial groundwater systems, the impacts of subsidence are temporary and will not affect the long term viability of the water source.

Sensitivity Analysis

A sensitivity assessment of the suitability of nominated vertical hydraulic conductivities in the constrained zone (see Figure E5 in Appendix I) has been conducted by considering the equivalent conductivity that might prevail for a randomised distribution (of conductivities).

The sensitivity assessment indicated that it is possible to increase the mean horizontal conductivity by several orders of magnitude in a randomised environment with some areas up to 6 orders of magnitude higher than the adopted values in the regional flow model without significantly affecting the vertical conductivity. Basically the horizontal conductivity is relatively insensitive when compared to the vertical conductivity in controlling vertical leakage through the constrained zone. Similarly, by introducing randomness to vertical conductivities it is possible to increase the mean value and without affecting the bulk conductivity of the column.

Peer Review

A peer review for the Groundwater Impact Assessment was conducted by Kalf and Associates. Kalf and Associates concluded that:

> *"The conceptualisation, model design, simulations and reported have been conducted in a professional manner and in considerable detail despite current limitations.*
>
> *The predictions provided are considered reasonable based on the available data. The main groundwater impacts are likely to occur at depth with some transient storage effects on the alluvial sediments but limited drawdown effects. There is unlikely to be significant losses of groundwater from the alluvial sediments and any such minor losses would be more than compensated by recharge through rainfall and significant storage buffering within these sediments based on the report findings.*
>
> *Maximum groundwater inflows to the mine are predicted to be between 2.0 and 2.5 ML/day after 20 to 25 years after mining commences. These results are reasonable in consideration of other similar mining project inflows based on this reviewers' experience."*

The 'current limitations' referred to by Kalf and Associates relate to the lack of data for calibrating mining influences, due to the fact that mining has not commenced on the site.

7.2.4 Mitigation and Management

Groundwater Monitoring Program

A comprehensive groundwater monitoring program will be developed as part of the EMP and will include:

- Measurement of groundwater levels, pore pressures and water quality within the existing regional network of monitoring bores, which will be expanded consistent with Section 8;
- Measurement of rates of groundwater seepage and monitoring of groundwater quality as part of the mine water management system;
- Compliance monitoring and measurement of any water discharges, including water quality monitoring of major ions and specific rare elements;
- Adoption of data transfer protocols to convey monitoring data from the mine to the relevant regulatory authorities; and
- Reporting groundwater monitoring programme results in the Annual Review.

As part of the above program piezometers will be installed to monitor pore pressures after the cessation of mining in any brine disposal areas. Transducers will also be installed from the seam elevation to approximately 50 m below the surface to monitor the recovery of pressure heads within the hardrock system. The purpose of this monitoring will be to confirm that there is no unanticipated migration of brine.

WACJV is not currently monitoring groundwater beyond its Honeysuckle Park and Buttonderry properties due to restricted access to other existing bores. WACJV will endeavour to re-instate monitoring at existing bore locations whilst this application is being reviewed. The current monitoring network will be expanded to adequately measure strata hydraulic gradients and rock mass permeabilities (as described below).

The results of monitoring will be used to regularly validate and verify the groundwater model for the Project. The monitoring program will be reviewed annually and will be reported in the Annual Review.

Depressurisation Monitoring

The following measures will be implemented for the monitoring of depressurisation as illustrated in Figure 30 and Figure 31:

- Construction of at least 20 standpipe piezometers to augment measurement of pressures / water levels in shallow alluvium and underlying strata to a depth of 50 m. As a minimum, the design would allow for isolation of bottom hole strata from mid hole and alluvial strata utilising combined standpipe and pore pressure transducer completions;
- Installation of vertical arrays of pore pressure transducers distributed within the Narrabeen Group of rocks (overburden) at a minimum of eight locations;

- Strata hydraulic conductivity measurement on rock core obtained at some of the above noted locations. Such measurement should comprise testing for matrix permeability and insitu testing for permeability over the piezometric intervals;
- Quarterly monitoring of water levels in all existing piezometers and new piezometers to be installed; and
- Daily monitoring of water levels by installed auto recorders in selected existing piezometers and in new piezometers in order to discriminate between oscillatory groundwater movements attributed to rainfall recharge, and longer term pressure losses related to mining.

An accelerated decline in pressure can be a precursor to increased seepage rates. This behaviour can occur in the unlikely event that previously unidentified major faults provide connectivity between the alluvial aquifers and the mine workings. If faulting is present, mine planning will be revisited to develop appropriate management and mitigation measures.

Mine Water Monitoring

The following measures will be undertaken for the monitoring of mine water seepage:

- Measurement of all water pumped underground and all mine water pumped to the surface on a daily basis. Measurement will be undertaken using calibrated flow meters or other suitable gauging apparatus;
- Routine monitoring of ROM coal moisture content delivered from the working face in order to more accurately determine the underground water balance; and
- Routine monitoring of ventilation humidity.

Groundwater Quality Monitoring

The following measures will be undertaken for the monitoring of groundwater quality:

- Quarterly monitoring of pH and EC in selected piezometers and pumped mine water. Such monitoring may provide early indications of the potential mixing of shallow groundwater within deeper strata groundwaters. Whilst this process is expected within the subsidence zone, it may not be evident within the wider piezometer network at the leakage levels predicted by groundwater monitoring;
- Six monthly measurement of TDS and speciation of water samples in selected piezometers to support identification of mixing of groundwater types. Speciation will include, as a minimum, major ions such as Ca, Mg, Na, K, CO_3, HCO_3, Cl, SO_4, and elements such as Al, As, B, Ba, F, Fe (total), Li, Mn, P, Se, Si, Sr, Zn; and
- Graphical plotting of basic water quality parameters and identification of trend lines and statistics including mean and standard deviation, calculated on a quarterly basis. Comparison of trends with rainfall and any other identifiable processes that may influence such trends.

For all monitoring, departures from modelled or monitoring data trends will be investigated to determine whether the departure is due to impacts generated by the Project. These investigations may indicate the need for more intensive monitoring, re-assessment of impacts or implementation of mitigation measures.

WACJV will develop an EMP describing groundwater monitoring and management for the approval of DP&I in consideration of the above.

Mitigation Measures

There is the potential for subsidence to cause damage to private groundwater bores and wells. Where necessary, WACJV will repair or replace damaged bores. In the unlikely event that the Project's impacts exceed the predictions in this assessment, these impacts will be mitigated by replacing the water supply to compensate for the water losses experienced.

Water Management Plan

WACJV will prepare a Water Management Plan in consideration of the findings from the groundwater assessment. It will ensure that the groundwater monitoring program as described above is implemented and maintained so that the modelled predictions and assumptions can be verified and any potentially unforeseen groundwater impacts can be promptly identified and managed.

Water Allocations

Table 34 shows the estimated average annual volume of groundwater take over the life of the Project. Since no WSPs are in place with respect to groundwater, no WALs will be required in respect to the WM Act.

However, water licences will be required under Part 5 of the Water Act in respect to any groundwater take for the Project (see Section 4.5.7).

WACJV does not currently hold any water licences under the Water Act for the groundwater to be affected as a result of the Project. WACJV will apply for the appropriate water licences upon the granting of Development Consent.

7.3 Surface Water

7.3.1 Background

A Surface Water Impact Assessment for the Project has been completed by WRM Water & Environment (WRM) and is summarised below. The surface water impact assessment is provided in full in Appendix J. The objectives of the assessment were to assess the potential impacts of the Project on regional water supplies (particularly the Gosford-Wyong Water Supply Scheme), regional water supply infrastructure, and licensed water users and landowners. The assessment also includes recommendations to manage and mitigate these impacts.

Catchment Description

The Project is located within the Tuggerah Lakes Basin, which has a total catchment area of approximately 700 km². The major rivers and tributaries in this catchment are the Wyong River, Jilliby Jilliby Creek and Ourimbah Creek as illustrated on Figure 2.

The Tooheys Road Site is located within the Wallarah Creek catchment on the eastern (and downstream) side of the F3 Freeway. Wallarah Creek flows to the east and enters Budgewoi Lake approximately 6.6 km downstream from the Tooheys Road Site. Wallarah Creek has a catchment area of approximately 45 km² to Budgewoi Lake. Wallarah Creek is ephemeral, with a median flow rate of approximately 0.25 ML/day and 10% of flows being recorded at greater than 4 ML/day.

The Buttonderry Site is located within the Buttonderry Creek catchment. Buttonderry Creek has a catchment area of approximately 5.4 km² upstream of the Project, and joins the Woongarrah and Hue Hue Creeks at the Porters Creek wetland to the east of the Buttonderry Site. This wetland has a surface area of 6 km² and a total catchment of 55 km². Porters Creek drains into the Wyong River, with the confluence located approximately 7.6 km downstream of the Buttonderry Site.

Buttonderry Creek and Wallarah Creek are ephemeral creeks with small, well defined low-flow channels. Both creeks have well vegetated banks, and small floodplains that are vegetated with grass cover and scattered trees.

The main stream overlying the Extraction Area is Jilliby Jilliby Creek, which is a major tributary of the Wyong River. The confluence of Jilliby Jilliby Creek and the Wyong River is located a short distance south-west of the Extraction Area. The headwaters of Jilliby Jilliby Creek are located within the Olney State Forest, approximately 36 km upstream of its confluence with the Wyong River. Jilliby Jilliby Creek has a total catchment area of approximately 100 km² and has a number of smaller tributaries joining the creek along its alignment, including Little Jilliby Jilliby Creek.

The character of Jilliby Jilliby Creek varies along its length. The upper reaches of the creek lie well to the north of the Project Boundary and are characterised by confined valleys. The downstream section of the creek is characterised by partially confined valleys, and is laterally unconfined at the confluence with the Wyong River. The section of the creek overlying the Extraction Area is laterally unconfined. The channel is predominantly sand, with a depth of up to 3 m. The creek is generally well vegetated, with the tree root mass providing a high degree of lateral stability. However, erosion is evident in sections of the channel that lack good vegetation coverage.

Stream Classifications

The streams within the Extraction Area have been classified according to the Strahler Stream Classification System. The upland streams in the western portion of the Extraction Area are generally 1st or 2nd order streams. Most of Little Jilliby Jilliby Creek and the lower reaches of Myrtle Creek are classified as 3rd order streams (see Figure 14). These 3rd order streams are located in areas containing minor to significant valley alluvium.

The 1st and 2nd order streams are drainage lines that commonly contain sandstone boulders, minor areas of alluvium and significant vegetative litter. The 1st and 2nd order streams are generally steep, ephemeral drainage lines, whereas the 3rd order streams are characterised by lower stream gradients.

Wallarah Creek is a 3rd order stream in the vicinity of the Tooheys Road Site (see Figure 19). This section of the stream is characterised by a stable, low gradient. The stream flows with low sinuosity within an alluvial zone between 10 m and 60 m wide. During periods of higher flow, Wallarah Creek changes from a well-defined single channel configuration to sections of stable multi-channel flow.

Table 34 Groundwater Allocations

Water Source	Predicted Average Annual Take (ML/year)	Predicted Average Annual Impact on Water Source (%)	Licences / Allocations Required (ML)
Coal Measures	638.75	N/A*	638.75
Alluvial	7.3	Negligible	7.3
Shallow Hardrock	14.6	N/A*	14.6

*There are no long term extraction limits for water sources that are not regulated under the WM Act.

Water Supply System

The Gosford Wyong Water Supply System is described in detail in Section 2.3. An analysis of baseflow in the Wyong River and Jilliby Jilliby Creek was undertaken as part of the Wyong Water Study (SKM, 2010). The results of the baseflow analysis indicate that baseflow comprises 14% to 28% of measured streamflow across the region. During dry periods, the proportion of baseflow may increase to 100% of recorded streamflow (SKM, 2010).

The combination of subsidence and changes in water table levels across the floodplain of Jilliby Jilliby Creek will potentially reduce the drainage efficiency of the floodplain, leading to possible increased wet areas and surface ponding during wet weather. As a consequence, slightly increased infiltration and evaporation may occur across the subsided floodplain. Through appropriate land management and remedial drainage management practices, the change in surface drainage efficiency is unlikely to result in a measurable reduction in total surface water volumes draining to the Gosford-Wyong Water Supply Scheme.

The total potential Subsidence Impact Limit of approximately 37 km^2, located within the catchment area of the Gosford-Wyong Water Supply Scheme, represents approximately 5% of the total catchment contributing to the Scheme. Approximately 29 km^2 of the Subsidence Impact Limit is located within the Jilliby Jilliby Creek catchment, a further 4.2 km^2 is located in the catchment of Hue Hue Creek and the remaining 3.8 km^2 is located in the direct catchment of the Wyong River.

Flow in upland drainage paths is highly ephemeral, with these drainage lines commonly featuring sandstone boulders, minor areas of alluvium and significant vegetative litter. Due to these features, no significant loss of surface flow through surface cracking along drainage paths in upland areas is anticipated (IEC, 2009).

An analysis of the impacts of subsidence on baseflow to surface drainage paths has been completed as part of the groundwater impact assessment (Appendix I). The results of these analyses show that subsidence will have no measureable impact on baseflows.

Subsidence of alluvial lands is likely to create a temporary increase in groundwater storage which may affect surface runoff volumes in the short term. The change in alluvial groundwater storages will vary from year to year depending on the progression of mining, with an estimated maximum increase in storage of approximately 181 ML for a period of eight to 10 months. Although this water is retained within the catchment, groundwater storage is not part of either the Jilliby Jilliby Creek Water Source or the Central Coast Unregulated Water Source. Water relocated in this way within the catchment is referred to in the WM Act as "taking" water. Considering uncertainty in permeability and effective porosity, it is conservatively estimated that a maximum annual volume of 270 ML could potentially be taken from the Jilliby Jilliby Creek Water Source and 30 ML from the Central Coast Unregulated Water Source.

Water Sharing Plans

The WSPs relevant to the Project are the Jilliby Jilliby Creek Water Source WSP and Central Coast Unregulated Water Source WSP.

The Jilliby Jilliby Creek Water Source WSP commenced in July 2004 and was updated in July 2009. At the time of commencement, there were 27 water access licences with a total entitlement of 1,016 ML/yr. This was comprised of 23 licences for irrigation purposes, two licences for stock and domestic purposes, one licence for farming and one licence for industrial purposes (DIPNR, 2005). These licences and the total entitlement quantity remained in place following the WSP update in 2009.

The Central Coast Unregulated Water Source WSP, which commenced in 2009 and was updated in January 2010, includes all unregulated rivers and creeks in the Central Coast region, with the exception of Jilliby Jilliby Creek and Ourimbah Creek (there are separate WSPs for these water sources). The total water entitlement for licensed users is 38,782 ML/yr, of which 10% is for irrigation purposes and 89% is for town water supply. The peak daily demand is 79.9 ML/day.

Existing Water Quality

Baseline water quality monitoring for the Project commenced in 1996 and continued until 2004. Following a hiatus, monitoring resumed and has been undertaken without interruption since 2006. Surface water sampling has been conducted at 14 sites for a range of water quality parameters: pH, salinity, temperature, dissolved oxygen, TSS, TDS, heavy metals and organic compounds. A summary of the monitoring data collected within the region is provided in Appendix J and briefly described below.

The following observations can be made about the water quality of Wallarah Creek near the Tooheys Road Site:

- The water is slightly acidic, with pH ranging from 5.7 to 7.3 (median 6.3);
- The water is fresh (low salinity), with EC ranging from 120 to 680 µS/cm;
- The concentrations of TDS, calcium, magnesium, sulphate, arsenic, barium, cadmium, chromium, copper, lead, nickel and mercury are below the ANZECC trigger values; and
- There have been several exceedances of the ANZECC trigger values for sodium, chloride, manganese, zinc, iron, ammonia and phosphorus.

Surface water quality in Buttonderry Creek, near the Buttonderry Site is generally characterised as follows:

- Water quality is generally similar to Wallarah Creek, although slightly higher concentrations of some pollutants are observed;
- The water is slightly acidic, with pH ranging from 5.9 to 6.8 (median 6.5);
- The water is generally fresh (low salinity), with EC ranging from 137 to 702 µS/cm;
- Calcium, sulphate and manganese concentrations are higher than Wallarah Creek; and
- Ammonia and total phosphorus concentrations are higher than Wallarah Creek and exceed the ANZECC trigger value for ecosystem protection.

The water quality of the other streams and watercourses within the Subsidence Impact Limit generally follows similar trends in water quality as Wallarah Creek and Buttonderry Creek. Deep groundwater quality sampling in the vicinity of the Project indicates that the groundwater to be treated for reuse within the water management system will be fresh to brackish, with an indicative TDS concentration ranging from 1,800 to 7,500 mg/L and pH values from 6.3 to 7.6 (MER, 2012).

Proposed Water Management System

The objectives of the water management system are to both provide suitable water for mine site use and to ensure that untreated mine water is not released from the site. Mine water requiring treatment will be a combination of deep groundwater pumped from the underground mine and surface water captured on site, which is potentially saline and sediment laden due to contact with coal stockpiles. The Project will also generate water through runoff from buildings and paved surfaces. This water is not expected to be saline and will only require treatment using sedimentation dams.

As the preferred approach, the Water Treatment Plant (a combined RO and brine treatment plant) will be utilised to treat sufficient mine water to meet the Project's operational needs and replace the environmental flows that have been removed from Wallarah Creek due to the reduction in the creek's catchment area. All mine water that is pumped from the underground mining area or collected within the mine water dams is processed in the water treatment plant, with the treated water used on site or discharged to Wallarah Creek. The Water Treatment Plant will have the capacity to treat a maximum of 3 ML/day (2.7 ML/day excluding backwash). Groundwater inflows are predicted to peak at 2.5 ML/day. The Water Treatment Plant will also be used to treat runoff collected within the mine water dams at the Tooheys Road Site. Therefore, the Water Treatment Plant has sufficient capacity to treat mine water for use within the water management system.

The RO process will generate both treated water and brine. The volume of brine produced is approximately equal to 10% of the total inflows to the Water Treatment Plant. The brine extract produced by the RO process will either be treated in a Brine Treatment Plant to produce a partly dried salt product or pumped directly to the underground mine workings for storage. The Brine Treatment Plant is anticipated to be used in the first 14 years of the Project and thereafter if deemed necessary. The objective of the Brine Treatment Plant is to reduce the volumes of salt byproducts that need to be stored underground. Appendix J provides further detail on the water management strategy.

The treated water produced by the RO process will be used to satisfy operational water demands. Beneficial uses of water will include at least: stockpile dust suppression, underground dust suppression, coal handling and coal moisture management. The quantities of treated water that will be required for these purposes is described in Section 7.3. Any surplus treated water beyond that required for operational demands will be released into Wallarah Creek according to the conditions of an EPL.

The main components of the water management system are:

- At the Tooheys Road site:
  - The Stockpile Dam at the Tooheys Road site collects runoff from the product coal stockpile;
  - The Portal Dam collects runoff from the raw coal stockpile, offices and workshop area;
  - The Mine Operations Dam stores water pumped out of the underground workings and water pumped from the Stockpile Dam and Portal Dam;
  - The Water Treatment Plant (including the Brine Treatment Plant) treats mine water from the Mine Operations Dam and supplies treated water to the Treated Water Storage;
  - The Treated Water Storage (a cell within the Mine Operations Dam) stores treated water for operational needs or for controlled discharge to Wallarah Creek;
  - A Brine Water Storage to store brine extract from the Water Treatment Plant;
  - Sediment traps and drainage channels collect and treat runoff from the rail loop and access road;
  - Clean water drains divert runoff from undisturbed catchments around disturbed areas;
  - Discharge infrastructure will facilitate releases of treated water to Wallarah Creek;

- At the Buttonderry Site:
  - The Entrance Dam stores water for non-potable uses at the Buttonderry Site;
  - A sedimentation dam collects and treats runoff from buildings, paved and hardstand areas at the Buttonderry Site;
- An underground mine water storage sump;
- Underground in-seam voids that become available for permanent mine water storage following extraction of longwall panels;
- A water supply pipeline to import water from offsite water sources (when required); and
- Connections to the WSC sewerage system.

The capacities of the water storages are listed in Table 35. The Sediment Dam and Entrance Dam will be constructed to be available at the commencement of the Project. The Portal Dam, Stockpile Dam, Mine Operations Dam, Treated Water Storage and Brine Water Dam will become available at the end of Year 1. The relationships between the components of the water management system are illustrated in Figure 32. The Brine Water Dam is a component of the Mine Operations Dam.

The Mine Operations Dam has been designed to accommodate a 100 year ARI, 72 hour storm event. The Buttonderry Sediment Dam, Entrance Dam, Portal Dam and Stockpile Dam have been sized in accordance with "Managing Urban Stormwater: Soils and Construction" (DECC, 2008). The Portal Dam and Stockpile Dam are integrally linked to the Mine Operations Dam in order to avoid any uncontrolled discharges of mine water.

Table 35 Storage Capacities

Storage	Capacity (ML)
Tooheys Road Site	
Mine Operations Dam	180
Portal Dam	30
Stockpile Dam	20
Treated Water Storage	20
Brine Storage	9
Buttonderry Site	
Entrance Dam	10
Sediment Dam	1
Underground	
Underground Sump	120

7.3.2 Methodology

Water Balance

The water balance modelling was designed to reflect changes in the water management system over the Project life. This includes both the construction and operating phases of the Project.

A computer-based simulation model (GoldSim) was used to simulate all the major components of the proposed water management system on a daily basis over the 28 year life of the Project. These major components are listed in Table 36.

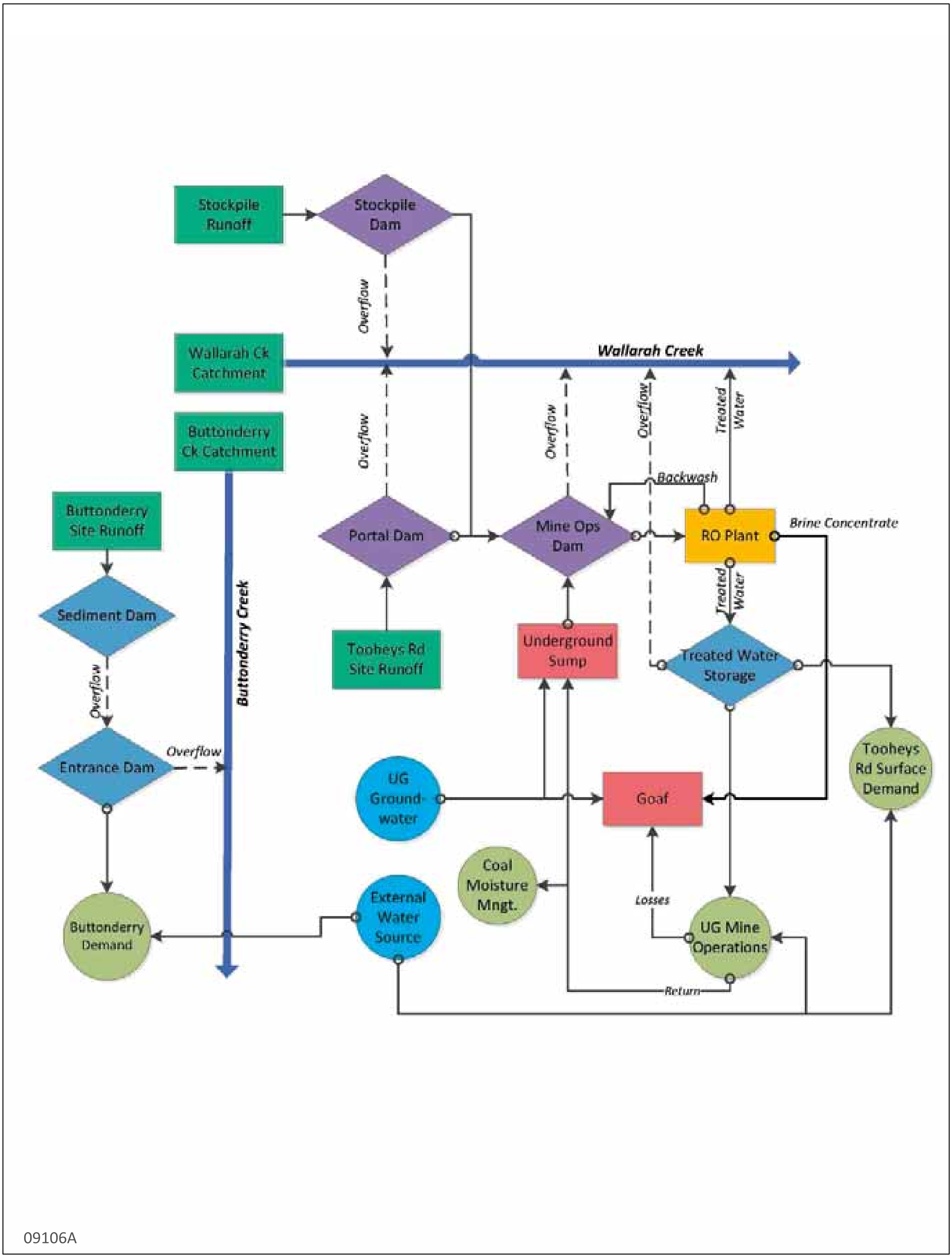
Rainfall data records for the region are available from 1889. This data was divided into 95 different sequences each representing a different 28 year sequential period of this historical rainfall data. The GoldSim model performed a simulation on each of the 95 climatic data sequences with each simulation reflecting the 28 year life of the Project. In total, the GoldSim model was run for 95 cycles, providing a range of water balance results for a wide range of climatic conditions.

Since water balance modelling is performed for a large range of climatic conditions, the model predicts a wide range of surface water impacts. In order to express the range of impacts, the climatic data sequences are ordered according to rainfall and assigned a percentile. For example, the 90th percentile result represents model results which are exceeded in only 10% of the model runs for the different climatic sequences. Conversely, the 10th percentile results are exceeded in 90% of the model runs. Surface water impacts are commonly expressed for 10th percentile (dry), 50th percentile (median), 90th percentile (wet) and 99th percentile (very wet) conditions.

Groundwater inflows were sourced from the groundwater impact assessment prepared by MER (see Section 7.2).

Table 36 Simulated Inflows and Outflows for the Water Management System

Inflows	Outflows
Direct rainfall on water surface of storages	Evaporation from water surface of storages
Catchment runoff	Surface water demands (including dust suppression)
Groundwater inflows to Underground	Underground water demand
Raw water supply from External Source	Treated water discharge to Wallarah Creek
	Brine/Salt and groundwater storage in goaf/sumps
	Offsite spills from storages



WALLARAH 2 COAL PROJECT

Proposed Water Management System

FIGURE 32

The surface water runoff volumes used in the water balance model were estimated using the AWBM model (Boughton, 1993). The AWBM calculates daily runoff values using measured rainfall and estimates of evapotranspiration. The model also considers the effect of groundwater recharge and discharge on surface flows. The AWBM model was calibrated using runoff data for Wallarah Creek collected by NOW. There was good agreement between the predicted and observed runoff volumes.

The underground void space available for permanent water storage increases as mining progresses, resulting in increasing volumes of mine groundwater inflows being diverted to these mine voids. Therefore, increasing quantities of mine groundwater will be pumped to an available mine void, instead of being pumped to the surface. The volumes of groundwater inflows and other water to be retained in the mine void were provided by WACJV and are listed in Table 37.

Table 37 Indicative Groundwater Inflows Diverted to the Mine Void

Project Year	Groundwater Inflows (Gross)	% of Gross Groundwater Inflows Retained in Mine Goaf	Underground (UG) Operations			Product Coal Moisture	Total Water to Goaf	Total Water to Underground
			Total UG Use	Total UG Recycle	Total UG Loss			
1	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.2	0.00	0.01	0.01	0.01	0.01	0.01	0.20
4	0.4	0.00	0.27	0.16	0.11	0.14	0.11	0.43
5	0.8	0.05	0.48	0.29	0.19	0.24	0.23	0.81
6	1.1	0.05	0.68	0.41	0.27	0.34	0.33	1.11
7	1.3	0.05	0.88	0.53	0.35	0.44	0.42	1.32
8	1.5	0.10	1.10	0.66	0.44	0.55	0.59	1.47
9	1.5	0.10	1.10	0.66	0.44	0.55	0.59	1.47
10	1.6	0.15	1.10	0.66	0.44	0.55	0.68	1.47
11	1.7	0.20	1.10	0.66	0.44	0.55	0.78	1.47
12	1.8	0.25	1.10	0.66	0.44	0.55	0.89	1.46
13	1.8	0.30	1.10	0.66	0.44	0.55	0.98	1.37
14	1.8	0.35	1.10	0.66	0.44	0.55	1.07	1.28
15	1.9	0.35	1.10	0.66	0.44	0.55	1.10	1.34
16	1.9	0.35	1.10	0.66	0.44	0.55	1.10	1.34
17	1.9	0.37	1.10	0.66	0.44	0.55	1.14	1.31

Predicted water demands for the Tooheys Road and Buttonderry sites were provided by WACJV. These estimates are presented in Table 38.

The water balance model also included a salt balance to predict the quality of water stored in the water management system. The adopted surface water runoff salinities were based on baseline water quality monitoring and data from similar operations (e.g. Mandalong Coal Mine).

Project Year	Groundwater Inflows (Gross)	% of Gross Groundwater Inflows Retained in Mine Goaf	Underground (UG) Operations			Product Coal Moisture	Total Water to Goaf	Total Water to Underground
			Total UG Use	Total UG Recycle	Total UG Loss			
18	2.1	0.40	1.10	0.66	0.44	0.55	1.28	1.37
19	2.2	0.40	1.10	0.66	0.44	0.55	1.32	1.43
20	2.4	0.40	1.10	0.66	0.44	0.55	1.40	1.55
21	2.4	0.40	1.10	0.66	0.44	0.55	1.40	1.55
22	2.4	0.40	1.10	0.66	0.44	0.55	1.40	1.55
23	2.5	0.40	1.10	0.66	0.44	0.55	1.44	1.61
24	2.4	0.40	1.10	0.66	0.44	0.55	1.40	1.55
25	2.3	0.40	1.10	0.66	0.44	0.55	1.36	1.49
26	2.3	0.40	1.10	0.66	0.44	0.55	1.36	1.49
27	2.3	0.40	1.10	0.66	0.44	0.55	1.36	1.49
28	2.3	0.40	1.10	0.66	0.44	0.55	1.36	1.49

Source: WACJV (2013)

Table 38 Predicted Water Demand

Project Year	Tooheys Road Site (ML/year)					Buttonderry Site (ML/year)		Total (ML/year)
	Construction	Mine Use (Surface)	Mine Use (underground[1])	Coal Handling	Coal Moisture	Construction	Mine Use (Surface)	
1	30	5	0	0	0	15	10	60
2	30	5	0	0	0	25	15	75
3	30	5	2	0	2	30	15	84
4	0	10	40	5	50	0	30	135
5	0	10	70	15	88	0	30	213
6	0	10	100	25	125	0	30	290
7	0	10	128	35	160	0	30	363
8 - 28	0	10	160	50	200	0	30	450

1 Net underground water losses; equivalent to 40% of underground water demand (Parsons Brinckerhoff, 2011)

7.3.3 Impact Assessment

Simulated Water Balance

The simulated water balance results for years 1, 5, 8 and 22 of the Project using the preferred water management strategy are summarised in Table 39 and are discussed in the following sections.

Demand from External Water Supplies

The water balance shows that the maximum demand from external water supplies is 52 ML in Year 1. The external water demand then decreases to approximately 20 ML/year over the first four years. From Year 4 onwards, the external water demand peaks at 49 ML/year in Year 14 before decreasing to approximately 20 ML/year for the remainder of the Project life.

Surface Water from the Catchment

Mining induced subsidence has the potential to cause surface water flows to be diverted to groundwater. The subsidence modelling study as discussed in Section 7.1 indicates that cracking above the goaf will not extend to the surface. The subsidence model predicts that there will be a 100 m – 400 m thick zone of rock that will be free of connected cracking. As a result, there is unlikely to be a significant increase in the rate of downward seepage from the alluvial aquifers to the deeper hard rock aquifers and hence minimal effect on the surface water flows.

A change in shallow groundwater storage may occur as a result of transient tensile cracking of ground strata caused by subsidence. The change in groundwater storage is likely to be transient in nature and would occur through either temporary filling of tensile cracking storage or by re-adjustments to the groundwater levels to changed surface geomorphology brought about by subsidence. Impacts on surface water flows resulting from this change in alluvial storage are expected to be minor.

Changes in water table elevations are likely to occur as a result of subsidence effects of the Project, which may affect surface water resources. In alluvial areas with slopes less than a few degrees, surface drainages and groundwater levels will initially fall as part of a panel being subsided relative to an adjacent unsubsided area.

The relative change in groundwater levels from unsubsided to subsided areas will establish localised gradients with groundwater migrating towards the subsided area. This will lower the water table in the unsubsided area and raise the water table within the subsided area. Additional alluvial storage volumes created by the transient subsidence effects will be filled with rainfall recharge and surface water runoff, potentially resulting in a marginal reduction in surface water flows.

If it is assumed that the increase in alluvial groundwater storage translates to an equivalent reduction in surface water, the Project will result in an estimated maximum additional groundwater retention equivalent to a surface water loss of approximately 300 ML/year or less than 1% of the long term average annual extraction limit of the water licences held by the Gosford / Wyong Water Authority (36,750 ML/year) under the Central Coast Unregulated WSP and the Jilliby Jilliby Creek WSP.

The 300 ML/year reduction in surface water occurs in the Jilliby Jilliby Creek water source (270 ML/year) and the Wyong River water source (30 ML/year). Flow volumes in these streams will decrease due to a reduction in baseflow and a loss of surface runoff. The Groundwater Impact Assessment (Appendix I) determined that the impact on baseflow is negligible. To ensure a conservative approach, it was assumed that the reduction in surface water runoff accounted for the entire volume diverted to groundwater.

Table 39 Project Annual Average Water Balance Summary

	Project Average Annual Water Balance (ML/year)			
	Year 1	Year 5	Year 8	Year 22
Water Inputs				
Rainfall/Runoff Yield	43	274	282	278
Groundwater Inflows to Underground[1]	0	292	548	876
External Water Source	47	13	13	13
Water Outputs				
Evaporation from Storages	6	93	94	94
Dam Overflows (offsite) (Buttonderry clean water system only)	19	19	20	19
Treated Water Discharge to Wallarah Creek	0	223	204	232
Water to Goaf[2]	0	98	235	532
Buttonderry Site Demands	25	30	30	30
Tooheys Road Site Demands	35	112	260	260

Notes: 1– Net groundwater inflows, not including groundwater inflows diverted directly to mine voids.
2 – Includes underground operational losses, diverted groundwater inflows and brine solids.

The pre-mining and post-mining flow-duration curves for Jilliby Jilliby Creek (see Appendix J) indicate that the loss of 270 ML/year in surface runoff will have a negligible impact on the flow regime of the creek. The impact on the Wyong River is also likely to be negligible, due to the lower impact on surface runoff and the greater flow volumes in the river.

Catchment Area

The Project's water management system will intercept surface water runoff within the Buttonderry Creek and Wallarah Creek catchments generally at constant rates throughout the life of the Project, including:

- At the Tooheys Road Site, the Wallarah Creek catchment (flows to Lake Budgewoi), will be reduced by approximately 36 ha (9.3% of the catchment to the downstream Project Boundary). However, it is intended to replace this loss with discharges of treated water from the Water Treatment Plant; and
- At the Buttonderry Site, the Buttonderry Creek catchment (flows to Porters Creek wetland) will be reduced by approximately 7.4 ha (1.1% of the Buttonderry Creek catchment to the downstream Project Boundary).

After the completion of mining, drains and sediment dams will be retained at both sites and the captured catchment areas will remain the same.

The reductions in each catchment area will result in a decrease in flow volumes in Wallarah Creek and Buttonderry Creek. On average, flow volumes in Wallarah Creek and Buttonderry Creek will be reduced by 150 ML/year and 30 ML/year respectively. The flows in Wallarah Creek will be replaced using controlled discharges of treated water, as discussed further below.

Flood Behaviour

Mining induced subsidence can alter the flood behaviour of undermined streams. These impacts are discussed in detail in Section 7.4.

The surface infrastructure for the Project will be located beyond the 100 year Annual Recurrence Interval (ARI) flood extents of Buttonderry Creek and Wallarah Creek. The culvert crossing the F3-Pacific Highway Link Road acts as a hydraulic control for Wallarah Creek, creating a pond behind the road embankment. This pond is not expected to infringe upon the surface infrastructure for the Project.

Uncontrolled Offsite Discharges

The mine water management system at the Tooheys Road Site is not expected to experience any uncontrolled discharges even under very wet rainfall conditions (99^{th} percentile model results).

The Entrance Dam at the Buttonderry Site is predicted to experience a number of overflows during the Project life. Discharges are predicted to range between 15 ML/year under median rainfall conditions and 67 ML/year under very wet conditions. Since there is no coal handling at the Buttonderry Site, the primary potential pollutant will be suspended sediment. Since this dam has been sized in accordance with 'Managing Urban Stormwater: Soils and Construction' (DECC, 2008), the runoff captured within this dam will be suitable for release after sedimentation occurs within the dam.

Controlled Discharges to Wallarah Creek

It is proposed that excess treated water will be released into a tributary of Wallarah Creek. These controlled discharges will restore the flows that are lost due to the reduction in the catchment area of Wallarah Creek. Maximum annual discharges are predicted to occur in Year 7 and range from 50 ML/year in a median rainfall year to more than 500 ML/year under very wet conditions.

With these proposed discharges of treated water to Wallarah Creek, the net impact on Wallarah Creek will be an increase in flow volumes. Under wet conditions, the flow volumes in Wallarah Creek are predicted to increase by approximately 2%. Under average to dry conditions, flows volumes are expected to increase by approximately 3%.

Controlled releases are predicted to have the following impacts on the flow regime of Wallarah Creek, including:

- Negligible impact on the frequency of flows greater than 10 ML/day; and
- An increase in the frequency of low flows (less than 10 ML/day) from 17% of the time to 30% of the time.

Releases to Wallarah Creek are not expected to have a flow rate of greater than 3 ML/day (35 L/s). Due to the proposed rate of release and the good condition of bank vegetation, it is unlikely that releases of treated water will cause increased erosion in Wallarah Creek. Since Wallarah Creek is an ephemeral stream in the vicinity of the Tooheys Road surface facilities, releases are likely to occur when there is no natural flow in the creek. Despite these releases, Wallarah Creek will remain ephemeral in nature.

Appropriate erosion control measures, such as the intallation of an energy dissipation device at the discharge point and channel bed protection immediately downstream of the outlet will minimise scour erosion at the point of release.

The maximum discharge rate of 35 L/s will result in a very low water level compared to the full capacity of the channel. As a result, bank stability is not predicted to be impacted. Due to the low risk of erosion, the geomorphology in the creek is also unlikely to be altered by the discharges. Cross-sections of Wallarah Creek and the water levels resulting from discharges are illustrated in Appendix J.

The Water Treatment Plant will treat mine water to a quality that is similar to the existing Wallarah Creek water quality. The expected quality of treated water is quantified in Appendix J. The expected quality of treated water is consistent with the existing water quality of Wallarah Creek for all key parameters. The detailed design of the Water Treatment Plant will consider the implementation of additional processes and technologies to eliminate excess quantities of water pollutants, as required. As a result, releases of treated water are not expected to adversely impact the water quality of Wallarah Creek.

Brine and Salt Disposal Requirements

During the first 14 years of the Project, all brine generated by the RO plant will be fed through the Brine Treatment Plant to produce a semi-solid salt by-product. In the first eight years of the Project, the brine volumes that will be treated within the Brine Treatment Plant are predicted to gradually increase to approximately 25 ML/year. Under median conditions, the Brine Treatment Plant will produce less than 5,270 m^3/year of salt to be disposed of underground.

The Brine Treatment Plant is not anticipated to be required after Year 14 of the Project. The brine volumes requiring storage underground will remain stable for the rest of the Project life, ranging from approximately 18 ML/year to 25 ML/year.

Geomorphology Impacts

Mining induced subsidence has the potential to cause changes to stream geomorphology. Differential subsidence along a stream can result in ponding and changes to flow conditions as further detailed in Appendix J.

The maximum subsidence predicted to occur along the Wyong River is 150 mm. Subsidence of this magnitude is not likely to have a measurable impact on the Wyong River as active scouring erosion and sediment deposition of (plus or minus) one metre can occur during flow events in this waterway.

There are not expected to be any significant impacts on Little Jilliby Jilliby Creek, since the mine plan has been designed specifically to reduce impacts in this area. Subsidence effects along Jilliby Jilliby Creek are predicted to be relatively uniform, which limits the impacts on flow velocities within this system. There are some locations along Jilliby Jilliby Creek that may experience increased ponding and impacts upon flow velocities. However, these impacts are predicted to be minor and readily remediated.

The risk of geomorphological impacts is greatest near the confluence of Jilliby Jilliby Creek and Little Jilliby Jilliby Creek with predicted subsidence of 1 m adjacent to an area which is likely to experience minor subsidence. This subsidence is likely to cause some localised ponding of low flows confined to the main channel along this section of Jilliby Jilliby Creek.

Inspections of Jilliby Jilliby Creek have indicated that the bed and banks of the creek are susceptible to erosion. Aerial photographs of Jilliby Jilliby Creek indicate the presence of abandoned channels and ox-bow channels, demonstrating that natural erosion processes have been occurring with the alignment of the creek previously changing over time.

A HEC-RAS hydraulic model was used to assess the impacts of potential subsidence on erosion potential along Jilliby Jilliby Creek and Little Jilliby Jilliby Creek. The model was generally based on the same channel cross-sections used in the flood impact assessment (G Herman & Associates, 2013). The model was run with discharges selected to approximate bankfull flow conditions, which are often regarded as representing the channel forming flow rate.

The results of the hydraulic modelling indicate that key hydraulic parameters for subsided conditions are generally within the range of pre-subsidence values. There is the potential for reduced sediment transport in reaches where bed gradients have been reduced and increased sediment transport where gradients have been increased.

Based on the existing dynamic nature of the main channel, particularly in the lower reaches of Jilliby Jilliby Creek and Little Jilliby Jilliby Creek, it is likely that impacts of subsidence on the creek channel will be difficult to separate from the existing natural variability in vegetation and bed and bank condition.

Ongoing monitoring of subsidence and possible associated impacts will be undertaken throughout the Project to identify and correct any observed impacts. As further explained in Section 7.3.4, a stream stability monitoring and management program will be developed following development approval to address subsidence impacts.

Impacts on Water Quality

Water proposed to be released from the Project includes:

- Treated water of a quality comparable to the background water quality of the receiving waters within Wallarah Creek at the Tooheys Road Site (see Section 3.9.1 for a description of how this process will be achieved); and
- Water released into Buttonderry Creek at the Buttonderry Site, which will be released after sedimentation occurs in the Entrance Dam.

The watercourses within the Subsidence Impact Limit may be impacted as a result of subsidence effects resulting in the potential for some localised erosion and sediment movement along the streams. However, these streams are subject to continual erosion and realignment under existing natural conditions. The subsidence effects predicted for the Project are unlikely to result in any measurable changes to the existing water quality .

Water Licensing Requirements

Table 40 shows the volumes of water that WACJV is entitled to take pursuant to harvestable rights. This table shows that harvestable rights are sufficient for authorising the runoff volumes taken from the undisturbed catchment.

7.3.4 Mitigation and Management

Water Management System

WACJV will implement the water management system described in Section 7.3.1 and assessed in the water balance modelling. This water management system has been designed to minimise the Project's surface water impacts.

The key principles of the water management system are:

- Diversion of clean surface water runoff away from areas disturbed by the Project;
- Operation of the water management system in a manner that avoids uncontrolled releases of unsuitable mine water from the site;
- Collection of potentially sediment-laden runoff in sediment dams for treatment prior to discharge or reuse;
- Transfer of mine water (groundwater inflows and water runoff from coal affected areas) to the Mine Operations Dam for treatment and reuse as a water supply or discharge as clean water to Wallarah Creek;
- Collection of contaminated water from industrial areas for treatment in an oil and grease separator prior to reuse in the water management system; and
- Minimising fresh water usage by using treated water from the water management system.

Further information about the proposed water management system is provided in Appendix J.

Surface Water Monitoring Program

WACJV will develop a surface water monitoring program, which will include expanded monitoring of surface water quality and stream stability. Monitoring of onsite, upstream and downstream water quality will assist in validating the effectiveness of the water management system. Monitoring will also allow potential impacts to be detected and managed at an early stage.

Water quality monitoring will include monthly monitoring of pH, EC and TSS for the dams at the Tooheys Road Site. These parameters will be monitored quarterly at the Buttonderry Site.

A review of water quality data will be performed annually. Water levels will be monitored weekly for the Portal Dam, Stockpile Dam, Entrance Dam and Treated Water Storage. Water levels will be monitored daily at the Mine Operations Dam.

Water quality monitoring will be undertaken at the 14 locations in the existing monitoring network. Two additional monitoring locations will be established:

- BD1 – located along Buttonderry Creek and near the F3 Freeway, which is downstream of the Buttonderry Site; and
- WTP – located along Wallarah Creek at the treated water discharge point.

WACJV will undertake a stream stability monitoring and management program in order to detect potential impacts of mining induced subsidence at an early stage of the Project. The program will include:

- A baseline ground survey of nominated creek cross-sections in areas of expected subsidence prior to undermining (surveys are part of the Subsidence Management Plan process);
- Periodic resurveys of nominated creek cross-sections following undermining;
- A walkover assessment of key areas, particularly around the confluence of Jilliby Jilliby and Little Jilliby Jilliby Creeks, identifying areas of water ponding, active bed and / or bank erosion;
- Qualitative assessments of the condition of riparian and floodplain vegetation;
- Photographing creek channel and floodplain conditions; and
- Preparation of a report documenting the results of each assessment with recommendations for any mitigation works that may be required.

This monitoring will initially be conducted quarterly, with additional inspections after significant flow events. The frequency of inspections will be modified as mining progresses. Inspections will be conducted less frequently after subsidence has stabilised.

Although subsidence effects and impacts have been assessed on a worst case basis to provide a high level of conservatism, the dynamic nature of fluvial systems makes it appropriate that an adaptive management approach be proposed for the management of stream stability.

Table 40 Harvestable Rights

Site	Land Area (ha)	Harvestable Right (ML)	Natural Catchment Area captured (ha)	Maximum Water Take (ML)	WAL Requirement (ML)
Buttonderry	83	9	0.3	0.6	Nil
Tooheys Road	354	39	13.4	22.9	Nil

Management measures will be developed in consultation with the relevant authorities and riparian landowners, and to the satisfaction of DP&I. The proposed monitoring program will enable impacts to be identified and managed on a case-by-case basis. However, these works will be carefully planned to ensure that they are targeted towards actual subsidence impacts, rather than naturally occurring variability in the stream.

A key element of the proposed remediation approach will be the use of "soft" engineering techniques that will aim to minimise soil and vegetation disturbance by using low impact construction methods and natural materials. Given the dominant role of vegetation in maintaining bank stability in the alluvial reaches, well planned remedial works will ensure that bank and vegetation disturbance poses a low risk to stream stability. Where bed controls are required, the preferred approach will be to attempt to replicate natural channel features using, for example, large woody debris which already plays a significant role in bed control.

WACJV will develop an EMP describing surface water monitoring and management in consultation with NOW and to the satisfaction of DP&I in consideration of the above.

Surface Water Licensing

The Project will require WALs to account for the reduction in surface flows due to subsidence induced increases in alluvial storage. WACJV will require a WAL under the JJCW WSP for the maximum impact of 270 ML/year.

Similarly, a WAL under the CCUWS WSP will be required for the maximum impact of 30 ML/year on the Wyong River water source.

Erosion and Sediment Control Plan

WACJV will prepare an Erosion and Sediment Control Plan for the Project. Erosion and sediment control measures will be implemented to separate runoff from disturbed and undisturbed areas, and to treat runoff from disturbed areas.

Erosion and sediment control measures will be designed according to the design standards recommended in the following guidelines:

- 'Managing Urban Stormwater, Soils and Construction' (Landcom, 2004); and
- 'Managing Urban Stormwater, Soils and Construction, Volume 2E Mines and Quarries' (DECC, 2008).

Creek lines will be visually monitored to assess the extent of erosion (if any) caused by mining induced subsidence.

7.4 Flooding

7.4.1 Background

A Flood Impact Assessment has been undertaken by G Herman and Associates (GHA) and is provided in full in Appendix K. The purpose of the Flood Impact Assessment was to determine the potential impacts on local and regional flood regimes caused by mining induced subsidence.

Previous flood impact studies for the Project were completed in 1999 and 2007 by ERM. The mine plan for the Project, as described in Section 3.2 was developed with reference to these earlier studies in order to minimise potential flood impacts. The FIA identified the potential impacts of the Project on local and regional flood regimes and resultant impacts on agricultural land, transport corridors, services, habitability and public safety. It also identified measures required to mitigate potential flood impacts.

Local Surface Water Network

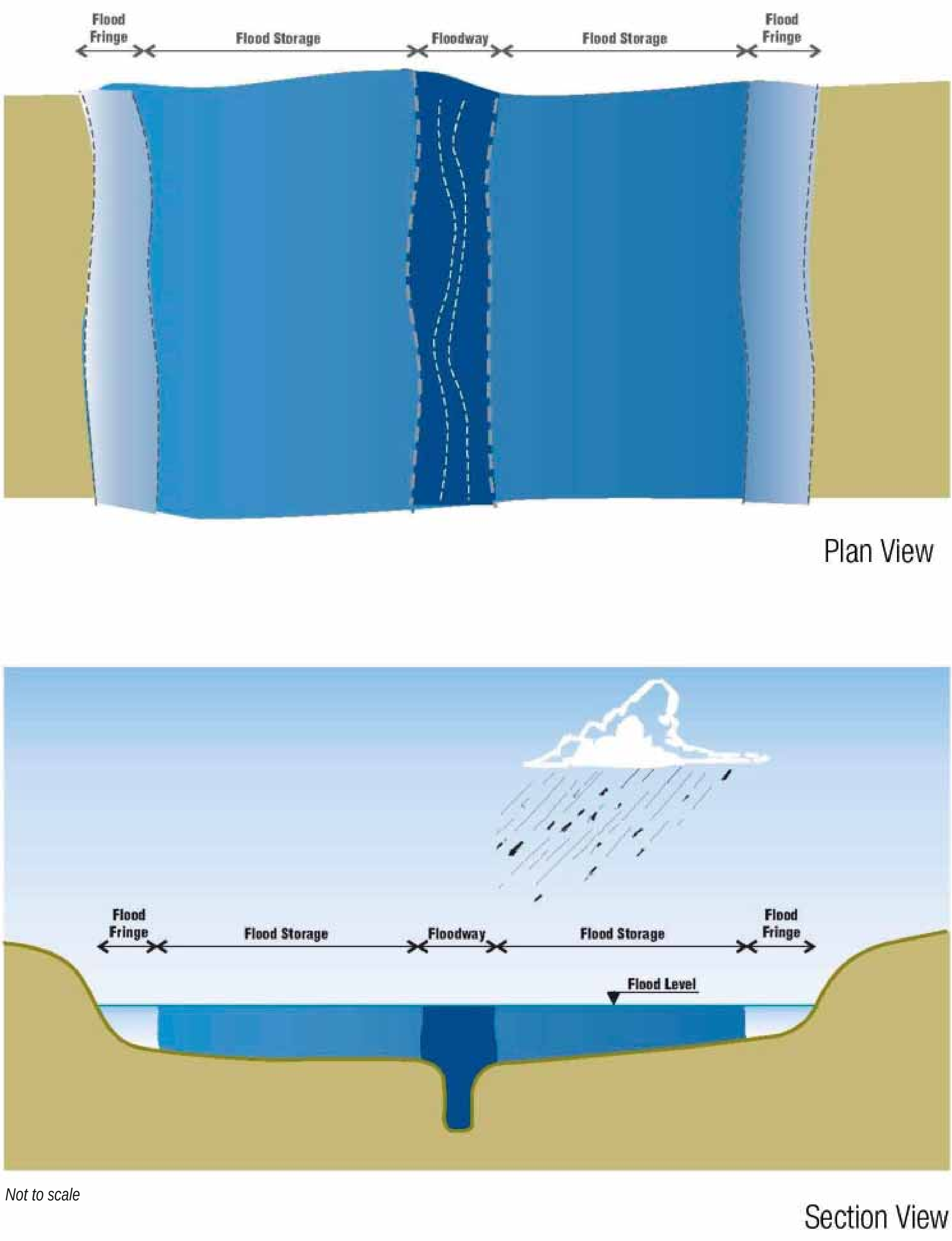
As explained in Section 2.3, the major catchments in the vicinity of the Project are the Wyong River catchment and an unnamed catchment between Jilliby Jilliby Creek and Buttonderry Creek. This unnamed catchment is referred to as the Hue Hue Creek catchment. The Wyong River catchment includes the Yarramalong Valley and Dooralong Valley, which are drained by the Wyong River and Jilliby Jilliby Creek, respectively. The floodplains of both streams are subject to regular inundation, given that the stream banks are overtopped during 2 to 5 year ARI flood events.

Hydraulic Categories

According to the *Floodplain Development Manual* (FDM) (DIPNR, 2005), a floodplain consists of the following components, known as hydraulic categories:

- The "Floodway" is the area of the floodplain that conveys a significant proportion of the flood flow. It is often aligned with the naturally formed main channel;
- The "Flood Storage" is the area outside of the floodway, which is important for the temporary storage of flood waters during the passage of a flood; and
- The "Flood Fringe" is the area outside of the flood storage, where depths and velocities are typically low.

Flow velocities and depths are usually greatest within the floodway. Flood storages are characterised by low to moderate velocities and are commonly defined by a line where constriction of the edge of the floodplain will produce an increase in depth of >0.1m or an increase in flow of >10%. The three hydraulic categories are depicted in Figure 33.



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Source: G Herman & Associates (2012)

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Floodplain Components

FIGURE 33

Hazard Categories

The FDM also defines the two hazard categories. A flood hazard is considered a "low hazard" where evacuation by trucks is possible and able-bodied adults can wade to safety. A flood hazard is considered a "high hazard" where evacuation by trucks is difficult and able-bodied adults cannot wade to safety, and where there is a danger to the safety of persons and structures. The hazard rating increases with flood depth and flow velocity.

7.4.2 Methodology

Previous flood assessments for mining in the Wyong Area by WACJV used the XP-RAFTS software for hydrological modelling and one-dimensional hydraulic models such as MIKE 11 and HEC-RAS. In 2008, the Independent Expert Panel conducting the *Strategic Review into coal mining in the Wyong Area* recommended that flooding predictions should be developed using two-dimensional flood modelling software instead of one-dimensional modelling packages. This recommendation was adopted for this assessment by conducting flood modelling using the TUFLOW package.

The topographical information utilised for the modelling was provided by two Digital Terrain Models (DTMs) prepared by WACJV. The first DTM was derived from a 1996 aerial survey, normalised against 150 ground survey stations. The second was produced during a 2006 Aerial Laser Survey (ALS), which provided topographical data to an accuracy of ± 0.1 m laterally and ± 0.2 m vertically.

The DTM derived from the ALS was used for virtually the entire floodplain area within the study area. The DTM derived from the 1996 aerial survey was used for areas outside of the ALS boundaries.

The 1996 aerial survey and 2006 ALS also generated high quality aerial photographs of the catchment area. The photographs indicated the vegetation types and land uses within the catchment. This information was used to estimate the surface roughness and permeability inputs for the TUFLOW model.

WSC has obtained additional ALS data since the development of the TUFLOW model. Although this additional ALS data extends further to the upper catchment areas, the ALS data used in this study is no less accurate for the area within the Subsidence Impact Limit.

Surveys were conducted to accurately define the creek cross-sections immediately upstream and downstream of bridges and culverts. These surveys also involved investigations of the bridges and culverts within the area. Actual rainfall and streamflow measurements were used to calibrate the TUFLOW model. Rainfall data was collected from rain gauges (owned by BoM) and pluviometers (owned by Manly Hydraulics Laboratory).

Streamflow data was obtained from stream gauges operated by NOW. Rainfall data that correlates with direct streamflow measurements can be used to determine the TUFLOW model parameters relating to runoff (initial losses, continuing losses and roughness). These parameters are adjusted until the modelled streamflows and flood levels replicate the actual recorded data.

Data from past storm events were used to calibrate the hydrological and hydraulic parameters in the TUFLOW model. For the Yarramalong / Dooralong model, the hydrological parameters were calibrated using data from the 1964, 1974, 1985, 1989, 1990, 1992 and 2007 floods. Three storms (1989, 1990 and 1992) were used to calibrate the various hydraulic parameters.

The flow data was sourced from the NOW flow gauges (Yarramalong, Gracemere and Jilliby) and water level data was obtained from WSC records and community accounts. There was no data available to assist in the calibration of the Hue Hue model. As a result, the parameters determined for the Yarramalong / Dooralong model were adopted for the Hue Hue model.

The largest flood event used in the hydrologic calibration of the Yarramalong / Dooralong model was the 1964 event. This flood represented a 40 to 50 year ARI event, which is classified as a moderate flood. In the absence of data for large floods to assist in the calibration exercise, the model has been developed using conservative parameters and has shown good correlation with low to moderate floods.

The TUFLOW model allows the rainfall intensity across a catchment to be varied by applying different hyetographs to different regions in the model. However, this assessment has adopted a conservative approach by taking the maximum intensity at any point in the catchment and applying this rainfall intensity to the entire catchment. Modelling using TUFLOW was initially performed for the existing topography to determine the pre-subsidence flooding behaviour. The topography was then amended to incorporate the effects of subsidence. The post-subsidence elevations were obtained by subtracting the predicted subsidence from the existing elevations (see Section 7.1). The TUFLOW model was then re-run for the post-subsidence topography to determine the impacts on flood behaviours.

The predictions of subsidence were sourced from the SIR (Appendix H) and are considered to be upper bound estimates. Flood modelling has been performed for 50%, 75% and 100% of the maximum predicted subsidence effects. Modelling these three cases provides a better indication of the range of flooding impacts caused by subsidence.

7.4.3 Impact Assessment

Subsidence has the potential to alter the topography within a floodplain, which can alter flood behaviours. The predicted subsidence for the Project is described in detail in Section 7.1. The maximum conventional subsidence for the main channel and floodplain of the Wyong River is predicted to be 150 mm, which is not considered significant. As a result, the changes to flood extents and depths in the Yarramalong Valley are expected to be negligible.

Subsidence is expected to occur along approximately 5.2 km of Jilliby Jilliby Creek and Little Jilliby Jilliby Creek, with conventional subsidence being generally less than 1.3 m. The floodplain of Jilliby Jilliby Creek will generally experience similar levels of conventional subsidence, although the Little Jilliby Jilliby Creek floodplain will experience less subsidence. Subsidence will occur along a 1.3 km section of the Hue Hue Creek floodplain, with conventional subsidence peaking at 0.95 m.

Existing Flood Behaviour

The Yarramalong Valley floodplain is typically 300 m to 600 m wide, including a 100 m to 200 m wide floodway. The flood storage areas extend almost entirely to the flood limits, with the flood fringes accounting for less than 5% of the floodplain. Flow velocities in the main channel during flood events range from 0.7 m/s to 2.2 m/s. Overbank flow velocities during flood events range from 0.3 m/s to 0.6 m/s, which are considered low. The majority of the Yarramalong Valley floodplain is categorised as high hazard, with flood depth being the main factor for this categorisation rather than flow velocity.

The Dooralong Valley floodplain is between 900 m to 1,400 m wide, with a floodway of 50 m to 100 m in width. The flood fringe accounts for around 10% to 20% of the floodplain area. Flow velocities in the main channel range from 0.5 m/s to 2.0 m/s and overbank velocities range from 0.02 m/s to 0.6 m/s. Due to the low overbank velocities, the majority of the floodplain is classified as low hazard. High hazard areas are generally limited to low lying areas adjacent to Jilliby Jilliby Creek and large farm dams. The lower 2.5 km of the Dooralong Valley is also high hazard due to flood depths caused by backwaters from the Wyong River.

The Hue Hue Creek floodplain is typically 200 m to 300 m wide and widens to 500 m near the F3 Freeway. The floodway is approximately 100 m to 150 m wide. The flood storage area extends almost entirely to the flood limits, with flood fringes taking up less than 6% of the floodplain. Flow velocities are generally low, except where the floodplain narrows between Sandra Street and Hue Hue Road. The majority of the floodplain is classified as high hazard, due mainly to flood depths.

Hydraulic controls for Hue Hue Creek exist due to culverts under Hue Hue Road and the F3 Freeway. As a result, tailwater levels downstream of the F3 freeway only have a negligible effect on flood levels.

During flooding, the F3 Freeway behaves like a dam, resulting in low flow velocities upstream of its embankment. Sandra Street and Hue Hue Road behave in a similar manner, but are overtopped during a 100 year ARI event.

Comparison with Other Studies

In order to validate the TUFLOW model for Hue Hue Creek, the predictions of the model were compared to the results of other flood studies. The 100 year ARI flood extent predicted by the model was almost identical to the Flood Planning Area shown in the Draft Porters Creek Floodplain Risk Management Plan.

Predicted flood levels for the Yarramalong Valley were compared to the finding of the *Lower Wyong River Floodplain Risk Management Study and Plan* (Paterson Consultants, 2010) and the *Upper Wyong River Flood Study* (Public Works Department, 1988). The predictions of the TUFLOW model were comparable to or more conservative than the results of previous studies.

Post-subsidence Flood Behaviour

Subsidence will generally result in a lowering of flood levels. This is because the water level drops with the land surface. However, the flood depth will generally increase within subsided areas. Flood behaviour in the Yarramalong Valley is not predicted to change significantly as a result of subsidence. This is due to the constraints incorporated into the mine plan to minimise subsidence effects on the Wyong River floodplain. The flood levels in the Yarramalong Valley are predicted to decrease by 0.01 m to 0.03 m. These small changes are due to subsidence effects on the Dooralong Valley creating a flood detention effect that reduces peak flows entering the Wyong River from Jilliby Jilliby Creek.

As there will be no significant areas of subsidence in the Yarramalong floodplain, flood depths in the Yarramalong Valley will also decrease by approximately 0.01 m to 0.03 m in almost all locations. The lateral flood extent will decrease by up to 5 m, which translates to a reduction in flood prone land of 0.55 ha. The only increases in flood depths within the Yarramalong Valley occur at three small backwaters on the left bank of the Wyong River that will experience minor subsidence. The flood fringe for these backwaters during a 100 year ARI event will increase by 5.2 ha. The increase in flood fringe arises since the topography has subsided without any material reduction in the flood level of the Wyong River.

The following changes to flood behaviours are predicted to occur in the Dooralong Valley during a 100 year ARI event:

- Flood levels will decrease by up to 1.3 m, but there are areas in the valley where the flood levels will remain unchanged;
- Flood depths will increase by up to 1.3 m, but generally by less than 0.5 m;
- Inundation extent on a lateral basis will increase by up to 240 m in areas affected by subsidence; and
- An additional 33.2 ha of land will become inundated; however 4.9 ha of land will no longer be inundated, resulting in a net increase in inundation of approximately 28.3 ha.

Changes in flood behaviours will be experienced along the 8.7 km length of Jilliby Jilliby Creek, upstream of its confluence with the Wyong River. The post-subsidence flow velocities are predicted to be similar to existing flow velocities. Subsidence will also alter the proportions of the three floodplain components. In the Dooralong Valley, approximately 28 ha of flood fringe will become flood storage and approximately 12 ha of flood storage will become floodway.

Conversely, there are also 7 ha of flood storage that will become flood fringe and 4 ha of floodway that will become flood storage. The predicted changes to the flood extents of the Yarramalong Valley and Dooralong Valley are shown in Figure 34.

Flood levels in the Hue Hue Creek floodplain will generally decrease by less than 0.1 m. However, the area immediately upstream from Sandra Street will experience a decrease of up to 0.5 m. The flood depth will increase by up to 0.64 m; however the increase in flood depth over most of the floodplain will be much less. The flood extent across the floodplain will increase by up to 30 m in the 1.6 km reach of the floodplain that is directly impacted by subsidence. An additional 1.9 ha of land will become inundated during flooding, but there will also 0.8 ha of land that will no longer become inundated. The post-subsidence flow velocities will remain similar to existing flow velocities. Due to the predicted increases in flood depths, the floodplain will remain in the high flood hazard category.

Impacts on Dwellings

Yarramalong Valley and Dooralong Valley

There are 283 known properties that are wholly or partially located within the predicted floodplains of the Wyong River and Jilliby Jilliby Creek considered in the Flood Impact Assessment study area. There are 88 structures (83 dwellings and five sheds) within or close to these floodplains (see Table 41). The five large sheds are not primarily used as dwellings. The majority of the dwellings are located in low hazard flood storage areas or flood fringe areas and are currently flood prone in the 100 year ARI flood.

There are 13 other dwellings located downstream of the flood impact assessment study area near the F3 Freeway or Deep Creek that will experience small beneficial impacts due to the (backwater) detention effects mentioned previously. These have not been considered in the flood impact assessment as they are too distant from the Subsidence Impact Limit to be significantly affected by the Project.

For a 100 year ARI flood event, 14 of the 83 dwellings will not experience any material changes to flood impacts. An additional 36 dwellings and three sheds will be beneficially impacted by the Project. That is, the predicted subsidence will lead to reduced flood impacts to these dwellings. A total of 33 dwellings and two sheds are predicted to be adversely impacted by the Project.

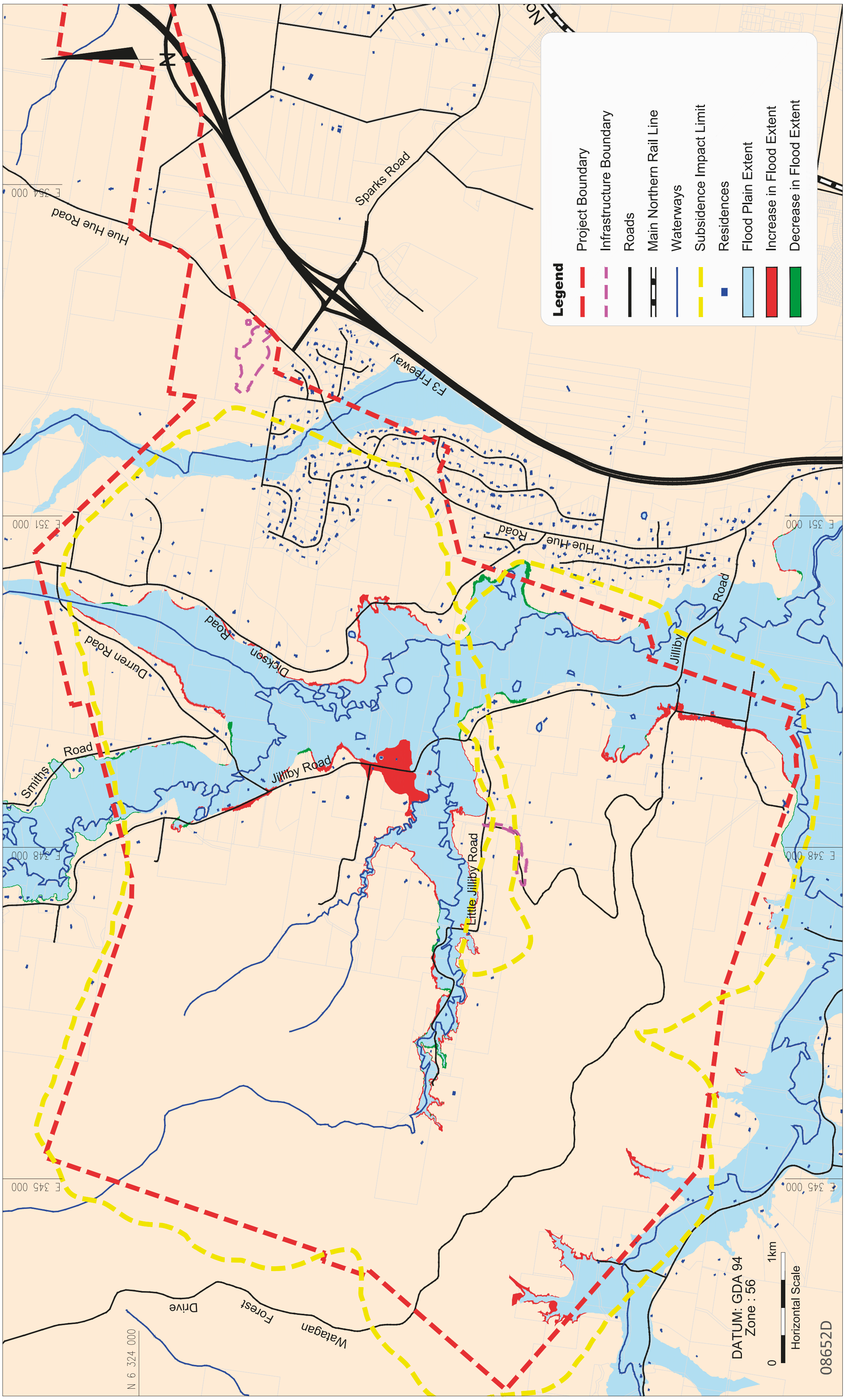
Of the 33 dwellings that are predicted to experience adverse impacts, four dwellings were not previously subject to inundation by flooding (see Table 42). That is, these dwellings are predicted to become subject to flooding as a result of the subsidence for the Project. There are an additional 10 dwellings and two sheds that will experience increased flood inundation. These dwellings are already prone to inundation, but will experience inundation more frequently (as the flood levels will exceed the floor levels during lesser floods). The remaining 19 dwellings will remain fully or partially within the flood limits, but will have reduced freeboard).

Of the 36 dwellings and three sheds that are predicted to be beneficially impacted, 33 will experience minor decreases in the frequency of inundation. The other six structures will have increased freeboard and will not be prone to inundation. The impacts on dwellings located within the Yarramalong and Dooralong Valley floodplains are summarised in Table 41.

Table 41 Impacts on Structures within the Yarramalong and Dooralong Valleys

Flood Event	Number of Structures			
	Positively Impacted	Adversely Impacted	Impacts Unchanged	Total
100 year ARI	39	35	14	88*
5 year ARI	36	33	10	79

*Of the 88 structures within or close to these floodplains, five are large sheds and are not primarily used as dwellings



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Subsidence Impacts on Flooding - 100 Year ARI Flood

FIGURE 34

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Table 42 Flooding Impact Categories for Dwellings

Category	Description	No. Affected	Affected Dwellings	Impacts
A	**Major Impacts**			
A1	House floor not flooded by 100 yr ARI flood prior to mining but becomes flooded after mining	5	D0060, D0061, D0063, D0855, D0430	Significant Impact – major increase in damage costs
A2	House floor flooded by 100 yr ARI flood prior to mining with >0.3 m increase in flooding after mining PLUS house floor not flooded by 5 yr ARI event flood prior to mining but becomes flooded after mining	1	D0237	Major Impact – increase in frequency of damage plus some increase in maximum damage costs
B	**Moderate Impacts**			
B1	House floor flooded by 100 yr ARI flood prior to mining with >0.3 m increase in flooding after mining BUT will remain unaffected by 1:5 yr (20%) flood	1	D0017 (Also a local heritage silo affected)	Moderate Impact – moderate increase in frequency and cost of damage from larger floods
B2	House floor flooded by 100 yr ARI flood prior to mining with only minor (<0.3 m) increase in flooding after mining	7	D0041, D0058, D0767, D0776, D0589 and two sheds: S0041, S0776	Moderate Impact - minor increase in frequency and cost of damage from very large floods
B3	House floor not flooded by 100 yr ARI flood prior to mining nor flooded after mining, BUT freeboard reduced by more than 0.5 m to <0.3 m after mining	3	D0240, D0870, D0513	Moderate Impact - moderate change in risk and no direct cost impacts but planning constraints no longer satisfied for freeboard
C	**Minor Impacts**			
C1	House floor not flooded by 100 yr ARI flood prior to mining nor flooded after mining, BUT freeboard reduced by less than 0.5 m to <0.3 m after mining	4	D0049, D0203, D0862, D0863	Minor Impact - slight change in risk and no direct cost impacts but planning constraints no longer satisfied for freeboard
C2	House floor flooded by 100 yr ARI flood prior to mining with negligible (<0.05 m) increase in flooding after mining	4	D0051, D0615, D0736, D0851	Minor Impact - negligible change in risk or cost impacts
C3	House floor not flooded by 100 yr ARI flood prior to mining nor flooded after mining, BUT freeboard reduced to 0.3 m to 0.5 m range	2	D0432, D0737	Minor Impact - less than desirable freeboard but negligible risk and no cost impacts
D	**Negligible Impacts**			
D	House floor not flooded by 100 yr ARI flood prior to mining nor flooded after mining and change in freeboard <0.1 m and freeboard remains >0.3 m (OR freeboard remains >0.5 m after subsidence regardless of reduction)	14	D0042, D0050, D0197, D0207, D0209, D0220, D0221, D0236, D0614, D0713, D0773, D0507, D0587, D0588	No impacts and no significant change
E	**Beneficial Impacts**			
E1	Significant (>0.2 m) reduction in flood levels in 100 yr ARI flood after mining plus achieving a freeboard of at least 0.3 m after mining	1	D0226 (freeboard increased from 0.25 m to 0.31 m)	Moderate Beneficial Impact
E2	Minor (0.05 m to 0.2 m) reduction in flood levels in 100 yr ARI flood after mining and no change to flood category after mining	2	D0852, D0415	Minor Beneficial Impact
E3	Negligible (<0.05 m) reduction in flood levels and/or freeboard after mining for all floods	46	(Tables 6.2 and 6.3 of Appendix K)	No impacts and no significant change
U	**Unchanged**			
U	No change in flood depths after mining but minor change in ground levels	14	D0006, D0009, D0048, D0106, D0108, D0115, D0170, D0201, D0377, D0384, D0712, D0869, and sheds S0048, S0842	No impacts

For a 5 year ARI event, the flood impacts will remain unchanged for 10 structures. For another 36 structures, flood impacts will improve as a result of subsidence. Nine of these dwellings will experience less frequent inundation. It is predicted that 33 structures will be adversely affected by the Project, including 10 structures which will be subject to increased inundation during a 5 year ARI event.

Hue Hue Creek

In the Hue Hue Creek catchment, there are a number of dwellings near the flood extent for a 100 year ARI event. There is only one dwelling that is prone to inundation under existing conditions. This dwelling will become subject to more frequent inundation as a result of subsidence. There is one other dwelling, currently not subject to inundation, that will become subject to inundation as a result of subsidence (see Table 42). There is another dwelling that is currently affected as flooding blocks access to the property from Cottesloe Road. This impact will remain unchanged after subsidence. Four dwellings will experience a reduction in freeboard as a result of the Project. Ten dwellings will be positively impacted through an increase in freeboard as a result of the Project. The Project will not adversely impact any infrastructure through changes to the flood behaviours of Wallarah Creek.

The changes to flood impacts on dwellings were categorised according to the extent and nature of the change. Adverse impacts are categorised as either A, B, C or D, with Category A being the most serious and Category D being the most minor. Beneficially impacted dwellings are within Category E, and dwellings where there are no changes to flood impacts are allocated to Category U. The categorisations for the affected dwellings are shown in Table 42.

Impacts on Access to Property

In addition to inundation, flooding can also affect dwellings by interrupting access to the property. In the Hue Hue Creek catchment, both Sandra Street and Hue Hue Road are expected to be inundated during a 100 year ARI event. However, access to properties in the Hue Hue precinct will still be available via other routes.

Flood depths at low points along roads are critical because these are the first locations that will be inundated. Flood levels at these locations will determine whether the route is trafficable by vehicle. The flood depths that can be trafficked are dependent on the flow velocity and depth as shown in Table 43.

The assessment identified 32 low points in the Yarramalong and Dooralong valleys, including 15 key low points. The key low points are the points that are potentially affected by subsidence. The remaining 17 low points are either too distant to be affected or are in areas where flood depths will be unchanged or slightly reduced. Each of these points is located on a primary access route for at least one property. The duration of inundation will increase for 7 of the 15 key low points as a result of subsidence. The other eight key low points will experience no material changes to their duration of inundation and trafficable flood level. The changes to inundation impacts for these 15 locations are provided in Table 44. The remaining 17 low points will experience a slight reduction in the duration of inundation.

Inundation durations after subsidence will be similar to or slightly lower than existing durations for low points in the Yarramalong Valley. Subsidence will not result in any major access interruptions for any dwellings that are not already subject to access interruptions. Three dwellings (D0016, D0028 and D0042) will experience access interruptions for a slightly longer period due to increased flooding of tertiary access roads.

In the Dooralong Valley, subsidence will not result in access interruptions for any dwellings that are not already impacted under existing conditions. The increase in inundation durations at low point D50 (see Table 44) will result in longer interruptions for 172 dwellings. Subsidence will increase the duration of impacts by slightly more than one day. These 172 dwellings will also be affected by increased inundation durations at points D80 and D81, but to a much lesser degree. An additional 20 dwellings will experience slightly longer access interruptions due to increased inundation durations at point D60. Increased inundation durations at point D70 will cause 27 dwellings to experience moderately longer interruptions (increase of 13 to 26 hours).

Table 43 Flooding - Safe Depths for Vehicles

Flow Velocity (m/s)	Maximum Safe Depth (m)
0 – 0.5	0.30
0.5 – 1.0	0.25
1.0 – 1.5	0.20
1.5 – 2.0	0.15
No depth is considered safe for flow velocities greater than 2 m/s	

Source: NSW Floodplain Development Manual (2005)

Table 44 Changes to Flooding Inundation of Primary Access Route Low Points

Road Low Point ID	Maximum Existing Trafficable RL (m AHD)	Maximum Subsided Trafficable RL (m AHD)	Existing Inundation Duration (hours)		Post-mining Inundation Duration (hours)		Increase in Inundation Duration (hours)	
			100 yr ARI	5 yr ARI	100 yr ARI	5 yr ARI	100 yr ARI	5 yr ARI
D20	20.0	20.0	19	9	19	9	Nil	Nil
D30	19.3	19.3	5	0	5	0	Nil	Nil
D40	18.35	18.35	19	11	19	11	Nil	Nil
D41 (Bridge C)	15.40	14.21	24	24	22	21	Nil	Nil
D50	10.0	8.7	6	0	33	31	27	31
D60 (Bridge A)	7.9	7.9	24	21	24	22	Nil	1
D70	12.45	11.24	15	12	28	25	13	14
D80 (Bridge B)	14.9	13.7	10	0	15	11	5	11
D81	14.7	13.4	11	4	17	10	6	6
Y80	12.6	12.4	71	68	73	69	2	1
Y90 (Bridge 7)	13.06	12.95	62	54	63	55	1	1
Y170 (Bridge 3)	9.84	9.84	50	50	50	49	Nil	Nil
Y180 (Bridge 2)	9.20	9.20	51	50	51	50	Nil	Nil
Y190	9.25	9.25	33	32	33	32	Nil	Nil
Y230	7.85	7.85	10	0	10	0	Nil	Nil

The access interruptions described above are the impacts to primary access routes. Access to some dwellings may still be available via secondary routes. However, if points D50 and D70 become inundated concurrently, 198 dwellings in the Dooralong Valley will become temporarily inaccessible for longer periods. These dwellings will be inaccessible for up to 28 hours, which is an increase of 13 hours on pre-subsidence conditions. Even when primary and secondary access routes become inundated, there are emergency evacuation routes available.

Sensitivity Analysis

The impacts discussed above are the results of the base case model. The input parameters for the base case model were determined through the calibration process. A sensitivity analysis was conducted to determine the changes to the predicted impacts caused by potential variations to the input parameters. The sensitivity model runs were performed for a 100 year ARI flood event.

The base case model used initial loss values of 15 mm to 20 mm and continuing losses of 1.5 mm/h. In order to simulate the impacts on a moderately saturated catchment, a sensitivity model run was performed for an initial loss of 5 mm and continuing losses of 1 mm/h (low losses scenario) to represent an extremely saturated catchment. Compared to the base case model, flood levels under the low losses scenario increased by no more than 0.02 m. This indicates that flood levels are not sensitive to antecedent wetness conditions. The flow velocities remained similar to the values predicted by the base case model. Consequently, there was no change to the flood hazard categories.

The sensitivity analysis also accounted for the possible impacts of climate change by increasing the design rainfall intensity by 20% (high rainfall scenario). Flood levels under this scenario were up to 0.45 m higher than under the base case model.

There will be no increase in the number of flood impacted dwellings under both the low losses scenario and higher rainfall scenario. That is, there are no impacted dwellings under these scenarios that were not already identified as impacted by the base case model.

However, some of the impacted dwellings will experience a greater degree of inundation under the low losses scenario and high rainfall scenario:

- Three dwellings will change from Category B3 to A1;
- One dwelling will change from Category C1 to A1;
- Three dwellings will change from Category C1 to B2;
- One dwelling will change from Category C2 to C1; and
- One dwelling will change from Category C3 to C1.

Although none of these scenarios is representative of the 100 year ARI design storm, these results should be revisited in the event that climate change results in changes to the design storms.

The other effect of climate change considered in the sensitivity analysis was rising sea levels. The tailwater levels at the downstream boundary of the flood study area (the F3 Freeway) were increased by 1.1 m to reflect increases in sea levels. In the Yarramalong Valley and Dooralong Valley, the increase in tailwater levels did not have any impact on flood behaviour beyond 600 m upstream of the F3 Freeway. There are no significant changes to the Hue Hue Creek flood levels upstream of the F3 Freeway. This shows that flood levels and extents are not sensitive to tailwater levels.

The surface roughness values used in the base case were increased by 10% for the sensitivity analysis. Such an increase is unlikely unless there is substantial revegetation of the area. Increasing surface roughness by 10% resulted in slightly lower peak flows and an increase in flood levels of up to 0.15 m. Under this scenario, one dwelling will change from Category C3 to C1, and another will change from Category C1 to B2.

The results of the base case scenario assumed that the maximum predicted subsidence impacts will occur. It is expected that actual subsidence will be in the range of 50 – 100% of the maximum predicted subsidence. As a result, the sensitivity analysis model was run for 50%, 75% and 100% of maximum predicted subsidence. As expected, the flood impacts are lower when the subsidence impacts are lower. Although the actual subsidence is likely to be lower than the maximum predicted values, changes to flood impacts have been assessed assuming the worst case subsidence.

The subsidence predictions relied upon in this flood impact assessment are detailed in Section 7.1.

7.4.4 Mitigation and Management

Summary

WACJV will prepare a Water Management Plan (WMP) which will include details on the potential flood impacts and the management and mitigation measures to be applied, as discussed further below.

The WMP will require the updating of the flood model as subsidence monitoring data becomes available to enable flood impacts to be appropriately managed.

Dwellings

WACJV is committed to ensuring that any additional flood impacts resulting from the Project are appropriately mitigated and managed. WACJV will implement mitigation and management measures where properties are predicted to experience an increase in adverse flood impacts (compared to pre-mining conditions) as a result of the Project. WACJV bears no responsibility for existing flooding impacts that are not altered as a result of the Project. Potential flood management measures are suggested by the *NSW Floodplain Management Manual* (2005), and are grouped into three categories: flood modification, response modification and property modification as described further below.

Flood Modification

Flood modification involves altering flood behaviour using hydraulic structures (such as dams and levees). A number of flood modification options were considered for the Hue Hue Creek catchment (see Appendix K). Most of these options were considered unsatisfactory because they only alleviated impacts for some dwellings, whilst resulting in additional impacts to others. The only potential flood modification with widespread benefits is the raising of Sandra Street. Raising the level of Sandra Street increases the retarding storage upstream. This option will worsen flood impacts for a single dwelling immediately upstream of Sandra Street, but will mitigate flood impacts for all other dwellings in the Hue Hue precinct.

Flood modification options are not required in the Yarramalong Valley due to minor additional impacts within this region. Due to the magnitude of flooding in the Dooralong Valley, flood modification structures will be neither practical nor effective and are not proposed.

Response Modification

Response modification involves developing administrative and procedural controls, such as community readiness, evacuation arrangements and flood predictions and warnings. Response modifications are generally measures that are adopted by local councils and local communities.

WACJV will provide flood model information and predictions to WSC to provide assistance in flood planning into the future. WACJV will also provide flood predictions to affected properties and WSC as these are updated over the life of the Project.

Property Modification

Property modification involves altering dwellings and other structures impacted by flooding. The four options available are:

- House raising;
- House relocation;
- Flood proofing using individual flood levees; and
- Voluntary purchase of affected properties (or other compensation).

House raising involves raising the floor level to above the post-subsidence flood level for a 100 year ARI event, with a freeboard of 300 mm to 500 mm. House raising is widely practised in NSW, but is not suitable for all houses.

House relocation involves moving a dwelling to a higher location on the landowner's property. Three adversely affected dwellings are timber-framed and have floor joists. As a result, house raising and relocation are suitable measures for the following dwellings:

- D0060 needs to be raised 0.6 m or relocated;
- D0061 needs to be raised 0.9 m or relocated; and
- D0237 needs to be raised 2.0 m or relocated.

There may also be other timber-framed buildings that can be raised or relocated. Where a property is unsuitable for relocation by virtue of its construction, 'relocation' will involve building a new but similar dwelling on that particular property.

Flood levees are typically in the form of a grassed bund constructed around the dwelling (ring levee). Flood levees are a suitable mitigation measure for the following dwellings: D0017, D0058, D0737, D0063 and D0430. Prior to the construction of any levees, the levee design will be modelled to determine whether there are any adverse effects caused by the levee itself. Changes will be made to the levee design to ensure that flood impacts are acceptable.

There are some high hazard areas where property modification options are impractical or ineffective. In these situations, WACJV may need to purchase the affected properties or provide compensation.

Property Access

Mining induced subsidence has the potential to reduce the elevations of low points along access routes. The reduction in elevations to these areas results in longer periods of inundation along these routes, and consequently prolongs the periods where access to properties is affected. These impacts can be mitigated by raising the potentially affected access routes or providing alternative access.

The level at low point D50 along Jilliby Road is predicted to reduce from RL10.7 m to RL8.4 m as a result of subsidence. In order to restore inundation durations to pre-subsidence values, a 400 m section of this road will need to be raised to RL8.9 m.

Low point D70 along Dickson Road will subside from RL12.2 m to RL10.9 m. In order to re-establish pre-subsidence inundation durations, a 400 m section of Dickson Road will need to be raised to RL14.0 m. If this is not practicable, alternative access may need to be provided.

Low point D80 on Jilliby Road will subside from RL14.6 m to RL13.2 m. Raising a 480 m section of the road to RL14.5 m will restore impacts to existing levels. Raising the road to RL15.0 m will completely flood proof the road, but significant culverts will be needed to maintain flow capacity.

Subsidence at low point Y80 on Boyds Lane Access increases the inundation duration by two hours. An 80 m stretch of this road will need to be raised by 0.4 m to mitigate this impact. Low point Y90 on Boyds Lane is a bridge crossing the Wyong River. This bridge needs to be raised by 0.1 m to mitigate additional impacts caused by the Project.

7.5 Air Quality

7.5.1 Background

An Air Quality and Greenhouse Gas Assessment was undertaken by PAEHolmes and is provided in Appendix L. The Greenhouse Gas Assessment is summarised in Section 7.6. A Health Risk Assessment is provided separately in Appendix M and summarised in Section 7.7.

The purpose of the assessment was to conduct a quantitative assessment of potential construction and operational air quality impacts on receivers with a particular focus on dust emissions including $PM_{2.5}$ and PM_{10} and the dust generation from coal transport. An odour assessment was also conducted in relation to ventilation air.

The assessment also recommends reasonable and feasible measures to mitigate dust impacts as well as outlining proposed monitoring and management measures.

7.5.2 Methodology

Meteorological Data

The CALMET / CALPUFF modelling system uses meteorological data and geophysical information to simulate the effects of temporally and spatially varying meteorological conditions on pollutant transport, transformation and removal. The modelling used for this assessment has been conducted in accordance with the guidelines published by the NSW Environment Protection Authority (EPA) (2011).

The model was centred on the proposed Tooheys Road Site, and used information gathered from WACJV plus the BoM data from Cooranbong (located 15 km north) and Norah Head (located 14 km south-east). Cloud amounts and cloud heights were sourced from observations at Williamtown RAAF base (located 60 km north-east). The windroses extracted from the CALMET modelling system used for the Project are shown in Figure 8.

Background Air Quality

An EMP was commenced in 1996, which provided monthly averages for dust fallout levels. In addition, PM_{10} and $PM_{2.5}$ concentrations were measured by High Volume Air Samplers (HVAS). Air quality monitoring was discontinued in early 2004 but recommenced in late 2006 and has continued to date.

The following provides a summary of the results of background air quality monitoring in the vicinity of the Project.

The locations of the current monitoring sites shown on Figure 13 include:

- Two HVAS measuring PM_{10} on a one day in six cycle;
- Two HVAS measuring Total Suspended Particulates (TSP) on a one day in six cycle until March 2012, with only one HVAS for TSP thereafter; and
- Six dust deposition gauges.

The background 24-hr PM_{10} concentrations are generally below the OEH air quality criterion of 50 µg/m^3. Exceedances of the criterion are usually associated with bushfires, dust storms and dry, hot conditions.

The annual average PM_{10} concentration has been below the criterion of 30 µg/m^3 for all years except 2002 and 2006. The annual average for 2002 is not representative of conditions for that year because monitoring was only undertaken in November and December, a period that was impacted by bushfires. Since PM_{10} monitoring was commenced in 1999, the mean annual average PM_{10} concentrations recorded at the two HVASs are 15 µg/m^3 and 21 µg/m^3. Since the commencement of TSP monitoring in 1999, the annual average TSP concentrations have been considerably lower than the criterion of 90 µg/m^3.

Dust deposition has been measured since 1997. The only exceedance of the annual average dust deposition criterion of 4 g/m^2/month occurred in 2005 at dust gauge D20. Annual average dust deposition levels are generally well below the criterion.

In the absence of $PM_{2.5}$ monitoring, an estimate was made from ratios of PM_{10} / $PM_{2.5}$ measured at the closest EPA monitoring sites. Data from the EPA monitoring sites at Beresfield and Wallsend indicate that $PM_{2.5}$ concentrations are approximately 30% of PM_{10} concentrations. By applying this ratio to historical PM_{10} levels, the annual average $PM_{2.5}$ concentration was determined to be approximately 5 µg/m^3.

Background NO_2 levels were collected as part of the Munmorah Rehabilitation EA (Aurecon, 2009). Annual average NO_2 levels for the area are less than a third of the ambient air quality goal of 62 µg/m^3, and maximum 1-hour NO_2 levels are less than half of the ambient air quality goal of 246 µg/m^3.

The assessment of air quality impacts for the Project requires consideration of the contributions from other local sources, including traffic along major transport routes, local power stations, domestic wood fires, local unsealed roads and exposed areas.

Dust Assessment Criteria

Table 45 and Table 46 summarise the OEH air quality assessment criteria relevant to the Project. Generally, these air quality criteria relate to the total dust burden in the air and not just the dust that is generated by the Project. As such, considerations of background levels need to be made when using these criteria to discuss impacts.

In addition to the consideration of the possible health impacts, airborne dust also has the potential to cause nuisance impacts by depositing on surfaces. Table 46 shows the maximum acceptable increase in dust deposition over the existing dust levels. The criteria for dust fallout levels are set to protect against nuisance impacts on a cumulative basis from all dust sources (DEC, 2005).

The Approved Methods criteria are typically consistent with the National Environment Protection Measures for Ambient Air Quality (Ambient Air-NEPM) (NEPC, 1998). In May 2003, the Ambient Air-NEPM was amended to include advisory reporting standards for particulate matter with an equivalent aerodynamic diameter of 2.5 µm or less ($PM_{2.5}$). The purpose of the amendment was to gather sufficient data nationally to facilitate the review of the Ambient Air-NEPM, which is currently underway. The Ambient Air-NEPM $PM_{2.5}$ advisory reporting standards are not impact assessment criteria and are shown in Table 47.

Odour Assessment Criteria

Odour criteria for the Project have been refined by the EPA to take into account the population density of the area. Table 48 lists the odour assessment criteria exceeded not more than 1% of the time for different population densities.

Table 45 Particulate Matter Assessment Criteria

Pollutant	Criteria ($\mu g/m^3$)	Averaging Period	Agency
TSP	90	Annual mean	National Health and Medical Research Council
PM_{10}	50	24-hour maximum*	OEH
	30	Annual mean	OEH long term reporting goal
$PM_{2.5}$	25	24 – hour Maximum	NEPM
	8	Annual	NEPM

Source: DEC, 2005 * Applies for each of i) Project alone and ii) Cumulative, provided the Project is implementing best practice dust controls

Table 46 Dust Deposition Assessment Criteria

Pollutant	Averaging Period	Maximum Increase in Deposited Dust Levels (g/m^2/month)	Maximum Total Deposited Dust Levels (g/m^2/month)
Deposited Dust	Annual mean	2	4

Table 47 EPA Advisory Reporting Standards for $PM_{2.5}$

Pollutant	Averaging Period	Standard / Goal	Agency
$PM_{2.5}$	Annual mean	8 $\mu g/m^3$	Ambient Air-NEPM Advisory Reporting Standard
	24-hour average	25 $\mu g/m^3$	

Table 48 Impact Assessment Criteria for Complex Mixtures of Odorous Air Pollutants

Population of the Affected Community	Odour Performance Criteria (nose response odour certainty units at the 99th percentile)
Single residence (≤~2)	7
~10	6
~30	5
~125	4
~500	3
Urban (>2,000), schools and hospitals	2

Air Quality and Odour Modelling

Air quality dispersion modelling and the assessment of air pollution sources has been undertaken in accordance with the Approved Methods (DEC, 2005). Dispersion models have been used in order to predict ground level concentrations of key pollutants. In order to estimate emissions for the operational phase of the Project, two scenarios were assessed. The first scenario assumes a daily production equal to the average daily production needed to achieve the maximum annual production rate of 5 Mtpa.

In reality, it is likely that there will be days when the production exceeds the average daily production needed to achieve 5 Mtpa. In order to predict the worst case air quality impacts, the second scenario considered the maximum production that can be achieved in a single day. This approach is very conservative.

The ventilation shaft at the Buttonderry Site was modelled as a vertically discharging point source. The emissions from flaring of methane were also included in the assessment. In estimating dust emissions, consideration has been given to Best Practice Management (BPM) and applicable controls have been applied to significant dust sources. During the construction phase of the Project, the estimated emissions are less than 35% of the emissions that are expected to occur during the operation phase. Therefore, compliance with the air quality criteria during the operational period will ensure that the criteria are complied with during the construction period.

7.5.3 Impact Assessment

Construction

During the construction of the surface infrastructure fugitive dust emissions can be expected from the following:

- Vegetation clearing / stripping;
- Bulk earthworks and material handling;
- Hauling along unsealed surfaces; and
- Wind erosion on exposed areas.

The total estimated emissions are less than 35% of the emissions estimated to occur during the operation of the Project and therefore further assessment for construction is not considered appropriate. Compliance with air quality goals during the operation of the mine is assumed to represent compliance during mine construction.

Dust Predictions

During operations, the Project will result in emissions of particulate matter, primarily from coal handling activities at the pit top and the operation of upcast ventilation shafts.

Figure 35 illustrates the air quality contours for predicted annual average TSP, annual average PM_{10}, average 24hr PM_{10} and annual average dust deposition concentrations in relation to neighbouring private receivers for maximum operations. The results of the modelling indicate that the incremental PM_{10}, $PM_{2.5}$, TSP and dust deposition at the closest residential receivers are all well below the impact assessment criteria.

All results for indicative receivers are presented in Appendix L. The highest ground level concentrations occur at the closest residence to the north of Tooheys Road Site. A cumulative assessment, incorporating existing background levels, indicates the Project is unlikely to result in additional exceedances of relevant impact assessment criteria at the neighbouring receivers. Based on the modelling results presented in the sections above, it is not anticipated that the Project will result in any significant impact for future residential dwellings as part of the Jilliby Subdivision (see Figure 5).

Coal Haulage

Dust emissions associated with train loading have been included as part of the modelling assessment on mining operations. PAEHolmes reviewed an assessment that has been completed by Queensland Rail (QR) that provided an environmental evaluation of coal dust emissions from rail lines in the Central Queensland Coal Industry (Connell Hatch, 2008).

Based upon the results of this study there appears to be a minimal risk of adverse impacts due to fugitive coal emissions from trains. The results of monitoring and modelling indicate that the levels at the edge of the rail corridor are below levels that are known to cause adverse impacts on amenity.

Flare Emissions

Initially methane will be flared in an enclosed structure; however consideration will be given for a beneficial use of methane in electricity generation as actual gas flows are assessed. Parameters used in modelling were typical for enclosed flares installed at Hunter Valley coal mines.

The maximum predicted 1-hour NO_2 ground level concentrations from flaring is approximately 14% of the goal while the maximum predicted annual average NO_2 ground level concentrations from flaring is less than 1% of the goal.

Odour Emissions

The potential for odour from the ventilation shaft was assessed and found to be minor. The modelling indicates that only one privately owned receiver in the vicinity of the Buttonderry Site is predicted to experience odour above the most stringent odour impact assessment criterion of 2 OU. It is important to note that odour impact assessment criteria are related to population density. An odour impact assessment criterion of 7 OU will be acceptable to the average person, but as the number of exposed people increases, the probability of a more sensitive individual being exposed increases.

The most stringent criterion of 2 OU is considered to be acceptable for the whole population. On this basis, a predicted odour level of 3 OU at one privately owned receiver will be acceptable to the average person. Notwithstanding this, it is recommended that post commissioning verification of the ventilation shaft emissions is conducted once operational, to validate the assumptions presented in this report.

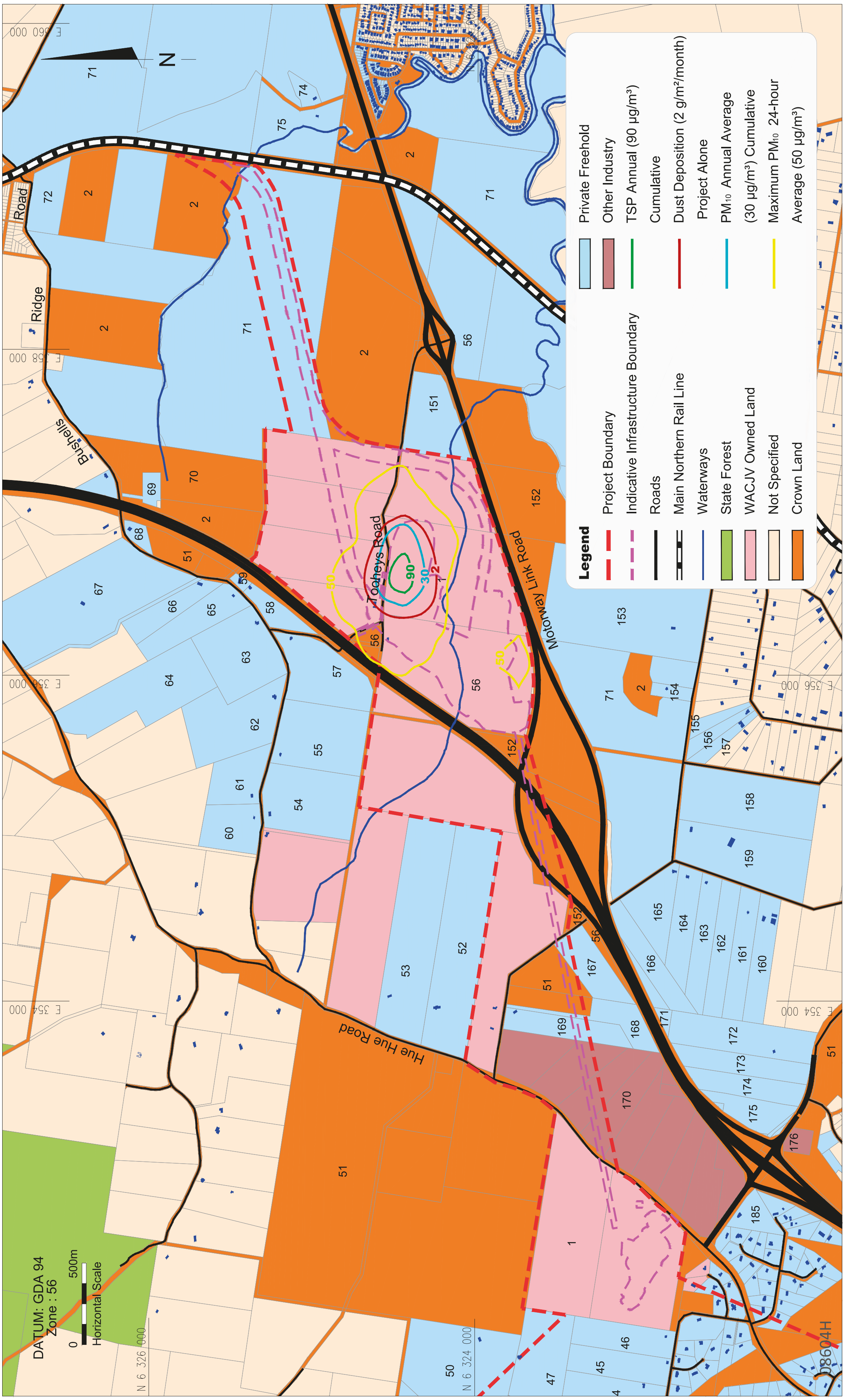
7.5.4 Mitigation and Management

Feasible and Reasonable Air Quality Control

The proposed controls for the Project are based on recommendations of the *NSW Coal Mining Benchmarking Study: International Best Practice Measures to Prevent and/or Minimise Emissions of Particulate Matter from Coal Mining* (Donnelly et al., 2011) (the Best Practice Report), a study that was commissioned by the NSW EPA.

Best Practice Management (BPM) measures adopted for this assessment include:

- Fixed water sprays on all stockpiles;
- Conveyors and Transfers:
- Application of water at transfers;
- Wind shielding applied to roof and one side wall of conveyors;
- Belt cleaning and spillage minimisation.
- Stacking and reclaiming product coal:



WALLARAH 2 COAL PROJECT

Air Quality Contours (Worst Case All Years)

FIGURE 35

Hansen Bailey ENVIRONMENTAL CONSULTANTS

Wallarah 2 COAL PROJECT

- Variable height stack;
- Boom tip water sprayers; and
- Telescopic chute with water sprayers.

Air Quality Monitoring Network

WACJV will continue to monitor air quality emissions using the existing environmental monitoring network to ensure compliance with the relevant air quality criteria. The existing monitoring network will be reviewed and augmented for the operation of the Project generally.

In accordance with best practice dust management at the site, the existing HVAS will be augmented or replaced by a continuous PM_{10} / $PM_{2.5}$ monitoring instrument at a location representative of receivers who may experience short term elevated dust concentrations. A short term average performance indicator will be set at a level that allows proactive dust management if dust levels are expected to approach the 24 hour PM_{10} impact assessment criteria in the upcoming 24 hours.

WACJV will develop an EMP describing air quality monitoring and management for the approval of DP&I in consideration of the above.

Air Quality Management Plan

WACJV will develop an Air Quality Management Plan (AQMP) for the construction and operation of the Project. The AQMP shall incorporate the feasible and reasonable air quality controls described above as well as additional practical air quality management. The AQMP will also include the air quality monitoring network described above.

During construction, mitigation measures to reduce dust emissions include:

- Modification of work practices by limiting excavation during periods of high winds;
- Limiting the extent of vegetation and topsoil cleared to the designated footprint and the appropriate staging of clearing;
- The use of water sprays during road construction and seal the main access roads as soon as practical;
- Vehicles on site should be confined to a designated route with speed limits enforced;
- Trips and trip distances should be controlled and reduced where possible; and
- The main access road will be sealed as soon as possible.

7.6 Greenhouse Gas

7.6.1 Background

PAEHolmes conducted an Air Quality and Greenhouse Gas (GHG) Assessment for the Project as part of the Air Quality and Greenhouse Gas Impact Assessment which is presented in full in Appendix L.

It provides a quantitative assessment of potential scope 1, 2 and 3 emissions, a qualitative assessment of the potential impacts of these emissions on the environment and assesses reasonable and feasible measures to minimise GHG emissions and ensure energy efficiency. A summary of the greenhouse gas assessment is provided below.

7.6.2 Methodology

The greenhouse gas assessment has been based upon the methods outlined in the following documents:

- The World Resources Institute / World Business Council for Sustainable Development Greenhouse Gas Protocol;
- National Greenhouse and Energy Reporting (Measurement) Determination 2008; and
- The Australian Government Department of Climate Change and Energy Efficiency (DCCEE) National Greenhouse Accounts Factors 2010.

Consideration was also given to the *Guidelines for Energy Savings Action Plans* (DEUS, 2005).

Three 'scopes' of emissions (Scope 1, Scope 2 and Scope 3) are defined for the greenhouse gas accounting and reporting purposes and have been considered in this assessment for the following gases:

- Carbon Dioxide (CO_2);
- Methane (CH_4);
- Nitrous Oxide (N_2O); and
- Synthetic gases (HFCs, SF_6, CF_4, C_2F_6).

Emission factors are standardised and expressed as carbon dioxide equivalent ($CO_{2\text{-}e}$) which is calculated by multiplying the individual gas emission factor by its respective Global Warming Potential (GWP).

7.6.3 Impact Assessment

The main sources of greenhouse gas emissions from the Project have been identified as resulting from electricity consumption, fugitive emissions of CO_2 and CH_4, diesel usage, emissions associated with flaring and the transport and final use of the product coal. The proposed planned capture and flaring of remaining CH_4 during operations was found to have significant benefits in the reduction of GHG emissions. When compared with 100% fugitive emissions of CH_4, the flaring scenario results in a GHG saving of approximately 8 Mt CO_{2-e} or 54% of Scope 1 emissions, over the Project life.

Additional GHG savings may be realised through the use of onsite power generation to be implemented if economically suitable to do so. Initially, methane will be flared, however consideration will be given for beneficial use of methane in electricity generation as actual gas flows are assessed. An installed capacity of 10 MW will provide enough power demand for the site (based on the anticipated electricity demand), thereby eliminating GHG emissions from purchased electricity (~1.5 Mt CO_{2-e} over the Project life). Any additional electricity generated onsite will be distributed back into the grid, thereby offsetting further Scope 1 GHG emissions.

Emission rates for gas engines have been derived based on an assumed total power output of 10 MW (2 MW across five gas engines) and using emission factors (kg/kWh) for uncontrolled gas turbines on natural gas (DEWHA, 2008). The parameters assumed for modelling are based on the gas engines approved at the Mandalong Mine (HAS, 2008) and are outlined in Table 49.

The average annual emissions from the Project are summarised in Table 50.

The Project's contribution to projected climate change, and the associated impacts, will be in proportion with its contribution to global GHG emissions.

Average annual Scope 1 emissions from the Project (0.2 Mt CO_{2-e}) will represent approximately 0.04% of Australia's annual average commitment under the Kyoto Protocol (591.5 Mt CO_{2-e}) and a very small portion of global greenhouse emissions, given that Australia contributed approximately 1.5% of global GHG emissions in 2005 (Commonwealth of Australia, 2011).

Table 49 Indicative Flare and Gas Engine Modelling Parameters

Parameter	Flare Stacks	Gas Engines
Location (E, N MGA)	356617; 6323862; 356618; 6323870; 356619; 6323880	356490; 6323881; 356491; 6323883; 356492; 6323886; 356492; 6323889; 356493; 6323892
Height (m)	8	10
Diameter (m)	4	0.36
Temperature (k)	1,273	482
Gas Flow Rate (L/s)	2,600	N/A
Power Output (MW)	N/A	10 MW (across 5 gas engines)
Exit Velocity (m/s)	5	35
Pollutant Emission Rates (g/s)		
NO_x	0.36 g/s (per flare)	0.28 g/s (per 2 MW gas engine)

Table 50 Total Greenhouse Gas Emission Predictions

Emission Source	Scope 1	Scope 2	Scope 3	Total
Emissions (t CO_{2-e})				
Diesel	86,476		6,595	**93,071**
Fugitive Mine Ventilation Air (MVA)	5,127,869			**5,127,869**
Flaring	1,572,425			**1,572,425**
Electricity		1,477,507	298,822	**1,776,329**
Energy Production			360,338,101	**360,338,101**
Rail			222,758	**222,758**
Total	**6,786,770**	**1,477,507**	**360,866,276**	**369,130,553**

7.6.4 Mitigation and Management

The Project will develop an Energy and Greenhouse Strategy within two years after the commencement of longwall coal extraction. The strategy will address interim and long term energy and greenhouse management plans and initiatives, including monitoring, reporting and continuous improvement.

The strategy will incorporate the following approaches to improving energy efficiency and reducing greenhouse emissions from the Project:

- Use of low-sulphur diesel fuel for underground mobile equipment;
- Conduct an options study for coal mine methane capture and utilisation within three years of the commencement of the longwall mining production;
- Monitor greenhouse gas emissions and mitigation actions from the commencement of operations;
- WACJV will undertake enclosed flaring of the initial production of captured methane to enable a significant reduction in greenhouse emissions;
- Conduct regular energy efficiency audits after the commencement of longwall mining operations; and
- Installation of energy efficient appliances including at least lighting and hot water system.

The Project will continue to assess and implement energy and greenhouse management initiatives during design, operation and decommissioning phases.

7.7 Health Risk

7.7.1 Background

A Human Health Risk Assessment (HRA) for the Project was undertaken by PAEHolmes and is provided in Appendix M. The HRA addresses the Project's environmental impacts (particularly air quality, noise and drinking water quality) in relation to the health of the local community. It considers direct and indirect impacts, such as may result from additional rail and road movements. Key findings from the HRA are described below.

7.7.2 Methodology

Introduction

The methodology adopted in the conduct of this HRA is consistent with the protocols and guidelines recommended by the enHealth Council. These are detailed in the document 'Environmental Health Risk Assessment: Guidelines for assessing human health risks from environmental hazards' (enHealth, 2002).

The development of formalised HRA has resulted in the process being categorised into distinct stages. Some of the key factors and questions that are taken into consideration at each of these stages include the following:

- Hazard and Concentration Response Assessment – Identifies hazards and health endpoints associated with exposure to hazardous agents and provides a review of the current understanding of the toxicity and risk relationship of the exposure of humans to the hazards;
- Exposure Assessment – This task identifies the groups of people who may be exposed to hazardous agents and quantifies the exposure concentrations; and
- Risk Characterisation – This task provides the qualitative evaluation of potential risks to human health. The characterisation of risk is based on the review of concentration response relationship and the assessment of the magnitude of exposure.

Existing Research

All particles irrespective of their origin appear to cause adverse health impacts. In recent years a significant amount of research has focused on the health effects of particles and an increasing body of literature reports associations between PM and adverse health effects. Epidemiological studies of the health effects of air pollution are usually classified as investigating acute effects (due to short-term exposures) or chronic effects (due to long-term exposures).

A range of health effects have been found for both PM_{10} and $PM_{2.5}$ and the majority of the information come from population-based epidemiological studies. Over the last few decades, there has been a substantial amount of research that added to the evidence that breathing Particulate Matter (PM) is harmful to human health.

Appendix M provides a detailed discussion on this research. Various lines of research have helped connect some of the important gaps in our knowledge. Different studies using alternative time series approaches and case crossover designs continue to observe reasonably consistent associations between morbidity and mortality outcomes and daily changes in PM.

It is important to note that the observed association between PM and health outcomes is statistical. The particles are not the primary cause of death, but are one of many environmental and other risk factors. More recently the statistical associations have been revised downwards based on a review of the statistical methods used, but the association remains (HEI, 2003). However the current Australian air quality goals for PM are still based on the more conservative associations.

7.7.3 Air Quality Impact Assessment

Hazard and Concentration Response Assessment

Dust

PM is an air-suspended mixture of solid and liquid particles that vary in number, size, shape, surface area, chemical composition, solubility and origin. PM is classified by aerodynamic diameter, as size is a critical determinant of the likelihood and site of deposition within the respiratory tract.

Both natural and anthropogenic processes contribute to the atmospheric load of PM. Coarse particles ($PM_{2.5\text{-}10}$) are derived primarily from mechanical processes resulting in the suspension of dust, soil, or other crustal materials from roads, farming, mining, dust storms, etc. Coarse particles (>PM_{10}) also include sea salts, pollen, mould, spores, and other plant parts. In general, mining dust is likely to be composed of predominantly coarse particulate matter (and larger).

Fine particles or $PM_{2.5}$ are derived primarily from combustion processes, such as vehicle emissions, wood burning, coal burning for power generation and natural processes (such as bushfires). Fine particles also consist of transformation products, including sulphate and nitrate particles, and secondary organic aerosol from volatile organic compound emissions.

Many studies have used PM_{10} as an indicator of PM. However, there is increasing evidence that the adverse health effects, particularly mortality are more closely associated with $PM_{2.5}$. For this reason, $PM_{2.5}$ is considered the best index of particulate air pollution for quantitative assessments of the associated health effects (COMEAP, 2009). In the HRA, $PM_{2.5}$ has been used as the metric to assess risks to health from exposure to PM.

Table 51 displays the resultant Relative Risks (RR) for a 1 µg/m³ increase in $PM_{2.5}$ used for risk estimation in the HRA. As the incremental increases in $PM_{2.5}$ as a result of the Project are less than 10 µg/m³ (see Section 7.5), the RRs have been adjusted for the estimated increments from the Project. A Concentration Response Function (CRF) (reported by epidemiological studies) is the empirically estimated relationship between the concentration of PM and the observed health endpoints of interest (for example, hospital admissions for asthma) in a population.

Respirable Crystalline Silica

Respirable Crystalline Silica (RCS) is emitted into the ambient air as a fractional component of particulate emissions or dust. Once entrained in the air, RCS may be inhaled and deposited in the lungs, where it could possibly cause disease. Although human exposure to RCS occurs primarily in occupational environments, the general public can also be exposed to lower levels of RCS emitted from other sources such as sand blasting and entrained particles from surface soil.

Table 51 Health Endpoints and CRF for Increases in $PM_{2.5}$

Health Endpoint	CRF for 1 µg/m³ increase in $PM_{2.5}$ – RR
Deaths	
Long-term deaths (age 30+ years)	1.0058 (0.58%)
Short-term all non-trauma deaths (all ages)	1.0009 (0.09%)
Hospitalisations	
Cardiovascular disease (age 65+ years)	1.0016 (0.16%)
All respiratory disease (all ages)	1.0007 (0.07%)

Table 52 Health Endpoints and CRF for Increase in NO_2

Health Endpoint	CRF for 1 µg/m³ increase in NO_2 - RR
Deaths	
Short-term all non-trauma deaths (all ages)	1.001
Hospitalisations	
Asthma admissions (5 – 14 years)	1.011

The HRA uses silicosis as the main health outcome indicator for annual average exposure to crystalline silica. Cumulative exposure is an estimate of the average respirable crystalline silica concentration to which a person is exposed over the course of a year multiplied by the number of years exposed, using an assumed lifetime of 70 years. A detailed discussion on the health impacts of RCS is provided in Appendix M.

This threshold dose metric has been determined to be a total exposure of 1,000 µg/m^3 accumulated over a lifetime of 70 years, or 14.3 µg/m^3 per annum for 70 years (1,000/70 = ~ 14.3). If the total exposure of 1,000 µg/m^3 was accumulated over 28 years (time estimate for life of the Project) the risk of silicosis will be close to zero.

Oxides of Nitrogen

The key pollutant released from flaring of methane or the use of gas engines will be oxides of nitrogen (NO_x). NO_x is comprised of Nitric Oxide (NO) and Nitrogen Dioxide (NO_2), however NO is not generally considered harmful to human health and not considered an air pollutant at the concentrations that are typically found in ambient environments. Controlled human exposure studies have presented mixed results (WHO, 2000) however normal healthy people exposed at rest or with light exercise for less than two hours to concentrations of more than 4,700 µg/m^3 experience pronounced decrements in pulmonary function; generally, such people are not affected at concentrations less than 1,880 µg/m^3.

Table 52 provides the health endpoints and CRF used in this study for estimation of impacts to health from exposure to NO_2. Original CRF were transformed to a 1 parts per billion (ppb) increase in NO_2 concentrations using the same method for $PM_{2.5}$.

Exposure Assessment

Operations - $PM_{2.5}$ Dust

The air quality impact assessment for the Project (see Section 7.5) presents the dispersion modelling predictions direct from the Project for maximum 24-hour and annual average $PM_{2.5}$ ground level concentrations (glcs) at assessment locations in the vicinity of the Project. Dust emissions associated with train loading have been included as part of the modelling assessment of mining operations.

The highest predictions were made at an assessment location to the north of the Tooheys Road – Receiver P11 (see Figure 35), with a predicted incremental increase in 24-hour $PM_{2.5}$ concentration of 5.0 µg/m^3 and a predicted incremental increase in annual average $PM_{2.5}$ concentration of 0.3 µg/m^3. These concentrations are used in the risk calculations.

Rail Transport - $PM_{2.5}$ Dust

Additionally, the Project will result in an increase in rail movements from Wallarah to Newcastle potentially increasing fugitive coal dust emissions along the rail corridor. Queensland Rail recently commissioned a study (QR Study) into fugitive coal dust emission and management along selected Queensland coal rail systems. A number of different approaches were used in the QR Study for the quantification and assessment of coal dust emissions from wagons as detailed in Appendix L. The QR study concluded there is a low risk of health impacts from coal dust, either within or outside the rail corridor.

Oxides of Nitrogen

A worst case assessment of NO_2 emissions from the capture and use of methane (flaring and / or power generation) was presented in the air quality assessment (see Section 7.5). Predicted glcs of NO_2 were made based on the conservative assumption of 100% transformation of NO_x to NO_2. In reality, conversion is more likely to be 10%-20% for shorter averaging periods and the predicted glcs are conservatively high. Emissions from the existing road network, including the freeway will contribute to ambient levels of NO_x in the local area.

The most affected assessment location is Receiver P6 (see Figure 35) as a predicted 1-hour NO_x concentration of 35 µg/m^3 (18.6 ppb) and is used in the risk calculations.

Respirable Crystalline Silica

Exposure to RCS is assessed using the estimated total annual concentration, which is a combination of existing background and increased concentrations due to the Project. Data collected in Victoria estimated the background concentration to be 0.7 µg/m^3 which has been applied to this HRA in the absence of any local data.

In the HRA, a proportion of 10% RCS in annual PM_{10} has been applied. The background annual average PM_{10} was reported in the air quality assessment (see Section 7.5) as 18 µg/m^3. The highest predicted incremental increase of PM_{10} as a result of the Project is 2.1 µg/m^3 and therefore the increase in RCS is 0.16 µg/m^3.

Risk Characterisation

The National Environment Protection Measures (NEPMs) consider an additional risk of '1 per 100,000' for adverse health outcomes to be sufficiently small and to be of no cause for concern. This is likely to be reflected in the upcoming enHealth criteria.

Operations – $PM_{2.5}$ Dust

The risk factors in Table 51 have been used to estimate the risks associated with exposure to the particulate emissions from the Project. Daily and annual mortality rates for the Central Coast Local Health District for 2009-2010 and daily hospital admissions for all of NSW in 2006-2007 were obtained in June 2012.

Table 53 summarises the risks for the most exposed individual assuming a daily incremental increase of 5.0 µg/m^3 and an annual increase of 0.3 µg/m^3.

Oxides of Nitrogen

The approach used to calculate the risks to health from NO_2 emissions has used the same method for estimating risks from $PM_{2.5}$ on health.

Table 54 summarises the risks for the most exposed individual assuming an incremental increase of 18.6 ppb.

Respirable Crystalline Silica

The US EPA has examined the non-cancer epidemiological literature on silica induced diseases and concluded that several studies of miners provide good quality data for risk assessment. The US EPA concluded through an analysis of the most extensive occupational studies available, each of which examined the medical histories of thousands of miners, that the cumulative risk of silicosis at or below 1,000 µg/m^3 over a lifetime of 70 years, or 14.3 µg/m^3 per annum (crystalline silica) is close to 0% (US EPA, 1996).

Total lifetime exposure to respirable crystalline silica from background and the Project is estimated at 137.2 µg/m^3 years. This exposure is approximately seven times lower than the cumulative exposure of 1,000 µg/m^3 years associated with close to zero risk of silicosis in workers. Additionally, the total cumulative RCS annual concentration of 1.96 µg/m^3 is considerably less than the Reference Exposure Level of 3 µg/m^3 set by the Environmental Health Hazard Assessment and adopted by the Victorian Environmental Protection Agency.

Summary

The analysis provides conservative estimates of the increase in annual and daily mortality due to emissions from the Project at the most affected receiver on the worst day. In addition estimates are provided on the increase in daily hospital admissions that could be expected from the most exposed individual due to emissions from the Project on the worst day. The increase in risk of daily mortality on the worst day in the life of the Project is estimated to be approximately 1 in 100,000. All other health outcomes risks are less than 1 in 100,000. This is a small risk.

In regards to risks from rail movements, the QR Study concluded that there appears to be minimal risk of adverse human health and amenity impacts due to fugitive coal emissions from trains throughout the network, based on results of monitoring and modelling predictions. To ensure fugitive dust emissions are kept to a minimum during the relatively short journey to port, WACJV will utilise a water spray system to be installed with the ability to spray water and/or dust surfactants on loaded train wagons as necessary.

7.7.4 Noise Impact Assessment

Sufficient evidence exists internationally that environmental noise may pose a general public health risk. Groups most exposed to this noise (by virtue of where they live, work and recreate) and those most sensitive to its impact, may face even greater risks. They include infants and school children, shift workers, the elderly, the blind, and those suffering hearing impairment, sleep disorders, and physical and mental health conditions. Australian surveys have found respondents were concerned about environmental noise from a wide range of transportation and other sources, as well as noise generated by neighbours' loud voices, loud appliances and pets (indoors and outdoors).

Table 53 Estimated Increase in Risk of Indicated Event for Project Worst Case Exposure to $PM_{2.5}$

Health Outcome	Base Incidence (per 100,000)	RR	PM2.5 Increase (µg/m^3)	Increased Risk (per 100,000)
Annual mortality	635	1.0058	0.3	1.1
Daily mortality	1.74	1.0009	5.0	0.008
Daily hospital admissions for cardiovascular disease (all ages)	1.04	1.0016	5.0	0.008
Daily hospital admission respiratory (all ages)	4.67	1.0007	5.0	0.016

Table 54 Estimated Increase in Risk of Indicated Event for Project Worst Case Exposure to NO_2

Health outcome	Base Incidence (per 100,000)	RR	NO_2 Increase (ppb)	Increased Risk (per 100,000)
Daily mortality	1.74	1.001	18.6	0.05
Daily hospital admissions for asthma (5-14 years)	0.35	1.011	18.6	0.07

The strength of current scientific evidence across the different components of human reaction to noise is variable, but there is sufficient evidence now with respect to intermediate effects in the model - annoyance and sleep for example. Some effects are measured by self-report of those affected (e.g. subjective assessments of annoyance) while others are by objective measurement on those affected.

The variability in responses from person to person must be considered in the assessment of noise exposure on human health. Effects may still be experienced by some people at levels below the bounds of the noise metric. Conversely, there will be other people that are unaffected by noise levels higher than the bounds of the noise metric. Conclusions of the Noise Impact Assessment (see Section 7.8.3) indicate that for the operational scenario modelled there are no predicted exceedances of the NSW amenity criteria for noise impacts at residences. In regards to existing background noise, site attended audits confirmed that the local acoustic environments are currently (i.e. in the absence of the Project) influenced by road traffic, natural sources and localised domestic activities. In regards to operational traffic and rail generated noise levels, criteria were satisfied or marginal increases (1-2 dBA) detected.

The management of noise, like many other environmental and occupational health hazards, involves three main options:

- Elimination or reduction of noise at the source;
- Elimination or disruption of the transmission path; and
- Isolation or insulation of the receiver from the noise.

Combinations of these three options represent much of international 'best practice'. In response to a potential criteria exceedance, a set of operational management strategies will be adopted to assist in controlling noise emissions from the Project as described in Section 7.8.4. The strategies consist of a combination of the above international best practice options and, when applied, they are assumed to effectively control noise emissions from the Project and consequently deeming any risk of adverse health effects as negligible.

7.7.5 Drinking Water Impact Assessment

The Project is located within the Macquarie Tuggerah Lakes Basin which houses the Mardi and Mangrove Creek Dams which are used for irrigation and domestic water storage for urban centres in the lower sections of the Tuggerah Lakes catchment. During operation, the Project will not discharge groundwater or mine water within the water supply catchment area. Section 7.3.1 provides detail on Project water management.

Some land disturbance (in addition to subsidence impacts) in the water supply catchment area may occur during the construction of the proposed ventilation shaft within the Wyong State Forest.

Land disturbance associated with the construction of the shaft will be managed through the implementation of best practice erosion and sediment control measures, which will ensure that surface runoff from any disturbed area will meet appropriate water quality standards prior to discharge.

It must be noted that the water supply catchment already contains extensive areas of land-disturbing activities, including agriculture and residential development. The construction of the Western Ventilation Shaft Site, with appropriate control measures in place, will have no measurable adverse effect on downstream water quality.

Impacts on low-flow water quality due to subsidence, such as reduced pH and increased metals concentrations due to fracturing of rock within drainage lines in the upper catchment, are not anticipated to occur. However, subsidence and water quality monitoring programs will be implemented to identify and manage any unexpected impacts. Monitoring of surface water quality both within and external to the Project Boundary will form a key component of the surface water management system.

Monitoring of upstream, on site and downstream water quality will assist in demonstrating that the site water management system is effective in meeting its objective of no adverse impact on receiving water quality and will allow for early detection of any impacts and appropriate corrective action.

The proposed water management system will ensure the separation of clean and mine water on the site and no uncontrolled discharges from the Mine Water System under all but extreme weather conditions. As the Project's key surface facilities are located outside of the drinking water catchment, no site discharges will occur in the drinking water catchment. The quality of treated water discharge into other catchment areas will be controlled through the operating parameters of the water treatment plant and these parameters will be set to ensure that the quality of water discharged is similar to the receiving water quality.

Given this, there is no likelihood of increases in risks to health from water discharge.

7.7.6 Mitigation and Management

No additional measures to that committed to in Sections 7.3.4, 7.5.4 and 7.8.4 are required to mitigate the Project's environmental impacts (particularly in relation to air quality, noise and drinking water quality) in relation to the health of the local community.

7.8 Noise

7.8.1 Background

A Noise and Vibration Impact Assessment for the Project was undertaken by Atkins Acoustics and is presented in full in Appendix N. The purpose of the assessment was to predict the Project's construction, operational and transport noise impacts on receivers in the vicinity of the Project Boundary. The assessment also recommends reasonable and feasible measures to mitigate noise impacts as well as outlining proposed monitoring and management measures.

The noise assessment is summarised below and has been undertaken in accordance with the following policies and guidelines:

- 'The NSW Industrial Noise Policy' (INP) (EPA, 2000) for operational and construction noise;
- 'Interim Construction Noise Guideline' (ICNG) (DECC, 2009);
- 'Road Noise Policy' (RNP) (OEH, 2011); and
- 'Assessing Vibration: a technical guideline' (AVTG) (OEH, 2009).

A summary of this noise impact assessment is provided in the following sections.

7.8.2 Methodology

Noise from the Tooheys Road Site, Buttonderry Site and Western Ventilation Shaft as well as road traffic generated from construction and operation of the Project was modelled with the OEH approved Environmental Noise Model (ENM). ENM is based on digital topographical data for each site and surrounding area, and calculates attenuation factors including distance, shielding from structures, ground vegetation, atmospheric absorption, topographical features and weather effects.

Background Noise Levels

In order to assess existing ambient noise, attended and unattended noise audits were undertaken during November 2006 and April 2007 and were re-visited in March 2012 at the locations shown in Figure 36.

These results were then evaluated in accordance with the INP assessment procedures in order to confirm existing Rating Background Levels (RBL) and to establish the Project Specific Noise Criteria (PSNC).

Results indicated that background noise levels at the monitoring locations were controlled by road traffic from the F3 Freeway (Sydney to Newcastle), Motorway Link Road, Hue Hue Road, and Bushells Ridge Road. Although industrial activities occur in the vicinity of the Project Boundary, these were inaudible at the monitoring locations.

Noise Criteria

Project Operational Noise

The INP recommends two separate noise criteria be applied to operational noise, these being an intrusive criterion 5 dBA above the background noise level and amenity criteria which depend on the nature of the receiver area and the existing level of industrial and mining noise in each time period.

The RBL and adopted noise criteria for all receivers are shown in Table 55. For preservation of acoustic amenity, the INP requires industrial noise in residential areas be within the acceptable levels for the locality and land use. The existing land uses in the vicinity of the Tooheys Road Site and the Buttonderry Site will be defined as Rural, Suburban or Urban.

Daytime is defined as 7:00 am to 6:00 pm, Monday to Saturday and 8:00 am to 6:00 pm Sundays and on Public Holidays. The evening period is 6:00 pm to 10:00 pm, Monday to Sunday and on Public Holidays whilst night is 10:00 pm to 7:00 am, Monday to Saturday and 10:00 pm to 8:00 am on Sundays and Public Holidays. PSNC for each monitoring site in consideration of the surrounding land uses is also presented in Table 55.

The location of each monitoring site is presented on Figure 36.

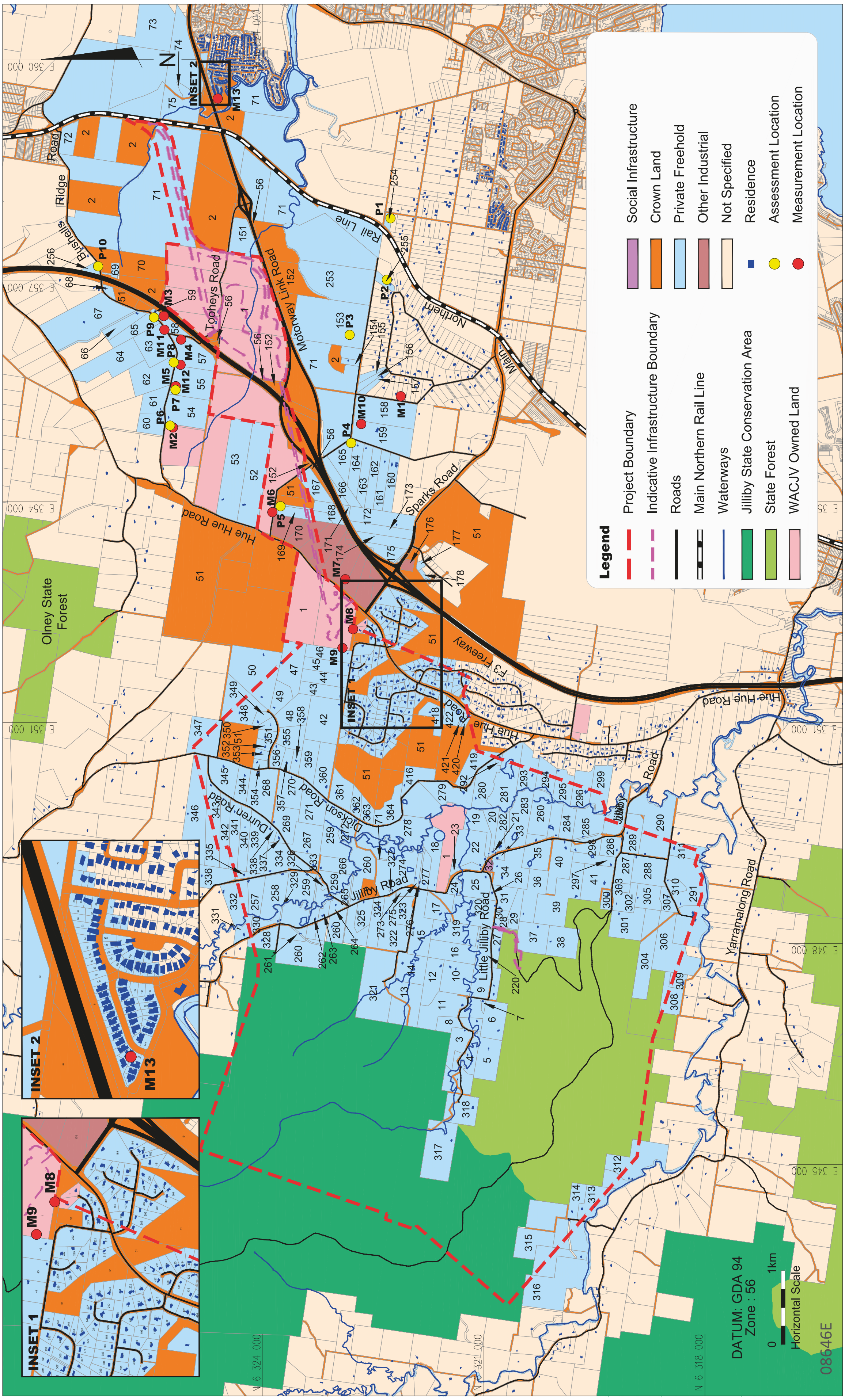
Construction Noise

For major construction projects in NSW, the OEH guidelines recommend that construction noise associated with mining be assessed under the INP. For construction works that extend longer than three weeks, a 'quantitative assessment method' is recommended. A quantitative method involves comparing predicted noise levels from the Project to the guidelines. Construction noise is assessed at a residential property boundary or 30 m from a residential dwelling, if the boundary is greater than 30 m from the dwelling.

As part of the Project site preparation, rock may be encountered; therefore rock hammers and small explosive charges may be required. The effect of vibration on humans and structures are evaluated in terms of annoyance and structural damage.

Blasting

To promote uniform environmental standards throughout Australia, the Australian and New Zealand Environmental Conservation Council (ANZECC) published the '*Technical Basis for Guidelines to Minimise Annoyance due to Blasting Overpressure and Ground Vibration*'. The model uses Air-Blast overpressure which is a function of maximum instantaneous explosive charge and the distance between the receiver and the blast location. The OEH/ANZECC air-blast overpressure criterion is 115 dB_{Lin}.



WALLARAH 2 COAL PROJECT

Noise Assessment & Measurement Locations

FIGURE 36

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Table 55 PSNC and Background Monitoring

Period	Recommended Criteria	Existing RBL	Existing	PSNC	
	$LA_{eq, Period}$	dBA	$LA_{eq, Period}$	Intrusive $LA_{eq, 15\ min}$	Amenity $LA_{eq, Period}$
Location M1: Bruce Crescent					
Day	50	36	49	41	50
Evening	45	41	47	41	45
Night	40	37	46	41	40
Location M2: Bushells Ridge Road					
Day	55	38	51	43	55
Evening	45	40	50	43	45
Night	40	33	48	38	40
Location M3: Bushells Ridge Road					
Day	60	53	61	58	60
Evening	50	52	60	57	50
Night	45	43	58	48	48
Location M4: Bushells Ridge Road					
Day	60	58	63	63	60
Evening	50	52	61	57	52
Night	45	47	59	52	52
Location M5: Bushells Ridge Road					
Day	55	37	48	42	55
Evening	45	43	50	42	45
Night	40	36	48	41	40
Location M6: Kiar Road					
Day	55	41	58	46	55
Evening	45	40	47	45	45
Night	40	39	47	44	40
Location M7: Hue Hue Road					
Day	55	43	57	48	55
Evening	45	46	54	48	45
Night	40	43	55	48	45
Location M8: Amberwood Close					
Day	55	41	50	46	55
Evening	45	46	51	46	45
Night	40	41	50	46	40
Location M9: Sandra Street					
Day	50	33	44	38	50
Evening	45	36	42	38	45
Night	40	33	42	38	40
Location M10: Mountain Road					
Day	50	39	49	44	50
Evening	45	41	48	44	45
Night	40	39	49	44	40

Period	Recommended Criteria	Existing RBL	Existing	PSNC	
	$LA_{eq, Period}$	dBA	$LA_{eq, Period}$	Intrusive $LA_{eq, 15 min}$	Amenity $LA_{eq, Period}$
Location M11: Bushells Ridge Road					
Day	55	44	64	49	55
Evening	45	44	57	49	47
Night	40	42	54	47	44
Location M12: Bushells Ridge Road					
Day	55	44	59	49	55
Evening	45	49	58	49	46
Night	40	42	56	47	46
Location M13: Popran Way					
Day	60	51	59	56	60
Evening	50	46	57	51	47
Night	45	37	55	42	45

Sleep Disturbance

Sleep disturbance can occur when a short, sharp noise is clearly audible over the background noise level. The OEH recommends a conservative sleep disturbance criterion of 15 dBA above the background noise level. The sleep disturbance criterion applies at a point 1 m outside a bedroom window during the night period.

Road Traffic Noise

The likely routes taken by vehicles travelling to and from the Project have been summarised in Section 3.8. During operation the main traffic will be mine personnel arriving and departing from both the Tooheys Road and Buttonderry Sites at shift changes. The model used for the assessment predicted peak hour traffic noise levels assuming a 50-50 split in traffic on both Hue Hue Road from the Buttonderry Site and 50-50 split on Bushells Ridge Road from the Tooheys Road Site.

For the purposes of assessment, construction of the Tooheys Road and Buttonderry Sites will be undertaken at the same time, and the Western Ventilation Shaft will not be constructed until around Project Year 13. Assuming each of the construction workers drove to the site, there will be a daily traffic generation of 440 two way car movements at the Buttonderry Site, 800 two way car movements at the Tooheys Road Site and 90 at the Western Ventilation Shaft. Procedures for assessing road traffic noise from new land use developments are documented in the OEH 'Road Noise Policy' (OEH, 2011).

Table 56 presents a summary of traffic noise assessment criteria for the Project.

Rail Traffic

All coal from the Project will be transported from the operation by rail. Coal out loaded from the Tooheys Road Site will be transported to the Port of Newcastle or power stations accessed from the Main Northern Rail Line. North of the township of Wyee, the Main Northern Rail Line services Vales Point Colliery, Eraring Colliery, Newstan Colliery and Teralba Colliery. In order to assess train noise impacts, the existing train movements between Wyee and Wyong have been considered.

Passenger train schedule information available for the Main Northern Rail Line north of Wyong shows that the average daily usage is comprised of V-set (50 per day), XPT (six per day) and Explorer (four per day) commuter trains. Effective from October 2009, the scheduled freight train passbys were in the order of 25 for weekdays and 16 on weekends. The Project is planned to generate up to six additional coal train return movements per day.

Table 56 Road Traffic Noise Criteria

Land Use Development	Traffic Noise Criteria		Where Criteria are Already Exceeded
	Daytime (7:00 am to 10:00 pm)	Night-Time (10:00 pm to 7:00 am)	
Land use developments with potential to create additional traffic on local roads	$LA_{eq, 1 hour}$ 55	$LA_{eq, 1 hour}$ 50	In all cases, the redevelopment should not increase existing noise levels by more than 2 dBA. Where feasible and reasonable, noise levels from existing roads should be reduced to meet the noise criteria. In many instances this may be achievable only through long-term strategies.
Land use developments with potential to create additional traffic on collector roads	$LA_{eq, 1 hour}$ 60	$LA_{eq, 1 hour}$ 55	

Source: OEH (2011)

Licences issued by the OEH regulate rail traffic noise in NSW. As part of the licensing conditions, the OEH incorporates requirements for the implementation of Pollution Reduction Programs. The noise levels recommended by the OEH for the assessment of rail noise exposure is that the cumulative noise levels should not exceed $LA_{eq,\ 24\ hr}$ 60 dBA and $LA_{max\ (95th\ percentile)}$ 85 dBA assessed at residential building facades.

Meteorological Conditions

The effects of meteorological conditions can enhance or reduce noise propagation and noise perceived at distant receivers. Wind effects become more important as distances increase. Temperature gradients create similar enhancement effects to wind, except that the effects are generally uniform in all directions.

Dominant meteorological conditions (which occur greater than 30% of the time) have been used in the predictive model. Meteorological data shows that the percentage occurrence of winds with speeds of less than 3 m/s during the daytime and the evening are predominantly from the south to north-east during spring and summer; and south to west during winter and autumn. The meteorological conditions adopted for the noise impact assessment are provided in Table 57.

7.8.3 Impact Assessment

Construction Noise

During construction, noise levels have the potential to exceed the PSNC at Amberwood Close by 4-9 dBA under worst case weather conditions. This property is owned by WACJV. PSNC are not predicted to be exceeded at any other residential receivers.

Construction Vibration

The greatest levels of ground vibration are produced by the dynamic impact rollers used during construction. Dynamic impact rollers typically produce vibration levels of 2-4 mm/s at a distance of 20 m and less than 1.5 mm/s at a distance of 40 m.

Vibration levels are predicted to be below the structural damage assessment criteria at distances greater than 20 m. Vibration levels at private receivers are predicted to be within acceptable limits for human comfort.

Ground vibration levels predicted from the use of rock hammers will satisfy the structural damage assessment criteria at all private receivers and will be acceptable from a human disturbance point of view.

Ground vibration levels predicted from the use of rock hammers at the distances to all receivers will satisfy the structural damage assessment criteria and will be acceptable from a human disturbance point of view.

Blasting

Qualitative modelling results show that the air blast overpressure criteria and the ground vibration criteria can be satisfied at the closest private receiver with the employment of controlled Maximum Instantaneous Charge (MICs) and detailed planning of any blasts needed to assist in construction of either surface facilities or underground activities.

Project Operational Noise

Tooheys Road Site

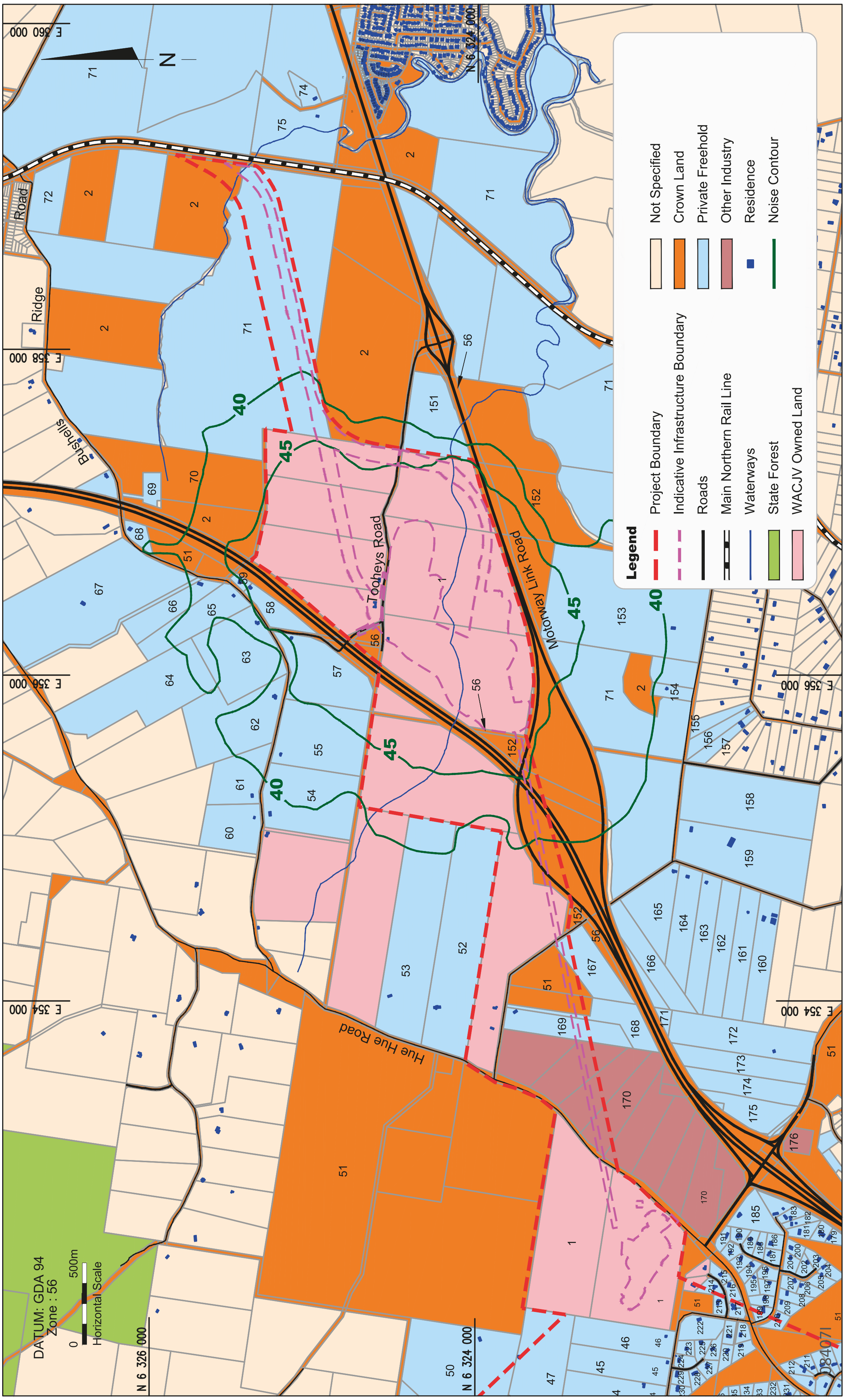
The noise modelling assumed that fixed and the mobile plant were operating simultaneously with train loading at the Tooheys Road Site. It has been assumed that train loading occurs with locomotives and wagons stationary on the rail loop and two locomotives stationary on the rail spur. Noise modelling for the Project shows that the PSNC will be met under all weather conditions at all private receivers surrounding the Tooheys Road Site. As such, operational noise levels predicted at Blue Haven and the Warnervale Town Centre are also predicted at less than 35 dBA under adverse wind and temperature inversion conditions at the nearest private receivers.

Receiver 57 and Receiver 58 are privately owned properties where the predicted noise levels under a worst case modelling scenario may exceed the PSNC for more than 25% of a contiguous block of land in single landownership (Figure 37 and Figure 38).

Table 57 Adopted Meteorological Conditions

Atmospheric Parameter	Day and Evening			Night				
	South	South-East	North-East	Calm	Inversion	East	South-West	West
Temperature (°C)	20	20	20	20	20	20	20	20
Relative Humidity (%)	60	60	60	60	60	60	60	60
Wind Speed (m/s)	3	3	3			3	3	3
Temp Gradient (°C/100 m)	N/A	N/A	N/A	N/A	3	N/A	N/A	N/A

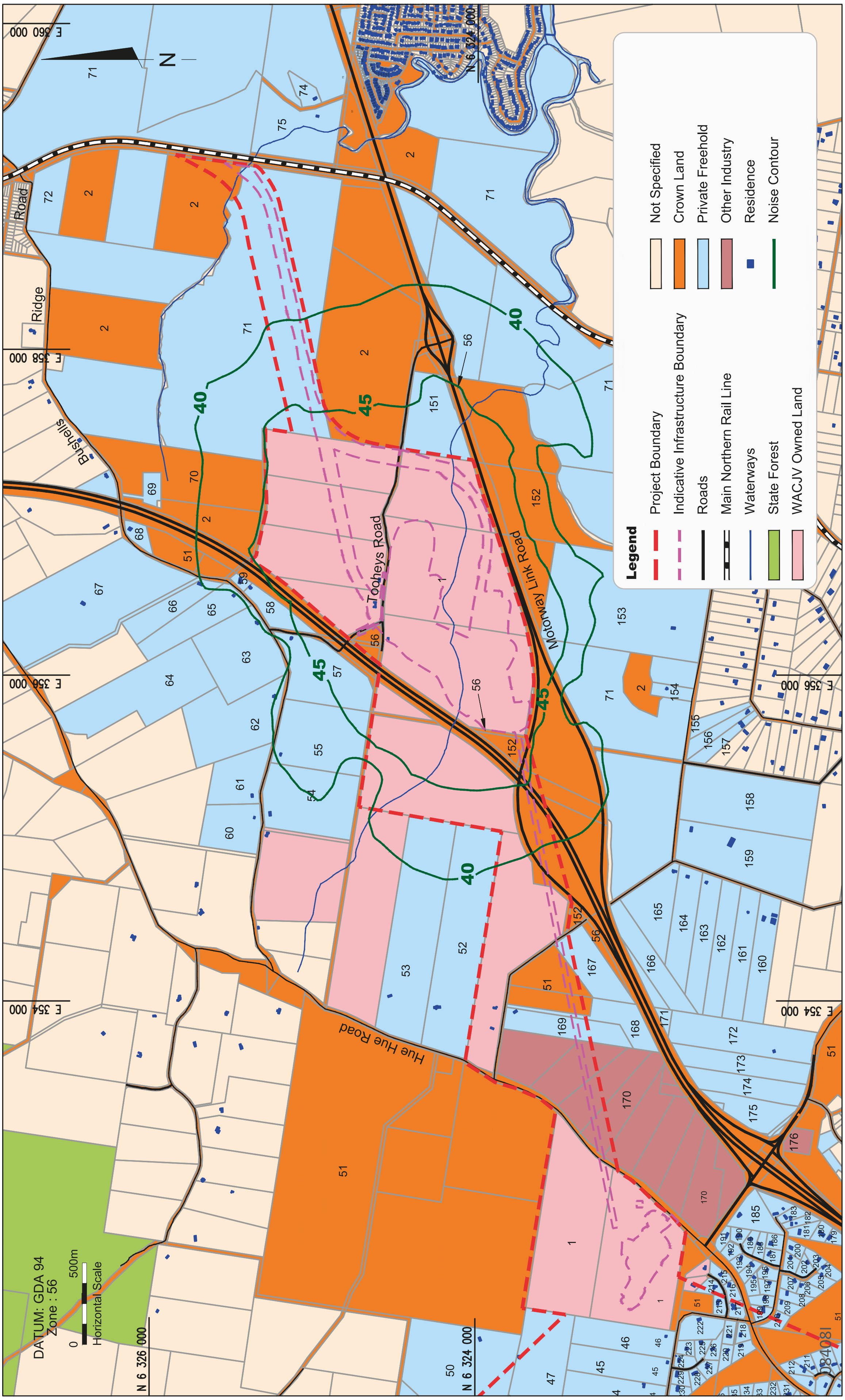
N/A – not applicable to scenario



WALLARAH 2 COAL PROJECT

Day Time Noise Contours (Indicative Worst Case)

FIGURE 37



WALLARAH 2 COAL PROJECT

Night Time Noise Contours (Indicative Worst Case)

FIGURE 38

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The Tooheys Road Site has been designed to minimise operational noise impacts. In order to minimise intermittent noise sources, the design includes an inclined track for training loading, avoidance of at-grade rail crossings, laminated transfer chutes, a concrete coal storage bin and insulated wall cladding on the crusher building.

All curves in the rail loop and spur have been designed with a radius of at least 200 m. Observations at West Wallsend Colliery, Tahmoor Colliery, Baal Bone Colliery, Charbon Colliery and Koorangang Island Coal Loader have established that wheel / rail interface noise does not occur where the radii of curvature is 200 m or greater and as such, locomotive noise is not anticipated to contribute to operatonal noise levels.

Buttonderry Site

Modelling shows that the PSNC are not predicted to be exceeded at any private residence or more than 25% of a contiguous block of land in single landownership due to activities from the Buttonderry Site. Consideration was also given to the proposed Jilliby 2 Subdivision as shown on Figure 5. Noise impacts are not predicted to exceed accepted amenity criteria at any future dwelling in this subdivision.

Sleep Disturbance

The noise impact assessment addressed sleep disturbance by considering plant and activities identified as likely to generate short term noise impacts. Key sources assessed included train horns, coal wagon bunching, train loading bin and coal transfer chutes. Without secondary noise mitigation, modelling (see Appendix N) identified that sources could give rise to noise levels that exceed the recommended sleep disturbance criteria at up to five representative receiver locations under worst-case meteorological conditions.

However with the application of effective noise controls described and committed to in Section 7.8.4, modelling has shown (see Appendix N) noise levels from the Project are predicted to remain below the recommended sleep disturbance criteria.

Road Traffic

Table 58 presents the predicted peak hour traffic noise levels on Hue Hue Road accessing the Buttonderry Site and Bushells Ridge Road accessing the Tooheys Road Site. Bold results in Table 58 indicate where an exceedance of the criteria is predicted to occur. Due to the limited number and duration of traffic at the Western Ventilation Shaft site around Project Year 13, the assessment has confirmed noise road impacts are unlikely to occur. The predicted $LA_{eq\ 1\ hour}$ road traffic noise levels for Hue Hue Road at 30 m satisfy the day time 60 dBA and night time 55 dBA criteria for collector roads.

Existing dwellings constructed along Hue Hue Road between Bushells Ridge Road and Sparks Road are set back approximately 200 m – 250 m. On Bushells Ridge Road, the predicted traffic noise levels satisfy the PSNC at 10 m from the road.

Existing dwellings constructed along Bushells Ridge Road are set back approximately 20 m – 60 m. During construction periods, traffic noise levels at 10 m are predicted to satisfy the day time 60 dBA target noise assessment goals for collector roads.

Rail Traffic

Noise modelling for peak annual production output of 5 Mtpa shows that the additional rail traffic noise will marginally increase (1-2 dBA) the existing $LA_{eq,\ 24\ hour}$ rail traffic noise levels on the Main Northern Rail Line. With respect to the LA_{max} noise levels, the Project is not expected to increase the existing levels.

Vibration

The key sources of vibration from mining related activities are anticipated to be dozers and trucks. Vibration levels at private receivers are predicted to be within acceptable limits for human comfort.

Table 58 Predicted Operational Road Traffic Noise Levels

Shift	Times	Criteria (dBA)	Predicted Road Traffic Noise Levels $LA_{eq,\ 1\ hour}$			
			10 m	30 m	50 m	100 m
Buttonderry Site (Hue Hue Road)						
Day	6:30 am to 8:30 am	55	**58.1**	54.1	52.1	49.2
Afternoon	1:30 pm to 3:30 pm	60	58.1	54.1	52.1	49.2
Night	9:30 pm to 11:30 pm	55	**57.5**	53.6	51.5	48.7
Tooheys Road Site (Bushells Ridge Road)						
Day	6:30 am to 8:30 am	55	48.6	44.6	42.6	39.7
Afternoon	1:30 pm to 3:30 pm	60	48.6	44.6	42.6	39.7
Night	9:30 pm to 11:30 pm	55	43.8	39.9	37.8	35.0

Bold figures represent exceedance of criterion

7.8.4 Mitigation and Management

Feasible and Reasonable Noise Control

During the development of the Project, 12 different combination options were considered to reduce impacts to private receivers with detail provided in Appendix N.

The following best practice noise controls have been included in the modelling for the Project:

- The rail spur will include relevant control measures (curve radii of at least 200 m to minimise wheel / rail interface noise, concrete bridges or vibration isolation material between the rails and steel bridges and continuously welded rails);
- Double skin insulated cladding of crushing plant;
- Low noise rated conveyors and motor drives;
- Conveyor structures with side and roof screens to provide effective directional noise amelioration;
- Concrete (or sand-lined or similar technology) coal loading bin;
- Acoustically isolated vibrating screens / transfers;
- Acoustically insulated conveyor head / transfer plates;
- Design of the Product Stockpile coal reclaim system to minimise dozer reliance for train loading;
- Selection of mobile plant with secondary noise control kits;
- Removal of surface rail crossing and requirement for trains to sound warning horns whilst on site;
- Replacement of mobile plant reversing alarms with low level alarms;
- Low noise rated gas flares and the use of enclosures; and
- Proactively engage predicted noise impacted Receivers (57 and 58).

Noise Monitoring Network

In addition to the meteorological monitoring system, WACJV will develop a leading practice noise monitoring network surrounding the Tooheys Road and Buttonderry Sites which is representative of the closest sensitive receivers, including:

- Quarterly attended noise monitoring (during construction and operations);
- Regular correlation of real time noise monitoring results with the meteorological station to proactively manage operations during noise enhancing conditions when surface facility activities are approaching the intrusive criterion (particularly during construction of Buttonderry Site in the vicinity of Amberwood Close); and
- A network of real time noise monitors.

Similar to the air quality monitoring system, trigger levels will be developed to generate visual alarms to notify the site supervisors of noisy operations that may require attention.

WACJV will develop an EMP describing noise monitoring and management for the approval of DP&I in consideration of the above.

Noise Management Plan

WACJV will develop a Noise Management Plan (NMP) for the construction and operation of the Project. The NMP will incorporate the feasible and reasonable mitigation and noise monitoring network described above as well as additional practical noise minimisation management including (but not limited to):

- Mobile and coal handling equipment will be maintained in good condition to minimise unnecessary noise;
- Noise suppression will be constructed and maintained on the conveyor system and transfer points;
- Selection of quiet plant for use in construction activities. When using contractors for construction, preference will be given to contractors able to use low noise emission equipment;
- All construction and operational personnel will receive training in best practice work methods to minimise noise; and
- Dozer operations will be managed or curtailed to avoid the risk of excessive noise from multi-dozer activity.

7.9 Ecology

An Ecological Impact Assessment for the Project has been undertaken by Cumberland Ecology and is included in Appendix O. The assessment investigates the impacts of the Project on current biodiversity values, including threatened species, populations and ecological communities protected under the TSC Act.

The assessment also addresses potential impacts to MNES as listed under the EPBC Act in a single section (see Section 7 of Appendix O). Assessments have been undertaken in accordance with relevant NSW and Commonwealth legislation and planning policies as relevant to the protection of biodiversity discussed in Section 4. The environmental record of WACJV is discussed in Section 1.4.

7.9.1 Background

The Ecological Impact Assessment was developed to update existing knowledge of the biodiversity values within the Project Boundary in line with current legislation, regulatory survey guidelines and any new protected species listings.

Detailed flora and fauna surveys within and surrounding the Project Boundary and on neighbouring WACJV lands were completed by OzArk from 2006 to 2012 and by Cumberland Ecology in 2012, where practicable, in accordance with accepted conventional guidelines (DEC (NSW) 2004) and included quadrat sampling, habitat assessments, targeted species searches, trapline surveys, nocturnal surveys and bat surveys (harp and anabat).

The Ecological Impact Assessment considers the Project's impacts on terrestrial flora and fauna, particularly threatened species, populations and ecological communities. The increasing importance placed by the government agencies on the conservation of CEECs and the changes in the Commonwealth's *Protected Matters* prompted the need for an accurate vegetation map over the Project Boundary and thus a large proportion of the most recent survey efforts have been dedicated to this purpose.

For this reason, matters such as the Charmhaven Apple, Back-eyed Susan, Spotted-tailed Quoll and the Giant Barred Frog were of particular focus to the investigation. Targeted flora searches were also conducted for *Acacia bynoeana, Angophora inopina, Callistemon linearifolius, Eucalyptus camfieldii, Eucalyptus parramattensis* subsp. *parramattensis* (Endangered population) *Grevillea parviflora* subsp. *parviflora*, and *Tetratheca juncea.* In December 2012, additional targeted surveys were conducted for *Angophora inopina* and *Melaleuca biconvexa.*

The vegetation present within the Project Boundary generally consists of a mixture of mature and regenerating forest and woodland communities, and cleared rural lands mainly on floodplains and adjacent slopes comprising grassland with some areas of wetland and riparian vegetation. Given that activities associated with the Project could not to occur without incurring impacts to native forests and woodlands, including habitats of Threatened flora and fauna, it was identified that land to be designated as compensatory offsets would be required to address the ecological impacts of the Project (see Section 7.10).

7.9.2 Methodology

Literature Review

A desktop review of previous studies undertaken within the locality of the Project Boundary was undertaken to identify the key ecological attributes and issues including Key Threatening Processes occurring as a result of the activities associated with the Project. The relevant results of these studies were incorporated into the Ecological Impact Assessment.

Other existing information on the biodiversity values of the area within the Project Boundary and its surrounds were obtained via interrogation of BioNet, the OEH Atlas of NSW Wildlife and SEWPaC's EPBC Act Protected Matters Search Tool.

The Protected Matters Search Tool provides a list of MNES that are predicted to occur within 10 km of the centre of the Project Boundary based on the presence of suitable habitat, which was useful for informing Threatened species searches during field survey. The BioNet search also provided a list of threatened species that have been recorded within 10 km of the centre of the Project Boundary.

The Protected Matters Search Tool and BioNet searches indicated that 81 listed species have the potential to occur in the locality of the Project. This is comprised of one threatened flora population, 20 threatened flora species and 60 threatened fauna species. The Protected Matters Search Tool also indicated that 11 migratory species have the potential to occur in the locality.

The literature review considered a number of ecology studies conducted by ERM, BHP and Bell between 1998 and 2003. The review of previous ecological studies also considered species that were listed after the completion of these studies.

Field Surveys

Comprehensive flora and fauna surveys were undertaken in the field for the area within the Project Boundary and on surrounding lands held by WACJV during the period 2006 to 2012 by OzArk Pty Ltd and its specialist ecological subconsultants. Additional field surveys were completed by Cumberland Ecology in 2012 and included:

- Targeted flora searches for *Angophora inopina* and *Melaleuca biconvexa* at the Tooheys Road and Buttonderry sites respectively;
- General flora surveys at the site of the Western Ventilation Shaft;
- Tree hollow density surveys of the Infrastructure and Offset Areas, and
- Vegetation mapping and general flora surveys of areas previously limited due to access issues.

The two key infrastructure areas which will largely be directly cleared by the Project are owned by WACJV and have been extensively surveyed. The Western Ventilation Site is located in Wyong State Forest and has also been extensively surveyed.

Private properties are located within the Project Boundary, particularly within the Subsidence Impact Limit. WACJV advises it has undertaken reasonable endeavours to obtain access to private land for survey work. Permission to access private property was sought through surveys and direct interviews with landowners. Despite these endeavours, WACJV was unable to obtain access to private properties above the Subsidence Impact Limit. Access was granted for six properties owned by the DLALC in the vicinity of the Tooheys Road Site. WACJV was also granted access to a large rural property to the north of Little Jilliby Jilliby Creek and adjacent to the Jilliby SCA.

Some additional areas were inaccessible due to hazardous terrain. These areas were mapped by OzArk using mapping previously conducted by Bell for WSC in 2002 and 2008. In addition, Cumberland Ecology surveyed these areas using visual observations from publicly accessible areas. Much of the unsurveyed private land is agricultural in character; and as such is predominantly disturbed, providing limited habitat for threatened species. Although most of the private land is agricultural grassland, there are still some areas of vegetation that have not been surveyed due to access restrictions. It has been conservatively assumed that these vegetated areas provide habitat for the threatened species that are normally associated with these communities. These areas were included in the areas of vegetation communities that are affected by subsidence (see Appendix O).

The survey efforts for this assessment are summarised in Table 59. Surveys were undertaken during several seasons and a wide range of weather conditions. The weather conditions during each survey and the species identified during each survey effort are detailed in Appendix O.

Flora and Vegetation Community Surveys

In order to obtain an understanding of the vegetation communities present and prepare initial vegetation mapping within the Project Boundary, a review of aerial photographs and available satellite imagery was conducted. The extent of occurrence of each community has been mapped using mapping conducted by Steven Bell in 2002 and the results of ground-truthing conducted by OzArk and Cumberland Ecology.Field investigation of vegetation and flora species mapping within and surrounding the Project Boundary included:

- Sampling of 48 flora quadrats, recording species composition and structure to confirm the distribution of vegetation map units present;
- Targeted searches and opportunistic recordings of threatened flora species
- Additional targeted surveys for *Angophora inopina* and *Melaleuca biconvexa* in December 2012; and
- Random meander surveys on foot and vehicle with vegetation units and boundary changes made.

Table 59 Ecological Survey Effort

Survey Dates	Tasks Completed
14-16, 26-30 September 2006	Flora and Fauna surveys, Orchid Surveys, Targeted threatened species surveys, Vegetation mapping
1, 4, 12, 18 October 2006	Flora and Fauna surveys, Orchid surveys, Targeted threatened species surveys, Vegetation mapping
1, 14, 20 November 2006	Flora surveys, Orchid surveys, Targeted threatened species surveys, Vegetation mapping
12, 19 December 2006	Flora surveys, Targeted threatened species surveys, Orchid surveys
23 February 2007	Orchid surveys, Targeted threatened flora surveys
12 July 2007	Orchid surveys, Targeted threatened flora surveys
7-8, 29-30 August 2007	Flora surveys, Orchid and targeted threatened species surveys
6, 14, 20 September 2007	Orchid surveys, Targeted threatened species surveys, Orchid surveys
8 October 2007	Orchid surveys, Targeted threatened species surveys
22 November 2007	Orchid surveys, Targeted threatened species surveys
5 December 2007	Orchid surveys, Targeted threatened species surveys
11 January 2008	Orchid surveys, Targeted threatened species surveys
2, 6 November 2009	Flora surveys, Orchid surveys, Targeted threatened species surveys, Vegetation mapping
17-21, 24-28 October 2011	Fauna surveys, Orchid surveys, Targeted threatened species surveys
5-9, 16-17 December 2011	Flora and Fauna surveys, Orchid Surveys, Targeted threatened species surveys
24 January 2012	Orchid surveys, Targeted threatened species surveys
20 February 2012	Orchid surveys, Targeted threatened species surveys
20-24 February 2012	Fauna surveys
27 February - 2 March 2012	Fauna surveys
9 – 10 August 2012	Vegetation mapping verification, Fauna habitat assessment
22 – 23 November 2012	Flora survey, Vegetation mapping, Tree hollow assessment
29 – 30 November 2012	Flora survey, Vegetation mapping verification
17 – 18 December 2012	Targeted threatened species searches (*Angophora inopina* and *Melaleuca biconvexa*), Tree hollow assessment

Targeted surveys for the newly listed (i.e. late 2012) orchid species *Corunastylis* sp. Charmhaven could not be conducted due to the lack of sufficient information on the appropriate survey period or flowering period for this threatened species.

Vegetation mapping included assessments of the general condition of the different vegetation types within the Project Boundary. Vegetation condition was assessed using the criteria outlined in the *Biobanking guidelines.* All vegetation communities were determined to be in moderate to good condition, with the exception of exotic/agricultural grassland areas, which are considered low quality vegetation.

All information gathered during field surveys was synthesised using a Geographical Information System (GIS) to create a database of spatial records. The information included in this GIS database was then analysed to produce a detailed vegetation unit map for the Project.

Fauna Survey Methods

Fauna Surveys were undertaken over a number of years under different seasonal conditions at a range of locations within the areas assessed for the Project by OzArk to maximise the likelihood of detecting fauna species present.

The fauna assessment component of the Ecological Impact Assessment included the following:

- Detection of terrestrial and arboreal species (via use of Elliot trapping, cage trapping, 'Faunatech' hair tubes);
- Spotlighting and call playback for nocturnal mammals and birds;
- Placement of infrared cameras on fauna pathways and adjacent to water bodies;
- Bat surveys (via the use of anabat echolocation recording units and harp trapping);
- Diurnal and nocturnal surveys for reptile and amphibian species (including active searches and opportunistic identification);
- Diurnal and nocturnal bird surveys; and
- Collection and analysis of scats and raptor pellets collected during the course of field studies.

Groundwater Dependent Ecosystems

Cumberland Ecology also conducted a desktop assessment of the vegetation communities within the Project Boundary and Subsidence Impact Limit utilising existing data on vegetation communities, location and topography to identify potential GDEs that may be impacted by the Project.

These ecosystems were identified on the basis of the presence of species such as Red Mahogany, Swamp Mahogany and several Melaleuca species such as Flax-leaved Paperbark and Prickly-leaved Paperbark. These species were considered due to floodplain and riparian communities dominated by such canopy and mid-storey species are generally found in areas that have surface expression of groundwater.

Cumberland Ecology then conducted field inspections in August 2012 to ground truth the condition of the existing environment that these species vegetation communities were located within and identify the location of potential GDEs.

Vegetation Communities

The vegetation within the Project Boundary is comprised of a mixture of forest and woodland communities, wetland and riparian areas and grassland derived from the clearing of the original forest and woodland communities. Grassland areas are dominated by exotic agricultural species.

The vegetation communities present within the Project Boundary and Subsidence Impact Limit include the following:

- Blackbutt - Turpentine open forest of the foothills of the North Coast (Endangered Ecological Community (EEC));
- Coachwood - Crabapple warm temperate rainforest of the North Coast and northern Sydney Basin (EEC);
- Paperbark swamp forest of the coastal lowlands of the North Coast and Sydney Basin (EEC);
- *Phragmites australis* and *Typha orientalis* coastal freshwater wetlands of the Sydney Basin (EEC);
- Rough-barked Apple - Red Gum grassy woodland of the MacDonald River Valley on the Central Coast, Sydney Basin (EEC);
- Spotted Gum - Broad-leaved Ironbark grassy open forest of dry hills of the lower Hunter Valley, Sydney Basin (EEC);
- Swamp Mahogany swamp forest on coastal lowlands of the North Coast and northern Sydney Basin (EEC);
- Woollybutt - Paperbark sedge forest on alluvial plains of the Central Coast, Sydney Basin (EEC);
- Mountain Blue Gum - Turpentine moist shrubby open forest of the coastal ranges of the Central Coast, Sydney Basin;
- Scribbly Gum - Red Bloodwood heathy woodland on the coastal plains of the Central Coast, Sydney Basin;
- Smooth-barked Apple - Red Bloodwood open forest on coastal plains on the Central Coast, Sydney Basin;
- Spotted Gum - Grey Ironbark open forest on the foothills of the Central Coast, Sydney Basin; and
- Exotic/Agricultural/Low Diversity Grassland.

Of the vegetation communities identified, the Blackbutt - Turpentine open forest of the foothills of the North Coast, Coachwood - Crabapple warm temperate rainforest of the North Coast and northern Sydney Basin, Paperbark swamp forest of the coastal lowlands of the North Coast and Sydney Basin, *Phragmites australis* and *Typha orientalis* coastal freshwater wetlands of the Sydney Basin, Rough-barked Apple - Red Gum grassy woodland of the MacDonald River Valley on the Central Coast, Sydney Basin, Spotted Gum - Broad-leaved Ironbark grassy open forest of dry hills of the lower Hunter Valley, Sydney Basin, Swamp Mahogany swamp forest on coastal lowlands of the North Coast and northern Sydney Basin and Woollybutt - Paperbark sedge forest on alluvial plains of the Central Coast, Sydney Basin are listed as EEC under the TSC Act.

No EPBC Act listed EECs were identified during Project surveys. The distribution of vegetation communities within the Project Boundary and Subsidence Impact Limit area assessed is shown on Figure 39.

Flora

As a result of surveys undertaken, over 450 flora species (approximately 5% exotic) were recorded within the Project Boundary and Subsidence Impact Limit. The dominant flora families recorded include Myrtaceae, Poaceae, Cyperaceae and Asteraceae. A full list of the flora species identified during the Project assessment is provided in Appendix O.

Six of the flora species recorded during surveys of the area within the Project Boundary and Subsidence Impact Limit are listed as threatened species under the TSC Act and EPBC Act. A summary of the threatened flora species listed under the EPBC Act and TSC Act is provided in Table 60.

The locations of threatened fauna species identified in the Project assessment are shown on Figure 40.

Fauna

The vegetation communities that occur within the Project Boundary and Subsidence Impact Limit support habitat suitable for a range of fauna, including amphibians, reptiles, birds, bats and terrestrial and arboreal mammals. Field surveys have resulted in the development of a comprehensive fauna species list for the Project (provided in full in Appendix O).

Over the course of surveys of the Project Boundary and Subsidence Impact Limit, 29 threatened and eight migratory fauna species have been identified. These species and their respective statuses under the TSC Act and EPBC Act are outlined in Table 61. The locations of threatened fauna species identified in the assessment are shown on Figure 41.

The presence of tree hollows is an indicator of habitat quality for arboreal fauna and hollow-dependent birds and bats. Tree hollow surveys were undertaken by Cumberland Ecology in November and December 2012.

Assessments of Significance

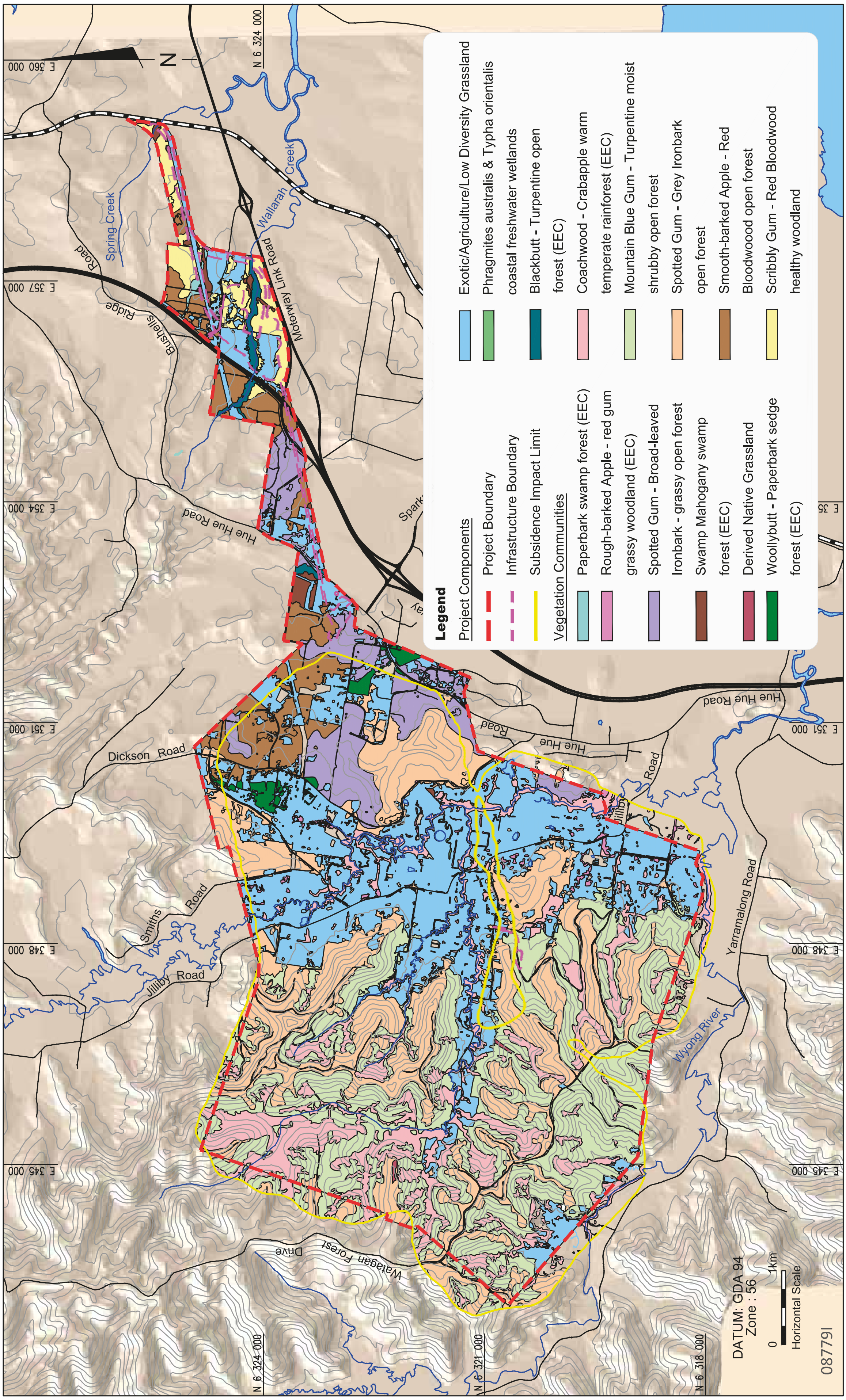
Assessment of Significance tests were undertaken in accordance with Section 5A of the EP&A Act for each of the threatened species, populations and communities listed under the TSC Act that were recorded or identified as having the potential to occur in the Project Ecological Impact Assessment. Further Assessments of Significance, in accordance with the EPBC Act Signficant Impact Criteria, were conducted for all MNES listed in the DGRs for the Project as well as additional MNES with the potential to occur. These tests were undertaken as a risk assessment tool to determine which listed threatened flora and fauna species may be most at risk from the Project.

Assessments of Significance tests for relevant listed species are provided in Appendix O.

Table 60 Recorded Threatened Flora Species

Scientific Name	Common Name	TSC Status	EPBC Status
Acacia bynoeana	Bynoes Wattle	E	V
Angophora inopina	Charmhaven Apple	V	V
Cryptostlis hunteriana	Leafless Tongue Orchid	V	V
Grevillea parviflora subsp. parviflora	Small-flower Grevillea	V	V
Melaleuca biconvexa	Biconvex Paperbark	V	V
Tetratheca juncea	Black-eyed Susan	V	V

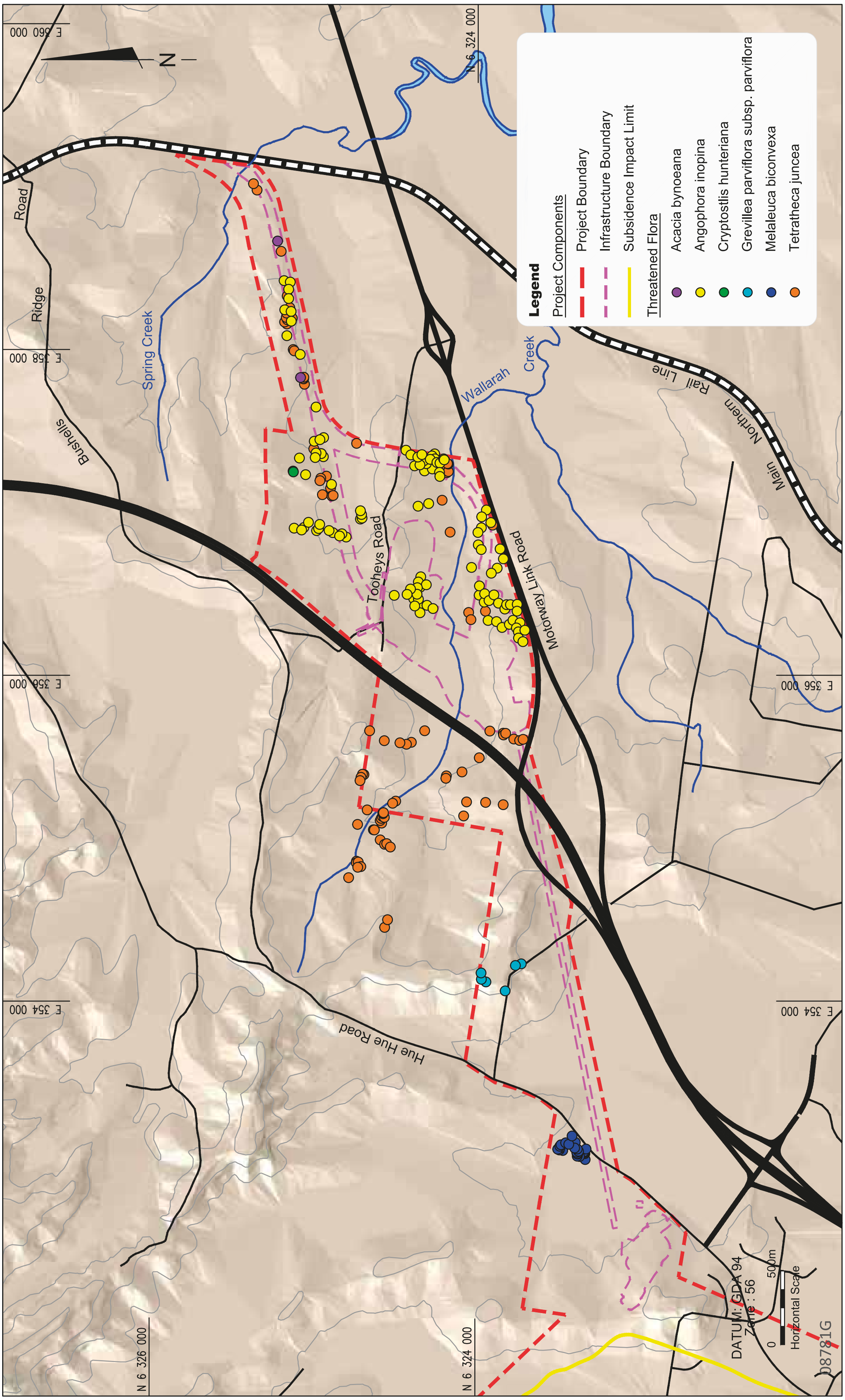
E: Endangered, V: Vulnerable



WALLARAH 2 COAL PROJECT

Vegetation Communities

FIGURE 39



WALLARAH 2 COAL PROJECT

Threatened Flora

FIGURE 40

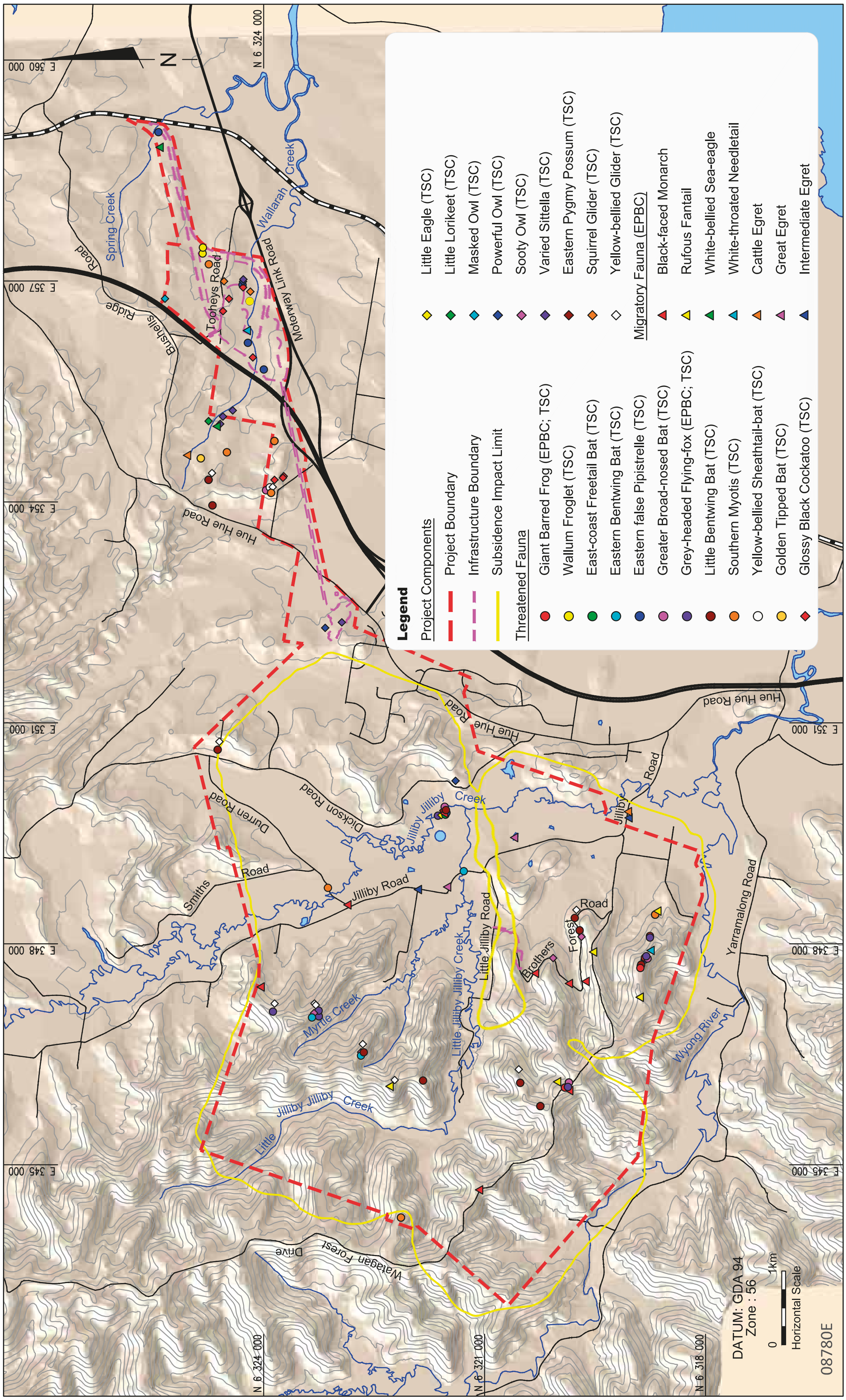
Hansen Bailey ENVIRONMENTAL CONSULTANTS

Wallarah 2 COAL PROJECT

Table 61 Recorded Threatened & Migratory Fauna Species

Scientific Name	Common Name	TSC Status	EPBC Status
Crinia tinnula	Wallum Froglet	V	N/A
Litoria aurea	Green and Golden Bell Frog	E1	V
Litoria brevipalmata	Green-thighed Frog	V	N/A
Mixophyes iterates	Giant Barred Frog	E1	E
Hieraaetus morphnoides	Little Eagle	V	N/A
Calyptorhynchus lathami	Glossy Black Cockatoo	V	N/A
Daphoenositta chrysoptera	Varied Sittella	V	N/A
Ephippiorhynchus asiaticus	Black-necked Stork	E1	N/A
Epthianura albifrons	White-fronted Chat	V	N/A
Glossopsitta pusilla	Little Lorikeet	V	N/A
Hieraaetus morphnoides	Little Eagle	V	N/A
Ixobrychus flavicollis	Black Bittern	V	N/A
Limosa limosa	Black-tailed Godwit	V	C, J, K
Ninox strenua	Powerful Owl	V	N/A
Tyto novaehollandiae	Masked Owl	V	N/A
Tyto tenebricosa	Sooty Owl	V	N/A
Ardea alba	White Egret	N/A	M,C,J
Ardea ibis	Cattle Egret	N/A	M,C,J
Gallinago hardwickii	Latham's Snipe	N/A	M,C,J,K
Haliaeetus leucogaster	White-bellied Sea-Eagle	N/A	M,C
Hirundapus caudacutus	White-throated Needletail	N/A	M,C,J,K
Monarcha melanopsis	Black-faced Monarch	N/A	M,B
Plegadis falcinellus	Glossy Ibis	N/A	M,C
Rhipidura rufifrons	Rufous Fantail	N/A	M,B
Cercartetus nanus	Eastern Pygmy Possum	V	N/A
Dasyurus maculatus	Spotted-tailed Quoll	V	E
Petaurus norfolcensis	Squirrel Glider	V	N/A
Petaurus australis	Yellow-bellied Glider	V	N/A
Pteropus poliocephalus	Grey-headed Flying Fox	V	V
Saccolaimus flaviventris	Yellow-bellied Sheathtail-bat	V	N/A
Mormopterus norfolkensis	East-coast Freetail Bat	V	N/A
Falsistrellus tasmaniensis	Eastern False Pipistrelle	V	N/A
Kerivoula papuensis	Golden-tipped Bat	V	N/A
Miniopterus australis	Little Bentwing Bat	V	N/A
Miniopterus orianae oceanensis (formerly *Miniopterus schreibersii oceanensis*)	Eastern Bentwing Bat	V	N/A
Myotis macropus (formerly *Myotis adversus*)	Southern Myotis	V	N/A
Scoteanax rueppellii	Greater Broad-nosed Bat	V	N/A

E/E1: Endangered V: Vulnerable M: Migratory B: Bonn Convention Migratory Agreement C: CAMBA Migratory Agreement J: JAMBA Migratory Agreement K: ROKAMBA Migratory Agreement



WALLARAH 2 COAL PROJECT

Threatened and Migratory Fauna Recorded

FIGURE 41

Key Threatening Processes

In accordance with the TSC Act, Key Threatening Processes (KTPs) were assessed for the Project in detail in Appendix O. The KTPs relevant to the Project include:

- The clearing of native vegetation;
- The alteration of habitat following subsidence due to longwall mining;
- The alteration of natural flow regimes or rivers and streams and their floodplains and wetlands; clearing of native vegetation;
- Infection of frogs by amphibian chytrid fungus causing the disease chytruduinyosis;
- Introduction and establishment of Exotic Rust Fungi of the order Pucciniales pathogenic on plants of the family Myrtaceae; and
- Anthropogenic climate change.

Ecological Offset Assessments

Due to the impacts to vegetation communities predicted for the Project (see Section 7.9.3), surveys were undertaken to identify areas that may be available as ecological offsets. This component of the Ecological Impact Assessment is discussed further in Section 7.10.

7.9.3 Impact Assessment

The assessment lands within the Project Boundary / Subsidence Impact Limit for the Ecological Impact Assessment show evidence of substantial alteration by long-term vegetation clearing for agriculture, farms and forestry activities. This has resulted in a highly disturbed and fragmented landscape. Despite this, the local area has been shown to support a high diversity of threatened flora and fauna and ecological communities, including EECs as listed under the TSC Act (see Figure 39).

Detailed assessments of vegetation communities and native flora and fauna have determined that the Project will not have any significant impacts on areas currently identified as potential conservation lands under WSC's Development Control Plan (DCP) 13 – Interim Conservation Areas. Similarly, assessments have confirmed that the Project will not have any significant impact within the areas zoned as 7(g) wetlands under the Wyong LEP. There is a small area of zone 7(g) land within the Project Boundary, as represented by the small yellow area near the Tooheys Road Site on Figure 6.

As described in Section 4.6.1, the Project has been deemed a Controlled Action under the EPBC Act for the Charmhaven Apple and Black-eyed Susan (listed as vulnerable under the Act), and Spotted-tailed Quoll and Giant Barred Frog (listed as endangered under the Act).

Vegetation Communities

Over the life of the Project, approximately 89 ha of vegetation will be directly impacted, consisting of remnant and regenerating forest and woodland communities and large areas of open grassland and scattered trees located within the Disturbance Boundary. The remaining 13.9 ha within the Infrastructure Boundary is land that is currently in a cleared state.

Areas of vegetation to be directly impacted due to the development of Project infrastructure are summarised in Table 62. The areas to be cleared consist of moderate to good condition vegetation, except for areas of Exotic/Agricultural/ Low Diversity Grassland which are considered low condition vegetation. The direct removal of vegetation communities for the Project is likely to result in the following impacts to remaining habitat by:

- Removing or reducing the availability of important habitat features that may offer forage, shelter or breeding opportunities for fauna, thus putting more pressure on remaining habitat to provide these features;
- Exacerbating fragmentation and isolation of already patchy areas of woodland vegetation; and
- Increasing edge effects, particularly along linear patches of vegetation.

In addition to direct impacts caused as a result of infrastructure development, a range of indirect ecological impacts also have the potential to occur. Potential indirect impacts to vegetated areas of the Project located outside of the Disturbance Boundary may include:

- Subsidence impacts due to surface cracking, surface subsidence or groundwater impacts associated with the longwall mining operations proposed for the Project (see Section 7.1);
- Noise generated by construction and operation of the Project;
- Lighting spillage effects as a result of the infrastructure area;
- Increased likelihood of vehicle strike;
- Erosion and sediment controls;
- Change in flow regimes of streams due to discharges of treated water into Wallarah Creek; and
- Weeds and feral animal controls.

Whilst the Project has the potential to affect the flow regime and water quality of Wallarah Creek through the discharge of surplus treated water into a tributary of Wallarah Creek, due to the low rate of discharge and the quality of water to be discharged, the controlled discharges are not likely to adversely impact the ecology of Wallarah Creek.

Flora

Suitable habitat is present within the Project Boundary and Subsidence Impact Limit for a number of threatened flora species listed under the EPBC Act and TSC Act. Despite the completion of targeted surveys for the Project, only six threatened flora species were found to occur (see Table 60).

Impacts to these species as a result of the Project include the removal of approximately:

- One known specimen of Bynoe's Wattle and 42.9 ha of potential habitat;
- 80 specimens of Charmhaven Apple and approximately 47.7 ha of potential habitat;
- 48.7 ha of potential habitat for the Leafless Tongue Orchid;
- 44.6 ha of potential habitat for the Small-flower Grevillea;
- 9.5 ha of potential habitat for the Biconvex Paperbark; and
- Known specimens of Black-eyed Susan from approximately 28 locations and approximately 50.5 ha of potential habitat.

Habitat suitable for 11 additional threatened flora species listed under the EPBC Act and TSC Act recorded in the locality that are considered to have potential to occur were also considered in the Ecological Impact Assessment (Appendix O).

All the native vegetation in the Project Disturbance Boundary was considered to be potential habitat for all of these potential species and as such, 60.5 ha has been assumed to be removed by the Project.

Fauna

The Project will result in the removal of forest, woodland and grassland vegetation communities which provide foraging, shelter and breeding habitat for fauna species in the area.

As outlined in Table 61, a number of threatened (TSC Act and EPBC Act) and migratory (EPBC Act) listed fauna species were recorded during field surveys for the Ecological Impact Assessment. Although not identified within the Project Boundary or Subsidence Impact Limit, a number of other threatened species were also considered to have the potential to occur. Additional species identified as having the potential to occur are listed in Appendix O.

The potential impacts of the Project on these species are mostly related to the removal of habitat and potential indirect effects. Approximately 89 ha of vegetation will be removed for construction of the surface infrastructure, and 4,011 ha of vegetation has the potential to be impacted through subsidence effects.

The fauna species most at risk of subsidence impacts are those that depend on waterways and riparian vegetation that have potential to be affected by changes in hydrology caused by subsidence and by minor surface cracking.

Table 62 Direct Vegetation Disturbance for the Project

Vegetation Community	Vegetation Condition	Area of Vegetation to be Removed (ha)			
		Tooheys Road Site	Buttonderry Site	Western Shaft Site	Total
Blackbutt - Turpentine open forest of the foothills of the North Coast *	Moderate to Good	5.9	0.0	0.0	5.9
Mountain Blue-Gum Turpentine moist shrubby open forest of the coastal ranges of the Central Coast, Sydney Basin	Moderate to Good	0.0	0.0	1.7	1.7
Paperbark swamp forest of the coastal lowlands of the North Coast and Sydney Basin *	Moderate to Good	1.1	0.0	0.0	1.1
Spotted Gum - Broad-leaved Ironbark grassy open forest of dry hills of the lower Hunter Valley, Sydney Basin *	Moderate to Good	0.0	4.5	0.0	4.5
Scribbly Gum - Red Bloodwood heathy woodland on the coastal plains of the Central Coast, Sydney Basin	Moderate to Good	33.8	0.0	0.0	33.8
Smooth-barked Apple - Red Bloodwood open forest on coastal plains on the Central Coast, Sydney Basin	Moderate to Good	1.8	2.0	0.0	3.8
Spotted Gum - Grey Ironbark open forest on the foothills of the Central Coast, Sydney Basin	Moderate to Good	0.0	0.0	0.8	0.8
Swamp Mahogany swamp forest on coastal lowlands of the North Coast and northern Sydney Basin *	Moderate to Good	1.8	0.0	0.0	1.8
Derived Native Grassland	Moderate to Good	7.3	0.0	0.0	7.3
Exotic/Agricultural/Low Diversity Grassland	Low	24.2	3.6	0.2	28.0
TOTAL		**75.9**	**10.1**	**2.7**	**88.7**

*Vegetation community listed as EEC under the TSC Act

Of the 89 ha of vegetation to be directly impacted, potential impacts to species from the Project include removal of approximately:

- 10.4 ha of habitat for threatened frog species (including the Wallum Froglet, Giant Barred Frog, Green and Golden Bell Frog and Green-thighed Frog which are known to occur);
- 44.5 ha of habitat for species of forest owl species, including the Powerful Owl, Masked Owl, Barking Owl and Sooty Owl;
- 46.6 ha of habitat for a range of arboreal mammals, including the Eastern Pygmy Possum, the Squirrel Glider and the Yellow-bellied Glider;
- 50.4 ha of habitat for nine threatened bat species;
- 2.9 ha of habitat suitable for threatened wetland birds, including the Black Bittern, Black-necked Stork, Black-tailed Godwit and White Fronted Chat;
- 51.6 ha of habitat for the two migratory parrot species, the Little Lorikeet and the Swift Parrot;
- 38.3 ha of habitat for the two threatened cockatoo species, the Glossy Black Cockatoo and the Gang-gang Cockatoo;
- 44.2 ha of habitat for the Regent Honeyeater;
- 48.4 ha of habitat for the Grey-headed Flying Fox, mostly due to the removal of areas of Spotted Gum – Grey Ironbark forest or Mountain Blue Gum Turpentine;
- 43.4 ha of habitat for the Little Eagle;
- 37.6 ha of habitat for the Varied Sittella;
- 37.6 ha of habitat for the Bush Stone-curlew;
- 51.5 ha of habitat for the Koala; and
- 48.4 ha of habitat for the Spotted-tailed Quoll.

Groundwater Dependent Ecosystems

Two potential GDEs types occur within the Project Boundary: Terrestrial Vegetation and Wetland ecosystems. These are shown on Figure 39. No permanently flowing rivers with a baseflow rate maintained by groundwater occur, and no limestone or karst environments occur.

Jilliby Jilliby Creek flows through the area within the Project Boundary. There is known to be a minor groundwater component to the flow in Jilliby Jilliby Creek (WRM, 2013). Although much of the originally existing riparian vegetation along the Jilliby Jilliby Creek has been removed, what remains has potential to be at least partially dependent on river baseflow.

Several areas of swamp / wetland are present within the area assessed for the Project, and this vegetation may also comprise a GDE.

The following vegetation communities may comprise GDEs:

- Blackbutt – Turpentine open forest of the hills of the North Coast (EEC);
- Coachwood – Crabapple warm temperate rainforest of the North Coast and Northern Sydney Basin (EEC);
- Paperbark Swamp forest of the coastal lowlands of the North Coast and Sydney Basin (EEC);
- *Phragmites australis* and *Typha orientalis* coastal freshwater wetlands of the Sydney Basin (EEC);
- Swamp Mahogany forest on coastal lowlands of the North Coast and northern Sydney Basin (EEC); and
- Woollybutt – Paperbark sedge forest on alluvial plains of the Central Coast, Sydney Basin (EEC).

The riparian Blackbutt – Turpentine forest and Coachwood – Crabapple rainforest are likely to be dependent on groundwater only during periods of drought, especially the Coachwood – Crabapple rainforest which generally occurs in elevated or hilly areas, whereas the wetland and swamp communities, which occur in low lying areas in close proximity to water are likely to have a higher dependence on groundwater.

The two main potential impacts that may occur to GDEs for the Project include:

- Direct disturbance or removal as a result of clearing for the surface infrastructure (see Table 62); and
- Subsidence affecting the hydrological regime.

Approximately 8.8 ha of potential GDE vegetation will be removed by the Project (comprising 1.1 ha of Paperbark Swamp Forest of the Coastal Lowlands of the North Coast and Sydney Basin, 1.8 ha of Swamp Mahogany Forest on Coastal Lowlands of the North Coast and Northern Sydney Basin and 5.9 ha of Blackbutt – Turpentine Open Forest of the Hills of the North Coast). These areas represent a very small proportion of the extent of these communities in the area and the locality.

All three of these communities are listed as EECs under the TSC Act and Assessments of Significance have been conducted for these communities (see Appendix O). The assessment of the vegetation communities present within the Project Boundary and Subsidence Impact Limit indicate that due to the small area of each community that will be directly impacted and the large areas that remain, no significant impact to GDEs is predicted to occur.

Due to their high dependence on specific hydrological regimes, subsidence effects (such as surface cracking, changes in drainage flows and groundwater storage) also have the potential to result in indirect impacts to GDEs.

For the Project, the most significant aspect of subsidence with the potential to impact on GDEs is considered to be the temporary change in the local water table level.

The water table is predicted to fall by up to 1.3 m; however, the water level is predicted to experience a 55% to 75% recovery within 6 months, depending on rainfall. These results indicate that groundwater will remain at levels where it will remain accessible for vegetation that is dependent on it. Long term lowering of the water table due to depressurisation is only expected to occur near the entry to the underground drift where there are no GDEs (see Figure 31).

In elevated terrain and forested areas, where the majority of the GDEs occur, the water table is generally predicted to be deep. As a result, the GDEs within the Subsidence Impact Limit are likely to depend predominantly on water from the saturated zone. Due to the lower reliance on the water table, subsidence is not expected to have a significant impact on GDEs.

Impacts on Matters of National Environmental Significance

In response to SEWPaC's submission on the Project DGRs, the Ecological Impact Assessment also considered the impacts of the Project on MNES, specifically concentrating on the species recorded within the Project Boundary and Subsidence Impact Limit as well as those considered as having the potential to occur. These species included:

- Charmhaven Apple (*Angophora inopina*);
- Black-eyed Susan (*Tetratheca juncea*);
- Bynoe's Wattle (*Acacia bynoena*);
- Leafless Tongue Orchid (*Cryptostylis hunteriana*);
- Small-flower Grevillea (*Grevillea parviflora*);
- Biconvex Paperbark (*Melaleuca biconvexa*);
- Australasian Bittern (*Botaurus poiciloptilus*);
- Grey-headed Flying Fox (*Pteropus poliocephalus*);
- Large-eared Pied Bat (*Chalinolobus dwyerí*);
- Little John's Tree Frog (*Litoria littlejohni*);
- Stuttering Frog (*Mixophyes balbus*);
- Giant Barred Frog (*Mixophyes iterates*); and
- Spotted-tailed Quoll (*Dasyurus maculatus maculatus*).

An assessment of whether each of the above species listed as Vulnerable constitutes an "important population" as defined by the Significant Impact Guidelines (DEWHA, 2009) and an Assessment of Significance is provided for each in Appendix O. The Assessments of Significance determined that there are no significant impacts on any MNES.

A description of the impacts of the Project on MNES including direct and indirect and short and long term impacts, and the impacts of subsidence are included in Appendix O. The areas of habitat to be cleared, habitat present within offset lands and potential habitat within the SIL for all EPBC listed flora species known or considered likely to occur within the Study Area are presented in Table 64.

Cumulative Impacts

A high proportion of the surrounding locality has been and will continue to be subject to underground mining, which involves limited surface disturbance. The Project will contribute to ecological impacts on a regional scale by removing approximately 89 ha of vegetation, including 60.5 ha of remnant forest, open woodland and derived native grassland. Substantial clearing has occurred in proximity to the Project in the past for agriculture, residential and industrial land uses. The offsets provided by the Project will protect existing remnant forest and woodland communities and restore vegetation in areas previously cleared for agricultural and other purposes.

7.9.4 Mitigation & Management

Management measures proposed for the Project have followed the OEH's 'Draft Guidelines for Threatened Species Assessment' (DEC, 2005b), which aim to avoid, mitigate or offset all identified impacts, as follows:

- Avoid: to the extent possible, developments should be designed to avoid or minimise ecological impacts;
- Mitigate: where certain impacts are unavoidable through design changes, mitigation measures should be introduced to ameliorate the ecological impacts of the proposed development; and
- Compensate: the residual impacts of the Project should be compensated for in some way.

Each of these principles have been applied to the Project and addressed below where reasonable and feasible.

Avoid

As discussed in Section 3.11, significant modifications were made to the design of the Project to improve biodiversity outcomes. The Project mine plan has been refined through the consideration of a number of alternatives which were developed to reduce the potential for adverse impacts to the environment, including specific impacts on threatened ecological communities and species.

The detailed configuration of proposed extraction in all areas of the mine plan has been modified to ensure that risks and impacts have been reduced to demonstrably low and manageable levels.

These measures were primarily associated with avoidance of potential subsidence impacts to ecology, including:

- Modification of the original mine plan to avoid mining underneath the Wyong River and avoid mining beneath the vast majority of the Yarramalong Valley and its floodplain;
- Design of the chain pillars to promptly yield following adjacent longwall panel extraction so as to ensure minimal differential vertical subsidence across the surface above adjacent longwall panels and to ensure subsidence management certainty;
- Shortening of some longwall panels immediately north of the main roadways to provide a setback from the Little Jilliby Jilliby Creek near its confluence with Jilliby Jilliby Creek; and
- Alignment of short longwall panel to allow only minor and consistent subsidence underneath Jilliby Jilliby Creek.

Avoidance measures implemented include the exclusion of an option to locate Project surface facilities to the west of the F3 Freeway. This would have resulted in impacts to vegetation that contained high conservation value identified in the Wyong Conservation Strategy.

The construction of the drift connecting the Tooheys Road Site with the underground mine has also avoided the need for a surface overland conveyor and the associated clearance of native vegetation. Where feasible, impacts have been avoided by locating surface infrastructure where vegetation has already been cleared or disturbed.

Mitigate

In order to coordinate the implementation of the ecological mitigation measures proposed for the Project, a staged Biodiversity Management Plan (BMP) will be prepared prior to the commencement of construction, to the satisfaction of DP&I. In addition to the description of mitigation measures for the Project, the BMP will also provide specifications for the restoration and management of biodiversity offset areas (see Section 7.10).

The BMP is the key document that will ensure that the conservation objectives of the Project are met and that impacts to biodiversity are adequately managed and mitigated for the life of the Project.

The BMP will also include commitments to reduce impacts from the Project to: air quality, noise, erosion and sediment, visual and lighting from Section 7 of this EIS as they relate to ecology. It will also include (at least): key objectives, targets, monitoring, responsibilities, predicted effectiveness of measures and corrective actions for each.

An ecological monitoring program will also be established as a component of the BMP to monitor the ongoing status and health of flora and fauna communities that will be retained within the Project Boundary, in order to assess the success of the mitigation and compensation measures. Threatened species monitoring will involve conducting targeted threatened species surveys in areas of known habitat. In particular, monitoring will be conducted to determine the potential impacts of subsidence on the Giant Burrowing Frog (*Heleoporus australiacus*) and the regeneration of Charmhaven Apple (*Angophora inopina)* in revegetation areas.

The BMP will include specifications for mitigation measures including:

- Fencing, rehabilitation and soil conservation;
- Pre-clearing surveys and fauna rescue or translocation, where practicable. In particular, pre-clearance surveys will be conducted for newly listed threatened species (e.g. *Corunastylis* sp. Charmhaven) during appropriate survey periods (once the appropriate season is able to be confirmed by OEH);
- Vegetation clearing protocols;
- Rehabilitation of habitat where possible;
- Control and ongoing management of environmental and noxious weeds;
- Control and ongoing management of feral animals;
- Rehabilitation methods and protocols; and
- Monitoring program.

Land Disturbance Protocol

As part of the BMP, WACJV will implement a Land Disturbance Protocol for the Project which will require that the Environmental Manager (or delegated specialist) carry out an inspection of proposed disturbance areas prior to any disturbance activities occurring. This process will consider ecology, along with (at least but not limited to): archaeology, sediment and erosion control, landownership and approvals.

This Protocol also provides a process to ensure compliance with the relevant licences and approvals and that appropriate environmental safeguards and mitigation measures are implemented prior to any disturbance. Areas described in Section 3.1 as limited activities within the Project Boundary but outside the nominated Disturbance Boundary (e.g. for bushfire control, fencing, boreholes, etc) will also be subject to the Land Distubance Protocol. These activiites will only occur if a qualified ecologist determines that they will not affect MNES.

Compensate

A Biodiversity Offset Strategy has been developed to compensate impacts of the Project. Further detail is provided in Section 7.10.

7.10 Biodiversity Offset Strategy

As a component of the Ecological Impact Assessment (Appendix O), WACJV formulated a Biodiversity Offset Strategy for the Project in conjunction with Cumberland Ecology.

This Biodiversity Offset Strategy was developed as a compensatory measure in response to the predicted ecological impacts of the Project, particularly those associated with direct disturbance to threatened vegetation communities and threatened species habitat as outlined in Section 7.9. A summary of the Biodiversity Offset Strategy and a discussion on how the implementation of proposed offset measures will maintain and improve conservation values in the locality is provided in the following sections.

7.10.1 Background

The Biodiversity Offset Strategy generally consists of the provision of biodiversity offset areas that ensure the best compensatory outcomes are achieved for the ecological impacts predicted for the Project. The Biodiversity Offset Strategy has been designed to meet NSW (DECC, 2007) and Commonwealth (DEWR, 2007) guidelines for offsetting requirements and to protect and improve biodiversity within the locality with the most efficient utilisation of resources.

This involves the protection for conservation of land within the Project Boundary that contains ecological values similar to those being impacted and the rehabilitation and restoration of degraded areas within the offset lands to improve biodiversity values.

Key principles considered in the development of the Project Biodiversity Offset Strategy provide that offsets should be:

- Targeted to the ecological communities and threatened species that will be impacted by the Project;
- Commensurate with the magnitude of the impacts; that is, there should be a net increase in the size and condition of the community types, populations or habitat types that will be impacted by the Project; and
- Lasting; that is, there should be a level of legal protection for offset areas.

7.10.2 Methodology

The Biodiversity Offset Strategy proposed for the Project has been developed to ensure that ecological impacts are reduced as far as practicable and that the principles of the OEH Draft Guidelines for Threatened Species Assessment (DEC, 2005b) have been applied.

The Project requires an offset package that addresses predicted impacts to EEC and the loss of vegetation, including habitat for a suite of threatened species (see Appendix O), all of which are well represented in the offset areas.

7.10.3 Strategy

The Biodiversity Offset Strategy for the Project has been developed to conserve specific areas within the existing land holdings of WACJV as offsets.

The three main areas proposed for conservation as biodiversity offsets for the Project are shown on Figure 42 and include a total of 261 ha comprised of the:

- Hue Hue Road Offset area (160 ha);
- Tooheys Road Site Northern Offset area (48.4 ha); and
- Tooheys Road Site Southern Offset area (52.5 ha).

Detailed field assessment of the proposed biodiversity offset areas was undertaken during the surveys for the Ecological Impact Assessment for the Project to determine their biodiversity values, including the vegetation communities, habitat and flora and fauna species present within each. The Project will impact on Charmhaven Apple (*Angophora inopina)* and Black-eyed Susan (*Tetratheca juncea);* however *Angophora inopina* occurs in higher densities within the offset areas. These surveys confirmed that the vegetation communities within the biodiversity offset areas were almost identical to those recorded in the Project Boundary.

The number of all threatened species found in the proposed biodiversity offset areas is provided in Appendix O.

Table 63 provides the offset ratios for vegetation communities predicted to be impacted by the Project.

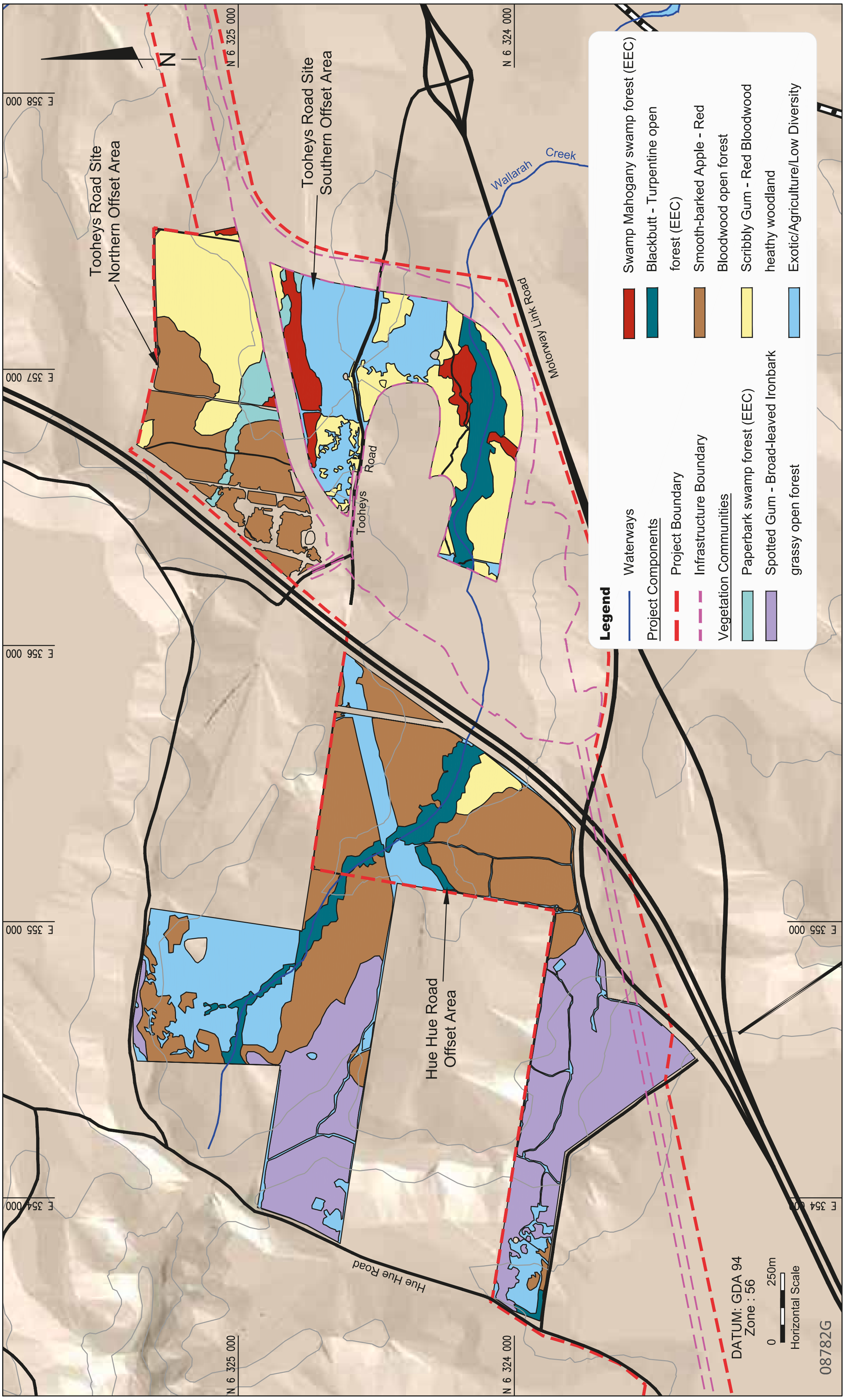
As noted in Section 7.9, no EPBC listed vegetation communities were recorded within the area assessed in the Ecological Impact Assessment for the Project.

Tree Hollows

The availability of tree hollows in the Study Area is likely to be very limited and in high demand by hollow-using fauna. Tree hollows occur within the Infrastructure Boundary and the offset areas. Tree Hollow density surveys determined that the offset areas contained a higher density of hollows than the areas to be disturbed by the Project (Appendix O). Therefore, the Biodiversity Offset Strategy adequately offsets the impacts on tree hollows.

Habitat Connectivity, Fragmentation and Edge Effects

The infrastructure areas for the Project are surrounded by land that has been cleared and developed, including the F3 Freeway, Main Northern Rail Line and Motorway Link Road. As a result, the Project will not significantly exacerbate the fragmentation effects that are already present. The offsets areas also exhibit fragmentation due to the presence of cleared paddocks and a powerline easement. Cleared areas within the offset areas will be revegetated, reducing the extent of fragmentation. The reduction of fragmentation within the offset areas outweighs the exacerbation of fragmentation within the Infrastructure Boundary.



WALLARAH 2 COAL PROJECT

Biodiversity Offset Strategy

FIGURE 42

Hansen Bailey ENVIRONMENTAL CONSULTANTS

Wallarah 2 COAL PROJECT

Table 63 Offset Ratios for Vegetation Communities to be Impacted by the Project

Vegetation Community	Condition of Offset Areas	Area Disturbed (ha)	Area in Biodiversity Offset Areas (ha)	Ratio
Blackbutt - Turpentine open forest of the foothills of the North Coast *	Moderate to Good	5.9	16.9	2.9:1
Rough-barked Apple - Red Gum grassy woodland of the MacDonald River Valley on the Central Coast, Sydney Basin *	Moderate to Good	0.0	0.4	N/A
Swamp Mahogany swamp forest on coastal lowlands of the North Coast and northern Sydney Basin *	Moderate to Good	1.8	6.5	3.7:1
Paperbark swamp forest of the coastal lowlands of the North Coast and Sydney Basin *	Moderate to Good	1.1	3.9	3.6:1
Spotted Gum - Broad-leaved Ironbark grassy open forest of dry hills of the lower Hunter Valley, Sydney Basin *	Moderate to Good	4.5	55.4	12.4:1
Mountain Blue Gum - Turpentine moist shrubby open forest of the coastal ranges of the Central Coast, Sydney Basin	Moderate to Good	1.7	0.0	-
Scribbly Gum - Red Bloodwood heathy woodland on the coastal plains of the Central Coast, Sydney Basin	Moderate to Good	33.8	40.0	1.2:1
Smooth-barked Apple - Red Bloodwood open forest on coastal plains on the Central Coast, Sydney Basin	Moderate to Good	3.8	74.0	19.6:1
Spotted Gum - Grey Ironbark open forest on the foothills of the Central Coast, Sydney Basin	Moderate to Good	0.8	0.0	-
Derived Native Grassland	Moderate to Good	7.3	11.0	1.5:1
Exotic / Agricultural / Low Diversity Grassland	Low	28.0	31.4	-
TOTAL EEC vegetation		**13.2**	**83.0**	**6.3:1**
TOTAL non-EEC native vegetation		**47.3**	**125.0**	**2.6:1**

*Vegetation community listed as EEC under TSC Act

The development of the infrastructure areas will generate additional edge effects along the Infrastructure Boundary. The Infrastructure Boundary is located in relatively degraded areas and will therefore not result in significant edge effects. There is also potential for edge effects to impact parts of the Offset areas at Tooheys Road due to the presence of existing powerline easements adjacent to the Infrastructure Boundary. Assessment of the vegetation condition determined that current vegetation along these easement areas is in a moderate to good condition despite current edge effects. A vegetation buffer zone is proposed for the offsets to reduce impacts from edge effects. The establishment of a vegetation buffer zone and the revegetation of degraded areas will reduce the likelihood of edge effects in the offset areas to lower than the likelihood of edge effects in the areas to be disturbed.

Discharges of treated water into Wallarah Creek are unlikely to generate edge effects within the offset areas. The maximum discharge rate of 3 ML/day is unlikely to result in substantial erosion of the creek banks. Furthermore, the discharge point occurs downstream of the offset areas, which minimises the risk of edge effects at the offset areas.

The biodiversity offset areas also provide potential habitat for a suite of threatened species listed under the TSC Act and/or the EPBC Act that are known to occur in the locality.

Key habitat features for listed species that are provided by the biodiversity offset areas include:

- Swamp areas – habitat for amphibians;
- Eucalypt woodlands and forest – habitat for birds, including threatened woodland birds and raptors, arboreal mammals and ground dwelling mammals; and
- Riparian areas – habitat for amphibians, birds, arboreal mammals and ground dwelling mammals.

There is also the potential for other threatened fauna species known to occur in the local area to be present within the biodiversity offset areas, including threatened microchiropteran bats and birds. The tree hollows and stags within each area also provide potential shelter, roosting and nesting habitat for threatened microchiropteran bats including the Large-eared Pied Bat. Foraging and nesting resources are also available for a range of threatened bird species such as the Regent Honeyeater and Swift Parrot. A summary of the habitat present within the offset areas as well as non-impacted habitat that will be retained and managed within the Project Boundary is provided in Table 64.

Table 64 Threatened Species Habitat Available within the Biodiversity Offsets and Project Boundary

Threatened Species	Habitat Required	Habitat cleared by the Project (ha)	Habitat in Biodiversity Offset Areas (ha)	Non-offset Habitat retained within Project Boundary (ha)
Flora				
Acacia bynoeana *	Scribbly Gum Red Bloodwood woodland, Smooth-barked Apple – Red Bloodwood Forest	42.9	169.4	1,357.2
Angophora inopina *	Scribbly Gum Red Bloodwood woodland, Swamp Mahogany Forest	47.7	135.4	208.2
Cryptostylis hunteriana *	Scribbly Gum Red Bloodwood Woodland	48.7	186.3	1,358.1
Grevillea parviflora subsp parviflora *	Spotted Gum – Broadleaved Ironbark Forest, Smooth-barked Apple – Red Bloodwood Forest	44.6	175.9	1,373.1
Melaleuca biconvexa *	Blackbutt – Turpentine Forest	9.5	27.3	997.8
Tetratheca juncea *	Scribbly Gum Red Bloodwood Woodland, Smooth-barked Apple – Red Bloodwood, Swamp Mahogany Forest , Blackbutt – Turpentine Forest	50.5	192.8	1,374.0
Potentially occurring flora species (Caladenia tessellata, Eucalyptus camfieldii, Hibbertia procumbens, Rutidosis heterogama, Syzygium paniculatum, Thelymitra sp. adorata, Eucalyptus parramattensis subsp. parramattensis)	Collectively all vegetation communities occurring within the Project Boundary	60.5	208.0	2,947.3
Fauna				
Amphibians (Wallum Froglet, Green and Golden Bell Frog, Green-thighed Frog, Giant Burrowing Frog, Giant Barred Frog *, Littlejohn's Tree Frog *, Stuttering Frog *)	Paperbark Swamp Forest, Swamp Mahogany Forest, Phragmites australis and Typha orientalis Coastal Freshwater Wetlands	10.4	27.3	1,811.0
Forest Owls (Powerful Owl, Masked Owl, Barking Owl, Sooty Owl)	Scribbly Gum – Red Bloodwood Woodland, Smooth-barked Apple – Red Bloodwood Forest, Spotted Gum – Broadleaved Ironbark, Spotted Gum – Grey Ironbark	44.5	169.4	2,338.7
Arboreal mammals (Eastern Pygmy Possum, Squirrel Glider, Yellow-bellied Glider)	Spotted Gum – Grey Ironbark Forest, Spotted Gum – Broadleaved Ironbark forest, Mountain Blue Gum Turpentine Forest, Scribbly Gum – Red Bloodwood woodland, Blackbutt – Turpentine Forest	46.6	112.3	2,187.5
Microchiropteran Bats (Yellow-bellied Sheathtail-bat, East-coast Freetail Bat, Eastern False Pipistrelle, Little Bentwing Bat, Eastern Bentwing Bat, Golden-tipped Bat, Southern Myotis, Greater Broad-nosed Bat, Large-eared Pied Bat *)	Spotted Gum – Broadleaved Ironbark forest, Spotted Gum – Grey Ironbark Forest, Scribbly Gum – Red Bloodwood woodland, Blackbutt – Turpentine Forest and Mountain Blue Gum Turpentine Forest	50.4	186.3	2,339.6
Wetland birds (Black Bittern, Black-necked Stork, Australasian Bittern *)	Paperbark Swamp Forest, Swamp Mahogany Forest, Phragmites australis and Typha orientalis Coastal Freshwater Wetlands	2.9	10.4	17.2
Migratory Parrots (Little Lorikeet, Swift Parrot)	Smooth-barked Apple - Red Bloodwood forest, Scribbly Gum Red Bloodwood Woodland	51.6	196.7	1,374.1
Cockatoos (Glossy Black Cockatoo, Gang-gang Cockatoo)	Spotted Gum – Broad Leaved Ironbark Forest, Scribbly Gum - Red Bloodwood Woodland	38.3	95.4	260.3

Threatened Species	Habitat Required	Habitat cleared by the Project (ha)	Habitat in Biodiversity Offset Areas (ha)	Non-offset Habitat retained within Project Boundary (ha)
Fauna cont.				
Regent Honeyeater	Blackbutt – Turpentine forest; Scribbly Gum - Red Bloodwood; Smooth-barked Apple - Red Bloodwood open forest; Spotted Gum - Broad-leaved Ironbark forest; Spotted Gum - Grey Ironbark forest,	44.2	130.9	175.1
Grey-headed Flying Fox *	Spotted Gum – Grey Ironbark forest, Spotted Gum – Broadleaved Ironbark forest, Mountain Blue Gum Turpentine Forest	48.4	118.8	2,729.2
Little Eagle	Scribbly Gum - Red Bloodwood woodland, Blackbutt – Turpentine Forest	43.4	130.9	187.7
Varied Sittella	Smooth-barked Apple - Red Bloodwood forest, Scribbly Gum - Red Bloodwood Woodland	37.6	114.0	186.7
Bush Stone-curlew	Smooth-barked Apple - Red Bloodwood forest, Scribbly Gum - Red Bloodwood Woodland	37.6	114.0	186.7
Koala	Smooth-barked Apple - Red Bloodwood forest, Scribbly Gum - Red Bloodwood woodland, Spotted Gum – Grey Ironbark forest, Spotted Gum – Broadleaved Ironbark forest, Mountain Blue Gum Turpentine Forest	51.5	190.2	2,339.7
Spotted tailed Quoll *	Smooth-barked Apple - Red Bloodwood forest, Scribbly Gum - Red Bloodwood woodland, Spotted Gum – Grey Ironbark forest, Spotted Gum – Broadleaved Ironbark forest, Mountain Blue Gum Turpentine Forest	48.4	118.8	2,729.2

* EPBC listed species noted in the SEWPaC submission to the DGRs

As shown in Table 63 and Table 64, the areas of vegetation and threatened species habitat within the offset areas are significantly greater than the areas to be disturbed. The offset areas will be conserved in perpetuity, resulting in a medium to long term improvement to the biodiversity values of the region.

7.10.4 Biodiversity Offset Management

Background

The management of the biodiversity offset areas will include the conservation and ongoing management of existing vegetation, as well as revegetation and rehabilitation of degraded areas.

The conservation and ongoing management of existing vegetation in the biodiversity offset areas will be undertaken in order to maintain and improve their ecological value and facilitate regeneration of native vegetation and associated fauna habitat.

This will include weed and feral animal management, active replanting and reseeding of vegetation and ongoing monitoring.

Revegetation remediation work is proposed for the biodiversity offset areas in order to establish habitat for the suite of threatened species impacted by the Project, particularly the threatened plants *Angophora inopina* and *Tetratheca juncea*. This will occur in areas of Derived Native Grassland and Exotic/ Low Diversity Grassland within the Tooheys Road Southern Offset and Hue Hue Road Offset, generally as shown on Figure 42. Trees and shrubs will be planted in these degraded areas to form the core of woody habitats to be progressively regenerated back into woodland or open forest communities in the medium to long term. Since the areas of Derived Native Grassland within the Tooheys Road Site are showing signs of natural regeneration, the prospects of successful revegetation are good.

Areas in the offset properties will be protected from edge effects by planting of a buffer zone and by undertaking weed and feral animal management.

Control action plans will be developed to account for unexpected impacts from discharges into creeks within the area. Details of these processes will be contained the BMP.

An estimate of the cost of revegetation and ongoing management of offsets has been prepared by WAJCV and is approximately $5.9 Million over the 28 years of the Project.

Long term Security of Offsets

The Biodiversity Offset Strategy will be permanently protected by an appropriate mechanism. There are a number of options that are available to permanently protect land for conservation, and these include:

- Voluntary Conservation Agreements, which are a joint agreement between landowners and the Minister for the Environment under the NPW Act;
- Application to change zoning regulation that dictates land use;
- Dedication of land to the National Parks reserve estates; and
- Land acquisition and management of the land under private ownership with conditions of commitment.

The final method used to provide long term security for Project Biodiversity Offset areas will be determined by WACJV, in consultation with OEH and other relevant agencies.

Biodiversity Management Plan

Details of the management procedures to be implemented within the offset areas will be contained within the BMP as discussed in Section 7.9.4. The BMP will guide the implementation and management of impact mitigation and compensatory measures over the life of the Project, including the proposed biodiversity offset areas. The BMP will also specify the management measures that will be undertaken for the biodiversity offset areas, how they will be undertaken, who they will be undertaken by and an associated timeline for each action.

The BMP will include details on pre-clearance surveys, capturing and release of fauna (where appropriate), translocation, measures to reduce edge effects and the monitoring and management measures required for the offset areas. Subsidence effects will be monitored to determine their impact on flora and fauna (refer to Section 7.1.4). The BMP will include an assessment of the likelihood of success of the revegetation proposed for the Project including relevant critieria.

If mine subsidence causes any harm to threatened biodiversity, including due to subsequent changes in surface water and groundwater flows, the Biodiversity Offset Package will offset the impact. All procedures will be conducted in accordance with relevant OEH policy guidelines, with appropriate licenses acquired where necessary. The final mechanism to fund management of the offsets in perpetuity will be determined by WACJV, in consultation with OEH and other relevant agencies for inclusion in the BMP.

7.11 Aquatic Ecology

7.11.1 Background

An Aquatic Ecology Impact Assessment for the Project has been undertaken by Marine Pollution Research and is included in Appendix P. The assessment investigates the impacts of the Project on aquatic ecology and provides management and mitigation measures for the enhancement of aquatic habitats.

7.11.2 Methodology

Literature Review and Database Searches

The literature review for this assessment entailed a reappraisal of the earlier studies and/or reports, in order to provide some understanding of the available aquatic ecology data and their value for the present study. These are described in detail in Appendix P.

The following database searches were conducted for specific details on possible threatened species, ecological communities and key threatening processes:

- Commonwealth SEWPaC EPBC Protected Matters Report for a 1,370 km^2 area to encompass the whole Project Boundary;
- NSW DPI (Fisheries) Records Viewer database;
- Australian Museum Biomap database; and
- OEH BioNet database/atlas search for the Wyong LGA.

The literature review considered a state-wide riverine ecosystem monitoring program faciltated by NOW (2010). This program included macroinvertebrate sampling in Wallarah Creek, conducted by OEH in Spring 2012.

The NSW Office of Water reported on a state-wide riverine ecosystem monitoring program. The OEH Monitoring Evaluation and Reporting Program, which monitored sites in Wallarah Creek and Ourimbah Creek, was considered in the desktop assessment. The potential aquatic habitat values of the sub-catchments and streams were assessed using available topographic information.

Literature and database searches identified the following listed species as having the potential to be present within the Project Boundary:

- Australian Grayling (*Prototroctes maraena*);
- Macquarie perch (*Macquaria australasica*);
- Adams emerald dragonfly (*Archaeophya adamsi*); and
- Giant dragonfly (*Petalura gigantea*).

Aquatic Baseline Study

Baseline aquatic ecological field investigations were undertaken seasonally in Autumn 2011, Spring 2011 and Autumn 2012. The adopted sampling methodology to achieve the Aquatic Impact Assessment aims incorporated:

- Sampling the aquatic macro-invertebrate fauna twice a year (Spring and Autumn) using the AusRivAS sampling, sorting and identification protocols. For AusRivAS standardised sampling purposes the 'Autumn' sample season is defined as 15 March to 15 June and 'Spring' is defined as 15 September to 15 December;
- Sampling priority locations based on stream orders for streams and drainages;
- Recording of changes in site riparian and aquatic habitat condition and of aquatic plant distribution within the study areas at each sampling time;
- Estimation of fish occurrence by a combination of overnight or short-term bait-trapping, dip netting and observation, with all captured fish identified in-situ and immediately released wherever possible;
- Metered depth profiles of basic water quality parameters at each site;
- Platypus and Australian water rat habitat surveys and collection of turtle, reptile and aquatic bird observations during field sampling activities; and
- Collection of alluvial bore waters from relevant sub-catchments to characterise if any stygofauna is present within the Project Boundary.

For all of the baseline surveys, ten sites were sampled for fish and macro-invertebrates; two in the Wyong River, two in Jilliby Jilliby Creek, two in Little Jilliby Jilliby Creek, and one site in each of Wallarah Creek, Spring Creek (western tributary), Buttonderry Creek and Hue Hue Creek. Additional field water quality readings, overnight fish trapping and River-Creek Environment (Peterson, 1992) descriptions were undertaken at six sites in Jilliby Jilliby Creek, Spring Creek and Wallarah Creek for the Autumn 2012 survey. All three of the baseline surveys occurred during periods of well above average rainfall.

Due to regional flooding and heavy rainfall, the streams in the western forested area were inaccessible during the three baseline surveys. Aquatic habitat inspection surveys for these creeks were undertaken during the first available dry period in August 2012. Aquatic habitat surveys, including water quality sampling, were undertaken for 10 streams in the western forested area and seven additional upper Little Jilliby Jilliby Creek sites. Additional water quality sampling was undertaken in higher order creeks to provide an indication of dry weather water quality, since the three seasonal aquatic ecology surveys occurred during very wet conditions.

There are no listed aquatic species, endangered ecological communities or critical habitat found or known from the total Wyong River study catchment and none are expected.

7.11.3 Impact Assessment

Survey Results

A total of 17 macrophytes were recorded from the combined study area sites over the survey period. The diversity of macrophytes increased over consecutive surveys either as a result of the more favourable conditions for observing macrophytes or owing to re-colonisation following scouring by floods immediately prior to the commencement of the first sampling in Autumn 2011.

A total of 77 macroinvertebrate taxa were recorded during the three baseline aquatic ecology surveys. The surveys identified 57 insects, nine crustaceans, four molluscs, springtails, water mites, seed shrimps, freshwater worms and leeches, temnocephalans, flatworms and freshwater sponges. The streams traversing the Extraction Area were the most diverse, with 45 taxa recorded in both the Wyong River and Jilliby Jilliby Creek. In addition, 43 taxa were recorded in Little Jilliby Jilliby Creek.

The three baseline surveys identified 19 taxa within Wallarah Creek. The sampling conducted by OEH in Spring 2012 identified 31 taxa. The OEH sampling was conducted in a higher order segment of Wallarah Creek and within a less disturbed subcatchment. The sampling site for this assessment was located in a disturbed sub-catchment within the proposed Tooheys Road Site. The contrasting natures of the sampling sites account for the discrepancy in the number of taxa identified.

Due to the flood conditions during the baseline surveys, only three fish species were recorded. Two native species were recorded in the Wyong River, Jilliby Jilliby Creek and Little Jilliby Jilliby Creek sites, namely the firetail gudgeon (*Hypseleotris galii*) and flathead gudgeon (*Philypnodon grandiceps*). The introduced pest species plague minnow (*Gambusia holbrooki*) was recorded at all ten sampling sites.

No water dependent mammals were recorded during the baseline surveys. However, Australian water rat tracks were observed along the sand banks of the Wyong River and Little Jilliby Jilliby Creek. There are also sections along the Wyong River, Jilliby Jilliby Creek and Little Jilliby Jilliby Creek that provide suitable burrowing, feeding and pool habitat for the platypus.

The aquatic habitat surveys in August 2012 determined that the lower order gullies in the western area are generally ephemeral drainages with short tail flows following rainfall and short-lived pools. As a result, these gullies do not provide any permanent or semi-permanent aquatic habitat. Myrtle Creek, Armstrong Creek and the upper reaches of Jilliby Jilliby Creek are classified as 3rd order streams.

These creeks are capable of providing aquatic habitat and are likely to support the species present in the lower reaches of Jilliby Jilliby Creek.

Project Component Impacts

Potential impacts on Aquatic Ecology arising from the Project can be broadly classified into three categories:

- Surface infrastructure development such as clearing and bulk earthworks for required infrastructure and associated ancillary works;
- Longwall mining, including indirect impacts from subsidence; and
- Surface operations, such as mine water discharges during mine operations.

Each is discussed below.

Impacts due to Infrastructure Development

The vegetation clearing and bulk earthworks required for the development of surface infrastructure have the potential to impact upon aquatic ecology. The various components of the surface facilities have been sited to avoid and minimise any direct impact on creek lines and associated riparian corridors.

The Tooheys Road Site facilities are located between the branches of Wallarah Creek to prevent direct damage to the creek aquatic habitats. There will be a need to clear 1.1 ha of paperbark swamp and 6 ha of Blackbutt-Turpentine open forest, with portions of this habitat located along the riparian bank of Wallarah Creek. There will also be a need to clear 1.8 ha of Swamp Mahogany forest, which also includes some riparian vegetation along a tributary of Spring Creek. The impact assessment and offsets for these vegetation communities are discussed in Section 7.9.

Road, rail and services links at the Tooheys Road site will need to pass over several branches of Wallarah Creek. These branches are not designated Key Fish Habitat (KFH) but are designated Class 3 to 4 fish habitat and include important wetlands and Wallum froglet habitat (see Section 7.9).

The Tooheys Road Site rail loop connects to the Main Northern Rail Line Spring Creek crossing, and will also require a crossing over Spring Creek. Spring Creek at this location is designated KFH and is a Class 2 stream. These crossings will need to be designed to minimise disturbance to riparian and aquatic ecosystems and to ensure minimum disturbance to stream hydrodynamics, water quality and aquatic habitat condition.

The Buttonderry Site facilities are located on mainly cleared lands approximately 200 m south-west of Buttonderry Creek. The clearing of vegetation for the Buttonderry Site facilities would not directly impact creek or creek riparian habitats. Whilst the Buttonderry site does not require any creek crossings, the site slopes to Buttonderry Creek, which is designated as a Class 3 to 4 aquatic habitat at the runoff locations.

The Western Ventilation Shaft site is located more than 100 m north of the Armstrong Creek (north arm) on a ridge that is accessible via an existing forest track access (Brothers Road). Clearing of vegetation for the site would not directly impact creek or creek riparian habitats. In addition, the Western Ventilation Shaft site does not require any creek crossings. However, the site is located on a hillside that slopes down to the north arm of Armstrong Creek and Brothers Road drains through agricultural land to Little Jilliby Jilliby Creek at its northern end and drains through forest to Armstrong Creek at its southern end.

Impacts due to Longwall Mining

Due to differential or variable slumping (higher subsidence under longwalls and lower subsidence over pillars between longwalls) there can be potential for sequential ponding as longwalls progress across a valley, with ponding occurring above subsided longwalls and drainage to the subsided longwall ponds from adjacent longwall areas not yet mined. Further, ponding can also be exacerbated by localised differential variations in groundwater levels. This has the potential for altering flooding regimes, causing localised ponding of catchment runoff waters and causing temporary changes in water depth for dams and natural lagoons leading to inundation or waterlogging of emergent or marginal/riparian vegetation.

These potential impacts are applicable to the alluvial plain in the Dooralong Valley and to the section of Hue Hue Creek within the Extraction Area. Given the comparatively flat nature of these valley floors there is the potential to create additional ponded water bodies. There is also the potential to alter the depths of existing shallow water bodies with subsequent alterations to emergent and fringing vegetation communities and increased isolation of ponds from one another.

It should be noted that these potential impacts need to be considered against the dynamic nature of the streams within the Project Boundary. These streams are subjected to natural events that result in stream, habitat and water quality/quantity changes over time including floods, changes during prolonged droughts, changes due to altered land-uses or changes in catchment soil stabilisation due to bushfires.

Subsidence modelling indicates that post-mining, the overall variation in valley floor topography will be similar to the pre-mining condition. Accordingly, it is anticipated that there will be sufficient adaptive opportunities available to ensure that there would not be significant changes to the overall makeup and function of aquatic habitats within the creeks on the alluvial plain or within the ponded water bodies over the valley floor as mining progresses.

Due to the plasticity of the gullies in the western forested area, the subsidence consequences associated with rock-constrained valleys are unlikely to occur (see Section 7.1).

The predicted tilts are not expected to result in any slope instability. However, some of the steeper gullies may experience slope instability due to the predicted ground curvatures and strains. The potential for impacts on the stability of the western streams will be assessed prior to mining in the western area. Adaptive management measures will be adopted if it is determined that there is a risk of slope instability.

Impacts due to Surface Operations

Mine water management has been detailed in Section 7.3.1. This will include active treatment of mine make waters in a Reverse Osmosis desalination plant (or similar facility) and site dirty water will be collected, settled and stored for re-use. The water balance model concludes that there will be excess water after the reuse of water for operational activities. All surplus treated water will be discharged to Wallarah Creek.

The water balance indicates that annual discharge volumes will range from 50 ML/year to 500 ML/year. Although the treated water discharges will alter the flow regime of Wallarah Creek, the creek will remain ephemeral. The frequency of no flow and low flow conditions is predicted to be similar to existing conditions. The impact of treated water discharges on the flow regime of Wallarah Creek is discussed further in Section 7.3.

7.11.4 Mitigation and Management

Mitigation measures, based upon the hierarchy of principles of avoidance, mitigation and compensation have been designed to minimise the ecological impacts of the Project. Avoidance is described in detail in Section 7.9. The following mitigation measures in relation to the Infrastructure Boundary will be included in the BMP described in Section 7.9:

- Siting of infrastructure away from aquatic habitats and the associated riparian corridors, where possible;
- Water management strategies as discussed in Section 7.3 to ensure the protection of aquatic habitats during construction; and
- Management measures to ensure water quality and quantity and preserve and protect downstream aquatic habitats including adaptive management.

A comprehensive stream health monitoring program will be included in the BMP for the Project.

In order to provide successful adaptive management measures, aquatic ecology monitoring will be undertaken using a guiding set of criteria and protocols developed to establish the circumstances under which additional mitigation measures would be required. These would be specified in the Extraction Plan and in TARPs. Thus, where perceptible impacts are noted through site monitoring activities, the following general procedure will be applied:

- Undertake additional investigations to ascertain the actual cause (mine-related or other cause) of deteriorating aquatic conditions;
- If mining related, notify relevant government authorities;
- Develop and implement a specific response plan to prevent further impacts; and
- Undertake remediation as required.

Compensation for impacts to aquatic ecology is included in the Biodiversity Offsets Strategy in Section 7.10.

7.12 Traffic and Transport

7.12.1 Background

A Traffic and Transport Impact Assessment was undertaken by Parsons Brinkerhoff and is provided in Appendix Q. The purpose of the assessment was to assess the Project's traffic and transport impacts in the vicinity of the Project Boundary with a focus on the capacity, efficiency and safety of the local road network with particular regard to the Wallarah interchange (F3 Freeway and Sparks Road), Motorway Link Road / Tooheys Road intersection and the Sparks Road / Hue Hue Road intersection. The assessment also provides a description of the measures that will be implemented to maintain and/or improve the capacity, efficiency and safety of the road network in the surrounding area over the life of the Project.

The regional transport network in the vicinity of the Project is shown on Figure 2.

Due to the high intensity of infrastructure surrounding the Project, there are a variety of routes that can be used to access the Tooheys Road Site, Buttonderry Site and the Western Ventilation Shaft.

Table 8 in Section 3.8 lists access points to the surface facilities. For further details of the roads located along access routes to the Project see Appendix Q.

All produced coal will be transported by rail, via a new rail loop at the Tooheys Road Site. Therefore, road-based traffic movements will mainly be associated with:

- Construction workforce;
- Construction deliveries;
- Operational workforce; and
- Deliveries and service vehicles once the Project is in operation.

The future years scenarios considered the peak construction activity at Year 2 (assumed to be calendar year 2015 in the model), the peak operations in Year 12 (assumed to be calendar year 2025 in the model), and the construction year of the Western Ventilation Shaft in Year 13 (assumed to be calendar year 2026 in the model).

Working hours for the construction of surface facilities will be during daylight hours, while the working hours for the underground construction (i.e. shaft and drift at the Tooheys Road and Buttonderry Sites) will be undertaken up to 24 hours per day, 7 days a week as work at these underground activities will be largely inaudible at private receivers and will be within PSNC (see Section 7.8).

To determine the impact of the mine's construction and operation, a set of 'no-Project' scenarios were analysed to determine what the comparable case would be if the Project did not proceed. The 'no-Project' scenarios take into consideration both the background traffic growth and the operation of other future identified developments near the Project.

7.12.2 Methodology

The Traffic and Transport Impact Assessment for the Project comprised the following:

- A review of the existing traffic and road conditions within the traffic study area;
- Forecasts of the traffic generation during the construction and operational periods and its impact on the surrounding road network;
- A cumulative assessment that includes current and future surrounding development and their impacts on the surrounding road network;
- Predicted potential road safety impacts;
- An assessment of the proposed site access points; and
- Identification of required mitigation and management measures to address the identified potential impacts.

The Traffic and Transport Impact Assessment for the Project was focused on a traffic study area which is located north of Wyong and west of Blue Haven shown in Figure 43.

Cumulative Impacts

Approved and proposed projects in the surrounding area (as shown in Table 65) were also taken into consideration in the assessment of possible future traffic volumes. These developments are described further in Section 2.4. Figure 5 shows the location of the developments in the vicinity of the Project.

Known additional traffic volumes generated from these developments were included in the background volumes of traffic in the future assessment years (see Appendix Q).

Traffic Counts

Traffic volume data was obtained from the following permanent RMS count stations (see Figure 43) collected between 1995 and 2004:

- 05.642 Wyee Road (MR454), east of Toronto Road at railway bridge;
- 05.514 Wyee Road (MR454) at Wyee Creek Bridge; and
- 05.165 Sparks Road (MR509), east of Pacific Highway.

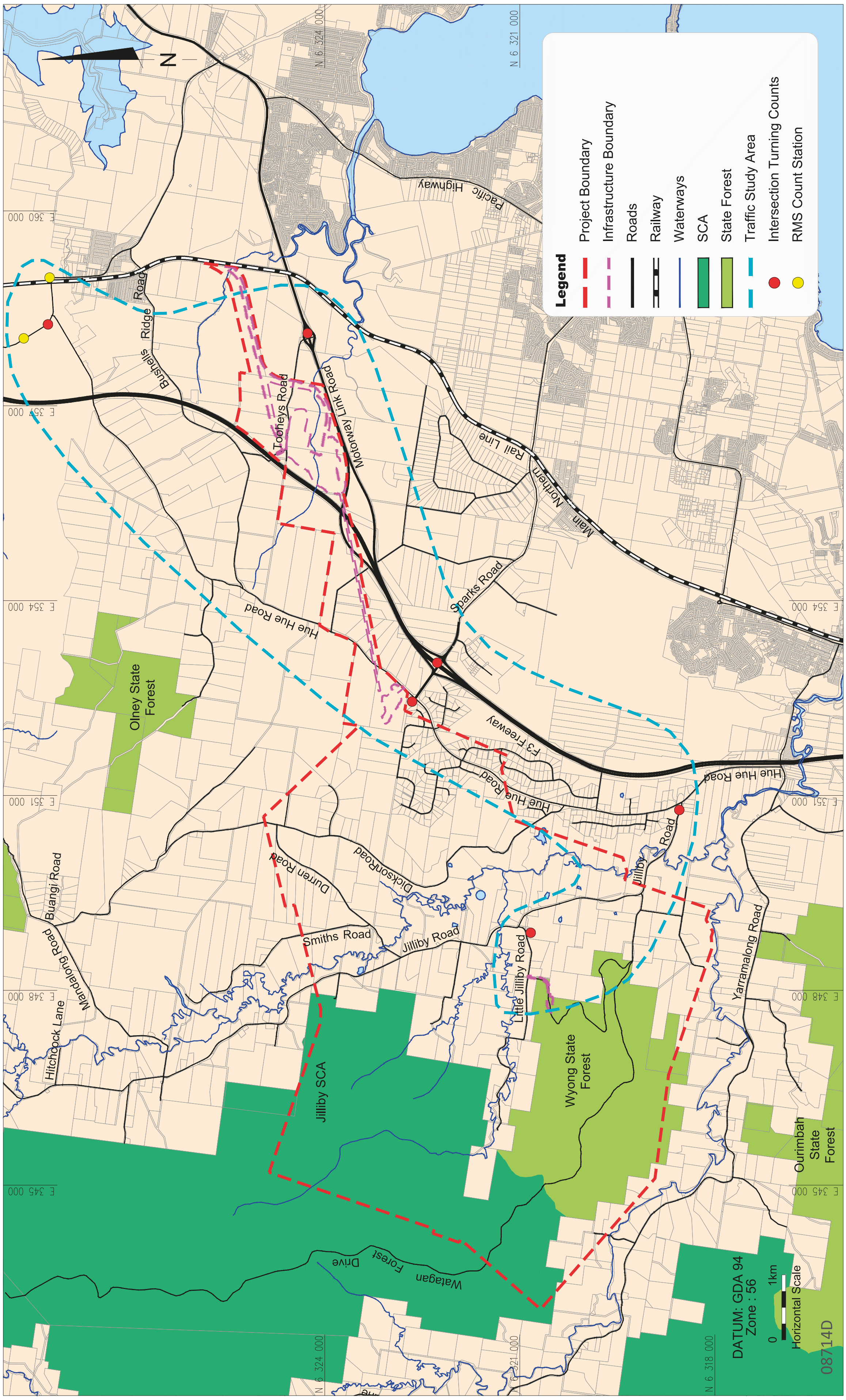
To supplement this information, turning traffic volumes were counted at the following key intersections (as shown on Figure 43) on 1 December 2011:

- F3 / Sparks Road interchange (both eastern and western side);
- Sparks Road / Hue Hue Road intersection;
- Hue Hue Road / Wyee Road intersection;
- Motorway Link Road / Tooheys Road interchange (both southern and northern side);
- Hue Hue Road / Jilliby Road intersection; and
- Jilliby Road / Little Jilliby Road intersection.

Queue lengths were recorded at the signalised intersection (the western side of the F3 Freeway / Sparks Road interchange).

Table 65 Approved and Proposed Projects in the Surrounding Area

	Development	Assumed Year of Commencement
1	Woolworths Retail Facility	2021
2	Wyong Employment Zone	2018
3	Warner Industrial Park	2018
4	Bluetongue Brewery	In operation
5	Bushells Ridge Employment Estate	2016 to 2025
6	Buttonderry Waste Management Facility Upgrade	In operation
7	Tooheys Road 18 Lot Subdivision	Prior to 2015
8	Warnervale Airport Industrial Subdivision.	Prior to 2015



WALLARAH 2 COAL PROJECT

Traffic Study Area and Count Locations

FIGURE 43

Hansen Bailey ENVIRONMENTAL CONSULTANTS

Wallarah 2 COAL PROJECT

Site inspections were undertaken on 16 February 2012 in wet weather conditions, and again on 23 March 2012 in fine weather conditions.

Road Network Assessment

In order to determine future growth of traffic rates, the published historical rates of traffic growth on the surrounding areas were analysed. Annual average daily traffic (AADT) data was available from 1995 to 2004 for key roads in the vicinity of the surface facilities. Table 66 summarises the AADT data that was available from 1995 to 2004 for key roads in the vicinity of the surface facilities. WSC also indicated the annual growth rates for a number of roads.

Annual growth rates in the range of 1.0% and 2.7% (RMS and WSC estimates), depending on location, were used to forecast increases in background traffic on these roads for future case scenarios to determine predictions of the Project on the road network. These traffic growth rates were applied on existing traffic volumes collected in the traffic turning movement counts (December 2011) to determine the future traffic volumes on the surrounding road network. Bus and school bus movements occurring in the vicinity of the Tooheys Road and Buttonderry sites have been included in the traffic analyses. Pedestrian and cyclist activities are low in the traffic study area.

The ability of each of the key intersections to cater for existing and future traffic forecasts were investigated using the SIDRA software modelling package. The indicators used by the software to determine the level of intersection performance include:

- Level of Service (LoS) which is a criterion related to the average intersection delay. Levels of service indicators range from A to F (see Table 67);
- Degree of Saturation (DoS) which is the ratio of demand flow to capacity. DoS ranges from 0 to 1.0 with a value closer to 1.0 indicating greater delays and queue lengths;
- Average intersection delay, which is the difference between interrupted and uninterrupted travel times through the intersection including deceleration, static delays and acceleration (refer Table 68); and
- Maximum queue length, which is measured in metres reflecting the number of vehicles waiting at the stop line and is usually quoted as the 95th percentile back of queue.

Table 68 shows the intersection performance assessment criteria.

Road Safety Assessment

A daylight site inspection of the traffic study area was carried out in February 2012 in wet weather conditions and in fine conditions during March 2012. A number of road safety issues were identified including:

- Insufficient delineation due to the deficiencies in signage, line markings and guideposts and reflectors; and the damaged/missing raised reflective pavement markers along the road;
- Roadside hazards (e.g. large trees, culverts) located within the clear zone;
- Clogged culverts caused by overgrown grass and accumulated debris;
- Damaged pavement including a drop in the pavement edge; and
- Insufficient provision of road shoulder.

Table 66 Historic Traffic Flows on Surrounding Areas

Station ID	Location	1995	1998	2001	2004	Annual growth (1995–2004)
05.642	Wyee Road (MR454), east of Toronto Road at railway bridge	5,816	6,295	6,503	7,391	2.7%
05.514	Wyee Road (MR454) at Wyee Creek bridge	4,867	5,716	6,011	6,695	3.6%
05.165	Sparks Road (MR509), east of Pacific Highway	17,056	17,722	19,114	22,168	3.0%

Source: RTA Traffic Volume Data for Hunter and Northern Regions (2004)

Table 67 Intersection Level of Service Performance Categories

Level of Service	Average Delay per Vehicle (seconds)	Description
A	Less than 14	Good
B	15 to 28	Acceptable
C	29 to 42	Satisfactory
D	43 to 56	Near capacity
E	57 to70	At capacity
F	Greater than 71	Unsatisfactory

Source: RTA Guidelines for Traffic Generating Developments (2002).

The crash record at the F3 / Sparks Road interchange as well as the Hue Hue Road / Sparks Road intersection is poor and includes a significant number of 'right turning / crossing' crashes.

7.12.3 Impact Assessment

Forecast Traffic Demand

The peak construction period (Year 2) at the Tooheys Road Site is expected to generate 600 two-way trips per day associated with contractors and employees shift changes. At the Buttonderry Site, construction of surface facilities including the shafts will generate 300 two-way trips per day. Deliveries of construction materials, equipment and concrete will be via rigid vehicles. The Tooheys Road Site expects 20 such deliveries per day. The Buttonderry Site only expects 10 deliveries per day using rigid vehicles. During peak production of the Project (assumed Year 12), the Buttonderry Site is expected to generate 500 two-way trips per day associated with the departure and arrival of employees, while the Tooheys Road Site only expects 42 two-way trips per day. It was also assumed that each site will experience 20 delivery and service vehicle movements per day (limited to the business hours of 7:00 am to 5:00 pm).

The construction of the Western Ventilation Shaft in Year 13 is expected to generate up to 25 two-way trips per day associated with the departure and arrival of employees. Up to four two-way construction vehicle trips per hour may access the site throughout the day, for delivering construction material, equipment, and concrete. The continuous operation of the Tooheys Road Site and Buttonderry Site in 2026 was assumed to generate the same number of traffic trips as it will in 2025.

Peak Hour Selection

The Future peak hours were assessed based on the sum of the following: the 2011 surveyed traffic; growth in the background traffic; traffic associated with the surrounding new developments; and traffic generated by the Project at key intersections.

Two separate peak hours have been assessed for each future assessment year:

- Total traffic peak hours: representing the highest traffic volumes in the morning and afternoon periods associated with the sum of the background traffic growth; the operation of the surrounding developments; and the inclusion of the Project; and
- Project traffic generation peak hours: the identified hour associated with the maximum traffic generation volumes in the morning and afternoon peaks associated with the Project's employee trips and delivery trips.

Road Intersection Performance

As part of the Traffic and Transport Impact Assessment, road intersection performance was assessed using SIDRA by calculating the performance indicators for intersections, including LoS, DoS, average intersection delay and queue lengths for each intersection. Table 69 shows the existing and predicted Year 2 and Year 12 DoS and LoS expected as a result of the Project. The Base Case (as at 2012) is also included. The 'Year 2 with Project' provides Project impact predictions during the construction phase, with background traffic growth and other nearby developments. The 'Year 12 with Project' provides impact predictions during peak production of the Project with background traffic growth and other nearby developments. Values shown in bold indicate intersection performance exceeding the acceptable level. A discussion on the results is provided below.

As shown in Table 69 the F3 Freeway / Sparks Road interchange (western side) is currently operating near its practical capacity during the AM peak hour, despite operating at an acceptable LoS D during the PM peak hour.

A comparison between the 'no-Project' results and those during the construction of the Tooheys Road and Buttonderry Site (Year 2) shows that there is only a marginal deterioration in the performance of the key intersection. Detail of 'no-Project' results for all scenarios is provided in Appendix Q

Table 68 Intersection Performance Assessment Criteria

Indicator	Criteria
Priority controlled intersections and roundabouts	
DoS	Less than or equal to 0.8
LoS	D or better
Back of queue does not interfere with other traffic movements	95th percentile
Signalised intersections	
DoS	Less than or equal to 0.9
LoS	D or better
Back of queue does not interfere with other traffic movements	95th percentile

Table 69 Base Case and Predicted Traffic Conditions

Intersection	2012 Base case benchmark		Year 2 with Project				Year 12 with Project			
	Peak hour		Total traffic peak		Project traffic peak		Total traffic peak		Project traffic peak	
	AM	PM	AM	PM	AM	PM	AM	PM	AM	PM
F3/Sparks Road interchange (western side of the interchange)	0.95 C	0.90 D	1.02 E	0.93 D	1.02 D	0.65 C	3.70 F	3.38 F	1.02 C	1.51 F
F3/Sparks Road interchange (eastern side of interchange)	0.42 B	0.38 B	0.58 B	0.39 B	0.55 B	0.30 B	11.1 F	1.25 F	1.18 F	3.00 F
Sparks Road/ Hue Hue Road	0.47 A	0.35 B	0.48 B	0.37 B	0.19 A	0.20 A	0.59 B	038 B	0. 32 B	0.38 B
Hue Hue Road/ Wyee Road	0.13 B	0.35 B	0.14 B	0.34 B	0.23 B	0.19 A	0.25 C	0.89 F	0.35 C	0.89 F
Motorway Link Road/ Tooheys Road interchange (north side of interchange)	0.01 A	0.01 A	0.35 A	0.14 A	0.35 A	0.14 A	0.99 B	0.49 B	0.71 A	0.36 B
Motorway Link Road/ Tooheys Road interchange (south side of interchange)	0.02 A	0.01 A	0.02 A	0.15 A	0.02 A	0.15 A	0.22 A	0.51 C	0.13 A	0.37 B
Hue Hue Road/ Jilliby Road	0.38 B	0.22 B	0.46 C	0.25 B	0.15 B	0.12 B	1.27 F	0.53 D	0.30 B	0.71 D
Jilliby Road/ Little Jilliby Road	0.05 A	0.04 A	0.05 A	0.04 A	0.05 A	0.04 A	0.06 A	0.06 A	0.03 B	0.06 A
Tooheys Road Site access	-	-	0.15 A	0.24 A	0.15 A	0.24 A	0.02 A	0.02 A	0.02 A	0.03 A
Buttonderry Site access	-	-	0.11 B	0.11 B	0.11 A	0.12 A	0.15 C	0.16 B	0.12 A	0.15 B

Year 13 will include the construction of the Western Ventilation Shaft and mine operations at both Tooheys Road and Buttonderry sites. The results of modelling of Year 13 (Appendix Q) demonstrate that when comparing the 'no-Project' results with those when both sites are in operation and the Western Ventilation Shaft is in construction (Year 13) there is a slight decrease in performance at all intersections during both the AM and PM peak hours as a result of the increased traffic on the network.

The intersections that are expected to perform poorly with the inclusion of Project related traffic flows in both the Year 2; Year 12 and Year 13 scenarios also show capacity constraints in the 'no-Project' scenarios. At these intersections the traffic queues will exceed the available turning bay lengths and interrupt the operation of their adjacent intersections. The analysis indicates that the construction and operational activities of the Project will not materially impact on the performance of any of the intersections of the road network. That is, the capacity constraints arising at various intersections are not caused by the Project.

The intersection of Hue Hue Road and Wyee Road is located within the Lake Macquarie LGA. This intersection is generally expected to perform satisfactorily. The exception is during the peak operational period (2025), where the intersection is predicted to perform poorly (LoS F) during the PM peak. However, the contribution of the Project to traffic at this intersection is negligible. The unsatisfactory LoS is due to growth in background traffic and the traffic volumes generated by other developments, as opposed to traffic generated by the Project.

Service and delivery trips associated with the Project will not use the Hue Hue Road / Wyee Road intersection. Therefore, the Project does not increase the heavy vehicle traffic at this intersection. The Project is predicted to account for approximately 4% of light vehicles accessing this intersection during the peak construction period (2015). During the peak operational period (2025), the Project contributes less than 1% of light vehicle traffic at this intersection.

The contribution of the Project to light traffic volumes at the Hue Hue Road / Wyee Road intersection is detailed in Table 70.

Table 70 Traffic Volumes Accessing the Hue Hue Road / Wyee Road Intersection

	Peak Construction Period			Peak Operational Period		
	Project Traffic	Total Traffic	Contribution of Project	Project Traffic	Total Traffic	Contribution of Project
AM Peak	28	603	4.6%	9	951	0.9%
PM Peak	26	609	4.3%	10	1260	0.8%

Road Network Performance

Tooheys Road in its current condition is unlikely to efficiently and safely accommodate the additional traffic, which includes a significant proportion of heavy vehicles (20%) associated with the surrounding new developments as presented in Table 65.

With the additional traffic associated with the operational activities of the Tooheys Road Site, the road is expected to carry only 20 additional vehicles per peak hour – which equates to approximately 3% of the total traffic volume during the peak hour. Consequently, the additional forecast traffic associated with the Project will not impose any adverse impact on Tooheys Road.

Hue Hue Road is expected to carry approximately 1,000 vehicles (two-way) during the total traffic peak hour by Year 13 on the section between Hue Hue Road and Alison Road. This is as a result of the background traffic growth supplemented with the commencement of the surrounding new developments and will occur irrespective of the Project. The additional traffic associated with the Project is estimated as being approximately 4% of the total traffic volume during the peak hours, and thus will not impact materially on Hue Hue Road.

Road Safety

Potential road safety impacts were identified as a direct result of creating new intersections to access the Buttonderry Site (off Hue Hue Rd), the Tooheys Road Site and the Western Ventilation Shaft Site (off Jilliby Road). Proposed layouts to address these issues for these newly created intersections are described in Appendix Q.

Hue Hue Road/Sparks Road intersection and the F3/Sparks Road interchange currently have a poor crash record and the additional Project related traffic changing the future traffic patterns at these intersections could impact on the frequency of incidents.

The mitigation and management measures outlined below will be employed to reduce these potential impacts.

7.12.4 Mitigation and Management

Results of the Traffic and Transport Impact Assessment indicate that the Project will not impose any additional adverse impacts on the surrounding road network as a result of the increased traffic associated with construction and operational activities.

Current development approvals and background growth rates will force many of the intersections in the area to perform or continue to perform at unacceptable levels in future scenarios. The main contributor to the future traffic is the WEZ scheduled to be in operation in Year 5 of the Project.

WACJV will prepare a Traffic and Transport Management Plan to manage possible impacts resulting from construction of the Project and its operation and to ensure the traffic network can be managed throughout the Project.

Roads and Intersections

Proposed layouts for the newly created intersections, including the Tooheys Road Site, Buttonderry Site and the Western Ventilation Shaft accesses are described in Appendix Q. These layouts are adequate to accommodate future traffic associated with the Project.

Tooheys Road is unlikely to efficiently and safely accommodate the future traffic volume as a result of the growth of background traffic and the inclusion of other surrounding new developments, irrespective of whether or not the Project proceeds. It is recommended that Tooheys Road be sealed and upgraded to provide four lanes in its section between the Bushells Ridge Employment Estate access and the Motorway Link Road Interchange.

Model forecasts identify five intersections which will perform at unacceptable levels in Year 12, due to the growth of background traffic and the inclusion of other surrounding new developments, irrespective of whether or not the Project proceeds.

Road Safety

WACJV will undertake consultation with RMS and WSC to develop an agreement for determining mitigation priorities/ responsibilities and providing an appropriate contribution towards addressing the relevant road safety deficiencies and ensure that adequate levels of safety are maintained during construction and operation of the Project. Any contribution to address the identified road safety deficiencies is proposed to form part of the Project's VPA.

The design of the access points at the Tooheys Road Site, Buttonderry Site and Western Ventilation Shaft has taken road safety into consideration. The proposed turning lanes will reduce the potential for accidents on the frontage roads by separating the through traffic from the turning traffic which is travelling at different speeds toward the site accesses.

7.13 Rail

7.13.1 Background

A Rail Study was completed for the Project by Rail Management Consultants Australia Pty Ltd (RMCA) with substantial input provided by RailCorp.

The purpose of the assessment was to examine the impact of the Project on the capacity, efficiency and safety of the current rail network having regard to the State's strategic objectives for the passenger and rail freight network. A summary of this assessment is provided below and presented in full in Appendix R.

The Project will occur in parallel with the Northern Sydney Freight Corridor (NSFC) Stage 1 Project. The NSFC Program is a jointly funded initiative, supported by both the Commonwealth and NSW Governments, to improve the capacity and reliability for freight trains on the Main Northern Rail Line between Sydney and Newcastle. The program will include grade separation, track amplification, and passing loops to provide sufficient additional network capacity to meet long-term freight and passenger business requirements. The Stage 1 NSFC Project has a number of specific components that are planned to provide 48 additional interstate one-way paths over and above the existing freight paths.

The main Hunter Valley track network to the coal export terminals at Newcastle is managed by Australian Rail Track Corporation (ARTC) while the rail network from Wyong to Newcastle (Main Northern Rail Line) is almost wholly within RailCorp's network. The RailCorp network is a shared one with a high content of passenger traffic whereas the main Hunter Valley coal network is either separated from passenger services or has only minimal levels of passenger service interaction. The Main Northern Rail Line network is demonstrated in Figure 44.

Increased future volumes of coal transport via rail are forecast from south of Newcastle, irrespective of whether the Project proceeds and will face a wider and more intensive scale of integration into the total rail network.

Various measures are being introduced to meet this increased demand including:

- The transition to new more powerful Alternating Current traction locomotives;
- A transition to 30 tonne axle load operations and adopting similar train configurations to those in the Hunter Valley; and
- Plans to operate up to double length trains to the Central Coast power stations.

Other challenges to future freight operations relate to the physical characteristics of this section of the network and its supporting infrastructure.

The Project is expected to require up to six trains per day whilst assembling a cargo at Newcastle for export.

7.13.2 Methodology

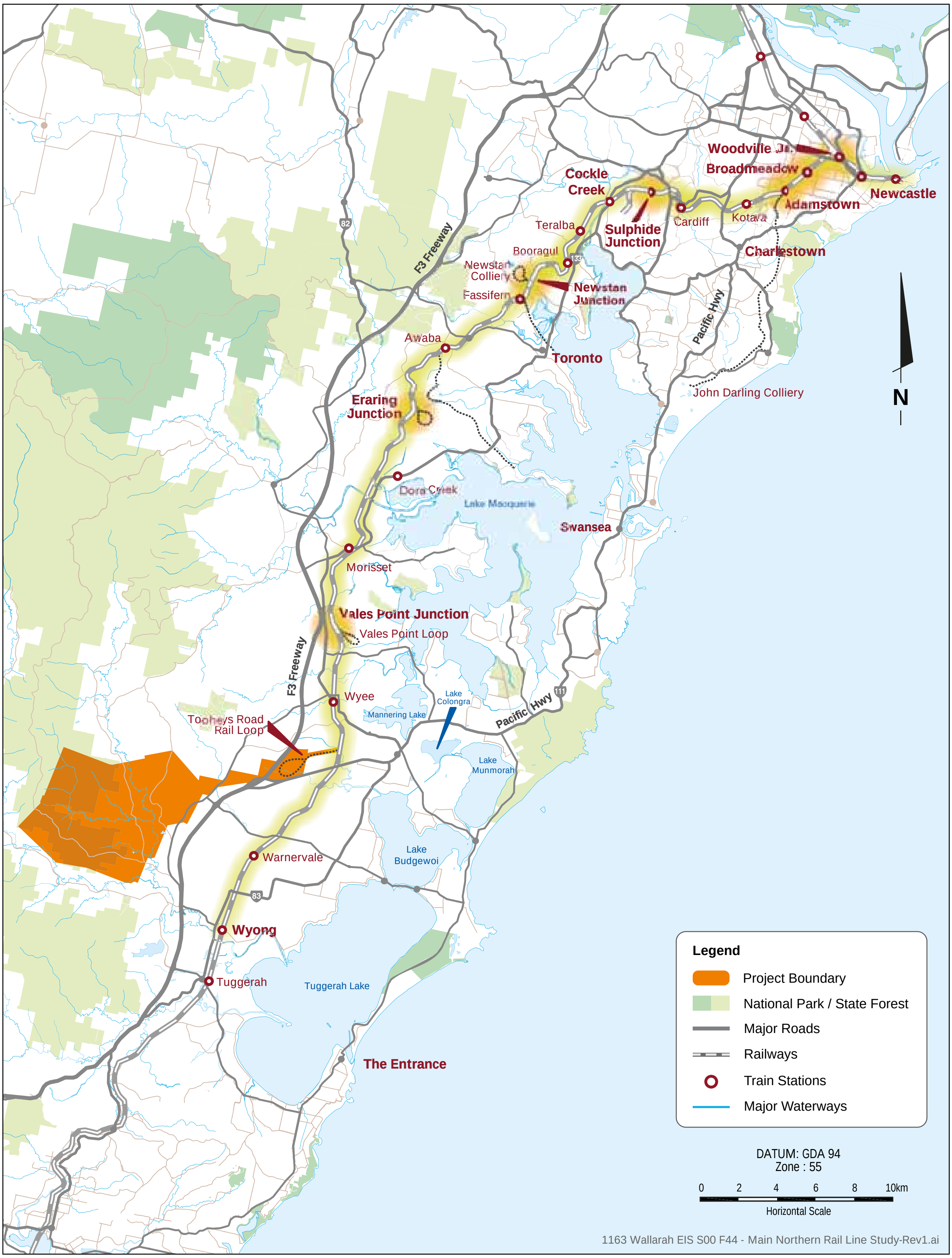
RMCA worked in close conjunction with the Network Access Division of RailCorp which carried out the network modelling outlined in this Assessment. The Railsys software was used by RailCorp for the modelling analysis. Railsys enables the modelling of future network infrastructure scenarios interposed with current schedules. Parameters of the model were adjusted to assess the most appropriate means of meeting the forecast transport task.

The Rail Study covers the scheduled passenger train operation for the network section between the Project and the port of Newcastle. Additional freight trains were also entered into the timetable as per the freight train schedule, and additional coal movements based on the current understanding of likely peak daily coal haulage were considered. This peak requirement represents the times when all of the rail network users were running at their maximum required rate and not their average annual demand. The analysis in total provides for 24 daily coal cycles as shown in Table 71.

The modelling was undertaken with the expansion of operations to these 24 coal train cycles superimposed over the existing freight and new NSFC interstate paths.

Table 71 Daily Coal Train Forecast

Route	Cycles
Teralba to Newcastle export (Xstrata)	5
Newstan to Newcastle export (Centennial)	5
Newstan to Port Kembla	Opportunistic Only
Eraring ex Cobbora (Eraring)	3
Teralba to Vales Point interim operations (pre-Cobbora)	Interim Only
Vales Point ex Cobbora (Delta)	2
Ex-Lithgow & Mt Thorley cross regional	3
Wallarah to Newcastle exports (the Project)	6
TOTAL	**24**



WALLARAH 2 COAL PROJECT

Wallarah 2 COAL PROJECT | Hansen Bailey ENVIRONMENTAL CONSULTANTS

Main Northern Rail Line

FIGURE 44

Train paths were assessed using the model as being “viable”, a “brittle at risk path”, or an “unviable non-sustainable path”. Brittle and unviable train paths are those that are vulnerable to constraints when coal and other freight paths converge through “choke points”. These choke points are the series of slow speed junctions that extend from Broadmeadow Yard south and through to Kooragang East Junction on the ARTC lease area.

Additional train cycles from Newstan to Port Kembla will be operated opportunistically when spare train paths are available. The interim cycles from the Macquarie Coal Preparation Plant (Teralba) to Vales Point will only operate until the commencement of the Cobbora Mine in 2015. The number of interim cycles is less than the daily train movements that will occur once the Cobbora Mine commences. The opportunistic cycles from Newstan to Port Kembla and the interim cycles from Teralba to Vales Point were not considered in this analysis. Due to the opportunistic and temporary nature of these movements, these cycles will not generally increase the future daily coal train forecasts.

7.13.3 Impact Assessment

Scenarios Assessed

Three scenarios were investigated for the model and are described below.

Scenario One

Existing infrastructure, trains with 46 x 100 t wagons as currently used on the Northern Line travelling at 80 kph

Modelling indicates that only 50% of modelled Project cycles could be considered as reliable. This scenario will not provide an acceptable, long term, sustainable and reliable transport plan. This scenario was reassessed with some of the existing coal paths being “flexed” in order to improve the problematic paths. Some problems were resolved with this option and some new path opportunities were identified, however these changes eliminated one NSFC interstate path each.

Scenario Two

Existing infrastructure, trains with 38 x 120 t wagons which are in line with industry standards for Hunter Valley coal wagons but travelling is constrained to 60 kph (due to track constraints)

The lower speed restrictions of this scenario resulted in substantial cumulative running time losses and path viability. Only one of the six cycles was found to be reliable over a 24 hour cycle. Similarly a “flexed “sub-option of Scenario 2 was developed in order to improve problematic cycles and the sub-option which resulted in some new path opportunities being presented. However, each of these improvements to the coal paths required the loss of one NSFC interstate path which occurred during the “core demand period” for such train paths.

None of these scenario modelling results provided an acceptable transport alternative and therefore suggested an argument for network capacity enhancement by way of additional infrastructure to make the train paths viable.

Scenario Three

Existing infrastructure with new loops and signals constructed at Awaba; trains with 38 x 120 t wagons travelling at 60 kph

This scenario examined the introduction of a northbound and southbound passing loop in order to improve path reliability. Awaba North was selected as the site of the new passing loop due to the undulating terrain between Broadmeadow and the Central Coast, the spacing of the various coal load points within this corridor, and the proximity to urban development. The introduction of an additional signal south of the Awaba Station was found to allow refuged trains to depart sooner from the passing loop and enhance viability.

The results show that the construction of southbound and northbound loops north of Awaba provide an overall more robust network operation for the Project trains with eight pairs of completely reliable cycles being achieved. The proposed loops also improved the performance of the other train movements on the network. This scenario provided the best outcome for all of the modelled scenarios.

Summary

The forecast growth in freight train movements on the Main Northern Railway Line is an aggregate of increased numbers of NSFC interstate trains, coal trains from Cobbora supplying domestic power stations and export coal trains to the port of Newcastle. These increased freight movements are placing growing pressure on the ARTC and RailCorp Networks specifically between Vales Pt Junction and Kooragang Island.

The provision of new 1,700 m southbound and northbound passing loops at Awaba, emerges as the most suitable option that should be considered by the rail network providers to maintain train programming robustness ahead of significant expansions in coal and interstate freight as associated with the NSFC programme and the forecast Newcastle related port expansion. Such infrastructure will also provide ‘future proofing’ to cover technical developments particularly in coal enabling the shorter train configurations currently used by the mines to be increased in length.

Level Crossings

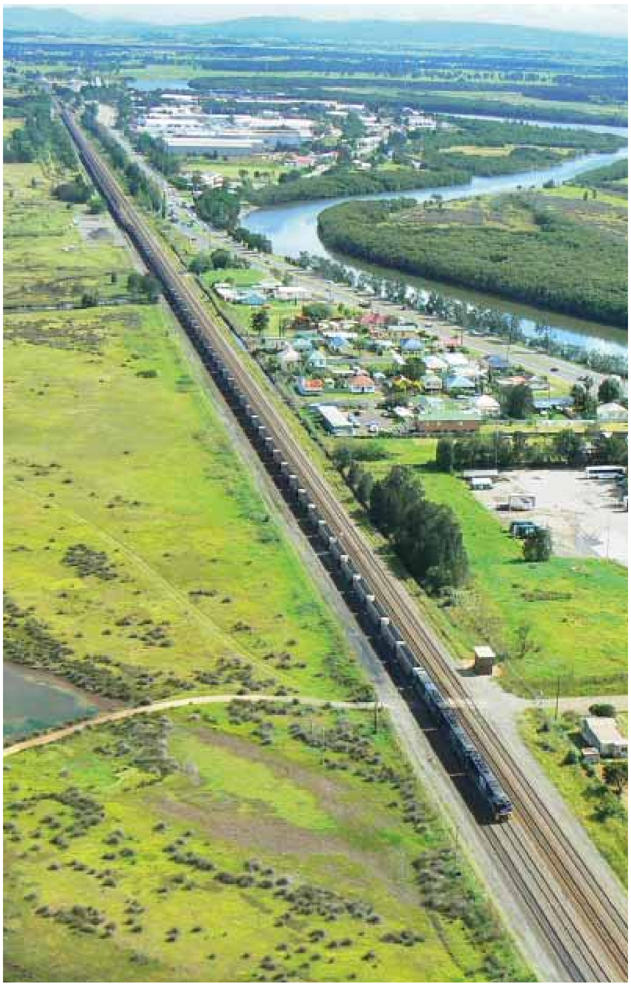
Train movements associated with the Project will increase delays for road traffic at level crossing. The Project will impact the level crossings on St James Road, Adamstown and Clyde Street, Islington. Under existing conditions, the Adamstown level crossing is closed for 432 minutes per day (30% of the time) and the Islington level crossing is closed for 463 minutes per day (32% of the time).

The Project will generate an average of 4.33 train movements per day. However, there is capacity for a maximum of 6 trains per day, 6 days per week. Each train will result in an additional closure time of 7 – 8 minutes in the loaded direction and 5 – 6 minutes in the unloaded direction. The average of 4.33 train movements per day will increase level crossing closure times by approximately 56 minutes. Therefore, closure time at the Adamstown Crossing will increase to 488 minutes per day (34% of each day) and closure time at the Islington level crossing will increase to 519 minutes per day (36% of each day). The additional closures due to the Project will generally occur during the night and other non-peak vehicular traffic periods.

7.13.4 Mitigation and Management

The following infrastructure enhancements should be considered by RailCorp in conjunction with the forecast expansion of general and coal freight services.

The Awaba North area is to be investigated for the siting and provision for the 1,700 m long passing loops that are suitable to support the predicted increases in coal haulage and provide reliability for general network operations including the operation of the 1,500 m long interstate services. These loops should also be fitted with 75 kph entry and exit turnouts located on tangent track. This investigation should include the installation of an additional signal south of Awaba station.



7.14 Aboriginal Archaeology and Cultural Heritage

7.14.1 Background

OzArk Environmental & Heritage Management Pty Ltd (OzArk) has undertaken an Aboriginal Cultural Heritage Assessment of the areas within the Project Boundary. The aim of the assessment was to review and assess the nature of the archaeological landscape of the area within the Project Boundary and assess the potential impacts that the Project may have on Aboriginal cultural heritage values.

A summary of this assessment is provided below and presented in full in Appendix S.

7.14.2 Methodology

This study builds on and combines several existing studies undertaken for the WACJV and the findings of investigations for other projects in the region, for which there is a considerable body of literature. Additionally, targeted field surveys were undertaken with representatives of the Aboriginal community.

Desktop Survey

A comprehensive desktop study was undertaken which included a:

- Review of the previous archaeological reports relevant to the regional and local area to assess the current status of Aboriginal cultural heritage and to provide a basis for developing a predictive model for the site;
- Search of the OEH AHIMS database for all registered sites within a 15 km radius of the Project Boundary; and
- Review of the landscape character and land use history which influence the patterning of sites.

A number of previous reports were identified as relevant to the local area to assess the current status of Aboriginal cultural heritage. The previous studies that have been undertaken within the Project Boundary were reviewed to gain an understanding of the Aboriginal heritage and cultural heritage values. Sites located as part of these studies are summarised in Table 72.

The review of these previous assessments and database findings enabled a predictive model of site types and locations to be formed, which was then tested by field assessment. The AHIMS database search returned three Aboriginal sites within the Project Boundary as described in Table 73 and shown on Figure 45.

Field Methodology

The field assessment component of the Aboriginal heritage assessment aimed to:

- Relocate and re-record all AHIMS registered Aboriginal archaeological sites located within the Project Boundary;
- Identify any previously unrecorded sites by way of targeted pedestrian transects where accessible;
- Identify levels of subsurface potential through excavation pits at the Tooheys Road Site;
- Achieve survey coverage that adequately reflects the variable archaeological potential of differing landform types within the Project Boundary;
- Inspect, where appropriate, areas of known or potential Aboriginal cultural value, as identified by Aboriginal stakeholder representatives; and
- Obtain sufficient data to facilitate the development of management and mitigation measures for the Project.

OzArk completed three targeted surveys for the Project in:

- November 2006;
- January 2010; and
- September 2011.

Additionally, a comprehensive test excavation program within the Tooheys Road Site was conducted in March 2010.

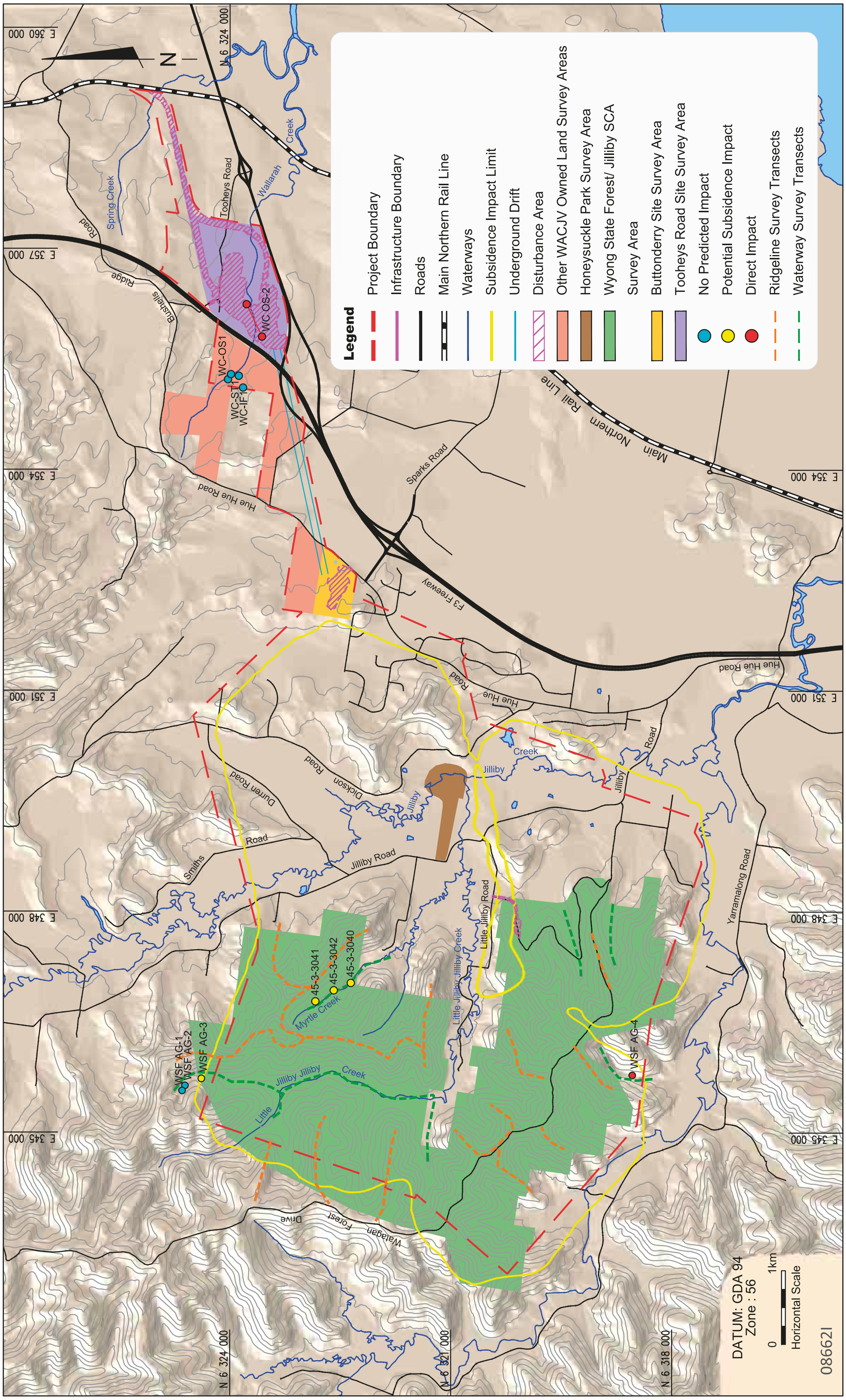
Survey within the Subsidence Impact Limit focussed on areas that have public access (Wyong State Forest and Jilliby State Conservation Area) or are owned by WACJV (Honeysuckle Park). These accessible areas were subjected to a full Aboriginal heritage assessment to verify the predictive model for site location. The Disturbance Area and the other WACJV owned land were surveyed and included the test excavation program at the Tooheys Road Site.

Table 72 Previous Aboriginal Heritage Studies in the Region

Author (Year)	Location in relation to the Project Boundary	Sites Found
Vinnicombe (1980)	10 km south	Approximately 243 sites were recorded
Attenbrow (2004a)	20 km west	179 sites were identified in the Upper Mangrove Creek
Dyall (1981)	10 km south	13 Aboriginal occupation sites were recorded during the survey
Koettig & Hughes (1983)	60 km to the west Study area has similar terrain to that found in the western portion of the Subsidence Impact Limit	17 sites were identified
Dallas (1986)	Survey along Hue Hue Road	3 artefacts were found
Kinhill (1995a)	20 km north of the Subsidence Impact Limit	41 Aboriginal sites were recorded
Kinhill (1995b)	40 km west	A total of 12 sites were located
Silcox (1996)	5 km to the southwest of the Subsidence Impact Limit	59 new sites were recorded
Nexus (1998)	Adjacent to the Buttonderry Site	No items of archaeological or heritage significance were found on the site
Heritage Concepts (2005)	Part of this survey traversed close to the Tooheys Road Site	Three isolated artefacts and two artefact scatters were recorded

Table 73 Previously Recorded Aboriginal Heritage Sites within the Project Boundary

Site ID	Site Name	Easting, Northing (GDA Zone 56)	Site Types	Recording
45-3-3040	Myrtle Creek/Maculata Road #3; Wyong State Forest	347040; 6322804	Axe grinding groove	Donovan, Welsh
45-3-3041	Myrtle Creek/Maculata Road #1;Wyong State Forest	346790; 6323285	Axe grinding groove	Donovan, Welsh
45-3-3042	Myrtle Creek/Maculata Road #2; Wyong State Forest	346940; 6323035	Axe grinding groove	Donovan, Welsh



WALLARAH 2 COAL PROJECT

Aboriginal Heritage Sites

FIGURE 45

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Wallarah 2 COAL PROJECT

The Aboriginal heritage assessment has been undertaken in accordance with the *Aboriginal cultural heritage consultation requirements for proponents* (DECCW, 2010) and previously under the *Guidelines for Aboriginal Cultural Heritage Impact Assessment and Community Consultation* (DEC, 2005). This process has been followed from the current Project's inception in 2006. The registered stakeholders comprised the DLALC, within whose administrative area the Project Boundary is located, and GTLAC.

The 2006 survey included the Tooheys Road Site, Buttonderry Site and Western Ventilation Shaft locality which will experience direct impacts as a result of the Project and those sites including other WACJV owned land where there will be no direct or indirect impacts from the Project. The Infrastructure Boundary was traversed using pedestrian transects by three or more surveyors. The surveyors assessed all locations within the Infrastructure Boundary, as well as a buffer surrounding the impact zones.

During the 2010 and 2011 field survey programs, coverage of the entire approximately 40 km^2 Subsidence Impact Limit that could be indirectly impacted was restricted due to a lack of access to privately owned lands in the cleared, rural lands dominated by the Jilliby Jilliby Creek floodplain. However, this area comprises highly disturbed landscapes with a low likelihood of remaining Aboriginal archaeological evidence. Some upland forest areas within the Subsidence Impact Limit were difficult to access because of safety concerns due to very steep topography and, at times, impenetrable vegetation growth.

The areas of the Wyong State Forest and Jilliby SCA within the Subsidence Impact Limit were surveyed in 2010 and 2011. Transects followed topographical features such as ridgelines and drainage lines, rather than artificial transect lines. All major ridgelines within the Subsidence Impact Limit were surveyed via pedestrian transects. The entire length of Little Jilliby Jilliby Creek within the Subsidence Impact Limit was surveyed in 2011. Calman's Gully and minor tributaries of Little Jilliby Jilliby Creek were also surveyed.

Due to previous recordings of sites along Myrtle Creek, the length of the creek within the Subsidence Impact Limit was intensively surveyed in 2010 and 2011. The transect lines followed for this assessment are illustrated on Figure 45.

The survey teams also investigated the WACJV–owned, large Honeysuckle Park property as a representative example of the cleared and disturbed rural lands within the Dooralong Valley, extending from the creek and riparian zone to the edge of the valley floodplain. The OzArk survey team was accompanied in the field on all survey days by representatives from both DLALC and GTLAC.

From October 2011, the Aboriginal stakeholder engagement program has been conducted in accordance with the latest Aboriginal Cultural Heritage Consultation Requirements for Proponents' (DECCW, 2010) which is discussed in detail in Section 5.6.

7.14.3 Impact Assessment

Archaeological Resource

The archaeological potential of the landform units investigated is constrained by the extent of previous land uses (e.g. cultivation, forestry and development) which have greatly altered the archaeological landscape.

As a consequence of the high levels of disturbance to the ground surface throughout the Infrastructure Boundary, findings confirmed that sites will be in a disturbed context. Landscapes around Wallarah Creek and Spring Creek were considered incapable of supporting large permanent populations, so the remaining sites found tend to display evidence of transient camps. Transient camps have lower levels of lithic discard which can be removed from the landscape if disturbed by ground surface alteration.

Table 74 states the anticipated impact to the sites from the Project: either directly within the Infrastructure Boundary; or indirectly in the Subsidence Impact Limit.

A total of eight sites were identified during the field survey (in addition to the three previously recorded sites described in Section 7.14.2) within the Project Boundary and on other WACJV owned land. Of these, an open site (WC-OS2) was located in the Infrastructure Boundary at the Tooheys Road Site. Another four sites (all axe grinding grooves) were located within or near the Subsidence Impact Limit in the west. The remaining three sites are located on other WACJV owned lands west of the Tooheys Road Site. No sites were located within either the Buttonderry Site or Western Ventilation Shaft Site.

The excavation program conducted along Wallarah Creek during March 2010 involved 46 separate excavation pits and confirmed that site WC-OS2 is of low archaeological potential. While items of Aboriginal heritage are present on site, the distribution and nature of these items suggest a random "background" scatter rather than a site (see Figure 45). The locations were recorded as an Aboriginal site as they were located within 50 m of each other (consistent with OEH requirements).

Table 74 Project Impacts on Aboriginal Archaeology and Cultural Heritage

Site Name	Site Type	Project Area	Project Impact
WC-OS1	Open site (artefact scatter including flakes, cores and chips)	Other WACJV owned land	None
WC-OS2	Open Site (artefact scatter including flakes, cores and chips)	Infrastructure Boundary: Tooheys Road Site	Direct
WC-IF1	Isolated find (flake)	Other WACJV owned land	None
WC-ST1	Culturally modified tree (potential)	Other WACJV owned land	None
WSF-AG1	Axe grinding groove site	Subsidence Impact Limit (Jilliby SCA)	None
WSF-AG2	Axe grinding groove site	Subsidence Impact Limit (Jilliby SCA)	None
WSF-AG3	Axe grinding groove site	Subsidence Impact Limit (Jilliby SCA)	Indirect
WSF-AG4	Axe grinding groove site	Subsidence Impact Limit (WSF)	Indirect
45-3-3040	Axe grinding groove site	Subsidence Impact Limit (Jilliby SCA)	Indirect
45-3-3041	Axe grinding groove site	Subsidence Impact Limit (Jilliby SCA)	Indirect
45-3-3042	Axe grinding groove site	Subsidence Impact Limit (Jilliby SCA)	Indirect

The assessment within the Subsidence Impact Limit recorded five axe grinding grooves in the Wyong State Forest/Jilliby SCA within the Terrigal Formation (WSF-AG3, WSF-AG4, 45-3-3040, 45-3-3041 and 45-3-3042). The results of previous studies and the use of the predictive model (see Appendix S) show that there may be at least some potential for further axe grinding groove sites on other drainage systems in the Wyong State Forest/Jilliby SCA although no other sites were found during field surveys. Other site types, such as open sites, will be rare given the nature of watercourses and the steeply sloping lands comprising the Subsidence Impact Limit. Other areas of the Subsidence Impact Limit include the floodplains which are represented by the survey area within Honeysuckle Park. The floodplains display high degrees of disturbance from farming and clearing activities and from periodic flooding. It has been concluded that this landform will hold low potential for the existence of undisturbed, subsurface deposits.

Definitive impacts as a result of the expected subsidence cannot be accurately predicted due to their indirect nature. Therefore the predicted impacts are a risk based consideration. The low strain impacts may serve to preserve the sandstone where the grooves are located from cracking. If there are minor increases in siltation along the bed of Myrtle Creek as a result of changes in runoff patterns then this may cover the grooves from view. This process can also occur naturally, for example following the sediment mobilisation after a bush fire event. These effects are considered to be of negligible to very low risk of damage to the sites' integrity.

Statement of Significance

The significance assessment was based on the relevant criteria from the Burra Charter which was adopted by the *Australian International Council on Monuments and Sites for the Conservation of Places of Cultural Significance* in 1979 (ICOMOS 1979). A significance assessment attempts to ascertain a relative value of heritage sites.

The appropriate criteria to determine significance in this assessment included cultural (importance to Aboriginal people), archaeological (scientific value), historical and aesthetic significance. The significance of the Aboriginal heritage material within the Project Boundary is held as high cultural value by the local Aboriginal community as these sites represent the ancestral footprint of today's Aboriginal people.

Resulting from the evidence of bioturbation and the lack of unique or rare artefacts found during excavations, site WC-OS2, has been assessed as holding a low archaeological value. This site has also been assessed as having a low aesthetic value as it is present in a highly modified environment.

Axe grinding groove sites recorded within the Subsidence Impact Limit (WSF-AG3, WSF-AG4, 45-3-3040, 45-3-3041 and 45-3-3042) conform to the distribution pattern that has already been established in the broader region. Axe grinding grooves can provide information about past settlement patterns, tool manufacture and food processing, however, there is no likelihood of associated deposits with the axe groove sites so archaeological research potential is limited. As such the sites recorded as part of this assessment are held to possess low-moderate archaeological value. The recorded axe grinding groove sites are situated in undisturbed landscapes with minimal access. This coupled with the ability of axe grooves to be easily interpreted by a lay person with only minor aid, have attributed the sites with a moderate aesthetic value.

All of the recorded sites occurring within the Project Boundary were determined to have low historic value due to the lack of connectivity to known Aboriginal sites as shown in Table 75.

An indicative significance assessment is provided for the previously recorded sites in Myrtle Creek based on consistency with other grinding groove site significance assessments.

Cumulative Impacts

Surveys conducted as part of this assessment show that the potential of undetected artefacts is low, therefore the predicted existing resource within the Project Boundary is minimal. Mining operations will have an insignificant cumulative effect as a result of surrounding land uses and the heavily modified state of the environment.

7.14.4 Mitigation and Management

Following Development Consent, WACJV will develop an Aboriginal Cultural Heritage Management Plan (ACHMP) for the Project. The ACHMP will be guided by specific policies and procedures to manage Aboriginal archaeological sites within the Project Boundary and periodically reviewed in consultation with Aboriginal stakeholders and OEH.

The ACHMP will include as a minimum:

- As practicable, protection of sites within the Disturbance Area prior to salvage and impact;
- Protection of sites that are not impacted by the Project by means of fencing and management controls;
- Detailed salvage methodologies to be carried out prior to direct impact activities; and
- Development of protocols for the monitoring of earthworks during construction of the Surface Facilities.

Consultation in relation to the ACHMP will continue to be undertaken in accordance with the “OEH Aboriginal Cultural Heritage Consultation Requirements for Proponents 2011”.

As part of the Extraction Plan, a comprehensive survey and assessment of all areas for Aboriginal heritage will be carried out at least 3 years prior to indirect disturbance.

In addition to the ACHMP, a Land Disturbance Protocol will be developed which will include appropriate induction information for employees and contractors who are involved in ground disturbing works, particularly in the Infrastructure Boundary along the banks of Wallarah and Spring Creeks. WACJV will maintain records identifying the employees / contractors that were inducted and when the induction occurred.

These inductions will stipulate:

- There may be isolated Aboriginal artefacts located in the landscape; and
- That if any objects are encountered that work crews suspect may be of Aboriginal origin then work should cease in that area and OEH and the DLALC be consulted on how to best proceed.

Removed topsoil from areas which will have a direct impact on the potential Aboriginal heritage resource should be retained on site for revegetation after construction is complete. This will ensure that any potential artefacts that are contained within the soil will remain in the general vicinity.

No Aboriginal sites were located in the Buttonderry and Western Ventilation Shaft sites. There is no constraint at these locations to the proposed construction of the Project due to Aboriginal cultural heritage.

Identified sites within the Subsidence Impact Limit are not predicted to be affected by subsidence from the Project.

Table 75 Aboriginal Heritage Sites Assessed Significance

Site Name	Cultural Significance	Scientific Significance	Aesthetic Significance	Historical Significance
WC-OS1	High	Low–Moderate	Low	Low
WC-OS2	High	Low	Low	Low
WC-IF1	High	Low	Low	Low
WC-ST1	High	Low Moderate	Low	Low
WSF-AG1	High	Low–Moderate	Moderate	Low
WSF-AG2	High	Low–Moderate	Moderate	Low
WSF-AG3	High	Low–Moderate	Moderate	Low
WSF-AG4	High	Low–Moderate	Moderate	Low
45-3-3040*	High	Low-Moderate	Moderate	Low
45-3-3041*	High	Low-Moderate	Moderate	Low
45-3-3042*	High	Low-Moderate	Moderate	Low

*Significance assessment of previously recorded sites is indicative only

As a precautionary measure, a detailed monitoring record by an Archaeologist will be undertaken prior to longwall mining occurring within 500 m of the site, and again following subsidence associated with longwall mining passing beneath the site. Monitoring will include a photographic record, GPS location, remarks on silt deposition levels in nearby catchments and any cracking of the bedrock / creek bed in the vicinity of the archaeological sites. Monitoring activity will also be undertaken with the involvement of the Aboriginal community.

On WACJV owned land west of the Tooheys Road Site, three sites were recorded (WC-OS1, WC-IF1, WC-ST1) and an area of archaeological sensitivity has been delineated along Wallarah Creek. No impacts are proposed for this area which is included in the Biodiversity Offset Strategy and it is recommended that the higher Aboriginal heritage values of this zone be managed through an appropriate ACHMP developed in consultation with the Aboriginal community.

7.15 Historic Heritage

A Historical Heritage Assessment was undertaken by OzArk to determine the potential impacts of the Project on historical heritage items identified within and adjacent to the Project Boundary. A summary of this assessment is provided below while the full report is reproduced in Appendix T.

7.15.1 Background

An historical overview of the area provides an indication of how the existing land use of the region has developed. Although timber getters worked and lived in the area from the 1790s, the Wyong LGA was generally settled in the early 1820s when large grants of over 1,000 acres were given in the Dooralong Valley and in the area of the current Wyong township. Again in the 1840s, land grants were given in the Ourimbah, Wyong and Jilliby areas in 1,000 acre parcels. The ‘poorer’ land of Warnervale and Gorokan was not ‘taken up’ until the 1870s. The timber industry had been critical to the Wyong Valley’s economy from the 1800s. Timber harvesting occurred in both the Dooralong and Yarramalong valleys, with timber often being cut and shipped to Sydney.

The timber industry also opened up the valleys and attracted farmers and settlers who cleared the river flats in the 1850s. These were mainly subsistence farmers growing fruit and vegetables and grazing stock. By the 1860s, there was an influx of settlers along the Wyong River and its tributaries including Jilliby Jilliby Creek. Many of these settlers were attracted by settlement incentives.

With the opening of the Sydney – Newcastle railway in 1889, Wyong’s population increased and a quicker link to Sydney was created, encouraging agriculture and fishing and the development of Wyong as a railway town and tourist destination.

After 1889, new timber mills were built in Wyong and in the valleys, thus opening the timber industry and local vegetable and dairy producers to overseas markets. The height of the timber industry was in the early 1900s when exports boomed, however by the late 1920s, much of the local timber had been felled and the area exhausted.

Farming has also been an important industry in the Wyong region. By the late 1880s, many citrus orchards were planted in Wyong and its valleys with an industry peak in the 1970s. Dairy farming was established by 1854 and peaked 40 years later when there were roughly 100 operational dairies in the area. However, dairy farming declined during the 1980s and by 1995-6 no dairy farms were operational in the Wyong Valley. Poultry farming remained a smaller industry which peaked in the 1960s. Fishing was a significant industry from the earliest days. Residential development increased with the opening of the Sydney Freeway in 1987.

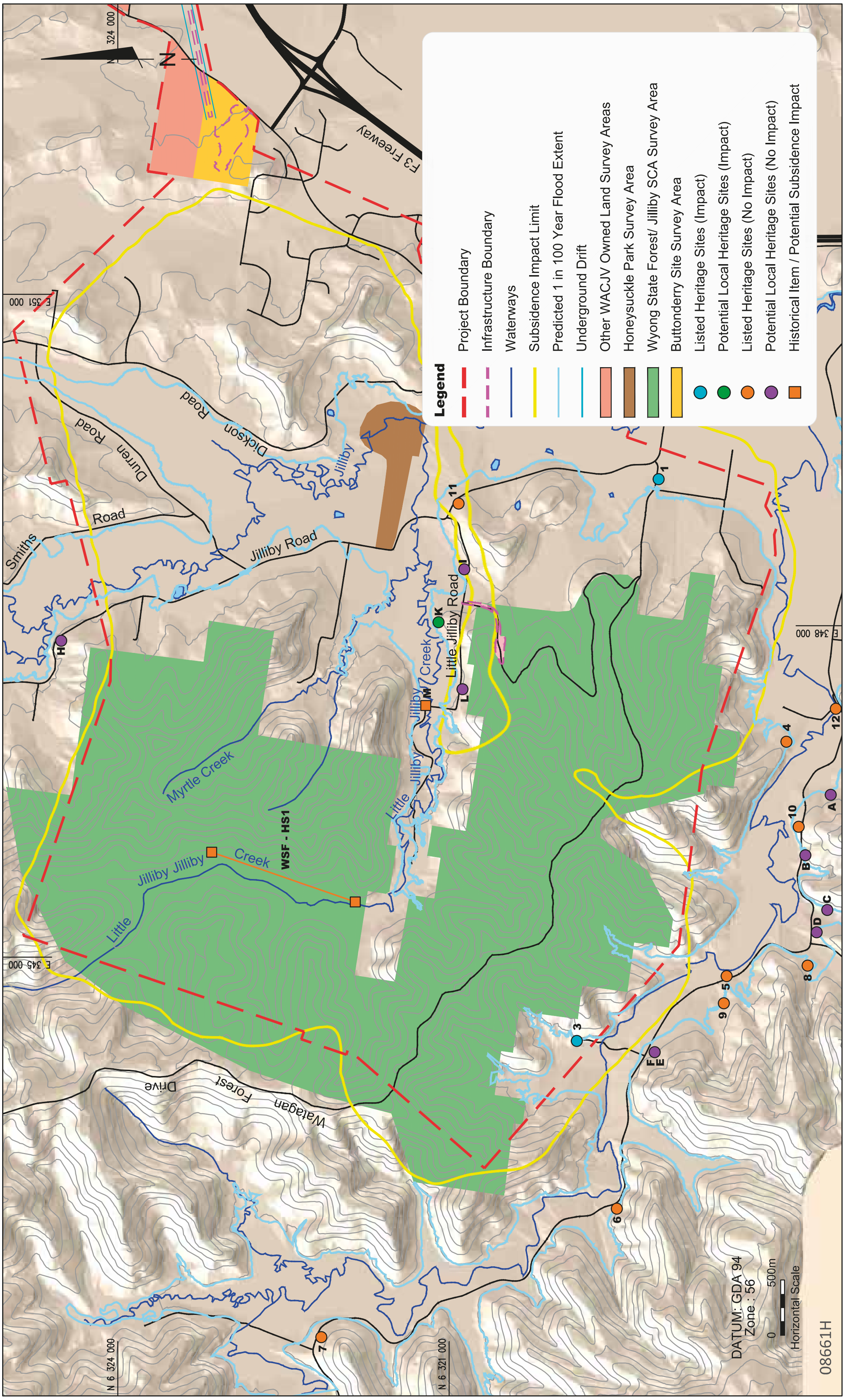
An influx of hobby farmers and rural residential development has centred on the Yarramalong Valley. Traditional large acreage agriculture has given way in the last 20 years to smaller hobby farms, rural weekend retreats, market gardens, orchards, nurseries, horse properties and turf farms.

7.15.2 Methodology

The methodology for the assessment consisted of several components to ensure that all relevant historical heritage items that had the potential to be impacted by the Project were identified and assessed.

A review was completed of the historical heritage surveys carried out within the Project Boundary by ERM up to 2001. These previously identified sites were included as appropriate in this assessment. A desktop search was completed to identify any potential items of heritage significance. The searches involved the relevant registers of historic heritage data – namely the Wyong LEP, the NSW State Heritage Office register, the Australian Heritage Database, SEWPaC Protected Matters Database and the RMS Heritage and Conservation Register.

Three field survey programs were undertaken on 13 October 2006, 14 to 16 November 2006, and 25 to 29 November 2010. The surveys traversed a variety of landforms within the Project Boundary. The area was surveyed using pedestrian transects by two or three surveyors. Other WACJV owned land was also surveyed using pedestrian and vehicle transects by a survey team. Lands within the Subsidence Impact Limit were traversed in the 2010 survey, focusing on two particular areas (Wyong State Forest / Jilliby SCA Survey Area and Honeysuckle Park Survey Area) where access was available. Study areas are identified in Figure 46.



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Historic Heritage Items

FIGURE 46

There are four categories of heritage significance recognised in the Australia ICOMOS Burra Charter (Australia ICOMOS, 1999) which include:

- Historic significance;
- Aesthetic significance;
- Scientific significance; and
- Social significance.

A significance assessment of the recorded historic sites was then conducted in accordance with *Assessing Heritage Significance* (Heritage Council of NSW, 2001).

Table 76 describes the significance assessment criteria that have been utilised for the assessment of cultural heritage significance for items and places within and adjacent to the Project Boundary. Based on the significance criteria, items are then categorised as having Local or State level significance, or as having no significance. The level of significance is assessed in accordance with the geographical extent of the item's value. An item of State significance is one that is important to the people of NSW, whilst an item of Local significance is one that is principally important to the people of a specific LGA.

7.15.3 Impact Assessment

Summary of Items

There were few previously unrecorded items of historical heritage documented during the most recent fieldwork. There was a low incidence of historical items which was not considered surprising given the nature of the surveyed lands. All items of historical heritage significance are shown on Figure 46 in relation to the Project. Items with a potential to be impacted by the Project are also identified in Table 77.

Disturbance Area

Previously identified sites within the Tooheys Roads Site were revisited and assessed and were excluded from further assessment as they were not considered to be of heritage significance or potential heritage significance. No mitigation or management strategies have been recommended for these items. No further discussion is required.

No historical heritage items were identified within the Disturbance Area. No further discussion of the Disturbance Area is required in relation to historic heritage items.

Subsidence Impact Limit

Items of Heritage Significance

Three items of heritage significance have the potential to be affected by Project related subsidence or the possibility of increased flooding levels as shown on Figure 46. This encompasses items of regional significance, including a brick and iron silo (Heritage Site 1), the dwelling 'Bangalow' (Heritage Site 3) and the Wyong State Forest Historic Site 1 (WSF-HS1). Also located within the Project Boundary is the locally significant Jilliby Public School (Heritage Site 11). This item is however located outside the Subsidence Impact Limit and there is therefore no predicted potential impact to this site.

The Wyong State Forest Historic Site 1 (WSF-HS1) was recorded on the eastern bank along the lower reaches of Little Jilliby Jilliby Creek. WSF–HS1 consists of a disused forestry road. Historical features of this site include road cuttings, axe marks in trees and evidence of repairs and upgrades being made to the road in the form of different styles of culverts. Currently the road is used by recreational walkers and is in a fragile state in places, with trees growing through the earthen road and wash outs destroying evidence of engineering efforts.

Table 76 Assessment of Historic Heritage Significance Criteria

Criterion	Assessment Criteria
(a)	An item is important in the course, or pattern, of NSW's cultural or natural history (or the cultural or natural history of the local area)
(b)	An item has strong or special association with the life or works of a person, or group of persons, of importance in NSW's cultural or natural history (or the cultural or natural history of the local area)
(c)	An item is important in demonstrating aesthetic characteristics and/or a high degree of creative or technical achievement in NSW (or the local area)
(d)	An item has strong or special association with a particular community or cultural group in NSW (or the local area) for social, cultural or spiritual reasons
(e)	An item has potential to yield information that will contribute to an understanding of NSW's cultural or natural history (or the cultural or natural history of the local area)
(f)	An item possesses uncommon, rare or endangered aspects of NSW's cultural or natural history (or the cultural or natural history of the local area)
(g)	An item is important in demonstrating the principal characteristics of a class of NSW's: • *Cultural or natural places; or* • *Cultural or natural environments.*

Source: Heritage Council of NSW Guidelines (2001)

Table 77 Historic Heritage Items Within or in Close Proximity to the Project Boundary

Heritage Site	Easting (ISG)	Northing (ISG)	Description	Within Project Boundary	Within Subsidence Impact Limit	Within Disturbance Area	Significance
Items of heritage significance (NSW State Heritage Register)							
1	335640	1318947	Brick & Iron Silo	Yes	Yes	No	Regional (Wyong LEP)
2	337012	1318483	Jilliby Cemetery	No	No	No	Regional (Wyong LEP)
3	330570	1319785	Dwelling "Bangalow"	Yes	Yes	No	Regional (Wyong LEP)
4	333242	1317836	Dwelling "Gracemere"	No	No	No	Regional (Wyong LEP)
5	331131	1318418	Wyong Creek Community Hall	No	No	No	Regional (Wyong LEP)
6	329045	1319452	Dwelling (Former "Ebenezer Cottage")	No	No	No	Regional (Wyong LEP)
7	327934	1322150	Dwelling "Hillview"	No	No	No	Regional (Wyong LEP)
8	331212	1317683	Dwelling "Marabilla"	No	No	No	Regional (Wyong LEP)
9	330885	1318448	Silos and Farm Shed	No	No	No	Regional (Wyong LEP)
10	332470	1317739	Wyong Creek Public School	No	No	No	Regional (Wyong LEP)
11	335454	1320763	Jilliby Public School	Yes	No	No	Local (Wyong LEP)
12	333532	1317383	Road Bridge, Kidman's Lane	No	No	No	Local (Wyong LEP)
WSF-HS1	332229 331755	1322876 1321585	Wyong State Forest Historic Site 1	Yes	Yes	No	Local (Low heritage value)
Items of heritage significance (ERM 2001d)							
M	333632	1321083	Little Jilliby Road Bridge	Yes	Yes	No	Local**
Items of potential heritage significance (ERM 2001d)							
A	332753	1317431	Dwelling	No	No	No	Potential heritage value
B	332211	1317671	Dwelling	No	No	No	Potential heritage value
C	331712	1317483	Dwelling	No	No	No	Potential heritage value
D	331512	1317583	Bridge (Yarramalong Road)	No	No	No	Potential heritage value
E	330455	1319083	Dwelling	No	No	No	Potential heritage value
F	330455	1319083	Dairy and Cattle run	No	No	No	Potential heritage value
G	335505	1320666	Dwelling	Yes	Yes	No	None*
H	334281	1324372	Dwelling	No	No	No	Potential heritage value
I	334858	1320710	Dwelling	Yes	No	No	Potential heritage value
J	334609	1320706	Dwelling	Yes	Yes	No	None*

Heritage Site	Easting (ISG)	Northing (ISG)	Description	Within Project Boundary	Within Subsidence Impact Limit	Within Disturbance Area	Significance
K	334384	1320952	Dwelling	Yes	Yes	No	Potential heritage value
L	333773	1320747	Dwelling	Yes	No	No	Potential heritage value
N	333212	1321083	Bunya Pine	Yes	Yes	No	None*
O	335312	1323183	Keegan's Silo	Yes	Yes	No	None*
P	336112	1323823	Picket fence on Durren Road	N/A	N/A	N/A	None*
Q	336912	1320483	Silos	No	Yes	No	None*
R	335912	1323733	Dwelling	Yes	Yes	No	None*
S	334708	1323661	Dwelling	Yes	Yes	No	None*

* Identified by ERM as holding potential heritage value. OzArk has since ground-truthed this feature and concluded that the item holds no heritage value.
** Identified by ERM as holding potential heritage value. OzArk has since ground-truthed this item and concluded that the item is of local heritage significance.

WSF–HS1 is assessed as holding low historic significance. This is a result of the poor state of repair and the widespread nature of logging in NSW, noting that sites similar to WSF-HS1 are common.

Items of Potential Historic Heritage Significance

The items of potential historic heritage significance recorded by ERM in 2001 (Table 77 items A–S) were not recorded in the heritage studies that led to the generation of the Wyong LEP heritage list. The majority of these items are privately owned dwellings or parts thereof (sheds / silos) while only two (bridges) are public utilities (see Table 73).

Nine of the 18 potential heritage items identified by ERM are situated within the Subsidence Impact Limit, comprised of five dwellings (G, J, K, R and S), Little Jilliby Road Bridge (M), Bunya Pine (N), Keegan's Silo (O) and Silos (Q). The locations of these items are shown in Figure 46 and Table 77.

The nine items within the Subsidence Impact Limit were surveyed on 27 November 2012 to determine their heritage significance. The assessment determined that seven of the items (G, J, N, O, Q, R & S) held no heritage significance. Item M was the only item that was assessed as holding heritage significance. Item M is a bridge on Little Jilliby Road (c. 1894) and was determined to be of local heritage significance. Item K is a dwelling located on private property and could not be accessed during the November 2012 survey. The heritage significance of the dwelling could not be assessed and consequently, the dwelling remains an item of potential heritage significance. Adopting a precautionary approach, mitigation measures have been recommended for Item K.

Items N, O and Q hold some heritage value, despite falling short of satisfying the criteria for local heritage significance. Accordingly, mitigation measures have been recommended for these items (see Section 7.15.4). The items identified by ERM that are outside of the Subsidence Impact Limit were not re-assessed. These items (A, B, C, D, E, F, H, I and L) remain as items of potential heritage significance (see Table 77). Since these items are not predicted to be impacted by the Project, no mitigation measures have been recommended.

Subsidence Consequences

The potential consequences of subsidence on historic heritage items were assessed by MSEC. Three items of heritage significance (Items 1, 3 & M) are located within the Subsidence Impact Limit. There is also one item of potential heritage significance (Item K) within the Subsidence Impact Limit.

The Brick and Iron Silo (Item 1) is predicted to experience a maximum tilt of 7.5 mm/m, which represents a change in grade of 1 in 135. The maximum hogging and sagging curvatures for this structure are predicted to be 0.09 km^{-1} and 0.04 km^{-1} respectively. The structure consists of full masonry walls. The maximum tilt of 7.5 mm/m is unlikely to affect the stability of the structure. However, the predicted curvatures could result in cracking of the masonry walls. The cracking is expected to be of a nature that can be remedied using ordinary maintenance techniques.

The dwelling known as "Bangalow" (Item 3) is predicted to experience a maximum tilt of 7.5 mm/m, which translates to a change in grade of 1 in 135. A tilt of this magnitude can adversely affect the serviceability of the house, such as impacts to gutter and wet area drainage.

Remediation measures may be necessary, such as re-levelling of wet areas. The maximum hogging and sagging curvatures are predicted to be 0.08 km^{-1} and 0.01 km^{-1} respectively. These curvatures are unlikely to significantly impact the structure. There is a low probability that significant repair work will be required.

The Little Jilliby Bridge (Item M) is predicted to encounter a maximum tilt of 0.8 mm/m. This represents a change in grade of 1 in 1,250. This change in grade is unlikely to affect the drainage or serviceability of the bridge. The maximum hogging and sagging curvatures are both predicted to be less than 0.01 km^{-1}. Curvatures of this magnitude are unlikely to cause adverse impacts on the structure.

Little Jilliby Bridge (Item M) is also expected to be subject to non-conventional subsidence movements. The bridge may encounter upsidence and closure movements of up to 50 mm. The bridge is expected to be able to accommodate these movements due to the flexibility of the timber and steel structure. Nevertheless, a structural inspection of the bridge will be undertaken prior to and following mining.

Item K is predicted to experience a maximum tilt of 1.5 mm/m, maximum hogging curvature of 0.02 km^{-1} and maximum sagging curvature of 0.01 km^{-1}. The predicted subsidence effects are not expected to have any significant impact on this dwelling. There is only a 1% probability that substantial repairs will be required.

All other items with potential heritage significance are outside of the Subsidence Impact Limit and will not be impacted.

7.15.4 Mitigation and Management

Management strategies to limit the potential impacts of the Project on historical heritage items will be detailed in a Historical Heritage Management Plan which shall be prepared in consultation with WSC and NSW Heritage following the granting of Development Consent.

Impacts of subsidence and increasing flood levels to privately owned historical heritage items will be addressed in the Extraction Plan. The Historical Heritage Management Plan and Extraction Plan will include management strategies listed in Table 78.

Table 78 Historic Heritage Mitigation and Management

Heritage Item No	Site Name	Management Action
Item 1	Brick and Iron Silo	A study will be undertaken to assess potential impacts with input from a structural engineer and a heritage consultant. Subsequent management strategies will be developed to ensure that heritage significance is not adversely affected and to establish appropriate remediation measures as part of the HHMP. Normal building maintenance techniques to repair cracking will be undertaken, if required. Management strategies will be developed to ensure that heritage significance is not adversely affected and to establish remediation measures.
Item 3	House 'Bangalow'	As this item is privately owned, potential impacts and any remediation will be addressed in the Extraction Plan. A study will be undertaken to assess potential impacts with input from a structural engineer, subsidence engineer and a heritage consultant. Subsequent management strategies will be developed to ensure that heritage significance is not adversely affected and to establish appropriate remediation measures. Minor to substantial remediation measures, including re-levelling of some 'wet' areas, may be required in consultation with a heritage consultant.
Item K	Dwelling	Minor to substantial remediation works. Study to be undertaken to assess potential impacts with input from structural engineer, subsidence engineer and heritage consultant. Management strategies will be developed to ensure that heritage significance is not adversely affected and to establish remediation measures.
Item M	Little Jilliby Road Bridge	Minor to substantial remediation works. Study to be undertaken to assess potential impacts with input from structural engineer, subsidence engineer and heritage consultant. Management strategies will be developed to ensure that heritage significance is not adversely affected and to establish remediation measures.
Item N	Bunya Pine	Further community consultation will take place prior to undermining in the area to fully determine if this item has any historical associations.
Items O & Q	Silos	Silos will be recorded to archival standards prior to undermining in the area.

7.16 Visual

7.16.1 Background

The Design Partnership was commissioned to complete a Visual Impact Assessment on the potential impacts of the Project. The Visual Impact Assessment was undertaken to identify the character of the surrounding visual landscape and provide management and mitigation measures for visual impacts associated with the Project. A summary of the Visual Impact Assessment is provided below and presented in full in Appendix U.

The existing visual environment of the Tooheys Road Site, Buttonderry Site and Western Ventilation Shaft includes a diverse range of landscape settings and views which differ in the following aspects:

- Degree of visibility and exposure;
- Current onsite and surrounding land uses;
- Density of vegetation; and
- Visual scale of landscape context.

Each site is described further below.

Tooheys Road Site

The landscape surrounding the Tooheys Road Site is characterised by undulating farmland. The landscape is vegetated to the north and south and is a mixture of freehold and Crown Reserve.

The Tooheys Road Site is at the convergence of two main arterial roads:

- The F3 (Sydney – Newcastle) Freeway is located along the western boundary of the site and runs north to south; and
- The Motorway Link Road forms the southern boundary of the site. A vegetated landscape mound constructed as part of the Motorway Link Road and cutting prevent views over the site.

A powerline easement runs through the site, resulting in a largely cleared corridor along the northern boundary. The remainder of the northern boundary of the site is largely vegetated, with thick stands of trees.

Beyond the ridgeline to the south, the landscape is heavily treed. To the south-west, Mountain Road forms the north-eastern limit of the WEZ. Further to the south-east of the site at the intersection of Sparks Road and the Main Northern Railway Line (3.1 km away from the Tooheys Road Site) is the proposed Warnervale Town Centre. The land to the east of the site is generally lower-lying, while land to the west and north-west of the F3 Freeway consists of a series of consistently more elevated ridgelines (see Figure 14).

Further to the south-west, the land lying alongside the F3 Freeway is generally lower-lying and comparatively cleared. To the north-west, only the southerly slope below Bushells Ridge Road has been cleared. The ridgeline which passes through the Tooheys Road Site from its north-west corner to the mid-point of the eastern boundary extends to the east as far as the Motorway Link Road and follows the general alignment of the unpaved Tooheys Road.

Buttonderry Site

The Buttonderry Site is consistently more elevated than the Tooheys Road Site; however it has a narrower road frontage with the bulk of the building infrastructure proposed to be set back from the road and towards the rear portion of the site. A continuous ridge arches from the south towards the north, effectively separating the Buttonderry Site from rural and rural-residential properties to the south and west.

Dense tree cover to the south of the site extends only as far as the intersection of Hue Hue Road and Sparks Road, whereas to the north it continues north for a number of kilometres and surrounds the cleared land of the Buttonderry Waste Facility. The west-side arcing ridgeline mentioned above forms the north-eastern boundary of the Buttonderry Waste Facility, separating that boundary from visual exposure to Hue Hue Road.

Western Ventilation Shaft

A second ventilation shaft will be required around Year 13 in the Wyong State Forest to augment the original shaft at the Buttonderry Site.

The Western Ventilation Shaft Site will be located adjacent to an existing unsealed forestry road that is used periodically by horse trail riders, walkers and 4WD enthusiasts but is not expected to be visible from residences. Accordingly the resultant impacts are considered to be very low.

7.16.2 Methodology

A Visual Landscape Character Assessment was undertaken for the Project which involved determining the limits for the Project elements to be seen and identifying any key viewpoints of the Project. From the key viewpoints, a visual character can then be established using local viewer responses.

View Shed and Private Receiver Viewing Locations

Following a desktop review of the area using contour and topographic maps of the site, key viewpoints were visited. At each of these key viewpoint locations, helium balloons were raised to elevations indicative of the proposed surface infrastructure. Where infrastructure was potentially seen by the public, photomontages were created to assess the visual impact.

Identifying Visual Character

Identifying visual character was determined from key sites and from local viewer responses. Character is then rated from "Highest" to "Poor Quality Landscape".

Tooheys Road Site

The visual access to the Tooheys Road Site (and its proposed structures and stockpiles) is predominantly by private users on the:

- F3 Freeway, where the site is viewed from the west (very short periods only);
- Motorway Link Road, where the site is viewed from the east (very short, intermittent lengths only);
- F3 Freeway, where the site is viewed from the north (very short period only);
- Motorway Link Road, where the site is viewed from the south (view generally not available);
- Bushells Ridge Road, where the site is viewed from the north-west (very low usage) with some screening by vegetation and intervening topography; and
- Tooheys Road, where the site is viewed from the north-east (very low usage).

Buttonderry Site

The visual access to the Buttonderry Site is defined by the following characteristics:

- Sparks Road (largely screened by existing trees);
- Hue Hue Road (short length only, and proposed infrastructure is consistent with current land zoning); and
- The ridgeline to the south and the west blocks any views from the rural residential areas.

Visibility

Visibility categories have been used which are based on the "Guidelines for Landscape and Visual Impact Assessment" (GLVIA) prepared by the Landscape Institute (UK), which are commonly used for Visual Impact Assessments within NSW.

The visibility criteria were then determined and used in the visibility assessment for each of the two sites. A visibility category of High, Moderate or Low was assigned with "High" indicating that a large number of people would see the proposed development at short distance over a short, moderate or long period of time and "Low" indicating that a small number of people would see the proposed development at long distance over a short, moderate or long period of time.

Visual Absorption Capacity

Visual Absorption Capacity (VAC) is the estimated ability of the landscape to absorb a development without creating significant visual change to the landscape which results in a reduction in the scenic qualities of the area (refer to Table 79). VAC increases where the development has visual forms which complement the existing environment.

Visual Impact Rating

The visibility and the VAC ratings of the sites combine to give a Visual Impact Rating (VIR) as demonstrated in Table 80. The VIR is the rating which determines whether mitigation measures are required to reduce the visual impact to an acceptable level.

7.16.3 Impact Assessment

Tooheys Road Site

Visibility

Key visual impacts towards this site are generally restricted to motorists, with the exception of some private residences in the east. The Tooheys Road Site has a Low visibility category to the public in general. House numbers 209 and 235 Bushells Ridge Road will have some minor impacts upon view as shown in Figure 47. However, these impacts are significantly reduced due to their views being limited to the uppermost section of the product coal stockpile.

Table 79 Visual Absorption Capacity Criteria

Category	Criteria
High	Landscape able to absorb development. Low degree of visual contrast would result.
Moderate	Landscape able to absorb some development. Some visual contrast would result.
Low	Landscape unable to absorb development. High degree of visual contrast would result.

Table 80 Visual Impact Rating Matrix

	Visibility		
	Low	Moderate	High
Visual Absorption Capacity	Visual Impact Rating		
High	Low	Low	Moderate
Moderate	Low	Moderate	High
Low	Low	Moderate	High

View to the South from Bushells Ridge Road

View to the South from hilltop at Tooheys Road
near Bushells Ridge Road Intersection

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Tooheys Road Site Visual Impacts

FIGURE 47

The Tooheys Road Site is not expected to have any visual impact on the Warnervale Town Centre and areas of the public domain associated with the town centre. This is due to screening provided by vegetation and a ridgeline between the Tooheys Road Site and the Warnervale Town Centre.

Visual Absorption Capacity

The scenic quality of the Tooheys Road Site is defined in part by its relationship to the wider locality, sharing a similar characteristic to the surrounding area. However, it is important to note that this is a transitional area, with large areas of surrounding land being zoned industrial, with subsequent developments anticipated to occur. Land to the north and west is largely rural in nature but zoned either rural or 10(a) Investigation.

The tallest elements on this site will be the Product Stockpile and the Raw Coal Stockpile which are approximately 29 m and 30 m respectively. The Product Stockpile base will be cut and filled on the southern section of the site. Extensive existing vegetation and the existing mound will effectively shield these features of the site from passing views.

As a result of the topography and the existing vegetation in the area, VAC has been assessed as moderate, as the Tooheys Road Site infrastructure can be absorbed by the surrounding environment. Other developments surrounding the site such as the Clay Quarry and Tile Factory, electricity pylons and the F3 Freeway also have the capacity to integrate the proposed infrastructure.

On the basis of the above assessment, it is clear that the Tooheys Road Site infrastructure as a whole can be easily absorbed visually by the hills and denser bushland trees as well as by the other developments surrounding the site, such as a quarry, electricity pylons and the F3 Freeway.

Overall, the VAC of the Tooheys Road Site is assessed as Moderate. With appropriate landscape management, (i.e. with very little physical intervention) the overall VAC can be increased to Moderate – High. In order to further minimise the effects, it is recommended that landscaping around key building structures and painting of these buildings in a neutral colour be undertaken to minimise potential impacts. The visual impact of the Tooheys Road Site can be expected to decrease with distance from the site. On this basis the overall VAC of the Tooheys Road Site is Moderate but tends towards High.

Visual Impact Rating

The VIR for the Tooheys Road Site is determined by utilising the visibility and VAC ratings. Using the matrix to align the Low level of visibility and the Moderate-High VAC given to the Tooheys Road Site, these two values result in a Low VIR.

Lighting

Lighting impacts may be created by night operations of the Project. Direct light effects are generally restricted to vehicle and train lights and lighting of coal handling and office areas. Lighting will largely be screened by topography and vegetation.

Buttonderry Site

Visibility

Given the approval of the Warner Industrial Park (discussed further in Section 2.4) on the opposite side of Hue Hue Road, and the appearance of this site as being of a commercial nature, the Buttonderry Site is in keeping with the desired future land use of the area.

As illustrated in Figure 48 the Project cannot be viewed by adjoining rural and rural residential properties due to both vegetation and topography. As such, the visibility of this site is not a major consideration, and the Project will have little to no adverse visual effects and will largely not be visible from any public or private areas.

The Buttonderry Site may be visible from areas within the proposed WEZ. The visual character of the Buttonderry Site is light industrial, which is similar to the character of the WEZ. Therefore, the visual impact on the WEZ is predicted to be minimal.

Visual Absorption Capacity

The development proposed in this part of the Buttonderry Site is located within a portion of the site that is largely sheltered from view by both topography and vegetation. The VAC of the eastern portion of the Buttonderry Site is currently Moderate – High. The minor mitigation work proposed will result in this classification being maintained. Overall, the VAC applicable to the Buttonderry Site is Moderate – High, tending towards High.

The rezoning of rural and residential lands to the east for the WEZ industrial development negates the need to consider viewing zone and viewsheds in that direction. In addition, the land immediately to the north is owned by WACJV and no residences exist in this vicinity. The Buttonderry Waste Management Facility is located beyond the northern boundary of the WACJV owned land. Consequently, there is no need to consider viewing zones or viewsheds in that direction.

The steep rise from the east to the west along the site's southern boundary obscures all views into the site from the south, other than the south-eastern corner. In this location, existing dense vegetation shields the eastern third of the site.

Visual Impact Rating

Using the matrix to align the low level of visibility and the Moderate-High VAC given to the Buttonderry Site, these two values result in a Low VIR for the Site.

View North from Amberwood Close

View West from Sparks Road/Hue Hue Road

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Buttonderry Site Visual Impacts

FIGURE 48

Lighting

Lighting impacts may be created by night operations of the Project. Direct light effects are generally restricted to vehicles and office areas. It is predicted that lighting will be screened by topography and vegetation.

Western Ventilation Shaft

The Western Ventilation Shaft is located within the Wyong State Forest and is not visible from any surrounding residences. As it is located adjacent to an existing forestry track it will be visible to any bushwalkers, horse riders or 4WD enthusiasts that may use the track. The number of passers-by is anticipated to be very low to negligible.

Due to the location of the site, the nature of the development and the surrounding environment, there is anticipated to be no adverse visual impact from this site.

7.16.4 Mitigation and Management

Tooheys Road Site

The Tooheys Road Site has a Low VIR. Landscape mitigation measures will be undertaken at the following perimeter zones of the Site to enhance the visual absorption capacity to further reduce visual impacts:

- The north western boundary area (northwards from halfway along the western boundary); and
- Along part of the eastern boundary.

Landscape works using native vegetation will involve a reinstatement of the local vegetated character and will achieve a reduction in the visual impacts of the Site to a Low VIR category for both close range and distant views.

Upon receiving a written request from an owner of privately-owned land with direct views to the Tooheys Road Site from a residence within 2 km of the Tooheys Road Site, WACJV will implement reasonable and feasible additional visual impact mitigation measures (such as landscaping treatments or vegetation screens) in consultation with the landowner, to the satisfaction of DP&I.

WACJV will minimise light spill and the offsite lighting impacts of surface works and ensure that all external lighting associated with the Project complies with Australian Standard *AS4282 (INT) 1997 – Control of Obtrusive Effects of Outdoor Lighting* (or latest version).

Buttonderry Site

For the Buttonderry Site, effective enhancement of the VAC will be achieved by screen planting along the Hue Hue Road Boundary and particularly adjacent to the entrance and the access roadway.

WACJV will minimise light spill and the offsite lighting impacts of surface works and ensure that all external lighting associated with the Project complies with relevant standards.

7.17 Social

7.17.1 Background

Martin & Associates Pty Ltd prepared a Social Impact Assessment for the Project, which is presented in full in Appendix V and summarised below. The objectives of the Social Impact Assessment were to:

- Assess implications of relevant Government policy and guidelines;
- Characterise the existing community, current behaviour and interactions of residents;
- Characterise and assess perceptions of the Project by those within the Directly Affected Area;
- Assess the potential impacts of the Project on population, temporary accommodation and housing;
- Identify the present use of social infrastructure and observed or perceived gaps from a community perspective;
- Discuss implications for the Directly Affected Area, particularly the likely spatial distribution of any non-local operational and construction work forces and their impacts on the community;
- Discuss implications for the broader Secondary Study Area in relative employment and population impacts; and
- Prepare a social management and monitoring program to mitigate potential and perceived impacts.

7.17.2 Methodology

The methodology of the Social Impact Assessment included setting the Study Area for the Project and analysing the baseline community and social environment. The next stages included considering how local community behaviour and interactions may change with the influence of the Project, assessing the impacts of the Project on local employment, housing and community infrastructure, and making recommendations to mitigate the social impact of the Project.

The main sources of data for the Social Impact Assessment were:

- The Australian Bureau of Statistics 2001 and 2006 Censuses;
- WSC social planning reports;
- Community attitude surveys of 400 residents within the Secondary Study Area in 2006 and 2012; and
- A community baseline survey carried out in 2008 within the Directly Affected Area.

In addition, consultation was held with key relevant WSC and LMCC staff.

Study Area

The Project is located in the Wyong LGA. The Study Area of the Social Impact Assessment comprises three components:

- Primary Study Area, which comprises five 2006 Census Collection Districts in Wyong LGA within and immediately surrounding the Project Boundary;
- Directly Affected Area, which is smaller in area within the Primary Study Area and which comprises:
  - Those who live nearby and above the proposed Extraction Area;
  - Those who will hear, smell or see the development or its effects on a daily basis as determined by other technical studies; and
  - Those who normally use the land where the Project is to be located; and
- Secondary Study Area, comprising the Central Coast (Wyong and Gosford LGAs) and Lake Macquarie LGA.

Workforce Scenarios

Two workforce scenarios were used in order to identify and appropriately assess potential social impacts associated with the Project. Both Scenarios assume that:

- The majority of the workforce for the Project will be drawn from within the Secondary Study Area and are considered 'Local Workers';
- Future workers not currently located within the Secondary Study Area are considered 'Non-Local Workers'; and
- Any non-local workers will relocate to the Secondary Study Area.

Scenario 1 is the 'Expected Case' and assumes that:

- 70% of the construction workforce associated with the Project is sourced from the Secondary Study Area;
- 30% of the construction workforce associated with the Project is sourced from outside the Secondary Study Area and will utilise temporary accommodation;
- 70% of the operational workforce associated with the Project is sourced from the Secondary Study Area; and
- 30% of the operational workforce associated with the Project is sourced from outside the Secondary Study Area and will relocate to the Secondary Study Area.

Scenario 2 is an 'Alternative Case', designed to test the sensitivity of the assumptions utilised for Scenario 1 and assumes that:

- 70% of the construction workforce associated with the Project is sourced from the Secondary Study Area;
- 30% of the construction workforce associated with the Project is sourced from outside the Secondary Study Area and will utilise temporary accommodation;
- 50% of the operational workforce associated with the Project is sourced from the Secondary Study Area; and
- 50% of the operational workforce associated with the Project is sourced from outside the Secondary Study Area and will relocate to the Secondary Study Area.

7.17.3 Existing Socio-Economic Environment

Current and Future Population Growth

The 2006 population of Wyong LGA was 139,801 (Place of Usual Residence Data) (ABS, 2006). The LGA had grown at an annual average growth rate of 1.73% for the previous ten years. The growth rate slowed considerably in the period 2001-2006 to 1.03% per annum (Place of Enumeration data) (ABS, 2006). The population of the Primary Study Area in 2006 was 2,435 or 1.74% of the total Wyong LGA population (ABS, 2006). The population of the Directly Affected Area in 2006 was estimated to be 1,428 or 1.03% of the Wyong LGA population.

"The Central Coast Regional Strategy" (NSW Department of Planning, 2011) identifies the following growth targets for the Wyong LGA over the next 20 years (to 2031):

- An additional 70,000 people;
- 39,500 new dwellings in existing urban and Greenfield areas;
- 19,400 new jobs over the next 25 years; and
- An additional 27,000 jobs created within Tuggerah-Wyong, various other town, village and neighbourhood centres, and within the area covered by the draft North Wyong Structure Plan (including the WEZ which is in the vicinity of the Project Boundary, as discussed in Section 2.4).

Population growth near the Project Boundary is expected to be concentrated in the Warnervale-Wadalba Planning Area of the Residential Development Strategy 2002, particularly in Greenfield development and in the Warnervale Town Centre.

Demographic Profile

Table 81 shows selected demographic statistics for the Primary Study Area and the Wyong LGA as at 2006. It also shows that the residents of the Primary Study Area had language, citizenship and ethnicity characteristics in 2006 similar to the Wyong LGA.

The significant differences between the Primary Study Area and the Wyong LGA are:

- The Primary Study Area had significantly higher mean individual, family and household incomes than the Wyong LGA;
- The density of persons was significantly lower in the Primary Study Area than the Wyong LGA;
- The proportion of people over 65 years in the Primary Study Area was more than half that of the Wyong LGA; and
- The household size in the Primary Study Area was larger than at the Wyong LGA level.

Wyong LGA has experienced significantly lower rates of children staying at school than at the NSW level. In 2010, the school retention rates for Wyong LGA were 16.6% lower than the NSW average rate of 69.7% (WSC, 2009).

At the 2006 Census, the Primary Study Area population was found to be more stable than the Wyong LGA as a whole, with approximately 60% of residents in both areas having lived at the same address in 2001 (ABS, 2006).

Labour Force and Skill

The 2006 Census showed that the most significant industries in the Wyong LGA were retail trade (employing 14.5% of employed people over 15 years), health care and social assistance (11.7%), manufacturing (11.3%), and construction (10.5%).

This pattern was slightly different for the Primary Study Area, with the four top industries being construction (18.9%), manufacturing (12.2%), retail trade (8.6%) and accommodation and food services (7.5%). Mining workers comprised a minimal 0.8% of employed people in the Primary Study Area and 0.5% in the Wyong LGA (ABS, 2006).

In 2006, the Wyong LGA labour force had the majority (56.4%) working in the occupations of tradespersons, labourers, clerical and sales workers. The most common occupation in the LGA was technicians and trade workers (17.1%). Professionals were under represented in professional and managerial roles compared with Sydney and NSW (WSC, 2011).

Employment and Trends

In December 2011, the unemployment rate for the Wyong LGA was 8%, which is significantly higher compared to Gosford LGA (4.7%) and NSW (5.2%) (DEEWR, 2011). The unemployment rate for the Primary Study Area was only available for the 2006 Census and showed rates of between 1.2% and 7.3%, while the rate for the Wyong LGA at that time was 8.2% (ABS, 2006).

The NSW Government considers chronic unemployment as a major issue on the Central Coast of NSW. Although the Central Coast has been attractive for residential living over the last 30 years, it has not had the same success in attracting businesses. The regional economy depends heavily on the retail and construction industries, with proportionally higher employment in both sectors than the state average.

Table 81 Selected Demographic Characteristics, 2006

Selected Demographic Characteristics	Primary Study Area	Wyong LGA
Total persons	2,435	139,801
Median individual income ($/weekly)	469	381
Median family income ($/weekly)	1,266	1,013
Median household income ($/weekly)	1,147	770
Median housing loan repayment ($/monthly)	1,767	1,462
Median rent ($/weekly)	248	200
Average household size	3.1	2.5
Median age of persons	38	39
Age 0-19 Years (%)	28.5%	28.0%
Age 65+ Years (%)	8.4%	18.3%
Population Density (Persons/km^2)	46.0	169
Born in Australia	82.0%	81.7%
Born overseas	11.7%	11.9%
Speaks English only	92.0%	92.0%
Speaks other language	3.2%	3.5%
Australian citizens	90.5%	89.9%

Source: ABS, 2006

A substantial proportion of Central Coast residents travel to neighbouring regions for work. The "Central Coast Regional Strategy" (2008) has identified the creation of local jobs as a regional challenge. The benefit of local employment opportunities will be a reduction of travelling times (and associated costs) for those commuting long distances to work. There will also be a greater likelihood that income earned locally will be spent locally, that is, leakage to neighbouring economies will be reduced.

Housing Market

The Wyong LGA had 53,312 dwellings in 2006, 85% of which were separate dwellings and 13% being medium density dwellings. This compares with 71% and 27% respectively for NSW (ABS, 2006).

December quarter data on temporary accommodation (of establishments of 15 rooms and over) for the combined area of Wyong, Gosford and Lake Macquarie LGAs showed an occupancy rate of 52%, well below the NSW rate of 69% (ABS, 2012).

Table 82 shows the changes in residential property prices experienced on the Central Coast and in NSW from 2001 to 2012. Table 82 shows that residential property prices between 2001 and 2012 did not increase as rapidly as those for NSW. Further, the median values of housing in Wyong LGA in the past 12 months have dropped by 2.5% while in the past five years they have increased by 5.5% (Property Observer website accessed May 2012).

Property values overall are much higher in absolute terms and transactions are much lower in the Directly Affected Area compared to outside the area. Comparison of housing values data suggest that overall property values (land and housing) within the Directly Affected Area have increased over the period.

However, when housing only is included there has been a significant decrease of 6.9%. Outside the Directly Affected Area, the results indicate a less volatile market with more reduced growth rates but still in line or greater than Wyong LGA median values.

Community Services and Facilities

An assessment of current community services and facilities in the Primary and Secondary Study Areas found the following key points:

- The retail and household services located nearest to the Project are at Wyong, Warnervale, Wyee, Tuggerah and Blue Haven;
- There are six primary schools and four secondary schools within reasonable proximity to the Primary Study Area. These schools had a total enrolment of approximately 4,200 in 2011 (NSW DET, 2012);
- TAFE campuses are at Wyong, Ourimbah and Gosford; however none cater to the mining industry. In 2010 there were 14,004 TAFE NSW enrolments at these campuses (WSC, 2009);
- The Central Coast (Ourimbah) Campus of the University of Newcastle had 4,205 enrolments in 2010 (WSC, 2009);
- A Community College and TAFE are co-located at Ourimbah with the University, which provides local access to tertiary education and further training (WSC, 2009);
- The number of Wyong LGA residents participating in TAFE increased by around 300 between 1996 and 2006, while the proportion decreased. There was also an increase in both the number and proportion of residents attending University. However, these rates are noticeably below the State average (WSC, 2009);
- There are a number of early childhood services operated by both WSC and private sector operators in and around Wyong. Waiting lists for childcare services are typically full;

Table 82 Median and Mean Property Sales and Unadjusted Growth Rate

Period / Parameter	Median Price	Mean Price
June 2001		
Wyong	$175,000	$182,000
Gosford	$232,000	$254,000
NSW	$193,000	$241,000
June 2012		
Wyong	$318,800	$336,400
Gosford	$400,000	$439,000
NSW	$445,000	$537,600
% Change / Year 2001-2012		
Wyong	6.18%	6.34%
Gosford	5.60%	5.62%
NSW	8.71%	8.35%

Source: NSW Housing, 2012

- Northern Sydney Central Coast Health (NSCCH) manages four hospitals in the Primary Study Area - Wyong Hospital, Gosford Hospital, Woy Woy Hospital, Long Jetty Health Centre and four community health centres in Wyong LGA at Lake Haven, Long Jetty, Toukley and Wyong Central. There is one private health care facility within the Wyong LGA at Berkeley Vale (NSW Department of Health, 2012);
- Population growth and the ageing population places considerable pressure upon the resources of NSCCH to meet the changing needs of the area (WSC, 2009);
- There is a lack of GPs to service the current population (WSCP & WSC Staff). Wyong LGA's doctor-to-patient ratio was 1:1,604, exceeding the Commonwealth Department of Health's recommendation for 1:1,100 to 1:1,200 persons (CCDGP, 2010);
- WSC provides an extensive network of community facilities throughout the Wyong LGA, including all purpose facilities (e.g. community centres), activity specific facilities (e.g. libraries) and group specific facilities (e.g. youth centres);
- There is extensive infrastructure that supports social development, culture and the arts in the Wyong LGA and there is also a diversity of cultural groups, businesses and individual artists and performers in the LGA; and
- Wyong LGA and the remainder of the Secondary Study Area are well serviced by urban standard services for police, ambulance and fire.

Some of the current community service issues identified by WSC (personal communication WSC, 2012) are as follows:

- Crime and antisocial behaviour;
- Domestic violence and families in crisis;
- Crisis accommodation for young people;
- Support services for youth, including mental health services and school retention;
- Access to services and facilities;
- Access to affordable transport; and
- Improving coordination of Government.

Community Values, Perceptions and Interactions with the Project Boundary

There have been a number of attitudinal surveys carried out from 2006 to 2012 which have regularly monitored the attitudes of the community to broader social and environmental issues. These are:

- CSIRO Research on Quality of Life and Sustainability on the Central Coast (2007);
- Central Coast Research Foundation (CCRF) Community Survey (2008); and
- CCRF Environmental Attitudes Survey (2010).

A wide range of findings and attitudes were sourced from these studies. In particular, the CCRF 2008 Survey found that sense of community is correlated with density of development and personal wellbeing. A baseline social survey was also carried out in the Directly Affected Area by Martin & Associates in 2008 in order to better understand how the community related to the area being affected by the proposal. Participants were given the opportunity to discuss their perceptions about the potential impacts of the Project. Of the 476 households that were invited to participate in the survey, 63 participated. The main conclusion of the survey was that local community infrastructure in the vicinity of the Project is very limited. Travel patterns on access roads for everyday community based activities adjacent to the Infrastructure Boundary were also very limited.

Two telephone surveys to canvas attitudes of residents of the broader sub region were also conducted on behalf of the proponent in 2006 and 2012 (CCRF, 2006 and UMR Research, 2012). Issues regarding other technical aspects of the Project were raised by respondents in these surveys. The 2012 survey also found that the Project had a low ranking as a spontaneously raised local issue. Also, 60% of respondents expressed no general objection to coal mining on the Central Coast, being prepared to judge each proposal on its merits.

Project Workforce

During the three year construction period, the Project will employ up to 450 personnel. The Project will employ up to 300 full time equivalent employees (including permanent contractors) during mining operations.

7.17.4 Impact Assessment

Construction Phase

The construction phase of the Project is expected to generate the following initial and flow on employment as shown in Table 83. It is projected that less than 10 households over three years will move into the Primary Study Area as a result of the direct construction workforce.

As the majority of the non-local construction workforce will be commuting to the site on a daily basis, no significant impacts are anticipated on the various elements of community infrastructure. The number of additional education and childcare places required in the Primary and Secondary Study Areas will be minimal, as will the impact on local outpatient health services. The main amenity impact on the Primary Study Area will be an increase in traffic volumes and any associated noise accessing the proposed Infrastructure Areas as a result of the commuting construction workforce. This has been addressed further in Section 7.8 and Section 7.12.

Table 83 shows that in Year 2, the construction phase of the Project is expected to generate approximately 1,041 jobs, with 70% of them being local (within the Secondary Study Area).

Operations Phase

Impacts of the operational phase of the Project were assessed under workforce Scenarios 1 and 2 described in Section 7.17.2. Table 84 shows the initial and flow on employment expected to be generated by the operations phase of the Project under the two workforce scenarios.

Table 84 shows that the operations phase is expected to generate a total of approximately 800 jobs, 300 being direct and an additional 500 being flow-on jobs. It should be noted that for the purposes of this Social Impact Assessment, the 30 contractor employees are accounted for in the production induced job numbers. The 'expected case' of Scenario 1 will result in 564 jobs being generated for local workers, and an additional 242 being generated for non-local workers (residing outside the Secondary Study Area). Whereas Scenario 2 would result in approximately 400 jobs being generated for local workers and a similar number for non-local workers.

Table 85 outlines the predicted increase in population in the Secondary Study Area associated with the non-local hires that will relocate to the area in the operations phase. The population increase assumes three persons per household (this assumes that each incoming worker will form their own household).

The increase in population in both Scenarios is considered to be within the normal growth expectations of the Primary and Secondary Study Areas. Further, the current social mix of the Primary Study Area is unlikely to change as a result of the Project, as any incoming mining related workforce will have higher income and similar family characteristics to the host population, and the increase in the projected number of households is very low in comparison to the host population.

The number of households expected to move into the Primary and Secondary Study Areas as a result of the incoming workforce is the same as the 'total job impact' (number of non-local workforce relocating into the area) as shown in Table 85.

Table 83 Estimated Employment Impacts from the Construction Phase at Peak Year 2

Type of Job Created	Local	Non Local	Total
Initial	225	225	450
Production Induced	352	0	352
Consumption Induced	239	0	239
Total flow-on	591	0	591
Total Job Impact	**816**	**225**	**1,041**

Source: Gillespie Economics and Martin & Associates, 2012

Table 84 Employment Impacts Operations Phase

Type of Effect	Scenario 1		Scenario 2		Total
	Local	Non-Local	Local	Non-Local	
Initial Direct Jobs	210	90	150	150	300
Production Induced	181	78	130	130	259
Consumption Induced	172	74	123	123	246
Total flow-on Jobs	354	152	253	253	505
Total Job Impact	**564**	**242**	**403**	**403**	**805**

Source: Gillespie Economics and Martin & Associates, 2012

Table 85 Additional Job and Population Impacts as a Result of Incoming Operations Phase Workforce

Location of Workforce	Scenario 1		Scenario 2	
	Total Job Impact	Population Increase	Total Job Impact	Population Increase
Will relocate to Wyong LGA	137 (including 12 in PSA)	416 (including 36 in PSA)	226 (including 20 in PSA)	678 (including 60 in PSA)
Will relocate to Lake Macquarie LGA	82	246	137	411
Will relocate to Gosford LGA	24	72	40	120
Total Non-local hires to relocate to Secondary Study Area	243	734	403	1,209

There will subsequently be an increased demand for the following number of houses across the Secondary Study Area:

- Wyong LGA – 137 (Scenario 1) or 226 (Scenario 2), including 12 in the Primary Study Area (Scenario 1) or 20 in the Primary Study Area (Scenario 2);
- Gosford LGA – 24 (Scenario 1) or 40 (Scenario 2); and
- Lake Macquarie LGA – 82 (Scenario 1) or 137 (Scenario 2).

It is estimated that the demand for rental housing will be 42 units, spread across the entire Secondary Study Area.

The social impacts of the operational phase of the Project are expected to be limited across both the Secondary and Primary Study Areas. Impacts are expected to be:

- Slight impacts on the health services facilities at Wyong Hospital;
- Some impacts on childcare and local primary schools, estimated to range between 12-20 children spread across primary schooling, secondary schooling, tertiary training and child care areas combined. This is considered to be well within the normal planning capacity of the existing school and childcare system;
- Demand on Wyong TAFE to provide suitable training in underground mining;
- An increase in traffic volumes of employees coming to the Infrastructure Areas, which will be aligned with the significant traffic increases associated with commuting and visitation to the nearby WEZ and Warnervale Town Centre;
- An increased local availability and connectivity for developments close to the Project of power, water and other utilities; and
- An increase in the feasibility of more regular public transport due to the concentration of employees having a common destination in the immediate vicinity of the Sparks Road Interchange.

The impact of 12 new households into the Primary Study Area and the low density of housing anticipated there indicate that sense of community in the Primary Study Area will not significantly change. Similarly, an increase of 242 households across the Secondary Study Area will not result in a significant change to the community values or sense of community in the Secondary Study Area.

Summary

The Project is not predicted to place significant increased pressure on community infrastructure, such as health or education facilities within the Central Coast Region. Additionally, population increase associated with the Project workforce is not predicted to place significant pressures on the currently depressed local housing market.

As the Wyong LGA has an unemployment rate 2.8% higher than the NSW state average, the Project will provide much needed employment opportunities to the Wyong LGA. The Wyong LGA has fared poorly in relation to NSW in many measurements of socio-economic indicators. For example, in December 2011, the unemployment rate of the Wyong LGA was 8%, compared to NSW of 5.2%.

The Project will contribute positively to the key economic and transport challenges identified in the Central Coast Regional Strategy 2008 particularly “increasing and diversifying job opportunities and increasing the level of employment self containment”.

The Strategy reported that “the proportion of the adult workforce commuting out of the region for work has increased to over 25 per cent” and that “there remains a noticeable reduction in the population of adults aged 20-29 years old attributed to people in this age group moving to Sydney for lifestyle and employment reasons”. The employment expected to be generated by the Project will assist in reversing these figures.

The operational phase of the Project is expected to generate a total of approximately 800 jobs - 300 direct and 500 flow-on jobs.

The Project is predicted to generate approximately 564 jobs in the Secondary Study Area (i.e. Wyong, Lake Macquarie and Gosford LGAs).

An additional 243 jobs are also predicted to be filled by people currently living outside the Secondary Study Area, but who are likely to relocate to that Area due to the Project.

The employment profile offered by the Project will contribute to reducing the socio-economic disadvantages of the Wyong LGA as identified in the ‘Index of Relative Socio-economic Advantage and Disadvantage’ in the Greater Sydney Area in 2006 (Australian Bureau of Statistics, 2008).

7.17.5 Mitigation and Management

The following are recommended to mitigate the social impacts of the Project:

- Prepare a workforce recruitment strategy which addresses the needs of the semi-skilled and unskilled workforce which is available locally but which will require on the job and more specific operator training;
- Emphasise the importance of hiring locally from within the Secondary Study Area in order to achieve the predictions of Scenario 1 on the basis of 70% of the workforce being recruited locally;
- Prepare a communications program within the Secondary Study Area targeting the current commuting workforce in order to publicise the type of professional and managerial positions that will be available locally;

- Work with TAFE in Wyong and/or Newcastle to identify and assist in the development of training and apprenticeship programs for skills relevant to the Project;
- The development of a local traineeship and apprenticeship program;
- The impact of the Project may increase the feasibility of some additional regular public transport due to the concentration of employees having a common destination in the immediate vicinity of the Sparks Road Interchange. This will be developed as part of an agreed community management and monitoring program; and
- Prepare a VPA with WSC in consideration of the findings of the Social Impact Assessment.

7.18 Economics

7.18.1 Background

An Economic Impact Assessment was undertaken for the assessment of the Project by Gillespie Economics and is reproduced in Appendix W.

The Economic Impact Assessment was primarily concerned with the determination of the following two issues:

- The economic efficiency of the Project (i.e. consideration of economic costs and benefits); and
- The economic impacts of the Project (i.e. the economic activity that the Project will provide to the regional and NSW economy).

A summary of the Economic Impact Assessment is provided below.

7.18.2 Methodology

The DP&I commissioned the development of the *Draft Guideline for Economic Effects and Evaluation in Environmental Impact Assessment* in 2002 (Economic EIA Guidelines) (James and Gillespie 2002). The Economic EIA Guidelines identifies economic efficiency as the key consideration of economic analysis.

Benefit Cost Analysis (BCA) is the method used to consider the economic efficiency of proposals. The Economic EIA Guidelines identify BCA as an essential component to undertaking a proper economic evaluation of proposed developments that are likely to have significant environmental impacts.

The main decision criterion for assessing the economic efficiency of a project to society is its net benefit. Net benefit is the sum of the discounted benefits to society, less the sum of the discounted costs. A positive net benefit indicates that it will be desirable from an economic perspective for society to allocate resources to a proposal, because the community as a whole will be better off.

The BCA for the Project utilised the following key steps:

- Identification of the base case;
- Specification of the Project and its implications;
- Identification and valuation of the incremental benefits and costs;
- Consolidation of value estimates using discounting to account for temporal differences;
- Application of decision criteria;
- Sensitivity testing; and
- Consideration of non-quantified benefits and costs.

The Economic EIA Guidelines indicates that a Regional Economic Impact Assessment may provide additional information as an adjunct to the economic efficiency analysis. Predicted economic stimulus to the regional and State economies can be estimated using input output modelling.

The Regional Economic Impact Assessment component of the Economic Impact Assessment was primarily concerned with the effect of the Project on the regional and NSW economy in terms of a number of specific activity indicators.

These indicators of economic activity are defined as:

- Gross regional output – the total business turnover;
- Value added – the difference between the gross regional output and the costs of the inputs of raw materials, components and services bought in to produce the gross regional output;
- Income – employees' wages including imputed wages for self-employed and business owners; and
- Employment – the number of people employed (including full time and part time).

Regional economic impacts were estimated for the LGAs of Gosford, Wyong and Lake Macquarie using an input-output analysis to examine the economic impacts to that region. The input-output analysis involved two main steps, being:

- Development of an appropriate input-output table (regional transaction table) that can be used to identify the economic structure of the region and multipliers for each sector of the economy; and
- Identification of the initial impact or stimulus of the Project (construction and/or operation) in a form that is compatible with the input-output equations so that the input-output multipliers and flow-on effects can then be estimated (West 1993).

A 2005 - 2006 input-output table of the regional economy (Gosford, Wyong and Lake Macquarie LGAs) was developed using the Generation of Input-Output Tables (GRIT) procedure with a 2005-06 input-output table of the NSW economy (developed by Monash University) as the parent table. The input-output table of the regional economy was aggregated to 30 sectors and six sectors for the purpose of describing the economies.

The economic impacts of the construction and operations phases of the Project were estimated from expenditure information provided by WACJV in relation to annual revenue, expenditure and employment profiles within the region. Flow-on effects were estimated by using the average output, expenditure and employment relationships in the input-output table.

7.18.3 Impact Assessment

Regional and State Economic Impact Assessment

Current Economy

The current economic structure of the regional economy (i.e. the three LGAs of Wyong, Gosford and Lake Macquarie) and the NSW economy at 2005-6 is described in the Economic Impact Assessment. The descriptions reveal that the regional and NSW economy structures were quite similar at that time.

Impact of Construction Phase

The average annual Project construction workforce onsite is estimated to reach a peak of approximately 450 in Year 2. For Year 1 and Year 3, the average annual construction workforce is estimated at 250 and 400, respectively.

In order to support 450 construction workers (Year 2), approximately $114 M of capital expenditure will be required in the “other construction” sector and “construction trade services” sector.

Expenditure on machinery and equipment is estimated to reach a peak of $65 M in Year 3.

The input-output impact analysis found that the construction workforce will provide the following contributions to the regional economy during the peak construction year (Year 2):

- $237 M in annual direct and indirect output;
- $100 M in annual direct and indirect regional value added;
- $76 M in annual direct and indirect household income; and
- 1,041 direct and indirect jobs.

The contributions made by the construction workforce to the regional economy during each of the construction years are summarised in Table 86.

When the impact of $114 M of expenditure in the other construction sector and construction trade services sector is assessed for the NSW economy, the impacts are greater due to the larger inter-sectoral linkages and hence multipliers of a larger economy.

The construction phase of the Project will contribute up to the following to the NSW economy during the peak construction year of the Project (Year 2):

- $351 M in annual direct and indirect output;
- $159 M in annual direct and indirect regional value added;
- $115 M in annual direct and indirect household income; and
- 1,403 direct and indirect jobs.

The contributions made by the construction workforce to the NSW economy during each of the construction years are summarised in Table 87.

Table 86 Impacts of the Construction Workforce on the Regional Economy

Project Year	Direct and Indirect Output ($000)	Direct and Indirect Value Added ($000)	Direct and Indirect Household Income ($000)	Direct and Indirect Jobs
Year 1	132,132	55,614	42,466	579
Year 2	237,807	100,091	76,429	1,041
Year 3	211,412	88,982	67,946	926
Total	**581,351**	**244,687**	**186,841**	**2,546**

Table 87 Impacts of the Construction Workforce on the NSW Economy

Project Year	Direct and Indirect Output ($000)	Direct and Indirect Value Added ($000)	Direct and Indirect Household Income ($000)	Direct and Indirect Jobs
Year 1	195,322	88,418	64,191	780
Year 2	351,533	159,131	115,528	1,403
Year 3	312,516	141,469	102,705	1,247
Total	**859,371**	**389,018**	**282,424**	**3,430**

The Project will also contribute to the regional and NSW economy through purchases of construction equipment. Expenditure on machinery and equipment is estimated to peak at $65 M in Year 3. The expenditures for Years 1, 2 and 4 are estimated at $15 M, $50 M and $40 M respectively.

In total, the construction equipment purchases of the Project during the peak year of expenditure (Year 3) will generate the following contributions to the regional economy:

- $23 M in annual direct and indirect output;
- $8 M in annual direct and indirect regional value added;
- $6 M in annual direct and indirect household income; and
- 74 direct and indirect jobs.

The impacts of construction equipment purchases on the regional economy are summarised in Table 88. The impact of the peak year of equipment purchases (Year 3) on the NSW economy will be up to:

- $114 M in annual direct and indirect output;
- $48 M in annual direct and indirect regional value added;
- $33 M in annual direct and indirect household income; and
- 382 direct and indirect jobs.

The impacts of construction equipment purchases on the NSW economy are summarised in Table 89.

Impact of Operations Phase

The input-output impact analysis found that the operations phase of the Project will contribute in the order of up to the following to the regional economy:

- $625 M in annual direct and indirect regional output or business turnover;
- $381 M in annual direct and indirect regional value-added;
- $79 M in annual direct and indirect household income; and
- 805 direct and indirect jobs.

Table 90 shows estimated direct and flow-on employment impacts of the operations phase of the Project. Table 90 indicates that direct, production-induced and consumption-induced employment impacts of the Project on the regional economy are likely to have different distributions across industry sectors. Production-induced flow-on employment will occur mainly in the manufacturing, wholesale/retail, services and mining sectors, while consumption induced flow-on employment will be mainly in the services, wholesale/retail trade and accommodation/cafes/ restaurants sectors.

Businesses that can provide the inputs to the production process required by the Project and/or the products and services required by employees will directly benefit from the Project by way of an increase in economic activity. However, because of the inter-linkages between sectors, many indirect businesses will also benefit.

Table 88 Impacts of Construction Equipment Purchases on the Regional Economy

Project Year	Direct and Indirect Output ($000)	Direct and Indirect Value Added ($000)	Direct and Indirect Household Income ($000)	Direct and Indirect Jobs
Year 1	5,281	1,934	1,390	17
Year 2	17,603	6,447	4,634	57
Year 3	22,884	8,381	6,024	74
Year 4	14,082	5,158	3,707	46
Total	**59,850**	**21,920**	**15,755**	**194**

Table 89 Impacts of Construction Equipment Purchases on the NSW Economy

Project Year	Direct and Indirect Output ($000)	Direct and Indirect Value Added ($000)	Direct and Indirect Household Income ($000)	Direct and Indirect Jobs
Year 1	26,213	10,994	7,547	88
Year 2	87,376	36,646	25,157	294
Year 3	113,588	47,640	32,704	382
Year 4	69,900	29,317	20,126	235
Total	**297,077**	**124,597**	**85,534**	**999**

Table 90 Sectoral Distribution of Total Regional Employment Impacts of the Project

Sector	Average Direct Effects	Production Induced	Consumption Induced	Total
Primary production	0	0	2	3
Mining	300	30	0	331
Manufacturing	0	87	18	105
Utilities	0	7	2	9
Wholesale/Retail	0	42	55	96
Accommodation, cafes, restaurants	0	6	37	43
Building/Construction	0	6	2	8
Transport	0	8	6	14
Services	0	74	123	196
Total	**300**	**259**	**245**	**805**

Note: Totals may have minor discrepancies due to rounding.

For the NSW economy, the operations phase of the Project is estimated to make up to the following contributions:

- $900 M in annual direct and indirect output;
- $507 M in annual direct and indirect regional value added;
- $154 M in annual direct and indirect household income; and
- 1,711 direct and indirect jobs.

The estimated contributions of the Project to the NSW economy are substantially greater than for the regional economy as the NSW economy is able to capture more Project and household expenditure, and there is a greater level of inter-sectoral linkages in the larger NSW economy. The Project is also estimated to make a substantial contribution to regional, state and federal Government revenue bases paying corporate taxation and royalty benefits amounting to a net present value of $346 M ($1.58 Billion undiscounted value) over the 28 year Project life.

Project Cessation

Cessation of the Project operation may lead to a reduction in economic activity in the region. The significance of these Project cessation impacts will depend on:

- The degree to which any displaced workers and their families remain within the region, even if they remain unemployed. This is because continued expenditure by these people in the regional economy (even at reduced levels) contributes to final demand;
- The economic structure and trends in the regional economy at the time. For example, if Project cessation takes place in a declining economy the impacts might be felt more greatly than if it takes place in a growing diversified economy; and
- Whether other mining developments or other opportunities in the region arise that allow employment of displaced workers.

Benefit Cost Analysis

A Benefit Cost Analysis for the Project was undertaken and details are provided in Appendix W.

The BCA indicated that the Project will have total net production benefits of $671 M (net present value), with a minimum of $346 M of these net production benefits accruing to Australia.

The estimated net production benefits that accrue to Australia were then used as a threshold value or reference value against which the relative value of the residual environmental impacts of the Project, after mitigation, were assessed. The threshold value indicates the price that the community must value the residual environmental impacts (i.e. be willing to pay) to justify the 'no further development' option in economic efficiency terms.

For the Project to be questionable from an economic efficiency perspective, all incremental residual environmental impacts from the Project that impact Australia will need to be valued by the community at greater than the estimate of the Australian net production benefits (i.e. greater than $346 M). This is equivalent to each household in the study region (the Gosford, Wyong and Lake Macquarie LGAs) and in NSW valuing residual environmental impacts at $1,725 and $130, respectively.

While the threshold value may be interpreted as the opportunity cost to Australia of not proceeding with the Project, an attempt has been made to quantify the residual environmental impacts of the Project. The main quantifiable environmental impacts of the Project that have not already been incorporated into the estimate of net production benefits relate to forestry impacts, agricultural impacts and greenhouse gas impacts.

These impacts are estimated at $56 M globally or $1 M to Australia, considerably less than the estimated net production benefits of the Project. There may also be some non-market benefits of employment provided by the Project which are estimated to be in the order of $186 M.

Overall, the Project is therefore estimated to have net benefits to Australia of between $346 M (if employment is not included) and $531 M (if employment is included), and hence is desirable and justified from an economic efficiency perspective.

The costs and benefits of the Project distributed across a range of stakeholders at the local, state, national and global level. Further, the environmental, cultural and social impacts of the Project may potentially accrue to a number of different stakeholder groups, but are largely internalised into the production costs of WACJV.

A sensitivity analysis of the BCA showed that it was not sensitive to reasonable changes in assumptions regarding a number of variables, including:

- Opportunity cost of land;
- Capital costs;
- Operating costs;
- Coal value;
- Forestry impacts;
- Agricultural impacts;
- Greenhouse gas impacts; and
- Social value of employment.

The results were most sensitive to decreases in the value of product coal, although substantial and sustained reductions in assumed coal prices will be required to make the Project undesirable from an economic efficiency perspective.

7.18.4 Mitigation & Management

Mitigation measures for the specific environmental issues considered in the Economic Impact Assessment are addressed within other sections throughout this EIS.

7.19 Soils And Land Capability

7.19.1 Background

A Soils and Land Capability Impact Assessment was undertaken by Environmental Earth Sciences (EES) and is provided in Appendix X. The purpose of the Soils and Land Capability Assessment was to:

- Map the major soil types across the area within the Project Boundary;
- Assess pre and post mining land capability and classes;
- Assess pre and post mining agricultural suitability;
- Assess the available topsoil resource for post mining rehabilitation for infrastructure areas;
- Determine any required management and mitigation measures; and
- Assess the distribution of acid sulphate soils and potential acid sulphate soils within the Project Boundary.

7.19.2 Methodology

The Soils Assessment followed a process of desktop assessment, site visit and assessment as described below.

Desktop Assessment

A desktop assessment was undertaken to construct a baseline conceptual site model. This model was created following the review of:

- Available previous assessment reports;
- Suitable maps and aerial photographs;
- Online databases for assessing land capability and agricultural suitability; and
- NSW Soil and Land Information System (SALIS) soil technical reports.

Site Visit and Inspection

In order to ground truth and complement the desktop component, EES conducted a field visit and inspection of relevant areas within the Project Boundary. The inspection occurred on 26 March 2012 and was predominately focused on the Tooheys Road and Buttonderry sites.

The field visit identified four locations where erosional features or open cuts along roadways were present. These existing features enabled the surveyor to develop an understanding of the sub-surface ground conditions within the Project Boundary. No intrusive works, sampling or laboratory analyses were carried out during the field assessment. Once profiles were identified, they were classified and recommendations made using the following guidelines:

- “The Australian Soil Classification” (Isbell, 1996);
- “Systems used to Classify and Rural Lands in New South Wales“ (Cunningham et al., 1988) (approved by DTIRIS); and
- “Guide for Selection of topdressing Material for Rehabilitation of Disturbed Areas” (Elliot and Veness, 1981).

Capability classifications were determined which presented a set of limitations regarding ongoing use of the land. This is a result of the interaction between land use and the specific chemical, physical and biological characteristics of the landscape.

7.19.3 Impact Assessment

The area within the Project Boundary comprises of a complex series of residual, erosional, colluvial and alluvial soil landscape types. The spatial distribution of the soil types found within the Project Boundary is shown in Table 91 and on Figure 49.

These soil types are described further below and have been developed as a function of the underlying geology and the local topography. Based upon the preliminary desktop studies and the site walkover, Table 92 identifies the occurrence and landscape association of the different soil types within the Project Boundary.

Soil Types

Dermosols

Dermosols cover 2.6% or 117 ha of the total 4,560 ha area within the Project Boundary. This soil type was not found within the Disturbance Area. In this location, this soil type has an acidic soil reaction (pH) range and predominantly moderate to strong pedality. The results of the assessment show that dermosols are located within close proximity to the perennial drainage lines located in low-lying areas within the floodplain (see Figure 49), making up the smallest percentage of soil types within the Project Boundary.

Kandosols

Kandosols cover 10.6% or 485 ha of the area within the Project Boundary and they also cover 24.8 ha of the Disturbance Area. The Kandosols soil type is acidic in nature, lacks strong texture contrast and has massive or weakly structured B horizons. The results of the assessment indicate that this soil type is generally situated on lower slopes and at the edge of floodplains. Surface erosional features, including gully and rill formations, and slumping can be encountered in the general vicinity of the Project Boundary.

Kurosols

Kurosols cover 62.2% or 2,836 ha of the area within the Project Boundary and they also cover 124 ha of the Disturbance Area. Kurosols are the most widespread soil type within the Project and Infrastructure Boundary. The Kurosol soil type has a strong texture contrast between the A and B horizons and strongly acidic B horizons. While the acidic subsoils mostly do not disperse, the A horizon is moderate to highly erodible.

Sodosols

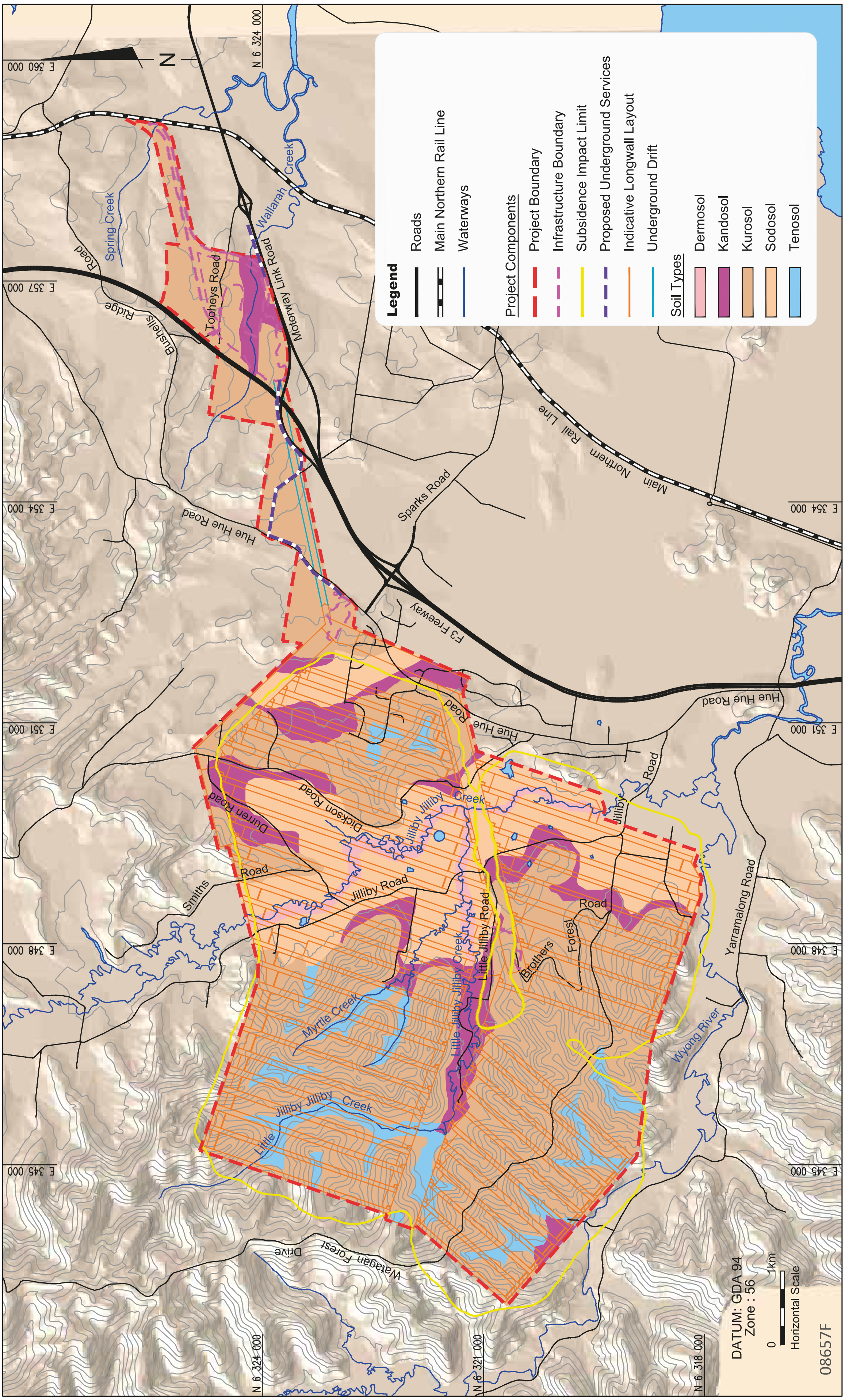
Sodosols cover 18.9% or 262 ha of the area within the Project Boundary. This soil type was not found within the Disturbance Area. This soil type has moderate to strong texture contrasts between A and B horizons. In general the B horizon is strongly sodic. The results of the assessment indicated that this soil type has largely been generated from a combination of alluvial and part-colluvial deposits across the Project Boundary.

Table 91 Project Soil Types and Areas

		Project Boundary		Disturbance Area	
Soil Type	Australian Soils Classification Name	Area (ha)	Area (%)	Area (ha)	Area (%)
DE	Dermosol	117	2.6	0	0.0
KA	Kandosol	485	10.6	18	17.4
KU	Kurosol	2,836	62.2	85	82.5
SO	Sodosol	860	18.9	0	0.1
TE	Tenosol	262	5.7	0	0.0
	TOTAL	**4,560**	**100**	**103**	**100**

Table 92 Project Soil Types' Distribution and Characteristics

Soil Landscape	Soil Landscape Grouping	Soil Type	Location within Project Boundary
Residual	Woodbury's Ridge	Kandosol and Kurosol	Not Found
Erosional	Erina	Kandosol	Not Found
Erosional	Gorokan	Kandosol	Dominant in the non-alluvial regions in the eastern portion of the area within the Project Boundary
Colluvial	Mandalong	Tenosol and Kurosol	Not Found
Colluvial	Watagan	Tenosol and Kurosol	Dominant in the western area within the Project Boundary
Alluvial	Wyong	Sodosol	Along Wallarah Creek and other waterways east of the Project Boundary
Alluvial	Yarramalong	Dermosol and Sodosol and Tenosol	Along Jilliby Jilliby Creek and Myrtle Creek



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Soil Types

FIGURE 49

Tenosols

Tenosols cover 5.8% or 262 ha of the area within the Project Boundary. This soil type was not found within the Disturbance Area. This soil type is generally situated in residual terrain and in the upper catchment of secondary watercourses. In general, Tenosols predominantly comprise a weak pedologic organisation, particularly in the B horizon, and a sandy composition greater than that of other soils within the Project Boundary. Surface erosional features, including channel incision and gully and rill formations, can be encountered in the general vicinity of the Project Boundary.

Topsoil Availability and Suitability

The consideration of preliminary final land use and hence post rehabilitation landform design for the Project involved calculating the area and volume of soil required to rehabilitate the Disturbance Area as shown in Table 93. This assists in providing an indication of the potential for the topdressing deficit or surplus during rehabilitation at closure.

The topsoil balance shown in Table 94 indicates that approximately 300,200 m³ of material from the Disturbance Area is required for reuse at the rehabilitation stage (10% handling loss included). As a result, the Project retains a surplus of approximately 273,700 m³ of topsoil material, demonstrating that there will be no shortage of suitable material for site landscaping and final rehabilitation purposes.

Rural Land Capability

A comparison of pre and post mining rural land capability classifications is provided in Table 95.

Table 93 Topsoil Balance – Volume Required

Soil Land Capability Class	Recommended Spreading Depth	Disturbance Area (ha)	Volume Required (m³)
VI	0.20	11	22,000
VII	0.15	3	4,500
Total Area (ha)		**14**	
Total Volume (m³)			**26,500**

Table 94 Topsoil Balance – Disturbance Area

Soil Type	Common Soil Name	Recommended Stripping Depth (m)	Disturbance Area (ha)	Volume (m³)	Volume (10% loss) (m³)
1	Kurosol	0.35	85.0	297,500	267,750
2	Sodosol	0.25	0.1	250	225
3	Kandosol	0.20	17.9	35,800	32,220
4	Tenosol	0.10	0.0	0	0
5	Dermosol	0.50	0.0	0	0
Total Disturbance Footprint			103	-	-
Total Volume (m³)				**333,550**	
Total Volume (10% Handling Loss Allowance) (m³)				**300,195**	

Table 95 Comparison of Pre and Post Mining Rural Land Capability Classes

Rural Land Capability Class	Pre Mining				Post Mining			
	Disturbance Area		Remaining Area		Disturbance Area		Remaining Area	
	ha	%	ha	%	ha	%	ha	%
Class III	18	18	1,025	23	0	0	31	1
Class V	0	0	0	0	0	0	993	22
Class VI	82	80	1,173	26	11	11	1,173	26
Class VII	3	3	2,259	51	3	3	2,260	51
Class M	0	0	0	0	89	86	0	0
Total	**103**	**100**	**4,457**	**100**	**103**	**100**	**4,457**	**100**

The land capability classification within the Project Boundary pre mining includes Class III, Class VI and Class VII, with Class VI being the dominant class in the existing environment. Class VI land is only suited to livestock grazing and is the lowest quality of grazing land as it is constrained by slope, acidity, and shallow topsoil. The percentage area of each class prior to and following mining is also indicatively shown in Table 95.

Direct impacts to the land as a result of the Project will be within the Infrastructure Boundary. Areas outside this Infrastructure Boundary are expected to remain the same as the pre mining class. An exception to this is the areas in the low lying slopes and floodplain which may be indirectly affected by mining through subsidence and increased flooding risk. Upon completion of mining, the Tooheys Road Site will remain reserved for industrial use therefore maintaining a Class M classification and will be unsuitable for agricultural use.

The majority of the remaining lands in the Disturbance Area will be covered in a low to moderate quality topdressing, returning it to Class VII, consistent with pre mining conditions. Land situated above the Extraction Area post mining will result in a land capability Class of IV in the low lying slopes due to the potential impacts to landform and localised hydrological conditions resulting from subsidence during operations and following mine closure. Based upon this classification, this land will be suited for livestock grazing with occasional cultivation. Lands on the upper slopes within the Wyong State Forest and Jilliby SCA will continue to have a Class VII classification due to the heavy native vegetation cover.

Agricultural Suitability

The pre and post mining agricultural suitability classification of the land within the Project Boundary is shown in Appendix X. The percentage area of each class prior to and following mining is shown in Table 96. Overall, the percentage area of each class of agricultural suitability will remain similar to that of the existing environment. The extent of Class III land however, will reduce along the slopes of the subsidence areas, lowering the overall area of land suitable for regular cultivation. The rehabilitated lands post mining will be most suitable for livestock grazing with minimal cultivation.

Acid Sulphate Soils

A review of the potential distribution of Potential Acid Sulphate Soils (PASS) and Acid Sulphate Soils (ASS) shows that there is no area which contains a high probability of PASS and ASS forming within the Project Boundary. There is a low probability of occurrence in the south of the Project Boundary along the Jilliby Jilliby Creek and Little Jilliby Jilliby Creek and along an unnamed waterway adjacent to the northern boundary of the Buttonderry Site. Infrastructure Areas do not occur within these low probability areas.

7.19.4 Mitigation and Management

In order to reduce the potential for degradation within the Project Boundary and adjoining lands, the following strategies will be implemented during operations and rehabilitation to achieve the desired post mining land capability and agricultural suitability:

- Materials will be stripped to indicated levels (see Appendix X) in a moist condition and placed directly onto reshaped areas during construction of Infrastructure Areas;
- Less aggressive soil handling procedures are to be employed to reduce the effects of compression and erosion, for example the minimisation of excessive stockpiling;
- Where topsoils are to be stockpiled, efforts should be made to reduce compaction by maintaining a maximum height of 3 m. Clay type soils should be kept in lower stockpiles for shorter periods of time. Where required, all stockpiles and stockpiling areas will be clearly identified to ensure that mixing of different soil types does not occur;
- Any long term stockpiles need to seeded and fertilised as soon as possible to promote vegetation growth and stabilise the stockpile slopes;
- When visibly dispersive soils are excavated and placed in long term stockpiles mulch is to be blended into the material for the purpose of enhancing breakdown of vegetation material and minimising dust generation and soil erosion;
- Weed infestations should be inspected and controlled during the management of soil stockpiles;

Table 96 Comparison of Pre and Post Mining Agricultural Land Suitability Classes

Agricultural Land Suitability Class	Pre Mining				Post Mining			
	Disturbance Area		Remaining Area		Disturbance Area		Remaining Area	
	ha	%	Ha	%	ha	%	ha	%
Class III	0	0	998	22.4	0	0	769	17.3
Class IV	84	81.6	371	8.3	0	0	509	11.4
Class V	19	18.4	3,088	69.3	14	13.6	3,179	71.3
Class M	0	0	0	0	89	86.4	0	0
Total	**103**	**100**	**4,457**	**100**	**103**	**100**	**4,457**	**100**

- Where feasible during the construction stage, all stripped topsoil materials will be re-spread directly on to the reshaped landscaping areas with no prior stockpiling and storage;
- The construction of contour furrows and contour banks at intervals downslope is considered an effective means of management of surface flows across disturbed areas. Furthermore contour ripping on disturbed areas should be undertaken for the purpose of erosion protection and the preparation of the soil for revegetation activities. Graded banks can also be used to minimise erosion and sediment generation; and
- All water that has flowed off disturbed areas should be disposed downslope through engineered waterways and sediment control dams designed to remove sediment from the water column prior to runoff entering natural water bodies.

PASS and ASS areas of the site are currently outside the Disturbance Area and so the likelihood of disturbance is low. In the event that the land noted as PASS or ASS is disturbed or impacted by altered hydrological conditions as a result of mine subsidence, WACJV will prepare an Acid Sulphate Soils Management Plan. The plan shall be prepared consistent with the Acid Sulphate Soils Manual (NSW Acid Sulfate Soil Management Advisory Committee, 1998).

WACJV will develop an internal Soil and Land Capability Procedure for management of its soil resources, in consideration of the above mitigation and management measures.

7.20 Agriculture

7.20.1 Introduction

An Agricultural Impact Statement was undertaken by Scott Barnett & Associates and is provided in full in Appendix Y. The purpose of the Agricultural Impact Statement was to:

- Identify the agricultural resources and enterprises in the general locality, including any State significant agricultural resources;
- Identify the potential agricultural domains of the land within the Project Boundary;
- Assess the current and maximum agricultural potential for each domain in terms of quantum, gross and net value of agricultural production;
- Assess the loss of agricultural production from within the Project Boundary and within the biodiversity offset property (the portion of the Biodiversity Offset Strategy which falls outside the Project Boundary) during the life of the Project in terms of the value of agricultural production and downstream activities within the value chain and support activities;
- Assess the use of the regulated water supply for the Project in comparison to it being used for agricultural purposes within the regulated system;
- Assess the potential impacts on the agricultural resources and enterprises within the Project Boundary; and
- Recommend appropriate mitigation and management measures.

7.20.2 Background

Regional Setting

There are several existing agricultural resources and enterprises within the Project Boundary and the surrounding locality (see Figure 5). The predominant land uses of the valley floor and near slopes are small scale beef grazing, horse enterprises and lifestyle blocks. The beef grazing enterprises are predominantly low input, low intensive management operations with many being sub commercial in scale.

Land to the east of the Project Boundary (east of F3 Freeway) is used for industrial and residential purposes.

Turf farming is also carried out on the creek flats of the Jilliby Jilliby Creek and Wyong River. There is one turf farm located in the Subsidence Impact Limit (see Figure 5). This operates on the Jilliby Jilliby Creek flats, straddling both sides of the watercourse. Just outside the Extraction Area on the south east corner is another turf farm operating on either side of the Wyong River. Other turf farms operate further upstream of the Wyong River (and south of the Project Boundary) and further south of the Wyong River along the Old Maitland Road.

Both the Tooheys Road Site and the Buttonderry Site are currently used for grazing. The Tooheys Road Site is Zone 4(e) Regional Industrial and Employment Development while the Buttonderry Site is Zone 1(c) Non Urban Constrained Lands.

Within the Extraction Area, land to the east of Dickson Road is predominately rural residential with limited grazing areas and areas of semi cleared timber and or regrowth. This area is Zone 7 (Environmental Protection) under the Wyong LEP.

Grazing land within the Extraction Area is used primarily for beef grazing or horse activities. Beef enterprises in the area consist of either breeding for vealer production or growing out of early weaned steers for local trade.

Horse activities are similar to those of the Yarramalong Valley. There are a couple of larger agistment and leisure facilities near the village of Jilliby. Other rural land uses in the Yarramalong Valley (outside the Project Boundary) include:

- Pleasure and performance horse keeping;
- Racing stables;
- Horse studs (thoroughbred, performance and pleasure horses);

- Spelling and agistment (thoroughbred, standardbred, performance and pleasure horses);
- Small scale extensive beef grazing, primarily breeding enterprises with some registered breeders; and
- Small scale horticultural enterprises (nut farm, lavender grove).

The land proposed to be used for biodiversity offset that lies outside the Project Boundary is Zone 10(a) (Investigation). This land is either covered with dense timber or cleared for low intensive grazing of beef cattle.

The location of these agricultural enterprises as well as surrounding land use is illustrated on Figure 5.

Water Sources

The Jilliby Jilliby Creek and its tributaries, Little Jilliby Jilliby Creek and Myrtle Creek flow through the Extraction Area. It is a major tributary of Wyong Creek. Wyong Creek flows to the south of the Extraction Area and outside the Project Boundary. These water sources drain to Tuggerah Lake to the east of the Project Boundary.

There are 27 water access licences in the Jilliby Jilliby Creek water source. Of these, 23 are for irrigation, one for farming purposes, one for industrial and two for domestic and stock purposes (DIPNR, 2005). There were no Local Water Utility or Aboriginal cultural licences. The requirements for all categories of licences from the water source totalled approximately 1,016 ML (based on one share component equalling 1 ML). In addition to the water access licences, the Basic Landholder Right (for properties that directly front the river) is estimated at 0.51 ML per day.

The Wyong River Water Source has a total surface water entitlement of 38,782 ML per annum of which 10% is used for irrigation and 89% is used for town water supply purposes (NSW DWE, 2009a). There are 94 surface water licences which have a daily extraction limit of 79.9 ML/day. This represents 78.6% of the Tuggerah Lake Extraction Management Units entitlement. There are no Aboriginal cultural water licences.

7.20.3 Methodology

Field Assessment

An initial field assessment was undertaken to inspect the land within the Project Boundary and surrounding locality including the biodiversity offset property. The survey aimed to assess the existing and potential agricultural production of the land. As part of the soil assessment completed by EES, a number of field surveys were undertaken to classify the soil profile types and determine the existing land use and land capability.

Desktop Assessment

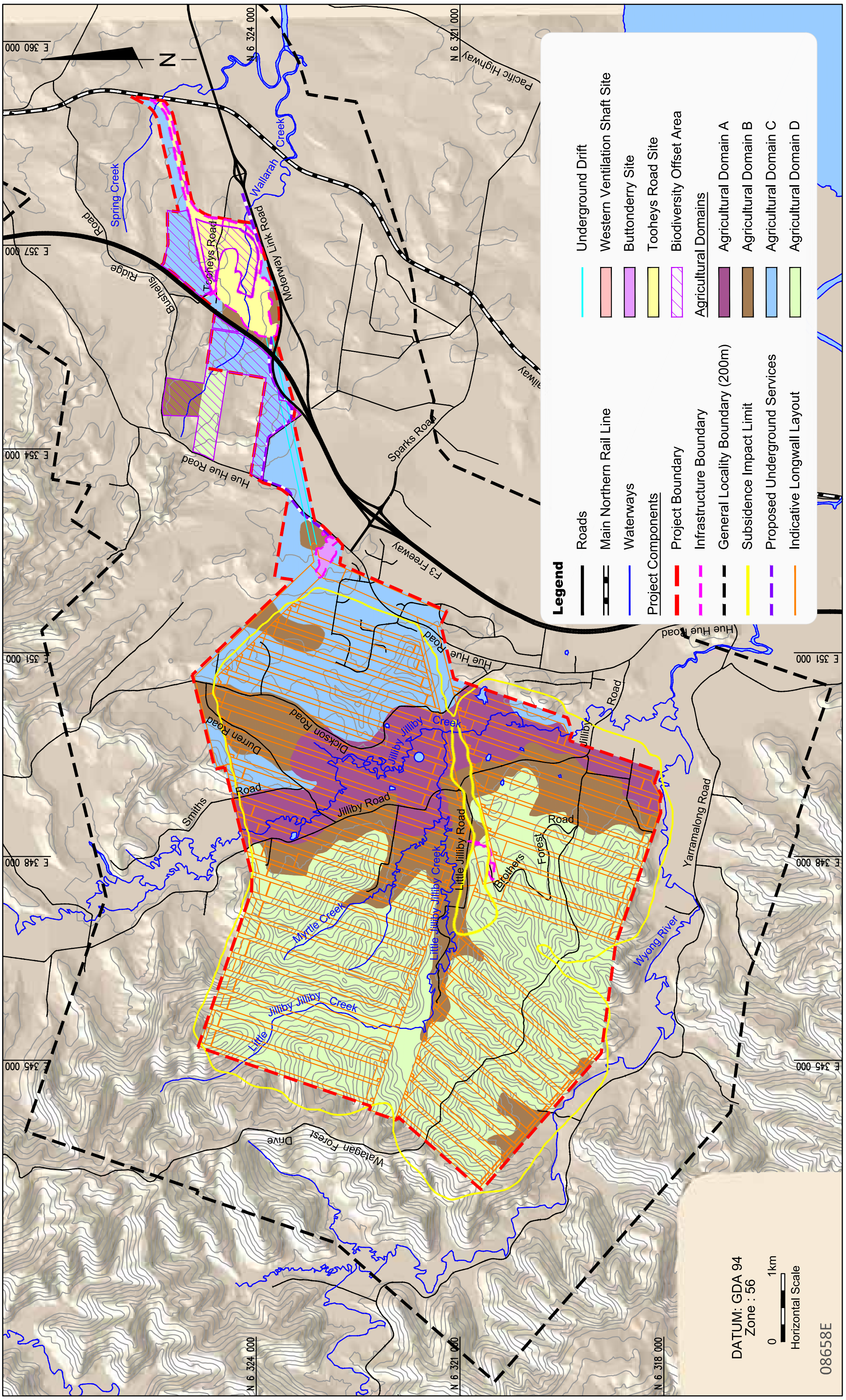
The desktop assessment involved a detailed review of available documents relevant to agricultural production pertaining to the surrounding region, the immediate locality and the State. A review of any studies undertaken for the Project relevant to agriculture including surface water, subsidence, groundwater, ecology, soils and land capability assessments was also undertaken. The value of agricultural production, from within the Project Boundary, biodiversity offset property and enterprises in the locality and their contribution to the local, regional, State and national agricultural output, was incorporated as part of the desktop assessment.

Agricultural Domain

Using the information gathered during the field assessment and desktop review, the Project and biodiversity offset property was dissected into agricultural domains and mapped (see Figure 50 and Table 97).

Table 97 Project Boundary Agricultural Domains

Domain	Description	Area (ha)	Area (%)
A	Area associated with the creek flats of Jilliby Jilliby Creek and tributaries, suited to grazing (naturalised and improved pastures) and fodder cropping with better areas able to be cropped for turf farming. Some areas are irrigated with others irrigated in the past	572	12.5
B	Area associated with lower slopes to mid slopes of Jilliby Jilliby Creek and tributaries, upper reaches of tributaries, and cleared areas associated with Tooheys Road Site and Buttonderry Site. Land suited to grazing as naturalised and improved pastures. Cultural techniques restricted to minimal to occasional soil disturbance. Also includes small areas within Project Boundary within Yarramalong Valley	826	18.1
C	Area associated with lower to mid slopes east of Jilliby Creek and running to the north east to the Tooheys Road site. Area has extensive areas of timber (regrowth) and partially cleared land. Land mainly Zone 7 Environmental Protection under Wyong LEP. Poor quality pasture and limited grazing activities	1,032	22.6
D	Land to west of Jilliby Jilliby Creek flats and slopes consisting of steeper slopes. Heavily timbered, non-cleared land. Main areas form part of Wyong State Forest and Jilliby SCA and timbered areas running to cleared lower slopes	2,129	46.7
Total		**4,559**	**100.0**



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Agricultural Domains

FIGURE 50

Each domain is annotated by generic letters (A-D) for division and descriptive purposes including:

- Domain A is the highest quality agricultural land suited to fodder cropping and/or cultivation to establish improved pasture. However it is not suited to continuous (annual) cultivation due to the underlying soil type and susceptibility to erosion. This land primarily coincides with the soil and land capability class III (see Section 7.19 for further discussion on soil classes);
- Domain B is suited to occasional cultivation for fodder cropping and pasture establishment. This land is capable of supporting reasonable levels of pasture production and as such can be used for beef cattle grazing for raising vealers. This land primarily coincides with land capability classes III and VI;
- Domain C has limited agricultural value due to slope, preventing or limiting the level of pasture improvement and requiring careful management to avoid over grazing and/or the extent of rural residential development. Land is suited to limited and occasional beef grazing and should not be cleared for further pasture development. This land primarily coincides with the land capability classes VI and VII; and
- Domain D is not suited to agriculture and corresponds to land capability class VII.

Agricultural Production and Value

To examine the quantum and value of the agricultural production within the Project Boundary and biodiversity offset property, information as to the current agricultural practices was obtained from discussion with officers of NSW DTIRIS – Primary Industries and the Hunter-Central Rivers CMA. This was supported by observations undertaken in the locality during the field assessment.

The predominant enterprises identified were:

- Turf farming;
- Beef cattle grazing (primarily breeding); and
- Equine activities (breeding, training and education, spelling and agistment).

DTIRIS (Primary Industries) (2011) beef cattle gross margin budgets and an economic analysis of the Australian turf industry commissioned by Horticulture Australia Limited (Aldous et. al. 2007) was then used to calculate the quantum and value of agricultural production enterprise for both the area within the Project Boundary and biodiversity offset property.

The potential impacts on agricultural land within the Project Boundary and biodiversity offset property was assessed in relation to the key Project related activities and inputs from various EIS impact assessments.

7.20.4 Impact Assessment

Existing Agricultural Domains, Production and Value

Project Boundary

The area within the Project Boundary was divided into four agricultural domains as outlined in Table 97. The majority of land within the Project Boundary is classified as Agricultural Domain D (2,129 ha or 46.7%) and is not suited to agriculture as per the NV Act. The predominant agricultural enterprises identified within the Project Boundary include turf farming, beef cattle grazing (primarily breeding) and equine activities (breeding, training and education, spelling and agistment). The enterprises found in each agricultural domain and associated production value per hectare are summarised in Table 98.

Table 98 Current Enterprises and Value within Project Boundary

Agricultural Domain	Enterprise	Carrying Capacity (DSE/ha)[1]	Stocking Rate (ha/ Cow or horse)	Number Animals Sold[2]	Gross Value of Production (per annum)	Net Value of Production (per annum)
A	Turf	-	-		$1,275,373	$858,867
	Vealers	8	2	186	$117,214	$66,058
	Horses				$316,675	$253,234
B	Vealers	4	4.1	114	$88,732	$50,006
	Horses				$244,975	$195,898
C	Weaners	1	27.6	29	$15,263	$8,629
D	-	-	-	-	-	-
Total	Turf			329	$1,275,373	$858,867
	Cattle				$211,209	$124,693
	Horses				$561,650	$449,132
Grand Total					**$2,058,232**	**$1,432,692**

1 DSE – Dry Sheep Equivalent. The equivalent daily energy requirement of a 50 kg wether not losing or gaining weight.
2 Cattle only - includes culled breeding stock.

The gross value of agriculture production (including horse related activities) within the Project Boundary, based on the current land use is $2.06 M per annum. Table 98 shows that the estimated value of production from agricultural land within the Project Boundary is a conservative (upper bound) calculation of the value of production and includes horse enterprises.

Biodiversity Offset Property

The biodiversity offset property was also divided into agricultural domains using the same criteria (see Figure 50). Table 99 provides an overview of each of the agricultural domains and their quantitative distribution within the biodiversity offset property.

The majority of the biodiversity offset property (45 ha or 68.2%) is composed of Agricultural Domain D which is not able to be used for agriculture as it is unable to be cleared as per the NV Act.

The predominant agricultural enterprise operating identified within the biodiversity offset property is beef cattle grazing for vealer production. The enterprises found in each agricultural domain and associated production value per ha is summarised in Table 98.

Table 100 shows that the gross value of agriculture production from the biodiversity offset property, based on the current land use, is $2,739 per annum. The net value of agricultural production is $1,543. This is from the sale of four head of cattle per annum (vealers, cull cows and bulls).

Impact on Existing Agricultural Areas and Values

The reduced availability and productivity of this land will have a minimal impact to the agricultural industry as the overall agricultural contribution of the land to be removed from agriculture from within the Extraction Area, Infrastructure Boundary and biodiversity offset property is small when compared to the total agricultural production on a regional, state and national scale.

Clearing Associated with Infrastructure Boundary

The Tooheys Road Site and the Buttonderry Site, which are owned by the WACJV, will be developed with the appropriate infrastructure resulting in 89.7 ha being removed from non-intensive beef grazing. Currently these areas are Agricultural Domain B, but have limited agricultural activity associated with them. The gross annual value of agricultural production from this 89.7 ha is $14,897 and the net annual value is $6,466.

Subsidence Associated With Extraction Areas

The nature of the subsidence shall be such that the change in gradient over these areas is expected to be 11 mm per 1 m length (1.1%) and as such will be unable to be detected by eye (MSEC, 2013). The depth of the mining below the surface and the depth of alluvial soils lessen these impacts. Furthermore, any cracking or heaving of the surface is predicted to be very minor and isolated if it does occur.

It is unlikely that subsidence impacts could result in the surface relief of the turf farm becoming uneven to the extent that efficient turf cultivation and harvesting is no longer possible without remediation. Mitigation of the surface (laser levelling) could be undertaken once subsidence has settled, any irrigation infrastructure repaired or replaced and the area resown and production commence again. After subsidence has settled, it will be expected that full production will be achieved within three growing seasons. Any potential impact to the turf farm will not occur prior to Year 22 of the Project. In this instance, the annual gross loss value of agricultural production affected will be $1.3 M while the annual net value loss is $0.86 M.

It is also unlikely that mine subsidence will affect underground irrigation mains. MSEC (2013) suggest these impacts, if they were to occur would consist of minor cracking of individual mains pipes and/or joints that could be readily repaired or replaced.

Table 99 Biodiversity Offset Property Agricultural Domains

Agricultural Domain	Description	Area (ha)	Area (%)
B	Cleared area with naturalised and native pasture.	21	31.8
D	No cleared area.	45	68.2
Total		**66**	**100.0**

Table 100 Current Enterprises and Value within Biodiversity Offset Area

Agricultural Domain	Enterprise	Carrying Capacity (DSE/ha)*	Stocking Rate (ha/ Cow or horse)	Number Animals Sold[1]	Gross Value of Production (per annum)	Net Value of Production (per annum)
B	Vealers	4	4.1	4	$2,739	$1,543
D	-	-	-	-	-	-
Total					**$2,739**	**$1,543**

* Cattle only - includes culled breeding stock.

Biodiversity Offset Property

The biodiversity offset property adjacent to the Infrastructure Boundary has an area of 21 ha used for non-intensively managed beef grazing. Due to the legal obligations applying to offsets, offset areas will be removed from agricultural production in perpetuity. Given that minor beef grazing will be the only loss to agricultural production in the biodiversity offset property, the loss of the gross annual value of agricultural production will be $2,739 and the net value is $1,543.

Surrounding Locality

The Project will not reduce the availability of land for agricultural purposes or affect the productivity of existing agricultural land outside the Project Boundary and biodiversity offset property. As such, this has not been discussed further in the assessment.

The total gross annual value of production from the impacted properties is $1.3 M per annum for any limited period that the turf farm was out of operation, otherwise the impact is $17,636 per annum.

This represents 0.84% of the gross value of agricultural production in the Secondary Study Area (Gosford, Wyong and Lake Macquarie LGAs), 0.016% of NSW's agricultural production and 0.003% of the national production.

Assessment of Impacts on the Locality

Surface Water

As described in Section 7.3, surface water flows and runoffs will not be significantly impacted by subsidence. There is some potential for subsidence impacts to alter localised surface water retention resulting in areas of water logging which could potentially impact on plant growth. However, it was concluded that the combination of depth of mining and depth of the alluvial deposits above the bedrock would result in impacts that were minor and isolated. Therefore the overall Project related impacts to surface water will not impact on downstream receiving waters in the locality.

Groundwater

As described in Section 7.2, the groundwater model for the Project predicts that there is some possibility of minor and isolated damage to water bores. If this does occur, in consultation with any affected landowner, WACJV will repair the bore to allow for continued access to the groundwater source.

Movement of Water Away from Agriculture

The Project will not result in any water supply being diverted away from agriculture. As described in Appendix J, the maximum water demand required from external sources and drawn from the town water supply is 52 ML per annum in Year 1 declining to approximately 20ML per annum by Year 3 as most of the Project water demand will be supplied by reprocessing saline water extracted from the coal seam.

Dust

As described in Section 7.5, Project generated dust will have minimal impacts on agricultural resources and enterprises in the locality. Any emissions will meet legislative criteria and requirements governed for air quality. The predicted dust deposition rates for the Project will have nil to minimal impact on the productivity of vegetation.

Noise and Vibration

As described in Section 7.8, Project generated noise and vibration will satisfy the legislative criteria governing industrial noise at private properties with agricultural value. As such, the Project's noise and vibration impacts will not adversely impact on agricultural resources and enterprises in the locality.

Visual

An assessment of visual impacts associated with the Project is described in Section 7.16. The mine infrastructure will be restricted to the Tooheys Road Site and the Buttonderry Site, both of which are remote to the agricultural precinct associated with the Jilliby Jilliby Creek area and therefore will have no visual impact on the agricultural industries within the Project Boundary.

Traffic and Support Infrastructure and Services

As described in Section 7.12, the Project's impacts on traffic and support infrastructure and services are anticipated to be minimal. Impacts to traffic infrastructure utilised by agricultural operations in the locality of the Project are minimal as access to the Project does not pass through the agricultural precincts of the Project Boundary. Support services directly employed by agricultural enterprises will not be shared by the Project and therefore will not be impacted.

Labour Supply

As detailed in Section 7.17, the agricultural industry in the Wyong LGA employs 433 people (ABS 2006) and 1,150 in the Secondary Study Area. This represents 0.3% of the workforce of the Wyong LGA and 0.7% of the three LGAs.

Given the scale of the increase in workforce numbers compared to the local workforce, the part time nature of most of the agricultural businesses and the high unemployment rate in the Wyong LGA, the labour supply available for the operation of agricultural operations is not expected to be impacted as a result of the Project and is therefore not discussed any further in this assessment.

Conclusion

The maximum impact from the Project on the value of agricultural production from the combined area lost to agriculture (the Disturbance Area, biodiversity offset property and a potential two year impact on one turf farm) is predicted to be $1.3 M. This represents 0.840% of the gross value of agricultural production in the Secondary Study Area, 0.016% of NSW's agricultural production and 0.003% of the national production. If the value of production from the turf farm is not lost, the annual lost agricultural production is $17,636 per annum.

As the overall agricultural contribution of the Disturbance Area within the Project Boundary and the biodiversity offset property is small when compared to the total agricultural production on a regional, state and national scale, the reduced availability and productivity of this land will have a minimal impact to the industry. In addition, the Project will not reduce the availability of land for agricultural purposes or affect the productivity of existing agricultural land outside the Project Boundary but within the locality.

7.20.5 Mitigation and Management

WACJV will develop and implement a Land Management Plan (LMP) including a weed and pest management plan in consultation with relevant regulators. The plan will address any measures proposed to control the distribution of invasive species and feral animals on WACJV owned land. The LMP will see the commitment of appropriate resources (physical, financial and labour) to ensure it is implemented in an effective manner.

Any impacts to agricultural enterprises associated with subsidence will be managed as part of the Extraction Plan process (or equivalent) and in accordance with the MSC Act. Monitoring of surface relief will be undertaken in the active mining areas within the Extraction Area.

If subsidence is identified as a potential risk to the turf farm operation within the Extraction Area, WACJV will undertake mitigation and remediation activities to minimise the impact on the turf farm operation.

Monitoring of surface relief will be required during active mining of areas within the Extraction Area to ensure there are no impacts on surface water used for agricultural purposes. Surface water quality and quantity monitoring will be undertaken as detailed in Section 7.3.4. A detailed monitoring program and mitigation measures required to manage impacts to groundwater have been detailed in Section 7.2.

7.21 Forestry

A Forestry Assessment for the Project was completed by GHD Pty Ltd (GHD) and is presented in full in Appendix Z. This study aimed to identify any potential impacts of the Project on forestry resources and forestry activities on publicly owned forest resources managed by Forests NSW. The assessment also identifies potential financial loss in relation to forestry production.

7.21.1 Background

The Wyong State Forest (State Forest No. 281) and surrounding ranges (including the Jilliby SCA (SCA)), a section of the Dooralong Valley and the Hue Hue area with privately owned land primarily to the east of these areas lie partly within the Project Boundary. The Wyong State Forest included within the Project Boundary is presented in Figure 2.

The Wyong State Forest is located within the Lower North-East Forest Management region and is included within the Lower North-East Regional Forest Agreement (RFA) Region for North-East NSW. The forest is managed under the principles of Ecologically Sustainable Forest Management (ESFM) and the five-yearly ESFM Plans developed by Forests NSW set out broad strategies, performance indicators and measurable outcomes for forest management in the region (Forests NSW, 2008).

Forests NSW utilises a zoning system in order to establish the most appropriate use of the land and the forest associated with this land. This zoning system may exclude some areas from commercial timber harvesting.

The proposed Western Ventilation Shaft is also situated within Forest NSW Forest Management Zone 4 (FMZ4). FMZ4 is managed as 'general management' which includes timber harvesting. Consequently the forest has the potential to be harvested for commercial purposes and is considered to have some commercial forest product value.

7.21.2 Methodology

Subsidence Impact Assessment

A detailed SIR for the Project was completed by MSEC and is summarised in Section 7.1. The subsidence assessment included consideration of any Project related subsidence impacts. This study was reviewed to assess the potential impact of underground mining methods and subsequent mine subsidence on factors affecting the health, tree species composition and by extension the commercial viability of the forest.

Land Resources Impact Assessment

As part of the assessment, a detailed review of any potential impacts on forestry as a land use was undertaken in consideration of any Project related activities. A range of potential impacts were assessed including any:

- General impacts associated with construction and / or operation of the mine and ancillary infrastructure; and
- Direct impacts on forest resources or activities associated with the removal of an area of commercial forest on a permanent basis.

Financial Compensation Assessment

Financial compensation has been calculated conservatively, to assume the highest possible commercial value for the forest resource. Determination of the commercial value included:

- Consultation with Forests NSW and a range of third parties;
- A detailed literature review of available management planning, harvesting activities, local and regional markets for forest products, tree species present, expected product yields, volumes and commercial values;
- Estimating the available commercial forest resource area based on these investigations and limited by any site physical constraints; and
- Assuming a conservative value (the highest possible value), of the standing commercial timber resource on the site. The value was calculated by incorporating a 100% increase in the estimated average values to account for potential site specific characteristics associated with species, yields, products or markets.

7.21.3 Impact Assessment

Subsidence

A detailed review of the Subsidence Impact Assessment undertaken for the Project indicates that any impacts associated with underground mining methods and subsequent mine subsidence are unlikely to significantly impact forest areas within the Project Boundary.

A maximum of 2.6 m of vertical subsidence has been predicted to occur across areas of the Wyong State Forest. Some tension cracks may develop on the tops of steep slopes, as a result of the extraction of the proposed longwalls increasing the potential for soil erosion to occur. However it is unlikely that any trees within the Wyong State Forest will be adversely impacted. Appropriate management measures will be implemented to minimise the extent of impacts that occur.

Forests NSW has confirmed during consultation that subsidence issues were not currently a significant issue for native forest management. It was advised that in some instances, consideration of potential subsidence or exercising care with machinery or road related activities may be required.

Therefore subsidence associated with the Project is not predicted to have any significant impact to forestry resources or forestry activities.

General Impacts on Forest Resources or Activities

The Project will utilise underground mining methods to extract coal and as a result no significant general impacts have been predicted. The Project will cause only minor disturbance on the surface within the Infrastructure Boundary. The potential general impacts of the Project on forest resources and activities may include:

- Altered or temporary restrictions on road access for forest maintenance, harvesting or fire protection activities;
- Reduced ability to control grazing or the access of third parties through temporary impacts on fencing and gates;
- Loss or alienation of vegetation and commercial forest due to infrastructure such as new roads, pipelines or powerlines; and
- Increased road construction and maintenance costs due to increased use of certain forest roads or impacts on local drainage.

Direct Impacts on Forest Resources or Activities

The Western Ventilation Shaft is the only infrastructure located within a forest area requiring long term removal of vegetation. The indicative infrastructure boundary associated with the ventilation shaft (and the area of direct impact on the Wyong State Forest) is illustrated in Figure 5.

Approximately 3.2 ha of the Wyong State Forest will be cleared to facilitate the construction and operation of the Western Ventilation Shaft. Removal of the entire volume of standing material is required in order to facilitate the Western Ventilation Shaft and ancillary infrastructure works. The construction and operation of the Western Ventilation Shaft will result in a number of direct impacts on the existing commercial forest resource. The removal of an area of commercial forest on a long term basis requires consideration in terms of loss of a forestry resource and potential future income for Forests NSW. An assessment has been made of the current commercial value of the forestry resource to ensure adequate financial compensation is provided.

Western Ventilation Shaft Financial Compensation

An assessment has been made of the current commercial value of the forestry resource occurring on the 3.2 ha of the Wyong State Forest where the proposed Western Ventilation Shaft and ancillary infrastructure is to be located. It was confirmed that the proposed Western Ventilation Shaft site is situated within FMZ4. FMZ4 is managed as 'general management' which includes timber harvesting. Consequently the forest has the potential to be harvested for commercial purposes and have a financial value.

The typical "average" standing timber value of Wyong State Forest, assuming the removal of 100% of the harvestable timber has been estimated as $3,600 per ha. This is based on the typical products, yields and values for the whole of Wyong State Forest. It is possible that the Western Ventilation Shaft site contains higher quality timber, a higher proportion of high value products, and/or a higher volume of merchantable timber than is estimated across the entire forest. Alternatively, the site could contain lower value timber than the average standing value for Wyong State Forest.

In order to present a conservative case, the 'highest possible value' for the forest has been estimated by increasing the Wyong State Forest average by a maximum expected variation factor of 100%. This equates to $7,200 per ha or a total value of standing timber over the affected 3.2 ha equivalent to $23,000. In reality there will be the opportunity to harvest any useable timber during the clearing process for the construction of the vent shaft such that the loss of timber will be far less than that calculated above.

7.21.4 Mitigation and Management

In order to reduce the potential for Project related impacts on the publicly owned forest resources managed by Forests NSW, the following strategies will be implemented during construction and operation of the Project:

- A Forestry Management Plan will be developed in consultation with Forests NSW to minimise and manage potential impacts on forestry resources and activities;
- If surface cracking is observed, management techniques will be implemented as discussed further in Section 7.25;
- Forestry NSW will be provided appropriate financial compensation in association with the 3.2 ha of the Wyong State Forest which will be cleared to facilitate the construction and operation of the Western Ventilation Shaft. Financial compensation will be agreed via commercial negotiations between Forests NSW and WACJV;
- Compensation associated with future loss of income will be determined in accordance with the Occupation Permit granted under Section 31 of the *Forestry Act 1916*; and
- Continued consultation with Forestry NSW will be undertaken to ensure any impacts to forestry resources and forestry activities are managed or appropriately compensated in relation to forestry production.

7.22 Contamination

7.22.1 Background

Introduction

A Phase 1 Contamination Impact Assessment was undertaken for the Project by DLA Environmental which is reproduced in full in Appendix AA. The objectives of this assessment were to conduct a review of all existing information on the Infrastructure Boundary and to assess the potential for past activities at these sites which may have caused contamination to soils or groundwater.

The investigation program and report was designed to be suitable for due diligence purposes or the ongoing management of the site. In particular this assessment meets the requirements of SEPP55.

Site History

The Tooheys Road Site has been utilised for small scale / semi-rural farming practices since the early 1960s with a large portion of the Site remaining uncleared and heavily vegetated. Due to the past agricultural land use activities, the properties had the potential for contamination including the impact of pesticides. However, site observation, aerial photography and anecdotal evidence suggest that pesticide contamination will be relatively low as farming practices were mainly cattle grazing and chicken sheds.

Aerial photography suggests that building structures were erected onsite during the 1960s and therefore the building structures used could possibly contain asbestos. Aerial photography also suggests that Tooheys Road was repositioned between 1975 and 1984. Structures including a residence and chicken sheds will have been demolished during this time and the potential for contamination from asbestos and pesticides exists at this location.

The Buttonderry Site history suggests the lower portion of the site was used for cattle grazing which has a low potential for contamination. However, on Lot 2 adjacent to the northern boundary and Hue Hue Road there was either a market garden or an orchard which suggests that there is potential for contamination from pesticide use. The building structures that previously existed at this site could also have contained asbestos.

The Western Ventilation Shaft has not been used for residential or semi-rural purposes. No development or land uses were evident onsite apart from the clearing on Brothers Road.

7.22.2 Methodology

An investigation into the Infrastructure Boundary was undertaken to determine if contamination has the potential to be present from previous land use activities. This included historical searches, review of historical aerial photographs and providing an overview of past and present land uses.

The Contamination Impact Assessment focused upon the Infrastructure Boundary for the Project (Tooheys Road, Buttonderry and Western Ventilation Shaft sites), rather than covering the larger natural forested areas of the subsidence impact area which have not largely been affected by anthropogenic influences and contamination risks.

Aerial photographs from 1954 to 2006 available from the NSW Lands Department were reviewed for each of the Buttonderry Site, Tooheys Road and Western Ventilation sites. Ground conditions were unable to be properly assessed in the aerial photographs due to the heavily vegetated state of the sites; however large scale clearing and building structure were clearly evident.

Field investigations at the site were undertaken during May and June 2012 and comprised of the following;

- Initial site inspection;
- Targeted sampling program; and
- Collection of soil samples.

The sampling strategy was employed in accordance with NSW EPA "Sample Design Guidelines 1994" that targeted identified areas of potential contamination. Assessment criteria used in this Contamination Impact Assessment followed the guidelines ensuring the sites are suitable for Commercial / Industrial use, as specified in "Schedule B1 Guideline on the Investigation Levels for Soil and Groundwater from the National Environment Protection (Assessment of Site Contamination) Measure 1999 Table 5a Column F – Commercial/Industrial".

7.22.3 Impact Assessment

Tooheys Road Site

Site history review and field observations identified potential contaminant sources within two of the properties at the Tooheys Road Site. Former building footprint areas and remnants of chicken farming were present at the property identified as 9 Kiar Ridge Road, Kiar).Dumped waste material was identified adjacent to the creek at another property, 77 Tooheys Road. Materials containing asbestos were removed from both sites prior to the site inspections, with a clearance certification issued.

Soil samples collected from the identified areas complied with the respective Health Investigation Levels (HIL) values for Organochlorine (OC) and Organophosphorus (OP) Pesticides and Heavy Metals associated with the use of pesticides and herbicides. No asbestos containing materials were identified within soils onsite, however they were observed within existing building structures, sheds and residential dwellings.

Buttonderry Site

Surface soil samples collected from the building footprint were analysed for OP and OC Pesticides and Heavy Metals associated with the use of pesticides and herbicides. Another sample of Total Petroleum Hydrocarbon (TPH) Contamination was collected from the surface soils in the area adjacent to the stockyard where a single, leaking motor oil drum was located. Oil sheen was evident on the surface however the subsurface material was not impacted.

Inspection of the dumped waste adjacent to the main access fire trail indicated the presence of tin, iron, car parts, timber, wire and other household waste. No asbestos containing materials was identified within any of the dumped waste piles.

With remediation of the minor Total Recoverable Hydrocarbons (TRH) contaminated soils, the site can be made suitable for land consistent with Commercial / Industrial use requirements. No offsite influences were identified as having potential to impact the suitability of the site or future occupants of the land.

Western Ventilation Shaft

No potential contaminant sources were identified within the Western Ventilation Shaft Site.

Groundwater Contamination

Considering onsite observations and detected level of contaminants, the likelihood of groundwater impact from existing sources is considered to be very low across the three proposed surface facilities sites. Groundwater is not expected to have been affected by activities onsite, based on the site observations, detected levels of contaminants in the soil, and hydraulic conductivity. It was determined that no further groundwater investigation was required for the assessment of contamination purposes.

Summary

No evidence was found to infer contamination by heavy metals, PAH compounds, pesticides or PCBs within the Infrastructure Boundary.

7.22.4 Mitigation and Management

TPH contamination associated with a minor motor oil spill, identified in surface soils at the Buttonderry Site will require removal of soil to a depth of 0.15 m, prior to a validation being conducted. As such, a Remedial Action Plan is not required.

The subject material located on the Buttonderry Site will be disposed of at a suitable licensed landfill facility in accordance with NSW DECC Waste Classification Guidelines, 2009.

Asbestos containing materials were identified on or above the ground surface and were removed prior to a clearance certificate being issued in accordance with Part 11; "Clearance to Reoccupy and Asbestos Work Area" of the "Code of Practice for the Safe Removal of Asbestos – 2nd Edition" (NOHSC:2002, 2005).

7.23 Hazard Analysis

7.23.1 Background

Hansen Bailey has completed a Preliminary Hazard Assessment (PHA) for the Project which is provided in full in Appendix AB. The key objectives of the assessment were to:

- Provide an analysis of hazards in accordance with legislative requirements;
- Identify any hazards and risks including potentially hazardous materials and events;
- Analyse the significance of each hazard in terms of likelihood of occurrence and potential off-site consequences;
- Assess the risks to the environment and public safety arising from potential hazardous materials and hazardous events; and
- Develop proposed mitigation and management measures as required for the Project in consideration of the relevance and adequacy of proposed safeguards.

This PHA was undertaken in accordance with *Hazardous and Offensive Development Application Guidelines – Applying SEPP 33* (DoP, 2011) (SEPP 33 Guidelines).

7.23.2 Methodology

The SEPP 33 Guidelines prescribe a screening process to determine whether a proposed development is potentially hazardous. The risk screening process is described in Section 7 of the SEPP 33 Guidelines and is summarised below:

- Identify all hazardous materials that will be used by the development;
- Determine the dangerous goods classification for each material using the *Australian Code for the Transport of Dangerous Goods by Road & Rail* (National Transport Commission, 2007) (Australian Dangerous Goods Code);
- Determine the quantities of each dangerous good that will be stored on site;
- Compare the quantities of each dangerous goods class to the screening thresholds prescribed in Table 1 of the SEPP 33 guidelines;
- Determine the average annual and weekly road movements for dangerous goods and the typical quantities in each movement; and
- Compare the number of road movements and the transport quantities of dangerous goods to the screening thresholds in Table 2 of the SEPP 33 guidelines.

If none of the screening thresholds are exceeded, the development is not considered to be a potentially hazardous development and a PHA is not required for a development.

If any of the screening thresholds are exceeded, the development is deemed to be a potentially hazardous development. A PHA must be completed in accordance with the SEPP 33 guidelines and HIPAP No. 6 'Hazardous Industry Planning Advisory Paper No. 6 – Guidelines for Hazard Analysis'.

The methodology for a PHA is described in Appendix 5 of the SEPP 33 guidelines. This introduces a multi-level approach to risk assessment. There are three levels of analysis:

- Level 1 is an essentially qualitative approach based on comprehensive hazard identification to demonstrate that the activity does not pose a significant risk;
- Level 2 supplements the qualitative analysis by sufficiently quantifying the main risk contributors to show that risk criteria will not be exceeded; and
- Level 3 is a full quantitative analysis.

The level of analysis required is dependent on the types of hazards present, the management measures employed and the nature of the surrounding land use. A Level 1 qualitative approach was deemed to be appropriate for this PHA as described below.

7.23.3 Impact Assessment

Potentially Hazardous Materials

The assessment identified a number of Project related activities which may require the use of potentially hazardous materials. The Project will require the transport and storage of diesel, oil, greases, degreasers and (at limited times) explosives material and other substances which may be potentially hazardous.

Explosives

Some blasting may be undertaken for the Project associated with construction of the underground entries and initial pit bottom service areas. Blasting may also be undertaken infrequently should any unexpected rock intrusions in the coal seams be encountered during mining operations.

The preferred approach for managing explosives is to avoid long term storage of explosives on site. No explosive materials or precursors will be stored onsite during the construction period. In order to avoid long term storage during the operations phase, explosive materials will be delivered to the Tooheys Road Site on an as needed basis by an authorised and licensed provider.

To accommodate emergency and extraordinary circumstances where storage is required, an explosives storage facility will be constructed within the Infrastructure Boundary at the Tooheys Road Site. The storage facility will be sited in accordance with the relevant legislation and guidelines. This facility may on extraordinary occasions store up to 10 kg of Powergel Permitted 3000 and a single 500 package of Carrick R detonators (or equivalent).

The explosives storage facility will be designed in accordance with *AS 2187.1 – 1998: Explosives – Storage, Transport and Use – Storage* and *Code of Practice – Precursors for Explosives* (AEISG, 1999). Detonators will be stored in a secure, separate earth-bunded compound, which will be fully fenced and locked from general access. To authorise the volumes of explosives that may intermittently be stored at the Tooheys Road Site, WACJV will seek a "Licence to Store" from WorkCover NSW.

Explosive materials will be transported to site in accordance with the Australian Code for the Transport of Dangerous Goods by Road and Rail (ADG Code) (National Transport Commission, 2007).

Fuels

Diesel is a combustible liquid (Class 1) as classified by *AS 1940-2004: The Storage and Handling of Flammable and Combustible Liquids* for the purposes of storage and handling. Petrol is classed as a flammable liquid and a dangerous good under the ADG Code. No bulk onsite storage of petrol will be required.

The potential hazards associated with fuels include spills and fires. Diesel has a flashpoint of approximately 61.5ºC and has the potential to result in a fire if ignited. Diesel can be damaging to the surrounding environment if a significant spill is experienced. If a spill leaves site, it has the potential to damage soils and/or aquatic environments.

Fuel storage facilities will be constructed at the Tooheys Road Site. All fuel, oil and hazardous goods areas will be constructed with bunding in accordance with the relevant standards including the OH&S Regulations and AS 1940-2004.

The storage facilities will be designed a sufficient distance from the Project Boundary to ensure that there will be no offsite impacts in the case of a fire or explosion. No other flammable liquids will be stored in the vicinity of these diesel storages and specifically no significant quantities of petroleum will be stored onsite. This will significantly minimise the severity of an explosion or fire in the unlikely event that it should occur. The transportation of fuels to the site will be undertaken by licensed contractors in accordance with OH&S standards and the ADG Code.

Water Treatment Agents

The Project will utilise a WTP to treat mine water for reuse on site or discharge into Wallarah Creek. The following likely chemicals will be used in the water treatment process:

- Sodium Hypochlorite (NaOCl);
- Ammonium Hydroxide (NH_4OH);
- Sodium Metabisulfite (SBS);
- Hydrochloric Acid (HCl);
- Antiscalant (Hypersperse MSI410);
- Sodium Hydroxide (NaOH);
- Antifoam (Foamtrol AF2290); and
- Specialty cleaning chemical for the brine concentrator.

These chemicals will be stored on site in Industrial Bulk Containers (IBCs) and have a storage capacity of 1,000 L each. Only one IBC for each chemical will be present on site at any given time and as such the maximum quantity of each substance that will be stored on site is 1,000 L. The exception is hydrochloric acid, where up to 15,000 L may be stored on site.

The antifoam product, antiscalant and cleaning chemical for the brine concentrator are not classified as dangerous goods under the ADG Code. These chemicals will be transported to the site approximately every three weeks. The chemicals will be safely contained in IBCs during transportation to and storage on site.

Other Hazardous Materials

Some other hazardous materials will also be utilised and stored within the workshop areas at the surface facilities. The Project will require the use of a number of hazardous chemicals including oil and degreaser. The oils used by the Project will consist of hydraulic oils and gear oils. These oils are not classified as dangerous under the ADG Code. However, oil is classified as a combustible liquid (Class C2) by AS 1940-2004. All hazardous materials will be managed in accordance with AS 1940-2004 and the relevant WACJV management plans and procedures.

The Project will also utilise solcenic fluid (Solcenic 801D) as a hydraulic fluid for longwall mining. Solcenic fluid is not classified as a dangerous good under the ADG Code.

The greases and degreasers used by the Project are not classified as dangerous under the ADG Code. These hazardous materials may be required to be stored within the Infrastructure Boundary in accordance with relevant Australian Standards and Guidelines. Substances will be stored onsite in above ground facilities at the Buttonderry and Tooheys Road Sites, at a suitable distance from any diesel or explosive storage areas to minimise any potential risks. These substances will be located in a bunded area in accordance with the OH&S Regulations, which will minimise the risk and severity should a fire or explosion occur and prevent any toxic contamination of the surrounding environment.

All storage buildings (flammable goods, bulk dry goods, etc) will consist of a prefabricated, steel frame, metal clad structure founded on a concrete slab.

WACJV will develop a chemical management system to include (at a minimum) a tracking database to assist in the recording and management of chemicals and a Material Safety Data Sheet (MSDS) for all chemicals used onsite.

Natural Events

Natural events such as floods, bushfires and landslides can also create hazardous conditions. Consideration of these natural hazards and their management has been included as part of this assessment. Due to the proximity of large areas of vegetation to the Project Boundary there is potential for bushfire impacts to the Infrastructure Boundary.

The bushfire risk assessment has been undertaken in accordance with the *Guideline for Bush Fire Prone Land Mapping* (NSW Rural Fire Service, 2006) (Bushfire Guideline). A Bushfire Prone Area is defined as "an area that can support a bushfire or is likely to be subject to bushfire attack". The Bushfire Guideline requires all vegetation to be classified into three groups:

- Vegetation Group 1 – Forest;
- Vegetation Group 2 – Woodlands, heaths and wetlands; and
- Vegetation Group 3 – Moist rainforests, shrubland, open woodlands, mallee and grasslands.

The vegetation groups are divided into two vegetation categories. Areas of Vegetation Groups 1 and 2 that are greater than 1 ha are categorised as Vegetation Category 1. Areas of Vegetation Group 3 that are greater than 1 ha are categorised as Vegetation Category 2.

The majority of the land within the Project Boundary is designated as bushfire prone land. The Tooheys Road Site is surrounded predominantly by Vegetation Category 1, with a small area of Vegetation Category 2 to the north. The Buttonderry Site is located on and surrounded by Vegetation Category 1 and Vegetation Buffer land. The Western Ventilation Shaft is located on and surrounded by Vegetation Category 1, with areas of Vegetation Category 2 to the south-east. The land to the north of the Western Ventilation Shaft is within the Jilliby Jilliby Creek floodplain, which is not bushfire prone land.

The Wyong Bush Fire Management Committee has prepared the Bush Fire Management Plan (WBFMC, 2011) for the Wyong area. This plan identifies community assets at risk from bushfire and sets out a program to reduce that risk to the identified assets. This management plan ascribes a risk rating to each of the assets. The bushfire risk at the Tooheys Road and Buttonderry Sites has been assessed by considering the risk ratings for assets in the vicinity of these sites.

The Buttonderry Site is in close proximity to assets 124 and 432 identified in the Bush Fire Management Plan. Asset 124 has been deemed to be high risk and asset 432 has been deemed to be medium risk. The Tooheys Road Site is close to assets 236 and 329. The levels of bushfire risk for these assets are high and medium respectively. Assuming that the bushfire risks determined for these assets are representative of bushfire risks near those locations, there is a medium to high bushfire risk at the two infrastructure sites for the Project.

Infrastructure development is largely proposed in sparsely vegetated areas and has been designed to largely avoid densely vegetated areas, which would pose a higher bushfire risk. To address residual bushfire risk, during construction and operation of the Project, a combination of select activities, equipment and fuel sources which could lead to the ignition of a bushfire will be documented in the Bushfire Management Plan (BMP). Mitigation and management measures will be included in the BMP and implemented to minimise the risk of fires being induced by the Project.

Bushfire risks will continue to be managed by the Wyong Bush Fire Management Committee. WACJV will continue to assist the Wyong Rural Fire Service in monitoring and reporting any fires, suspect behaviours and fuel load within the Project Boundary, and specifically within the Wyong State Forest and Jilliby State Conservation Area. A range of management techniques will be implemented including firebreaks, fuel reduction, fire fighting access and provision of a sufficient water supply.

The Project is located in an area with no recorded history of landslides and exhibits no evidence of instability. Slope angles and shapes are negligible across the area within the Project Boundary. On this basis, the geological and geomorphological conditions indicate negligible risk of landslide occurrence. Flooding and associated risks are discussed further within Section 7.4. The surface facilities sites are not flood prone.

Summary of Risk Screening and Assessment

In accordance with the risk screening process prescribed by the SEPP 33 Guidelines, the hazardous materials used by the development have been classified using the Australian Dangerous Goods Code. The screening threshold is only exceeded by the Project for dangerous goods class 3PGIII (i.e. diesel).

Additional, oils, greases, degreasers and solcenic fluid used on site are not classified as dangerous goods. The antiscalant, antifoam and cleaning products used in the WTP are also not classified as dangerous goods

Due to the 55,000 L of diesel propsed to stored on site, the risk screening process has confirmed that the Project is a potentially hazardous industry. Accordingly, a risk assessment was has been undertaken to satisfy the requirements of SEPP 33.

A qualitative assessment was undertaken as the following conditions are satisfied:

- Screening and risk classification and prioritisation indicate that there are no major off site consequences and societal risk is negligible;
- The necessary technical and management safeguards are well understood and readily implemented; and
- The surrounding land uses are relatively non-sensitive.

The proposed storage and management safeguards will ensure that there are no major risks of off site consequences. All dangerous goods will be stored in facilities designed in accordance with the relevant standards. The explosives will be stored in accordance with AS 2187.2-2006 – *Explosives – Storage, Transport and Use*.

Diesel fuel will be stored in a bunded storage tank designed to comply AS 1940 – 2004. The dangerous goods used in the Water Treatment Plant will be contained within IBCs which are fit for the purpose of storing these corrosive substances. The Hydrochloric Acid used in the water treatment process will be stored in a fibreglass reinforced plastic vessel designed to hold corrosive substances.

Predicted impacts associated with the Project are summarised in Table 101 which details:

- The level of risk associated with the identified hazards;
- A consequence analysis; and
- An estimated likelihood of occurrence.

The qualitative risk assessment has identified potential hazards associated with the Project and ensures adequate risk mitigation and response measures will be implemented. The assessment has confirmed that the Project will not impose any unacceptable level of risk and therefore the development is not considered hazardous or offensive.

7.23.4 Mitigation and Management

The PHA determined that the Project is not a hazardous or offensive development, and no offsite impacts are anticipated. However management procedures will be implemented to ensure any potential hazards are minimised and their likelihood of occurrence decreased by ensuring compliance with relevant legislation, regulations and guidelines.

The hazard management measures for the Project are summarised below:

- WACJV will develop a Hazard Management Plan to support an application for a Notification from WorkCover under the *Occupational Health and Safety Regulation 2001*. This will outline procedures for transport and storage of substances, storage locations with respect to the Project Boundary, quantity of material and detailed procedures should an event such as fire, explosion or spill occur;
- WACJV will develop a database to assist in the recording and management of chemicals. This chemical management system will contain a MSDS for all chemicals used onsite;
- All hazardous materials associated with the Project will be transported by a licensed contractor in accordance with the relevant Australian Standard and legislation;
- Storage facilities, vehicles and transport vessels will be regularly inspected for leaks, spills and other damage or faults;
- All storage facilities will satisfy the following requirements:
  - Facilities will be designed, constructed, inspected and maintained in accordance with the requirements of the *Work Health and Safety Act 2012*, *Explosives Act 2003* and the relevant Australian Standards;
  - All facilities will be secure and protected from damage and theft;
  - Designs will ensure easy access for fire fighting should a fire occur;
  - Products used in the Water Treatment Plant will be stored in IBCs that are fit for purpose;
  - Chemical containers and storage facilities will be designed to minimise any physical damage due to temperature extremes, moisture, corrosive mists or vapours and vehicles; and
  - All substances shall be stored in the areas or facilities provided.

Table 101 Project Hazards & Risk Assessment Summary

Hazard	Event	Likelihood of Hazardous Incident	Analysis of Consequences	Risk Analysis
Storage Facility (Explosives and Fuel)	Explosion	Remote	Moderate	Moderate
	Leak / Spill	Possible	Minor	Moderate
Workshop Storage Areas	Fire	Remote	Moderate	Moderate
	Theft	Remote	Major	Moderate
Transport Hazardous Materials	Explosion / Fire	Remote	Moderate	Moderate
	Leak / Spill	Probable	Moderate	Significant
	Theft	Remote	Major	Moderate
Project Operations	Spill / Leak	Probable	Minor	Significant
	Fire	Remote	Moderate	Moderate
	Explosion	Remote	Major	Significant

- Explosive storage facilities will be located a minimum of 200 m from Project facilities such as offices;
- Personnel entering the explosives storage facility will be authorised to do so and trained in relevant procedures for the loading, transport and preparation of hazardous substances;
- Storage areas will be located at a sufficient distance from the surface infrastructure to ensure there will be no offsite impacts;
- All explosives will be stored in a purpose built magazine built to appropriate standards; and
- Magazines will be designed and maintained in accordance with the *Dangerous Goods Amendment Regulations 2005* and NSW Department of Mineral Resources regulations.

Additionally, a Bushfire Management Plan will be developed incorporating a range of management techniques including firebreaks, fuel reduction, fire fighting access and sufficient water supply.

7.24 Waste Management

7.24.1 Background

Hansen Bailey has completed a Waste Assessment for the Project which is summarised below. This study aimed to identify potential waste generated by the Project related activities requiring onsite management and storage. Tailings and coarse reject will not be generated by the Project and as such, estimates of the quantity and nature, disposal strategy and further assessment is not considered in this EIS.

This assessment has been undertaken in accordance with the legal and strategic framework for managing wastes in NSW including the:

- POEO Act;
- *Waste Avoidance and Resource Recovery Act 2001* (Waste Act); and
- *Protection of the Environment Operations (Waste) Regulation 2005*.

7.24.2 Methodology

The potential waste streams associated with the Project have been classified in accordance with the *DECCW Waste Classification Guidelines Part 1 2008* (revised in December 2009).

Appropriate mitigation and management measures have been proposed in accordance with the Waste Act. The key waste management options for the Project have been considered against the following priorities:

- Avoidance including reducing the amount of waste generated by the Project;
- Resource recovery including reuse, recycling, reprocessing and energy recovery; and
- Disposal including management of all disposal options in the most environmentally responsible manner.

Waste management, storage, transport, processing, recovery and disposal procedures have been developed in accordance with any relevant legislative requirements.

7.24.3 Impact Assessment

Waste generating activities associated with the Project have been assessed to determine the type and approximate quantities of waste which may be generated by the Project. The key waste generating activities have been described in detail below.

Coal Rejects and Waste Rock

The WAJCV is targeting a policy of zero rejects by avoiding the need to include a CHPP as part of the Project, which is feasible due to the high quality of the coal resource. By avoiding the need to have a CHPP, the production of coarse rejects or fine tailings that are normal by-products of a CHPP will not occur. This in turn removes the need for coal tailings storage facilities as well as significantly reducing the Project's water consumption and power demands.

Clean excavated waste rock will be created during the construction of the drift and shafts. This is predicted at approximately 160,000 m^3 for the Tooheys Road Site and approximately 20,000 m^3 for the Buttonderry Site. It is intended to use this material for the creation of perimeter bunding and landscaping features on the two sites (conceptually shown on Figure 21).

Sewage Treatment

The Project will be connected to the municipal sewerage system as discussed in Section 3.

Hazardous Waste

Contaminated materials generated at the workshop such as grease and bulk waste oil will be held in storage tanks in a bunded area prior to removal from the site by a licensed contractor for recycling or disposal at a licensed facility. Any spills that occur within collection areas will be contained within bunds and managed appropriately.

Hazardous materials will be handled, transported and disposed of in accordance with the *Waste Classification Guidelines* (DECCW 2008) and the *Australian Code for the Transport of Dangerous Goods by Road and Rail* (National Transport Division 2007). Hazards associated with the Project including possible management and control procedures have been discussed further in Section 7.23.

General Waste

Small volumes of scrap metal, batteries, empty drums, wooden pallets, timber, green waste and mixed recyclables (including paper cardboard, glass and aluminium cans) are typical of the general waste collected on site at the Project. Each waste material will be separated into the appropriate receptacle for reuse, recycling or disposal.

7.24.4 Mitigation and Management

A Waste Management System will be developed for the Project to promote waste avoidance and resource recovery by developing appropriate strategies and programs in accordance with the Waste Act and the POEO Act.

Regular inspections and monitoring will be conducted by qualified personnel to ensure adequate maintenance and operation of the waste facilities and to ensure management practices are sufficient to manage any waste products.

WACJV will ensure that each major waste stream is segregated in the appropriate receptacles for recycling, reuse and/or disposal. The following measures will be implemented to minimise the production of waste onsite including:

- Training designed to improve efficiency in the minimisation of waste streams, reuse and recycling options and management strategies for each major waste stream relevant to key work areas;
- Maximising the recycling of suitable materials where possible into designated bins;
- An internal spill response procedure will be developed to describe the measures to be followed in the event of a spill incident. Any spills that occur within collection areas will be contained within bunds and managed by WACJV's pollution control systems; and
- New improved technologies will be used in conjunction with the water management system to ensure wastes are minimised and reused within the mining activities.

WACJV will develop a Waste Management Plan to ensure the minimisation, storage, transport, disposal, tracking and reporting of all waste and hazardous materials generated onsite is in accordance with all relevant legislative requirements and in consideration of the management and mitigation measures proposed above.

7.25 Rehabilitation and Closure

As part of this EIS a detailed review of the total area to be disturbed by the Project was undertaken including an assessment of any impacts associated with the clearing of vegetation on a permanent basis for the construction and / or operation of the mine and ancillary infrastructure.

Any impacts associated with underground mining methods and subsequent mine subsidence have also been assessed.

The rehabilitation strategies described in this section have been developed in consideration of relevant specialist studies undertaken as part of the EIS process including:

- The ecology assessment summarised in Section 7.9 and presented in full in Appendix O;
- The soils and land capability assessment summarised in Section 7.19 and presented in full in Appendix X; and
- The subsidence assessment is summarised in Section 7.1 and presented in full in Appendix G and Appendix H.

7.25.1 Rehabilitation Objectives

WAJCV's primary rehabilitation objective is to ensure any rehabilitated areas are integrated with the regional land use strategies and suitable for the proposed future land use. This will be developed in consultation with surrounding landowners, local government and any other interested parties. Infrastructure will be decommissioned if it is not required post mining or sold on for other industrial purpose.

Limited rehabilitation activities will be required as the Project is an underground operation that generates limited surface impacts. The Project will require minor disturbance on the surface associated with the Infrastructure Boundary to be remediated.

Rehabilitation activities to be undertaken as part of the Project include:

- Ongoing rehabilitation of surface subsidence effects arising from underground coal extraction as required; and
- Decommissioning and rehabilitation of mine infrastructure areas.

7.25.2 Strategic Framework

Rehabilitation processes implemented for the Project will be undertaken generally in accordance with the 'Strategic Framework for Mine Closure' (ANZMEC MCA) and the 'Mine Rehabilitation and Mine Closure and Completion' Handbooks both developed as part of the Leading Practice Sustainable Development Program by the Department of Industry, Tourism and Resources.

Planning objectives for rehabilitation activities for the Project will be based on those management measures already in place, including:

- The development of a Landscape Management Plan for the Project;
- Early characterisation of materials to avoid any future issues associated with materials used in rehabilitation; and
- Understanding the external environment and how it may affect the success of rehabilitation.

The key objectives for mine closure include:

- Enabling all relevant stakeholders to have their interests considered within the mine closure process;
- Ensuring the mine closure process is timely, cost effective and in consideration of future land-use plans;
- Ensuring the cost of mine closure is reflected in the budget adequately and that the community is not left with a liability;
- Ensuring there is effective implementation of the mine closure process including adequate resources and clear accountability;
- The establishment of a set of indicators and a rehabilitation monitoring program to ensure mine closure can be demonstrated as a successfully completed process where completion criteria are met;
- Establishing a point where all agreed criteria is deemed successfully met by the relevant Authorities;
- Ensuring future public health and safety, environmental resources, post mining land use and socio-economic assets are not unduly negatively affected and enhanced where possible; and
- The implementation of sustainable development considerations in corporate decision making processes and the reduction of risk through management strategies based on sound data.

7.25.3 Relevant Planning Instruments

As discussed in Section 2.4, the Project is located within land zoned under the Wyong LEP which outlines development zones and permitted land use and building types including planning controls. The Wyong LEP sets out land zoning for the area within the Project Boundary. Zoning for the area within the Project Boundary includes:

- Tooheys Road Site is Zone 4 (Industrial) under which mining is permissible with development consent;
- Buttonderry Site is Zone 1(c) (Non Urban Constrained Lands) where development ancillary to mining is permitted with Development Consent; and
- The Subsidence Impact Limit is a mixture of Zone 1(a) (Rural), Zone 1(f) (Forestry), Zone 7(a) (Conservation), and Zone 7(b) (Scenic Preservation) with small areas of Zone 6(a) (Open Space & Recreation) and 6(b) (Regional Open Space and Recreation).

Land zoning within the Project Boundary is illustrated on Figure 6. The Rural Zone 1(a) is associated with the creek flats of the Jilliby Jilliby Creek and Little Jilliby Jilliby Creek and close-by lower slopes. The conceptual final landform and rehabilitation strategy will provide consideration of all of the above objectives from the Wyong LEP.

7.25.4 Rehabilitation Techniques

The Project will utilise underground mining methods, rather than open cut and as such no significant general impacts have been predicted. The Project will require only minor disturbance on the surface associated with the infrastructure areas. The following broad rehabilitation techniques will be applied to all rehabilitation areas.

Land Clearance Protocol

Prior to the clearing of any native vegetation, in particular for the construction and use of various mining related infrastructure, the Land Clearance Protocol as described in Section 7.9 will be utilised.

Rehabilitation

Some minor rehabilitation activities will be required during construction, progressively during mining operations and at mine closure. Prior to mining activities occurring, vegetation and some topsoil will be removed in association with the construction of mining related infrastructure. Rehabilitation of any disturbed areas will be undertaken after construction is complete to develop a stable non-polluting landform to reduce the potential impacts of the Project.

Clean excavated waste rock will be created during the construction of the drift and shafts. This amounts to approximately 160,000 m^3 for the Tooheys Road Site and approximately 20,000 m^3 for the Buttonderry Site (including a 25% swell factor).

It is intended to use this material for the creation of perimeter bunding and landscaping features on the two sites. Where practical, topsoil stripped will be immediately spread over available rehabilitation areas to enhance the rehabilitation outcomes.

Some minor rehabilitation will be undertaken as required throughout the mining operation phase. Some rehabilitation is anticipated to be required in the Subsidence Impact Limit in association with predicted mine subsidence.

Rehabilitation may also be required at any additional exploration drilling sites and for the management of mine related infrastructure such as stabilisation of water dams and surface water drainage. The key rehabilitation goal throughout operations will be to maintain a stable non-polluting landform.

Revegetation

Revegetation works will generally be carried out to stabilise any disturbed areas. Revegetation works will involve direct native seeding and supplementary tube stock planting as required. Revegetation details and key objectives are provided in Section 7.9.

7.25.5 Post Mining Final Landform

WACJV will maximise opportunities for a post mining landscape that is generally consistent with pre mining land use. Four key rehabilitation domains have been identified in the rehabilitation strategy based on the Project impacts, post mine landform, future land use and biodiversity values. These are discussed below.

Tooheys Road Site

Upon completion of mining works, the Tooheys Road Site may be subsequently utilised for industrial purposes. The Tooheys Road Site will not be rehabilitated post-mining to a pre-mining land condition as it is more suitable for industrial development in accordance with the site zoning.

It is considered as Class M and therefore unsuitable for rural production. Tooheys Road Site will be left relatively intact for resale for industrial land use. Some relevant remediation and rehabilitation will still be required and will include:

- Sealing of the drift portal entry;
- Removal of carbonaceous material;
- Removal of the water treatment plant and dams if a future industrial user has not identified it as an asset;
- Removal of conveyors and other coal handling equipment; and
- Removal of the gas management facility if it is not identified as an asset by a future industrial user.

Buttonderry Site

The Buttonderry Site is currently proposed to be fully rehabilitated unless developed for a relevant industrial use, consistent with its zoning. Rehabilitation works will therefore include:

- Filling and capping of ventilation, employee / materials access shafts and ballast borehole consistent with contemporary DRE Guidelines;
- Removal of all buildings and equipment / infrastructure; and
- All contaminated hardstand areas remediated and removed.

If not utilised for industrial use, the Buttonderry Site will be covered in low to moderate quality topdressing and revegetated as detailed above. A final land capability class of VII has been predicted which is equivalent to the pre-mining conditions. The rehabilitated land post mining will be unsuitable for livestock grazing at these locations, and will be best utilised as industrial land use or otherwise protected with timber planting to minimise erosion risk.

Western Ventilation Shaft

Rehabilitation activities undertaken within the Western Ventilation Shaft will be similar to those proposed for the Buttonderry Site. The Western Ventilation Shaft site will be fully rehabilitated and activities may include:

- Filling and sealing of the shaft; and
- Removal of all surface infrastructure.

As predicted for the Buttonderry Site, a final land capability class of VII has been proposed which will be unsuitable for livestock grazing at these locations and will be best replanted and returned to forestry land use.

Subsidence Impact Limit

After mine closure, all areas outside this Infrastructure Areas are expected to remain the same status as was held prior to mining commencement. Surface subsidence impacts shall be minor and such that the change in gradient over these areas is expected to be 11 mm per 1 m length (1.1%) and as such will be undetected by eye (MSEC, 2013). The depth of coverage (depth of mining below surface level) and the depth of alluvial soils will lessen the impact of subsidence. Evidence of subsidence and its impacts on the ground surface will be monitored through regular inspections, ongoing subsidence data collection and recording and reporting of monitoring results.

If tension cracks were to develop in private lands as the result of the extraction of the proposed longwalls, WACJV will respond to the issue in accordance with the terms of the Property Subsidence Management Plan that has been previously agreed with the landowner. Minor remediation works, if any, are all that are likely to be required but in any case the work will be undertaken at no cost to the landowner.

7.25.6 Decommissioning

The detailed Mine Closure Plan that will be prepared within five years of closure shall reflect the contemporary expectations including changes to the final mine plan, regulatory requirements, new technologies and stakeholder expectations.

Decommissioning and removal from the site of all infrastructure items at the Buttonderry Site and the Western Ventilation Shaft will take place unless required post mining or sold on for other industrial purposes. Decommissioning of the Infrastructure Area will include removal, remediation of any land contamination, ripping, topsoiling and seeding. The Tooheys Road Site is anticipated to be converted into an industrial building therefore minimal decommissioning activities will be required. Any infrastructure including dams, roads and buildings, which is beneficial for future use by post mine landowners, will be left in place in accordance with the relevant stakeholder or landowner agreements.

7.25.7 Rehabilitation Completion Criteria

Completion criteria for mine closure will be developed and agreed in consultation with the relevant government agencies and community and incorporated into the final Mine Closure Plan (developed as part of the Landscape Management Plan). These criteria will continue to be revised and developed to demonstrate that the rehabilitation objectives have been achieved. The achievement of the completion criteria post closure will be monitored and reported to relevant stakeholders.

WACJV is committed to the achievement of leading practice completion criteria, as this will ensure the long term protection and management of the post mine landscape and its biodiversity conservation values. A list of preliminary rehabilitation completion criterion for the Buttonderry Site and the Western Ventilation Shaft is outlined in Table 102.

Table 102 Preliminary Rehabilitation Criteria

Aspect	Domain			
	Tooheys Road Site	Buttonderry Site	Western Ventilation Shaft	Subsidence Impact Limit
	Criteria			
Land Capability	• Will be utilised for industrial purposes in accordance with the site zoning and will not be returned to pre-mining conditions or Land Class	• Retention of pre-mining land capability status	• Retention of pre-mining land capability status	• Retention of pre-mining land capability status
Landform	• Erosion will be managed to ensure the final land use is not compromised			
	• Surface soils will be free from hazardous materials • Riparian areas will be managed to prevent instability and erosion where possible and to ensure similar pre mining flows	• Surface soils will be free from hazardous materials	• Surface soils will be free from hazardous materials	• All drill holes will be sealed • Erosion caused by surface cracking will be rehabilitated by infilling surface cracks, or by locally regrading and re-compacting the surface
Soil	• Topsoil will be spread on all disturbed surface areas as soon as possible to prevent the requirement for stockpiling and will include weed infestation assessment	• Topsoil will be spread on all disturbed surface areas as soon as possible to prevent the requirement for stockpiling and will include weed infestation assessment	• Topsoil will be spread on all disturbed surface areas as soon as possible to prevent the requirement for stockpiling and will include weed infestation assessment	• N/A
	• Erosion and sediment control will be achieved through the construction of contour furrows or contour banks at intervals down slopes, where required	• Erosion and sediment control will be achieved through the construction of contour furrows or contour banks at intervals down slopes, where required	• Erosion and sediment control will be achieved through the construction of contour furrows or contour banks at intervals down slopes, where required	• N/A
	• Soil conditions will be monitored to encourage acceptable pH ranges and nutrient status for plant growth	• Soil conditions will be monitored to encourage acceptable pH ranges and nutrient status for plant growth	• Soil conditions will be monitored to encourage acceptable pH ranges and nutrient status for plant growth	• Should tension cracks or potential erosion as a result of subsidence from the proposed longwalls, protection measures including revegetation and filling of cracks will be implemented
Water	• Runoff water quality from rehabilitated areas will be managed to reduce any possible threat to downstream water quality			
	• Catchment areas in rehabilitated areas will be free draining with low velocity to minimise surface erosion	• Catchment areas in rehabilitated areas will be free draining with low velocity to minimise surface erosion	• Catchment areas in rehabilitated areas will be free draining with low velocity to minimise surface erosion	• N/A

Aspect	Domain			
	Tooheys Road Site	Buttonderry Site	Western Ventilation Shaft	Subsidence Impact Limit
	Criteria			
Vegetation	• Significant weed infestations or noxious weeds from rehabilitated areas will be removed in accordance with relevant guidelines and Weed Management Plans	• Significant weed infestations or noxious weeds from rehabilitated areas will be removed in accordance with relevant guidelines and Weed Management Plans	• Significant weed infestations or noxious weeds from rehabilitated areas will be removed in accordance with relevant guidelines and Weed Management Plans	• N/A
	• Rehabilitated vegetation will be designed in consideration of the desired post-mining land use	• Rehabilitated areas will utilise flora species characteristic of the pre mining vegetation assemblages	• Rehabilitated areas will utilise flora species characteristic of the pre mining vegetation assemblages suitable for slope stabilisation	• N/A
		• Rehabilitated vegetation will be designed to develop the desired structure • Rehabilitated vegetation will include viable timber species for future use in the forestry resource industry • The health of trees will be monitored for the long term to ensure high survival rates • The highest percentage soil surface cover possible will be maintained	• The health of trees will be monitored for the long term to ensure high survival rates • The highest percentage soil surface cover possible will be maintained	• N/A
Fauna	• Vertebrate pests will be managed to ensure effective control	• Rehabilitated areas will be designed to support stable populations of native fauna and will be monitored in accordance with the Mine Closure Plan	• Rehabilitated areas will be designed to support stable populations of native fauna and will be monitored long term	• N/A

7.25.8 Management and Mitigation

In accordance with the Landscape Management Plan to be developed for the Project, rehabilitation areas will be monitored on a regular basis to ensure that rehabilitation objectives are being met and that sustainable revegetation and long term landform sustainability is achieved.

Rehabilitation monitoring will include regular inspections of rehabilitated areas to assess:

- Structural stability;
- The effectiveness of erosion and sediment control measures;
- Revegetation success; and
- The effectiveness of weed and pest management measures.

Maintenance works in rehabilitation areas (including any surface cracking from Project subsidence) will be completed as required to address any issues of concern identified during monitoring. Maintenance activities may include a range of responses, including:

- Supplementary seeding and fertilising of vegetated areas;
- Weed and pest control;
- Desilting or repairing drainage structures and dams; and
- The infilling and regrading of any eroded areas.

WACJV will undertake ongoing rehabilitation maintenance works as required. The results of rehabilitation and landform monitoring and the effectiveness of any maintenance activities required for the Project will be assessed and utilised in the continual refinement of rehabilitation techniques and reported in the Annual Review.

7.26 Cumulative Impacts

This EIS has considered the cumulative impacts of the Project and other mining operations. There are several existing mines within the Lake Macquarie LGA as described in Table 3. The nearest mining operation is the Mannering Colliery (currently under care and maintenance), situated approximately 10 km to the north-west. Due to the significant distances to other mining operations, the contributions of other mines to cumulative environmental impacts are considered negligible.

7.26.1 Air Quality

Cumulative air quality impacts were assessed by adding the background pollutant concentration to the predicted pollutant concentrations for the Project alone. The adopted background levels account for emissions from all other developments, including other mining operations. The cumulative air quality assessment concluded that cumulative pollutant concentrations are unlikely to exceed the relevant air quality criteria.

The assessment also considered cumulative dust impacts arising from coal transportation. Connell Hatch (2008) conducted a study into fugitive dust emissions from coal trains. This study concluded that dust concentrations at the edge of rail corridors are unlikely to be adverse to human health and amenity. The Connell Hatch study relied on air quality monitoring results, which are indicative of cumulative dust levels. PAEHolmes reviewed this study and determined that its conclusions are applicable to coal transportation in NSW. Section 7.5.3 provides further detail in relation to cumulative air quality impacts from the Project.

7.26.2 Noise

Cumulative noise levels resulting from coal transportation were considered in the Noise and Vibration Impact Assessment. The rail traffic noise criteria recommended by OEH for cumulative noise levels are $LA_{eq,\ 24\ hour}$ 60dBA and LA_{max} (95^{th} percentile) 85dBA.

Cumulative noise levels are predicted to be within the $LA_{eq,\ 24\ hour}$ criteria at distances of greater than 70 m from the rail line.

Cumulative noise levels are predicted to be within the LA_{max} criteria at distances of greater than 100 m. Section 7.8.3 provides further detail in relation to cumulative noise impacts from the Project.

7.26.3 Groundwater

The significant distance between the Project and other mining operations ensures that there are no cumulative groundwater impacts. Section 7.2.3 provides further detail in relation to groundwater impacts from the Project.

7.26.4 Traffic and Transport

The traffic movements generated by other mining operations are reflected in the background traffic volumes adopted for the traffic modeling. The impacts of the Project on road traffic are discussed in Section 7.12.

Wallarah 2
COAL PROJECT

Wallarah 2 Coal Project

Environmental Impact Statement

April 2013

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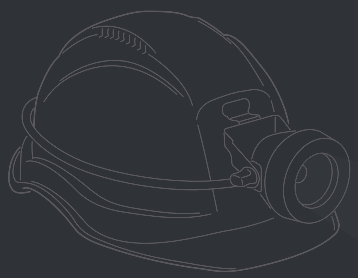
Management and Monitoring Summary



Hansen Bailey
ENVIRONMENTAL CONSULTANTS

Management and Monitoring Summary

8

Table 103 provides a consolidated summary of the proposed environmental management and monitoring measures included in this EIS and the source of each. The monitoring plan shall be subject to review in consultation with relevant regulators over the life of the Project.

In the event that the measures described in this EIS are not adequate for mitigating the impacts of the Project, WACJV will consult with the necessary regulators to develop additional and / or alternate management and mitigation measures.

Table 103 Project Management & Monitoring Measures

Ref	Commitment	Section
Environmental Management		
1.	WACJV will develop and implement an Environmental Management System in consultation with the relevant regulators (and the Aboriginal community where relevant) consistent with **Section 7** of this EIS to the approval of DP&I which shall comprise: • Environmental Management Strategy (EMS) • Environmental Monitoring Plan (incorporating subsidence, groundwater, surface water, air quality and noise) • Extraction Plan • Water Management Plan • Air Quality Management Plan • Energy and Greenhouse Strategy • Noise Management Plan • Biodiversity Offset Strategy • Land Clearance Protocol • Traffic and Transport Management Plan • Aboriginal Cultural Heritage Management Plan • Historic Heritage Management Plan • Soil and Land Capability Procedure (including an Acid Sulphate Soils Management Procedure) • Land Management Plan • Bushfire Management Plan • Waste Management System • Landscape Management Plan	7
2.	The existing monitoring program as shown in **Figure 13** shall be revised and updated in consultation with relevant regulators over the life of the Project in consideration of operations and impacts	2.8
Subsidence		
3.	The Extraction Plan will include a Trigger Action Response Plan (TARP) to allow WACJV to respond to impacts as they arise and enable adaptive management to occur over the life of the Project	7.1.4
4.	Subsidence monitoring will be conducted before, during and after secondary extraction of each longwall to enable periodic evaluation of environmental consequences against the predictions in this EIS	7.1.4
5.	Monitoring will also be conducted post-mining to evaluate the success of remediation programs	7.1.4
6.	The Extraction Plan will include Property Subsidence Management Plans for individual properties to manage potential impacts to residential and non-residential buildings	7.1.4
Water		
7.	The Water Management System will be managed as described in this EIS	7
8.	In consideration of the findings from the groundwater and surface water assessments, the Water Management Plan will ensure that the monitoring program as described is implemented and maintained so that the modelled predictions and assumptions can be verified and any potentially unforeseen water impacts can be identified and managed	7.2, 7.3 and 7.4
9.	The Erosion and Sediment Control Plan will incorporate control measures to separate runoff from disturbed and undisturbed areas and to treat runoff from disturbed areas	7.3
10.	A comprehensive monitoring program of the site water management system will be developed as part of the EMP	7.2, 7.3 and 7.4

Ref	Commitment	Section
Air Quality		
11.	The Air Quality Management Plan shall incorporate the feasible and reasonable air quality controls and details of the air quality monitoring network described in this EIS	**7.5.4**
12.	An Energy and Greenhouse Strategy will be developed within two years after the commencement of longwall coal extraction. The strategy will address interim and long term energy and greenhouse management plans and initiatives, including monitoring, reporting and continuous improvement	**7.6.4**
13.	Air quality emissions will be monitored using the revised EMP to ensure compliance with relevant air quality criteria. The existing monitoring network will be reviewed and augmented for the Project	**7.5.4**
Noise		
14.	The Noise Management Plan will incorporate the feasible and reasonable mitigation and noise monitoring network	**7.8.4**
15.	The Environmental Monitoring Program will incorporate regular noise monitoring surrounding the Tooheys Road and Buttonderry Sites which is representative of the closest sensitive receivers	**7.8.4**
Ecology		
16.	The Biodiversity Management Plan will incorporate the management and mitigation methods in this EIS	**7.9.4**
17.	The Biodiversity Offset Strategy as described in this EIS will be implemented for the life of the Project	**7.10**
18.	Prior to the clearing of any native vegetation, the Land Clearance Protocol as described in this EIS will be utilised	**7.9.4**
Traffic and Transport		
19.	The Traffic and Transport Management Plan will incorporate the management and mitigation measures in this EIS	**7.12.4**
Heritage		
20.	The Aboriginal Cultural Heritage Management Plan will be guided by specific policies and procedures to manage Aboriginal archaeological sites within the Project Boundary and periodically reviewed in consultation with Aboriginal stakeholders and relevant regulators	**7.14**
21.	The Historic Heritage Management Plan will incorporate management strategies to limit the potential impacts of the Project on historical heritage items and will be prepared in consultation with relevant regulators	**7.15**
Visual		
22.	Landscape mitigation measures will be undertaken at the Tooheys Road using native vegetation to achieve a reduction in the visual impacts of the Site	**7.16.4**
23.	Upon receiving a written request from an owner of privately-owned land with direct views to the Tooheys Road site from a residence within 2 km of the Tooheys Road Site, WACJV will implement reasonable and feasible additional visual impact mitigation measures (such as landscaping treatments or vegetation screens) in consultation with the landowner, to the satisfaction of DP&I	**7.16.4**
24.	For the Buttonderry Site, effective landscape enhancement will be achieved by screen planting along the Hue Hue Road Boundary and particularly adjacent to the entrance and the access roadway subject to traffic visibility safety requirements	**7.16.4**
Social		
25.	WACJV will use its best endeavours to develop a Voluntary Planning Agreement with Wyong Shire Council in consideration of the findings of the Social Impact Assessment	**7.17**
26.	WACJV will operate a Project Community Consultative Committee in accordance with relevant guidelines	**7.17**
27.	WACJV will use its best endeavours to achieve 70% local hires for its operational workforce	**7.17**
Land Resources		
28.	The Soil and Land Capability Procedure (including management of Acid Sulphate Soils) will be developed in consideration of the mitigation and management measures in this EIS	**7.19**
29.	The Land Management Plan will include measures to manage weeds and feral animals on WACJV owned land within the Project Boundary	**7.9** and **7.25**
30.	In order to reduce the potential for Project related impacts on the publicly owned forest resources managed by Forests NSW, the strategies detailed in this EIS will be implemented during construction and operation of the Project	**7.21**
Contamination		
31.	Remediation of the existing minor hydrocarbon contamination at the Buttonderry Site will be conducted in accordance with this EIS	**7.22**

Ref	Commitment	Section
Waste		
32.	A Waste Management System will be developed for the Project to promote waste avoidance and resource recovery by developing appropriate strategies and programs in accordance with relevant regulations	**7.24**
Rehabilitation		
33.	In accordance with the Landscape Management Plan to be developed for the Project, rehabilitation areas will be monitored on a regular basis to ensure that rehabilitation objectives are being met and that sustainable revegetation, remediation and long term landform sustainability is achieved	**7.25**
34.	Completion criteria for mine closure will be developed and agreed in consultation with the relevant government agencies and community and incorporated into the final Mine Closure Plan (developed as part of the Landscape Management Plan)	**7.25**
Training and Reporting		
35.	WACJV will provide regular, relevant training to all employees and contractors in relation to the commitments in this EIS	**7**
36.	WACJV will prepare an Annual Review report (which summarises coal quantities, monitoring results and reviews performance against the predictions and commitments in this EIS) and distribute it to the relevant regulatory authorities and make available on the Project website	**7**

Wallarah 2
COAL PROJECT

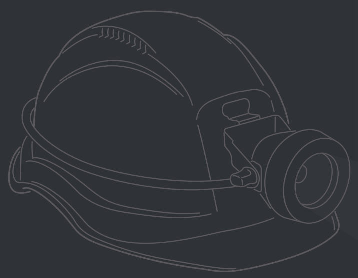
Wallarah 2 Coal Project

Environmental Impact Statement

April 2013

9

Project Justification



Hansen Bailey
ENVIRONMENTAL CONSULTANTS

Project Justification 9

9.1 Overview

This EIS has assessed the potential impacts of the Project in accordance with the DGRs issued on 12 January 2012 and the supplementary DGRs issued on 11 July 2012. All relevant regulatory requirements and the findings from the consultation program undertaken for the Project have also been considered in its preparation.

The Project as designed, after considering all options, will maximise the social and economic benefits from the extraction of the NSW Government owned coal resource within EL 4911 and A 405. At the same time it will minimise any impacts to the natural and man-made environment.

In particular, it has been determined that the Project will not unduly impact on either the surface or groundwater regime within or beyond the Project Boundary and will not affect in any measurable way the water supply to the Wyong-Gosford catchment. The Subsidence Impact Limit for the Project encompasses an area of approximately 37 km^2 representing about 5% of the total catchment area contributing to the Gosford-Wyong Water Supply Scheme.

Further, the Project is consistent with the objects of the EP&A Act when its resultant social and economic benefits are weighed carefully against its predicted social and environmental costs.

When the management and mitigation measures committed to in this EIS are adopted, the residual environmental impacts of the Project are well within acceptable limits. These impacts are justifiable when considered against the need for the Project and its social and economic benefits.

9.2 Project Need

9.2.1 World Demand for Energy and Coal

There is general acceptance, including from the United Nations sponsored International Energy Agency (IEA, 2011) and Australian Energy Market Operator (AEMO) (2011), that there will be a continuing need for thermal coal to meet anthropological based energy needs, in particular electricity generation. International and local predictions indicate the need for coal as a source of energy for electricity production will increase for some years to come, despite an expectation of an increase in energy generated by alternate sources.

Greenhouse and anthropogenic climate change is a global issue. Since the 2009 Copenhagen Climate Conference, it has become more apparent that the path to achieving a material reduction in the use of carbon based energy is challenging and will take time. There will continue to be actions to manage climate change which include different approaches in different jurisdictions, the objective being to reduce reliance on carbon by making it more expensive and by developing alternate non-carbon based sources of energy such as wind, solar, geothermal and others.

However, an alternative source to replace carbon based fuel as the primary source of energy for base load electricity supply has not yet been and is considered not likely to be sufficiently developed in the near future (IEA, 2011). The demand for electricity is predicted to continue to increase with growing populations and the standards of living that are expected and required in the developing world.

While there will be development of non-carbon based energy, the socio-political and technological challenges and infrastructure development requirements (due to the inevitable increase in world demand for electricity) will result in a continued need for low sulphur, export quality coal, as would be produced by the Project, providing affordable and reliable electricity and energy security.

The Project will facilitate the recovery of a valuable, export quality thermal coal. Thermal coal remains a highly sought after energy source in Asian countries, including Japan, China and India. These countries continue to be the world's largest coal importers, and will largely account for an approximate 70% growth in total coal imports between 2009 and 2035 (US EIA, 2011).

This increasing demand supports the need for the Project and justifies further investment in the thermal coal mining industry. To this end the Project will:

- Assist Australia to continue to meet the international and local demand for thermal coal, for at least the next 28 years, during which time it is expected that there will continue to be a strong world demand for coal for the purposes of electricity generation;
- Support Australia in maintaining its reputation as a consistent and reliable supplier of thermal coal to its existing and expanding markets; and
- Contribute materially to sustaining the Australian economy and maintaining the economic stability of NSW and the Central Coast region.

9.2.2 Employment and Other Social Benefits

The Project is not predicted to place significant increased pressure on community infrastructure, such as health or education facilities within the Central Coast region. Additionally, population increase associated with the Project workforce is not predicted to place significant pressures on the currently depressed local housing market.

The Project will provide much needed employment opportunities to the Wyong LGA which has fared poorly in relation to NSW in many measurements of socio-economic indicators. For example, in September 2012, the unemployment rate of the Wyong LGA was 8.1%, compared to the NSW rate of 5.1%.

The Wyong North-East Statistical Local Area was ranked the fifth most disadvantaged Statistical Local Area in the 'Index of Relative Socio-economic Advantage and Disadvantage' in the Greater Sydney Area in 2006 (Australian Bureau of Statistics (2008) Socio-Economic Indexes for Areas (SEIFA), Australia – Media Release March 26, 2008).

The Wyong LGA was ranked the 17th lowest LGA in NSW (within a total of 153 LGAs) in the 'Index of Education and Occupation' in 2006 (Australian Bureau of Statistics (2008) Socio-Economic Indexes for Areas (SEIFA)).

The Project will contribute positively to the key economic and transport challenges identified in the *Central Coast Regional Strategy 2008*, particularly "increasing and diversifying job opportunities and increasing the level of employment self containment".

The Strategy reported that "the proportion of the adult workforce commuting out of the region for work has increased to over 25 per cent" and that "there remains a noticeable reduction in the population of adults aged 20-29 years old attributed to people in this age group moving to Sydney for lifestyle and employment reasons". The employment expected to be generated by the Project will assist in reversing these figures. The operational phase of the Project is expected to generate a total of approximately 800 jobs - 300 direct and 500 flow-on jobs. The Project is predicted to generate approximately 564 jobs in the Secondary Study Area (i.e. Wyong, Lake Macquarie and Gosford LGAs).

An additional 243 jobs are also predicted to be filled by people currently living outside the Secondary Study Area, but who are likely to relocate to that Area due to the Project.

Should the Project be approved, WACJV will implement the following strategies which will result in tangible social benefits to the Wyong LGA:

- A workforce recruitment strategy which addresses the needs of the semi-skilled and unskilled workforce which is available locally but will require on the job and more specific operator training;
- The use of best endeavours to achieve the WACJV goal of 70% of its permanent workforce residing within the Secondary Study Area;
- The preparation of a communications program within the Secondary Study Area targeting the current commuting workforce in order to publicise the type of professional and managerial positions that will be available locally;
- Assistance in the development of training and apprenticeship programs for skills relevant to the Project at the College of TAFE in Wyong and/or Newcastle; and
- A VPA with WSC to provide contributions to address demands on local community infrastructure associated with the Project.

9.2.3 Economic Benefits

When the Project production costs (acquisition of affected land, opportunity cost of land, operating costs, environmental costs, decommissioning costs, etc.) are considered in the context of production benefits (revenues from production, residual values of land, etc.) the net financial benefits of the Project are approximately $671 M.

A minimum of $346 M of these will be net benefits accruing to Australia. There may also be some non-market benefits of employment provided by the Project which are estimated to be in the order of $186 M.

The Project will deliver significant socio-economic benefits to the region and the State of NSW through the provision of employment, taxes and fees.

During the construction phase, the Project will result in the following economic benefits to the region:

- $641 Million in direct and indirect output or business turnover;
- $267 Million in direct and indirect value-added;
- $203 Million in direct and indirect household income; and
- 1,098 direct and indirect jobs at the peak of construction.

During the operational phase, the Project will provide the following economic benefits to the region:

- $625 M in annual direct and indirect regional output or business turnover;
- $381 M in annual direct and indirect regional value-added;
- $79 M in annual direct and indirect household income; and
- 805 direct and indirect jobs.

During the construction phase, the Project will provide the following economic benefits to the state:

- $1,156 Million in direct and indirect output or business turnover;
- $514 Million in direct and indirect value-added;
- $368 Million in direct and indirect household income; and
- 1,697 direct and indirect jobs at the peak of construction.

During the operational phase, the Project will provide the following benefits to the state:

- $900 M in annual direct and indirect output;
- $507 M in annual direct and indirect regional value added;
- $154 M in annual direct and indirect household income; and
- 1,711 direct and indirect jobs.

Contribute financial support to the region, NSW and Australia with taxation and royalty benefits amounting to a net present value of $346 Million ($1.58 Billion undiscounted value) over the 28 year Project life.

9.3 Alternatives Considered

Since the granting of the WACJV mining authorities in 1995, extensive exploration programs and detailed feasibility studies have been carried out in order to identify the most efficient and environmentally responsible mining operation to extract the coal reserves. This process has included the consideration and refinement of numerous mine plans and operational alternatives.

The objective of these studies was to develop a mine plan that considered financial viability, the principles of ESD and the minimisation of potential negative environmental and social impacts, whilst maximising coal recovery and retaining operational flexibilities.

From the outset of Project planning, open cut mining options were discarded due to the substantial depth of the resource. Other options considered and discounted are briefly described below.

Option 1: The 'Do Nothing' option was rejected as it would result in the relinquishment of the WACJV Mining Authorities to the NSW Government. This would result locally in a loss of employment opportunities, socio-economic benefits and royalties or other payments to the Federal, NSW and Local Governments predicted for the Project.

This option would fail to maximise resource recovery and therefore was not considered to meet the Objects of the EP&A Act, in particular that of encouraging the proper development of natural resources for the purpose of promoting the social and economic welfare of the community.

Option 2: Involved the development of an underground mining operation utilising the bord and pillar underground mining method. This method, which generally results in a lower level of surface subsidence above the mine Extraction Area relative to longwall mining, was investigated and deemed unviable for extraction of a large resource at significant depth due to safety implications and the lack of economic feasibility (high initial capital cost and higher operating costs).

This option would also result in a large portion of the resource being sterilised and the remainder more than likely not being economically viable for exploitation.

Option 3: The Project as it is proposed and assessed in this EIS is a 28 year underground longwall mining operation within the Extraction Area. This option will maximise the social and economic benefits of the Project while minimising impacts on environmental aspects such as surface water regimes, water supply, ecology, Aboriginal archaeology and soils.

This option was considered to be the best alternative in terms of meeting the principles of ESD and the Objects of the EP&A Act.

9.4 Project Development Process

9.4.1 Environmental Benefits

Following selection of the preferred mining method, an extensive range of options for the development of the Project mine plan were evaluated in Project feasibility studies. These assessments were conducted to identify the most efficient and socially responsible mining option to extract the coal reserve, resulting in a number of benefits to the environment through changes in the mine plan design.

The mine plan selected (when compared to other mine plan options considered) will provide the following benefits to the environment:

- Modification to mine layout within the Hue Hue MSD to ensure consistency with local subsidence criteria;
- Restrictions to longwall panel design and layouts to ensure protection of surface and groundwater systems in key areas surrounding Jilliby Jilliby Creek and other surface water channels;
- Removal of specific longwall panels from the mine plan to avoid the Wyong River and its associated alluvium to address perceived community risks in relation to these features;
- Minimised ecological disturbance footprint and a reduction in potential surface water and visual impacts due to the location of the Tooheys Road and Buttonderry sites; and
- Major reduction in infrastructure development footprint (ecological, surface water, air quality, noise and visual impacts) through the removal of a CHPP and associated infrastructure from the Project design, whilst locating the remaining required infrastructure in existing cleared or disturbed areas.

9.4.2 Economic Costs

The implementation of the various Project design changes to further reduce environmental impacts resulted in a number of associated socio-economic costs to WACJV, including:

- Sterilisation of significant coal reserves (approximately 20 Mt) due to modified longwall panel layout;
- Development of water and sewerage infrastructure connections to the Tooheys Road and Buttonderry Sites;
- Reduced coal values due to not including a CHPP for the Project;
- Additional capital costs in drift development for site connectivity rather than alternative transport options; and
- Acquisition of redundant land holdings for WACJV for areas no longer required for Project infrastructure.

9.5 Environmental Impacts

The Project has been assessed with certainty based on a worst case scenario and assuming that operations will be undertaken at a maximum coal production rate of 5 Mtpa over an exaggerated Extraction Area, with all feasible and reasonable management and mitigation measures applied (as described in this EIS).

The Project mine plan has been prepared to facilitate resource extraction and economic productivity within the constraints of the site and all relevant environmental impact criteria.

The environmental assessment of the Project has adopted the following general methodology:

- Considering the objects of the EP&A Act, including the principles of ESD and leading practice environmental and social standards (Section 4);
- Performing a Project risk assessment (Section 6);
- Consultation with stakeholders to identify any additional issues to be addressed in this EIS (Section 5);
- Undertake a detailed technical assessment to quantify potential environmental impacts with certainty (Section 7); and
- Develop environmental management and mitigation measures (Section 7 and 8).

Project impacts are outlined in Section 7 with the most significant environmental impacts (despite the application of all reasonable and feasible management controls) summarised below.

9.5.1 Subsidence

Project-induced subsidence impacts on identified natural and man-made sensitive surface features were assessed in great detail in this EIS. Of the 245 residences within the Extraction Area, 88 are situated within the Hue Hue MSD. Impacts on these residences are predicted to be within the Hue Hue MSD subsidence design criteria, that is, these are expected to be limited to minor serviceability impacts on these residences. The remaining 157 residences within the Extraction Area are situated within the Wyong MSD.

The maximum tilt predicted as a result of the Project is not expected to exceed the Wyong MSD criteria at the majority of these residences. Thirteen residences may require more substantial remediation works which if required, will be undertaken in consultation with the landowner.

Impacts on sealed roads will be of a nature that can be remediated using normal road maintenance techniques. The predicted subsidence levels are unlikely to result in any adverse impacts on local road bridges. Impacts to powerlines as a result of subsidence are unlikely and will generally be of a minor nature. Impacts to powerlines that do arise can be remedied through minor adjustments to the cables or poles.

The Project mine plan has been designed so that any environmental consequences of mine subsidence are minimised wherever practicable. The chain pillars have been designed so that they yield when isolated in the goaf, which will result in a reduction in the impacts of long-term subsidence. Various design iterations have been made to the mine plan to minimise the extent and severity of potential flood impacts caused by mine subsidence, including changes to the longwall panel layout, panel geometry and location of underground roadways.

Detailed monitoring of actual subsidence behaviour will be undertaken to validate the model predictions presented in this EIS. This will enable adaptive management to be incorporated into ongoing detailed mine plan design. Results will be incorporated in the detailed Extraction Plan to be approved by relevant regulators.

9.5.2 Surface Water

A site surface water management system is proposed to both provide suitable water for mine site use and to ensure that untreated mine water is not released from the site. The maximum external water requirement of 52 ML peaks in Year 1 before quickly decreasing to 20 ML/year by Year 4. After Year 4, the external water demand peaks at 49 ML/year in Year 14 before decreasing to approximately 20 ML/year for the remainder of the Project life.

The water management system will intercept surface water runoff within the Buttonderry Creek and Wallarah Creek catchments. The Wallarah Creek catchment will be reduced by approximately 36 ha, which represents 9.3% of the catchment area to the downstream extent of the Project Boundary. The Buttonderry Creek catchment will be reduced by approximately 7.4 ha, which represents 1.1% of the catchment area to the downstream Project Boundary.

Excess treated water will be discharged into a tributary of Wallarah Creek. The maximum annual discharge volume occurs in Year 7, and ranges from 50 ML/year in a median rainfall year to over 500 ML/year in a very wet year. These controlled discharges will compensate for the reduction in the Wallarah Creek catchment. The net impact of the Project is a 2% to 3% increase in flow volumes along Wallarah Creek.

Discharges to Wallarah Creek will be treated to a quality that is similar to the background water quality of the creek. The only other discharges will be from the Entrance Dam at the Buttonderry Site. Since the Entrance Dam is a sediment dam, overflows from this dam will be in the form of treated water. Therefore, the Project will not significantly affect water quality in receiving waterways.

WACJV will implement the proposed water management system to minimise impacts on surface water. WACJV will also conduct monitoring of water quality and stream stability.

9.5.3 Groundwater

The extraction of coal from the WGN seam will result in the depressurisation of the coal seam and adjacent strata. Due to the very low hydraulic conductivities of the hard rock strata, the upward migration of the zone of depressurisation is limited. As a result, the alluvial aquifers in the Yarramalong and Dooralong Valleys are not predicted to be impacted by the deep strata depressurisation resulting from the Project.

The only drawdown in the water table is predicted to occur near the Tooheys Road Site due to the development of the drift, and is not expected to have a magnitude of greater than a few metres.

The loss of baseflow from alluvial aquifers to creek catchments is predicted to be 2 mL/day (millilitres per day) per square metre of alluvial land surface. Given that recharge from rainfall is estimated at 130 mL/day (assumed 4% of rainfall), this loss of water can easily be restored.

Mining induced subsidence can cause shallow cracking at the hard rock surface below the base of the alluvium. These cracks increase the storage capacity of the alluvium, thereby increasing the demand on rainfall recharge. The cracking induced by the Project is predicted to increase the storage capacity by only a negligible amount (0.05%). Therefore, the quantity of runoff that will be diverted to groundwater is minimal.

The daily groundwater influx to the underground workings of the mine is predicted to peak at 2.5 ML/day in year 22 of the Project. Dewatering of the underground workings will be conducted in accordance with the mine water management system and will not result in any measurable environmental harm.

The underground storage of salt and brine is not predicted to have any significant impact on water quality. For at least 500 years after mining, the underground workings will act as a groundwater sink. This prevents the highly saline salt and brine from migrating outwards.

A comprehensive groundwater monitoring program will be incorporated in the EMP, and will include monitoring of depressurisation, mine water seepage and water quality. The existing monitoring network will also be expanded to adequately measure strata hydraulic gradients and rock mass permeabilities. The results of monitoring will be used to validate and verify the groundwater model for the Project. The groundwater monitoring program will be reviewed annually and updated as required.

9.5.4 Amenity

With the implementation of all reasonable and feasible mitigation measures, no operational air quality or noise impacts at any private residences above relevant criteria are predicted to occur as a result of the Project operations. WACJV will develop an EMP and management plans for the Project, including air quality and noise monitoring and practical air quality and noise minimisation management measures.

With the implementation of landscape works utilising native vegetation, both close range and distant views to the Tooheys Road Site views will experience a low visual impact.

For the Buttonderry Site, effective enhancement of the visual catchment will be achieved by screen planting along the Hue Hue Road boundary and adjacent to the entrance and the access roadway, reducing any impacts to low level.

9.5.5 Greenhouse Gas

Average annual scope 1 emissions from the Project (0.2 Mt $CO_{2\text{-}e}$) will represent approximately 0.04% of Australia's annual average commitment under the Kyoto Protocol (591.5 Mt $CO_{2\text{-}e}$) and a very small portion of global greenhouse emissions, given that Australia contributed approximately 1.5% of global GHG emissions in 2005 (Commonwealth of Australia, 2011).

The Project will develop an Energy and Greenhouse Strategy which will address interim and long term energy and greenhouse management plans and initiatives. The Project will assess and implement energy and greenhouse management initiatives during the design, operation and decommissioning phases.

9.5.6 Ecology and Offsets

The Ecological Impact Assessment did not identify any EPBC Act listed EECs during Project surveys. A total of 13 vegetation communities were identified within the Project Boundary, of which eight are listed as EECs under the TSC Act. Over 450 flora species (approximately 5% exotic) were recorded within the Project Boundary and Subsidence Impact Limit and six threatened flora species listed under the TSC Act and / or EPBC Act were identified. Over the course of surveys of the area within the Project Boundary and Subsidence Impact Limit, 29 threatened and eight migratory fauna species have been identified.

Over the life of the Project, approximately 89 ha of vegetation will be directly impacted, consisting of remnant and regenerating forest and woodland communities and large areas of open grassland and scattered trees located within the Disturbance Boundary. Suitable habitat is present within the Project Boundary and Subsidence Impact Limit for a number of threatened flora species listed under the EPBC Act and TSC Act. The Project will result in the removal of forest, woodland and grassland vegetation communities which provide foraging, shelter and breeding habitat for fauna species in the area.

Approximately 8.8 ha of potential GDE vegetation listed as EECs under the TSC Act will be removed by the Project however; these areas represent a very small proportion of the extent of these communities in the area and the locality. The assessment of the vegetation communities present within Project Boundary and Subsidence Impact Limit indicates that due to the small area of each community that will be directly impacted and the large areas that remain, no significant impact to GDEs is predicted to occur.

The Biodiversity Offset Strategy for the Project has been developed to conserve specific areas within the existing land holdings of WACJV as biodiversity offsets. The Biodiversity Offset Strategy will address the predicted loss of 53.3 ha of remnant forest and woodland by provision of 200.7 ha of forest and woodland within the offset areas, or a ratio of 2.9:1 for total vegetation to be cleared.

The Biodiversity Offset Strategy will address the predicted loss of 13.2 ha of State listed EECs by the provision of 83 ha of like-for-like vegetation at a ratio of 6.3:1.

The Biodiversity Offset Strategy will provide 200.7 ha of forest and woodland that provides habitat for the threatened species recorded from within the Project Boundary.

9.5.7 Heritage

Recorded within and surrounding the Project Boundary were 11 Aboriginal archaeological sites. Of the 11 sites, five axe grinding grooves are predicted to receive subsidence impacts. One open site at Tooheys Road Site is predicted to receive direct impacts associated with disturbance and the remaining six sites are not predicted to be impacted.

WACJV will develop an Aboriginal Cultural Heritage Management Plan for the Project which will be guided by specific policies and procedures to manage sites within the Project Boundary and periodically reviewed in consultation with Aboriginal stakeholders and relevant regulators.

Four items of historic heritage significance and one item of potential heritage significance have the potential to be affected by mining induced subsidence or the possibility of increased flooding levels.

Detailed monitoring of the sites will be undertaken during longwall mining in accordance with management plans to be developed in consultation with relevant regulators to ensure the impact on heritage items is minimised.

9.5.8 Transport

The Project is not predicted to impose any adverse impacts on the surrounding road network as a result of the increased traffic associated with construction and operational facilities. Traffic expected to be generated as a result of current development approvals for developments in proximity to the Project and current background traffic growth rates are expected to force many of the intersections in the area to perform or continue to perform at unacceptable levels in the future.

The main contributor to future traffic levels in the area is expected to be the WEZ which is scheduled to be in operation from Year 5 of the Project. WACJV will prepare a Traffic and Transport Management Plan to manage possible traffic impacts resulting from construction and operation of the Project and to ensure the traffic network can be managed throughout the Project.

9.6 Consistency with the Objects of the EP&A Act

Section 5 of the EP&A Act describes its objects which are reproduced below followed by a consideration as to how the Project achieves these:

> *"To encourage the proper management, development and conservation of natural and artificial resources, including agricultural land, natural areas, forests, minerals, water, cities, towns and villages for the purpose of promoting the social and economic welfare of the community and a better environment."*

WACJV will develop an underground coal mine to extract the coal resource with minimal surface disturbance, while at the same time, provide for the management of land owned by the WACJV and the establishment of a Biodiversity Offset Strategy to conserve forests and natural systems.

The Project will not affect the region's water supply and through the additional employment generated will assist in sustaining the socio-economic viability of the nearby population, towns and the Central Coast region. All of these elements of the Project will promote the welfare of the community while protecting and providing benefits to the environment.

> *"To encourage the promotion and co-ordination of the orderly and economic use and development of land."*

The Project will result in the recovery of a valuable coal resource from within NSW's identified coal reserves. The recovery of this coal resource has been designed to occur with the minimal amount of surface disturbance, while maximising the economic benefit to NSW.

The conversion of land within the Project Boundary will be to one with a higher value production activity (underground mining) which offers the greatest potential for regional growth while maintaining the vast majority of existing surface land uses (agriculture, lifestyle, etc). The Project will help to stimulate the economy with regional spending for production related costs and with wages for labour which will also contribute to the regional economy.

> *"To encourage the protection, provision and co-ordination of communication and utility services."*

The Project will expand utility services in the local area, improving the potential for increased connectivity by other adjacent industrial users. The provision of services such as water, power and telecommunications to this location is currently low. Development of the Infrastructure Area by the Project will facilitate the provision of these and other services. As the Project may in some cases underwrite the initial development cost of these services, any subsequent access by other parties located in the vicinity of the Project will be improved.

> *"To encourage the provision of land for public purposes."*

The Project will result in the establishment of a Biodiversity Offset Strategy which will include approximately 260 ha of land to be set aside for recreational, scientific and conservation purposes.

> *"To encourage the protection, provision and co-ordination of community services and facilities."*

The net economic benefit resulting from the Project will encourage the provision and co-ordination of community services and facilities to the Central Coast region.

The Project will also implement a VPA which is being developed in consultation with WSC for the ongoing provision of community services, facilities and other local infrastructure.

> *"To encourage the protection of the environment, including the protection and conservation of native animals and plants, including the Threatened species, populations and ecological communities, and their habitats."*

The Project will result in the establishment of Biodiversity Offsets that are specifically designed to protect and conserve native animals and plants in the long term. Further to this, management and mitigation measures will be implemented to minimise any ecological impacts during construction and operation of the Project.

"To encourage ecologically sustainable development."

The Project has evolved throughout a comprehensive planning, stakeholder engagement and environmental assessment process to ensure that it appropriately considers the principles of ESD. The impacts of the Project have been predicted in a detailed assessment process outlined in this EIS and management measures to address them incorporated into the Project as required, thus addressing the Precautionary Principle.

The environmentally optimised recovery of the in situ coal resource and the establishment of the Biodiversity Offset Strategy address the principles of Intergenerational Equity and Improved Valuation. Further, the Biodiversity Offset Strategy proposed for the Project also addresses the principle of the Conservation of Biological Diversity and Ecological Integrity.

"To encourage the provision and maintenance of affordable housing."

At a state level, the economic benefits that will flow from the Project to the NSW Government will assist in ensuring the provision and maintenance of affordable housing. Further, the predicted low impacts on housing demand from the Project as a consequence of the proposed mitigation measures are consistent with this object of the Act.

"To promote the sharing of the responsibility for the environmental planning between the different levels of government in the state."

The consultation engagement process undertaken during the preparation of this EIS at all levels of Government has promoted environmental planning and decision making responsibilities being well considered and integrated.

"To provide increased opportunity for public involvement and participation in environmental planning and assessment."

Section 5 describes the stakeholder engagement process relied upon during the preparation of this EIS. This process was extensive and hence fulfils this object of the Act.

9.7 Consistency with the Principles of ESD

The objects of the EP&A Act adopt the principles of ESD in the application of the Act. The principles of ESD are also articulated in Section 6(2) of the *Protection of the Environment Administration Act 1991* where it is stated that "*ecologically sustainable development requires the effective integration of economic and environmental considerations in decision-making processes. Ecologically sustainable development can be achieved through the implementation of the following principles and programs: …*"

The Principles of ESD are listed below with a summary of how the Project seeks to address each.

9.7.1 Precautionary Principle

The precautionary principle is "*that if there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation.*

In the application of the precautionary principle, public and private decisions should be guided by:

- *careful evaluation to avoid, wherever practicable, serious or irreversible damage to the environment, and*
- *an assessment of the risk-weighted consequences of various options,"*

Adherence to the precautionary principle requires avoiding serious or irreversible environmental damage by properly assessing potential impacts and taking the necessary mitigation measures.

This EIS identifies, with certainty, all environmental impacts from the development of the Project, which has been designed to avoid serious or irreversible environmental damage.

To ensure this, the assessment approach in this EIS is based on a 'worst case scenario' basis, where if potential serious or irreversible damage was identified, an appropriate re-design of the Project was implemented to avoid those consequences.

Additionally, this EIS adopted a risk-based approach to assessment whereby key aspects of the Project with a high risk profile have been peer reviewed by authoritative experts to ensure certainty over the predicted impacts of the Project.

9.7.2 Intergenerational Equity

This principle requires "*that the present generation should ensure that the health, diversity and productivity of the environment are maintained or enhanced for the benefit of future generations*".

The Project design, determined through the examination of the alternatives along with the commitments to environmental management systems and the management and mitigation measures proposed, will operate to ensure that there is no significant effect on the environment as a result of the Project which would diminish the health, diversity or productivity of the environment for future generations.

This has been achieved by limiting the scale of the Project and excluding surface development from environmentally sensitive areas (e.g. wetlands). To comply with this principle, the Project has been subjected to relevant development and operational standards. In addition, offset areas will be established for the Project as part of the Biodiversity Offset Strategy.

In particular, expert peer review of key scientific studies have confirmed with certainty that the Project will not measurably impact on the health, diversity and productivity of the region's water resources.

9.7.3 Biodiversity Conservation

This principle requires the "*conservation of biological diversity and ecological integrity—namely, that conservation of biological diversity and ecological integrity should be a fundamental consideration*" of any development proposal.

The design of the Project excludes, where possible, areas of native vegetation and endangered species. Along with the Biodiversity Offset Strategy committed to by WACJV, this demonstrates adherence to this principle.

These actions will ensure that the Project will not threaten the preservation of biodiversity and ecological integrity of the area and that the biodiversity and ecological value of the area is maintained and potentially improved in the long term.

9.7.4 Improved Valuation

This principle addresses "*improved valuation, pricing and incentive mechanisms—namely that environmental factors should be included in the valuation of assets and services, such as:*

- *Polluter pays—that is, those who generate pollution and waste should bear the cost of containment, avoidance or abatement,*
- *The users of goods and services should pay prices based on the full life cycle of costs of providing goods and services, including the use of natural resources and assets and the ultimate disposal of any waste,*
- *Environmental goals, having been established, should be pursued in the most cost effective way, by establishing incentive structures, including market mechanisms, that enable those best placed to maximise benefits or minimise costs to develop their own solutions and responses to environmental problems."*

Since WACJV will be a producer of coal, only the 'polluter pays principle' is applicable through:

- The requirement to obtain WALs in accordance with the relevant WSP when in places, to ensure water extraction limits are not exceeded;
- Capital investment in the acquisition of offset lands and the establishment of rehabilitation programs to protect and enhance local and regional ecological biodiversity values;
- Direct payments to the Commonwealth government in accordance with requirements of the Carbon Tax; and
- The sterilisation of coal resources to manage stakeholder expectations and environmental impacts.

WACJV also accepts the cost of mitigation measures designed to reduce impacts, such as air quality management and dust suppression, and as such abides by this principle to the extent that it is applicable.

9.8 Matters for Consideration Under Section 79C EP&A Act

The Minister for Planning and Infrastructure (or delegate) is to take into consideration the following matters in Section 79C of the EP&A Act as are of relevance to the Project:

"(a) *the provision of:*

(i) *any environmental planning instrument, and*

(ii) *any proposed instrument that is or has been the subject of public consultation under this Act and that has been notified to the consent authority (unless the Director-General has notified the consent authority that the making of the proposed instrument has been deferred indefinitely or has not been approved), and*

(iii) *any development control plan, and*

(iiia) *any planning agreement that has been entered into under section 93F, or any draft planning agreement that a developer has offered to enter into under section 93F, and*

(iv) *the regulations (to the extent that they prescribe matters for the purposes of this paragraph), and*

(v) *any coastal zone management plan (within the meaning of the Coastal Protection Act 1979) that apply to the land to which the development application relates,*

(b) *the likely impacts of that development, including environmental impacts on both the natural and built environments, and social and economic impacts in the locality,*

(c) *the suitability of the site for the development,*

(d) *any submissions made in accordance with this Act or the regulations,*

(e) *the public interest."*

The sections below describe how this EIS has addressed each in relation to the Project.

9.8.1 Permissibility and Planning Controls

The Project is wholly located within the Wyong LGA. The local EPI governing land use in the Wyong LGA is the Wyong LEP. The Tooheys Road Site is primarily zoned 4(e) Regional Industrial and Employment Development, with a small area zoned 7(g) Wetlands Management.

Under the Wyong LEP, mining is permissible in the 4(e) zone with Development Consent. The Buttonderry Site is zoned 1(c) Rural Holdings where development ancillary to mining is permitted with Development Consent.

The Project's underground Extraction Area is largely zoned 1(a) Rural, 1(c) Non Urban Constrained Lands or 1(f) Forestry in respect of which mining is permissible with development consent. There are several areas within the underground Extraction Area which are zoned 7(a) Conservation, 7(b) Scenic Protection, 7(c) Scenic Protection: Small Holdings or 6(a) Open Space and Recreation or where mining is prohibited.

The Mining SEPP applies to the whole of NSW and pursuant to clause 5(3) of the Mining SEPP it prevails over any other EPI to the extent of any inconsistency. The practical effect of clause 5(3) is that if there is any inconsistency between the provisions in the Mining SEPP and those contained in any other EPI, including relevantly the Wyong LEP, the provisions of the Mining SEPP will prevail.

As the Project in its entirety can be characterised as development for the purpose of "underground mining" (which incorporates in its definition the defined term "mining"), the Project is permissible with Development Consent on the land on which the Project will be carried out.

Chapters 13, 28, 30 and 75 of the Wyong DCP potentially apply to the area within the Project Boundary. Impacts from the Project to conservation lands, landscape and scenic protection, bushfire protection, noise, access, water supply and wetlands have been assessed and mitigation measures formulated in Section 7 of this EIS.

Section 93F enables a VPA to be established which may replace the imposition of a condition under Section 94 or Section 94A. WACJV has commenced discussions with WSC in relation to entering into a VPA to meet the required contributions in relation to the Project under Division 6 of Part 4 of the EP&A Act and in consideration of WSC's *Wyong Shire Council Planning Agreements Policy*.

No coastal zone management plan applies to the area within the Project Boundary.

This EIS has been prepared in accordance with Part 2 of Schedule 2 of the EP&A Regulation as shown in Section 4.1. Detailed design as required under Schedule 1 of the EP&A Regulation is provided in Appendix E. DGRs were issued for the Project under Part 2 of Schedule 2 of the EP&A Regulation on 12 January 2012. Section 5.4.2 lists each DGR and indicates where each is addressed in this EIS.

9.8.2 Natural and Built Environment Impacts

This EIS provides a detailed assessment of identified potential impacts on the natural and built environments. Section 7 provides a summary of the predicted impacts associated with the Project. The Project design minimises the environmental impacts to the natural and built environment whilst maximising resource recovery.

9.8.3 Site Suitability

Abundant natural resources in the Newcastle Coalfield have enabled a long history of underground coal mining in the area. Currently operating coal mines in the vicinity of the Project include: Mandalong Colliery, Cooranbong Colliery, Newstan Colliery, Chain Valley Colliery, Myuna Colliery, Awaba Colliery and Mannering Colliery.

Land zoning within and adjacent to the Tooheys Road Site is either '*Industrial*' or '*Investigation*' which allows for mining under the objects of those zones as described in the Wyong LEP. Although the Buttonderry Site is located on land zoned as 'Rural', it is adjacent to the WSC Buttonderry Waste Facility and the approved Warner Industrial Park, leading to a commercial and / or industrial scenic quality in the area. As such, both the Tooheys Road and Buttonderry sites lend themselves to the industrial land use proposed.

The Project is not likely to have a significant impact regarding land use trends or be incompatible with any of those existing, approved or likely preferred uses of land surrounding the Infrastructure Boundary. The Project will not impact on the existing or proposed uses of the land above the Extraction Area. The Project is not likely to have a significant impact regarding land use trends or be incompatible with any of those existing, approved or likely preferred uses of land above the Extraction Area.

The location of the Tooheys Road and Buttonderry Infrastructure Areas are proposed in locations commensurate with the largely industrial land use and extensive transport routes in the vicinity. The area accommodates a range of industrial land uses from light industrial, commercial and (more remotely) housing developments.

A significant buffer of over 1.5 km exists between the Tooheys Road Site and private residences at Wallarah to the south across the large, largely vacant blocks and the Motorway Link Road. The Tooheys Road Site is also buffered to private residences in the east at Blue Haven by a clay quarry, tile factory, railway line, industrial subdivision, the land that will host the Bushells Ridge Road Employment Estate and large, mostly vacant blocks. To its north and west are largely rural residential properties whose buffer zone from the Project is bisected by the F3 Freeway.

The Buttonderry Site is immediately west of the 340 ha WEZ site which is zoned for large scale, industrial purposes in the vicinity of the intersection of Sparks Road and the F3 Freeway. To the north is the Buttonderry Waste Facility which has operated since 1990 and has an estimated 50 year life (WSC, 2012).

Major transport routes traverse the area to the east of the Project Boundary, including the F3 Freeway, Motorway Link Road and the Main Northern Railway Line (which the Project's rail loop is proposed to connect to).

The proposed surface facilities for the Project are therefore in keeping with the surrounding land uses.

9.8.4 Submissions

The Minister will consider any submissions made in accordance with the EP&A Act or the EP&A Regulation.

9.8.5 Public Interest

On the basis of this EIS which has quantified the Project's social and environmental impacts with a high degree of scientific certainty, it is available to conclude that the Project is consistent with the objects of the EP&A Act, the principles of ESD and that the economic and social benefits of the Project outweigh its social and environmental costs.

As such, it may be concluded that the Project is in the public interest.

9.9 Conclusion

The Project has been rigorously environmentally assessed in accordance with the EP&A Act, its 'objects', including the principles of ESD, and by processes and in the manner required by the DGRs. This assessment has concluded that the Project should be approved under the EP&A Act.

There are environmental costs which have been identified and which are capable of being acceptably managed by operational controls, land acquisition and management plans that would be established and adopted as approved by the Director-General of Planning & Infrastructure and appropriate other Government agencies and authorities. Ecological and long term costs have been minimised and will be offset by management strategies to maintain and improve vegetation and ecological values in the long term.

The Project mine plan appropriately represents a material reduction in scale and impact from the maximum resource extraction mine plan and justifiably sacrifices a material proportion of the remaining in-situ coal reserve. The Project as proposed meets environmental and social requirements and still results in a mine plan and development for which there is a demonstrated need and from which there are material economic, environmental and social benefits.

The Project will maximise the economic and social value from the remaining coal resource by a mine plan that will appropriately address the environmental and socio-economic constraints and the objects of the EP&A Act, including the principles of ESD.

The Project will provide net benefits of $671 M (net present value) over the 28 year Project life and:

- Maximise the recovery of a high quality, thermal coal resource for which there is an increasing global demand;
- Create approximately 1,100 construction jobs in the region, which is an area with a high unemployment rate;
- Create approximately 800 (300 direct and 500 indirect) jobs in the region during the operational phase;
- Create approximately 1,700 (direct and indirect) jobs in NSW during both the construction and operational phases;
- Continue and extend financial support to the region, NSW and Australia with taxation and royalty benefits of $1.58 Billion (net present value of $346 M) over the 28 year Project life; and
- Achieve the most efficient economic use of the land.

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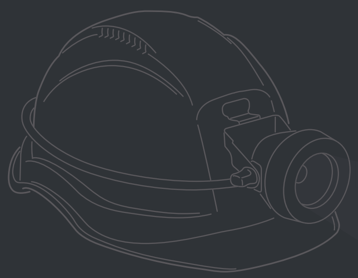
Abbreviations



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Abbreviations 10

Table 104 provides a list of abbreviations used in this EIS.

Table 104 Abbreviations

Abbreviation	Description
A	Authorisation
AADT	Annual Average Daily Traffic
ABS	Australian Bureau of Statistics
AC	Alternating Current
ACARP	Australian Coal Association Research Program
ACHMP	Aboriginal Cultural Heritage Management Plan
AI Policy	Aquifer Interference Policy
AHD	Australian Height Datum
AHIMS	Aboriginal Heritage Information Management System
AHIP	Aboriginal Heritage Impact Permit
ALS	Aerial Laser Survey
Ambient Air-NEPM	National Environment Protection Measures for Ambient Air Quality
ANZECC	Australian and New Zealand Environmental Conservation Council
AQMP	Air Quality Management Plan
ARI	Average Recurrence Interval
ARTC	Australian Rail Track Corporation
AS	Australian Standard
ASS	Acid Sulphate Soils
AVTG	Assessing Vibration: a Technical Guideline
AWS	Automated Weather Station
bcm	bank cubic metres
BMP	Biodiversity Management Plan
BoM	Bureau of Meteorology
BOMP	Biodiversity Offset Management Plan
C_2F_6	Hexafluoroethane
CALMET	A diagnostic meteorological modelling system known as California Meteorological
CALPUFF	A dispersion model used to predict the maximum 24 hour PM_{10}, annual average PM_{10}, annual average TSP and annual average dust deposition.
CAP	Catchment Action Plan
CCC	Community Consultative Committee
CCRS	Central Coast Regional Strategy
CCUWS WSP	*Water Sharing Plan for the Central Coast Unregulated Water Sources 2009*
CEEC	Critically Endangered Ecological Community
CF_4	Tetrafluoromethane

Abbreviation	Description
CH_4	Methane
CLM Act	*Contaminated Land Management Act 1997*
CMA	Catchment Management Authority
CMHS Act	*Coal Mines Health and Safety Act 2002*
CMTS	Cellular Mobile Telephone Service
CO_2	Carbon dioxide
$CO_{2\text{-}e}$	Carbon dioxide equivalent
Coastal Policy	*NSW Coastal Policy 1997*
CP Act	*Coastal Protection Act 1979*
CRG	Community Representative Group
Crown Lands Act	*Crowns Lands Act 1989*
DA	Development Application
DC	Direct Current
dBA	The peak sound pressure level, expressed as decibels (dB) and scaled on the '*A-weighted*' scale, which attempts to closely approximate the frequency response of the human ear
DCCEE	Commonwealth Department of Climate Change and Energy Efficiency
DEC	NSW Department of Environment and Conservation
DECC	NSW Department of Environment and Climate Change
DECCW	Commonwealth Department of Environment, Climate Change and Water (now the Office of Environment and Heritage)
DEWHA	Commonwealth Department of Environment, Water, Heritage and the Arts (now Department of Sustainability, Environment, Water, Population and Communities)
DG Act	*Dangerous Goods (Road and Rail) Transport Act 2008*
DGRs	Director-General's Requirements
DIPNR	NSW Department of Infrastructure Planning and Natural Resources
DLALC	Darkinjung Local Aboriginal Land Council
DoL	NSW Department of Lands
DoS	Degree of Saturation
DP&I	NSW Department of Planning & Infrastructure
DPI	NSW Department of Primary Industries
AI Policy	NSW Aquifer Interference Policy
Draft NWSP	Draft North Wyong Structure Plan
DS Act	*Dams Safety Act 1978*
DSC	*Dams Safety Committee*
DTIRIS - MR	NSW Department of Trade and Investment, Regional Infrastructure and Services – Minerals and Resources
DTIRIS - DRE	NSW Department of Trade and Investment, Regional Infrastructure and Services – Division of Resources and Energy
DTM	Digital Terrain Model
EC	Electrical Conductivity
ECRTN	*Environmental Criteria for Road Traffic Noise 1999*
EEC	Endangered Ecological Community
EIS	Environmental Impact Statement
EL	Exploration Licence
EMP	Environmental Monitoring Program

Abbreviation	Description
EMS	Environmental Management System
EMU	Extraction Management Unit
ENM	Environmental Noise Model
EP&A Act	*Environmental Planning & Assessment Act 1979*
EP&A Regulation	*Environmental Planning & Assessment Regulation 2000*
EPA	NSW Environmental Protection Authority
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth)
EPL	Environmental Protection Licence
EPI	Environmental Planning Instrument
ERM	Environmental Resources Management
ESD	Ecologically Sustainable Development
ESFM	Ecologically Sustainable Forest Management
FDM	Floodplain Development Manual
FLAC	Fast Lagrangian Analysis of Continua
FIA	Flood Impact Assessment
Fisheries Act	*Fisheries Management Act 1994*
Forestry Act	*Forestry Act 1916*
FMZ4	Forest Management Zone 4
GCC	Gosford City Council
GDA	Geocentric Datum of Australia
GHA	G Herman and Associates
GHG	Greenhouse Gas
GLVIA	Guidelines for Landscape and Visual Impact Assessment
GPS	Geographical Positioning System
GTLAC	Guringai Tribal Link Aboriginal Corporation
GWC	Gosford and Wyong Council
GWP	Global Warming Potential
ha	Hectare
Heritage Act	*Heritage Act 1977*
HFCs	Hydrofluorocarbons
HHMP	Historic Heritage Management Plan
HIL	Health Investigation Levels
HIPAPS	Hazardous Industry Planning Advisory Papers
HS	Historic Site
HVAS	High Volume Air Sampler
ICCRs	OEH Interim Community Consultation Requirements
ICOMOS 1979	Australian International Council on Monuments and Sites for the conservation of places of cultural significance in 1979
ICNG	Interim Construction Noise Guideline
INP	Industrial Noise Policy
IPM	Incremental Profile Method
JJCW WSP	*Water Sharing Plan for the Jilliby Jilliby Creek Water Source 2003*

Abbreviation	Description
km	Kilometres
km^2	Square Kilometres
Kores	Kores Australia Pty Ltd
kV	Kilovolts
L	Litre
LA1	The noise level exceeded for 1% of the time
LA10	A noise level exceeded for 10% of the time
LA90	Commonly referred to as the background noise, this is the level exceeded 90% of the time
LAeq	The summation of noise over a selected period of time. It is the energy average noise from a source, and is the equivalent continuous sound pressure level over a given period
LAmax	Maximum noise level measured at a given location over the fifteen minute interval
LDO	LD Operations (Chain Valley Coal Mine)
LEP	Local Environment Plan
LGA	Local Government Area
LMCC	Lake Macquarie City Council
LMP	Land Management Plan
LoS	Level of Service
m	Metres
Mbcm	Million bank cubic metres
MER	Mackie Environmental Research
MGA	Map Grid of Australia
MIC	Maximum Instantaneous Charge
Mining Act	*Mining Act 1992*
ML	Megalitres
mL	Millilitres
MLA	Mining Lease Application
MNES	Matter of National Environmental Significance
MSB	Mine Subsidence Board
MSC Act	*Mine Subsidence Compensation Act 1961*
MSD	Mine Subsidence District
MSDS	Material Safety Data Sheet
MSEC	Mine Subsidence Engineering Consultants
Mt	Million tonnes
Mtpa	Million tonnes per annum
MVA	Mine Ventilation Air
MVKT	Million Vehicle Kilometres Travelled
MW	MegaWatt
MWMS	Mine Water Management System
N_2O	Nitrous oxide
NEPC	National Environment Protection Council
NMP	Noise Management Plan
NOHSC	National Occupational Health and Safety Commission

Abbreviation	Description
NOW	NSW Office of Water
NPV	Net Present Value
NPW Act	*National Parks and Wildlife Act 1974*
NPWS	NSW National Parks and Wildlife Service
NSFC	Northern Sydney Freight Corridor
NT Act	*Native Title Act 1993* (Commonwealth)
NV Act	*Native Vegetation Act 2003*
OC	Organochlorine
OEH	NSW Office of Environment and Heritage (formerly DECCW)
OH&S	Occupational Health and Safety
OP	Organophosphorus
OTDR	Optical Time Domain Reflectometer
OzArk	OzArk Environmental & Heritage Management Pty Ltd
PAC	NSW Planning and Assessment Commission
PAH	Polycyclic Aromatic Hydrocarbons
PASS	Potential Acid Sulphate Soils
PCBs	Polychlorinated biphenyls
pH	Potential of hydrogen
PHA	Preliminary Hazard Analysis
$PM_{2.5}$	Particulate Matter <2.5 microns
PM_{10}	Particulate Matter <10 microns
POEO Act	*Protection of the Environment Operations Act 1997*
Project Boundary	Project Application Boundary
PSNC	Project Specific Noise Criteria
QR	Queensland Rail
RBL	Rating Background Level
RCS	Respirable Crystalline Silica
REP	Regional Environmental Plan
RL	Reduced Level
RMS	NSW Roads and Maritime Service
RNP	Road Noise Policy
RO	Reverse Osmosis
Roads Act	*Roads Act 1993*
ROM	Run of Mine
RRPMs	Raised Reflective Pavement Markers
RTA	NSW Transport, Roads and Maritime Services
Rural Fires Act	*Rural Fires Act 1997*
SCA	State Conservation Area
Secondary Study Area	Combined Wyong, Lake Macquarie and Gosford Local Government Areas
SEPP	State Environmental Planning Policy
SEWPaC	Commonwealth Department of Sustainability, Environment, Water, Population and Communities (formerly Commonwealth Department of Environment, Water, Heritage and the Arts)

Abbreviation	Description
SF_6	Sulfur Hexafluoride
SIR	Subsidence Impact Report
SMS	Subsidence Modelling Study
SRD	NSW Department of State and Regional Development
SSD	State Significant Development
t	Tonne
TARP	Trigger Action Response Plan
TDS	Total Dissolved Solids
The Project	Wallarah 2 Coal Project
tpa	Tonnes per annum
tph	Tonnes per hour
TPH	Total Petroleum Hydrocarbon
TRH	Total Recoverable Hydrocarbons
TSC Act	*Threatened Species Conservation Act 1995*
TSP	Total Suspended Particulates
TSS	Total Suspended Solids
TTIA	Traffic and Transport Impact Assessment
VAC	Visual Absorption Capacity
VIR	Visual Impact Rating
VLCA	Visual Landscape Character Assessment
VPA	Voluntary Planning Agreement
WACJV	Wyong Areas Coal Joint Venture
WAL	Water Access Licence
Water Act	*Water Act 1912*
WEZ	Wyong Employment Zone
WGN Seam	Wallarah-Great Northern Seam
WM Act	*Water Management Act 2000*
WSC	Wyong Shire Council
WSP	Water Sharing Plan
Wyong LEP	*Wyong Local Environmental Plan 1991*

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Wallarah 2
COAL PROJECT

Wallarah 2 Coal Project

Environmental Impact Statement

April 2013

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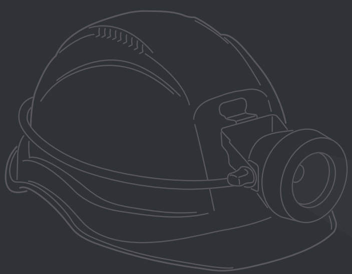
Study Team



Hansen Bailey
ENVIRONMENTAL CONSULTANTS

Study Team 12

Table 105 provides a list of personnel involved in the preparation of this EIS.

Table 105 Study Team

Section	Role / EIS Component	Team Member and Company	
Project Management			
	Managing Director	In-sik Kim	Wyong Areas Coal Joint Venture
	Project Manager	Kenny Barry	
	Environment and Community Manager	Peter Smith	
	Geoinformation Manager	Keith Bartlett	
	Commercial Manager	Chan Park	
	Geology & Subsidence Co-ordinator	John Edwards	
EIS Management			
	Project Director	James Bailey	Hansen Bailey
	Project Manager	Dianne Munro	
	Project Coordinator	Belinda Hale	
	Project Coordinator	Andrew Wu	
	Peer Review	Nathan Cooper	
Stakeholder Engagement			
	Project Manager	Kenny Barry	Wyong Areas Coal Joint Venture
	Environment and Community Manager	Peter Smith	
	Project Director	James Bailey	Hansen Bailey
	Project Coordinator	Belinda Hale	
EIS Sections			
	Executive Summary	Dianne Munro	Hansen Bailey
1	Introduction	Belinda Hale	
2	Existing Environment	Andrew Wu	
3	The Project	Belinda Hale	
4	Regulatory Framework	Dianne Munro	
5	Stakeholder Engagement	Belinda Hale	
6	Risk Assessment	Dianne Munro	
7	Impacts, Management and Mitigation	Dianne Munro, Nathan Cooper, Belinda Hale, Andrew Wu and Renee Attard	
8	Management & Mitigation Summary	Belinda Hale	
9	Project Justification	Dianne Munro	
10	Abbreviations	Andrew Wu	
11	References		
12	Study Team		

Section	Role / EIS Component	Team Member and Company	
Appendices			
Appendix A	Schedule of Land to which this EIS Applies	Belinda Hale	Hansen Bailey
Appendix B	Regulatory Correspondence	Belinda Hale	Hansen Bailey
Appendix C	Geology Report	John Edwards	Wyong Areas Coal Joint Venture
Appendix D	Stakeholder Engagement	Belinda Hale	Hansen Bailey
Appendix E	Detailed Design Drawings	Garry Wardley	CPG Resources
Appendix F	Revised Environmental Risk Assessment	Belinda Hale	Hansen Bailey
Appendix G	Subsidence Modelling Study	John Edwards	Wyong Areas Coal Joint Venture / Strata Control Technologies Pty Ltd
Appendix H	Subsidence Predictions and Impact Assessments	Don Kay	Mine Subsidence Engineering Consultants
Appendix I	Groundwater Impact Assessment	Col Mackie	Mackie Environmental Research
Appendix J	Surface Water Impact Assessment	David Newton	WRM Water & Environment Pty Ltd
Appendix K	Flood Impact Assessment	Geoff Herman	G Herman & Associates
Appendix L	Air Quality and Greenhouse Gas Assessment	Ronan Kellaghan	PAEHolmes
Appendix M	Health Risk Assessment	Nathan Aust	PAEHolmes
Appendix N	Noise and Vibration Impact Assessment	Graham Atkins	Atkins Acoustics and Associates Pty Ltd
Appendix O	Ecological Impact Assessment	David Robertson	Cumberland Ecology
Appendix P	Aquatic Ecology Impact Assessment	Paul Anink	Marine Pollution Research Pty Ltd
Appendix Q	Traffic and Transport Impact Assessment	Doris Lee	Parsons Brinckerhoff Australia Pty Ltd
Appendix R	Rail Study	Uli Mohr	Rail Management Consultants Australia Pty Ltd
Appendix S	Aboriginal Cultural Heritage Assessment	Ben Churcher	OzArk Environmental & Heritage Management Pty Ltd
Appendix T	Historic Heritage Assessment	Ben Churcher	OzArk Environmental & Heritage Management Pty Ltd
Appendix U	Visual Impact Assessment	Andrew Neil	The Design Partnership
Appendix V	Social Impact Assessment	Douglas Martin	Martin and Associates Pty Ltd
Appendix W	Economic Impact Assessment	Robert Gillespie	Gillespie Economics
Appendix X	Soils and Land Capability Impact Assessment	Jonathon Hilliard	Environmental Earth Sciences
Appendix Y	Agricultural Impact Assessment	Scott Barnett	Scott Barnett & Associates
Appendix Z	Forestry Assessment	Stephen Dahl	GHD Pty Ltd
Appendix AA	Contamination Impact Assessment	David Lane	DLA Environmental
Appendix AB	Preliminary Hazard Analysis	Andrew Wu	Hansen Bailey
Legal Advice provided by Ashurst Australia Drafting and Graphic Design by Pegasus Technical Pty Limited and Hansen Bailey Photographs courtesy of Kenny Barry, WACJV, OzArk and Cumberland Ecology			