



MANNERING COLLIERY – MODIFICATION 2

Environmental Assessment

2

Section 75W Modification to MP06_0311

Prepared for LakeCoal Pty Limited
April 2014



Mannering Colliery - Modification 2

Environmental Assessment | Section 75W Modification to MP06_0311

Prepared for LakeCoal Pty Limited | 22 April 2014

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Manning Colliery - Modification 2

Final

Report J13117RP1 | Prepared for LakeCoal Pty Limited | 22 April 2014

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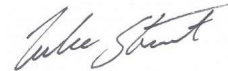
Position Environmental Planner

Position Director

Signature



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Date 22 April 2014

Date 22 April 2014

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Executive Summary

ES1 Introduction

The Mannering Colliery (MC) is an underground coal mine located on the southern side of Lake Macquarie approximately 60 km south of Newcastle (see Figure E.1). Underground mining commenced at the MC in 1960 extracting coal using both the bord and pillar and longwall mining methods in the Great Northern and Fassifern coal seams.

The MC was granted project approval (MP06_0311) on 12 March 2008 for the continued production of up to 1.1 million tonnes per annum (Mtpa) of run-of-mine (ROM) coal until 31 March 2018. This Environmental Assessment (EA) has been prepared to accompany an application to modify MP06_0311 under Section 75W of the EP&A Act to enable the construction of an underground linkage between MC and Chain Valley Colliery (CVC) within the Fassifern Seam workings (see Figure E.2).

This EA was prepared by EMGA Mitchell McLennan Pty Limited (EMM) on behalf of the proponent, LakeCoal Pty Limited (LakeCoal). LakeCoal is wholly owned by LDO Coal Pty Limited and is the operator of MC and CVC.

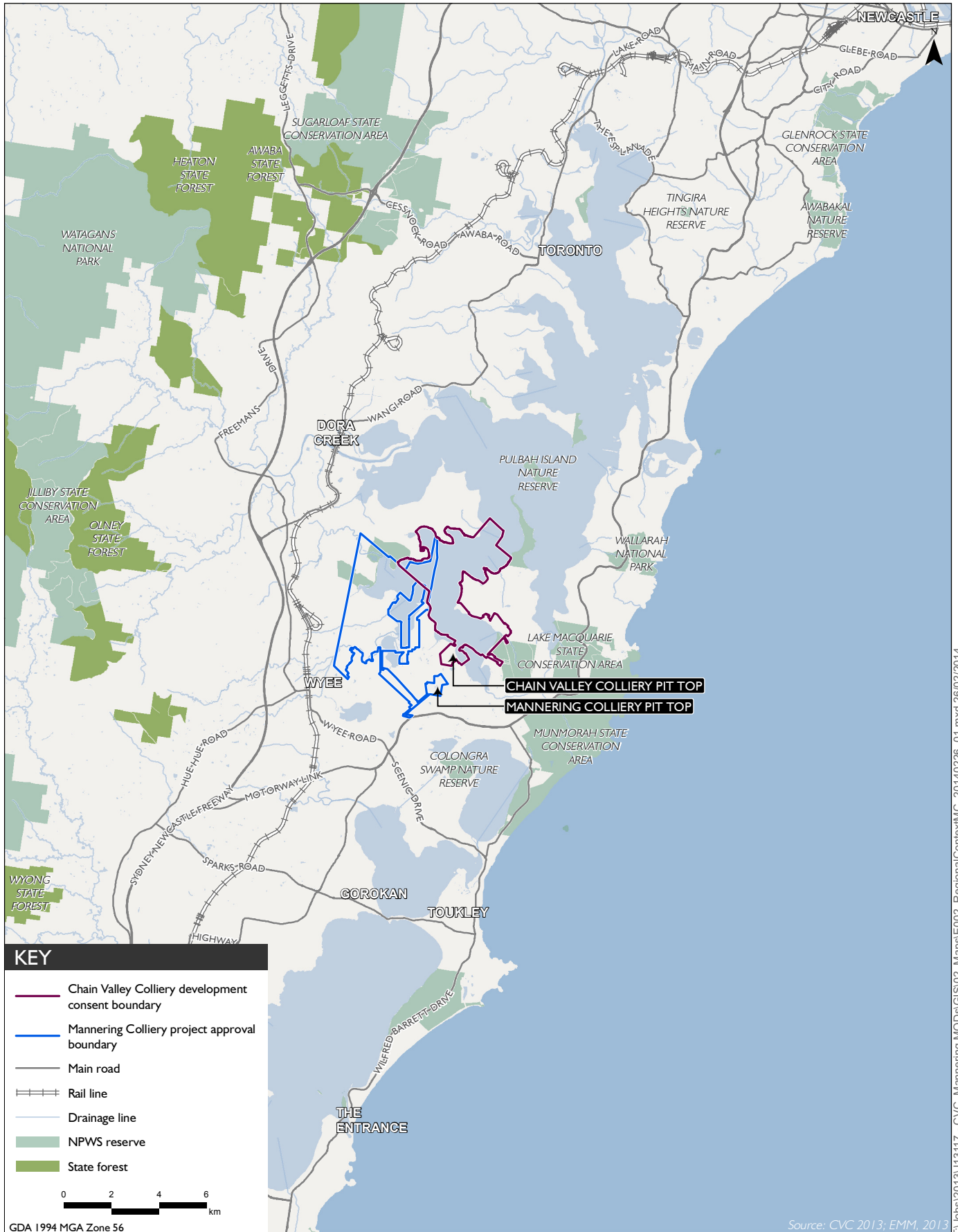
ES2 Statutory approvals framework

MP06_0311 was granted under Part 3A of the EP&A Act. Part 3A was repealed by the *Environmental Planning and Assessment Amendment (Part 3A Repeal) Act 2011*. However, transitional provisions were introduced enabling 'transitional Part 3A projects' to continue to be subject to Part 3A of the EP&A Act. Therefore, MP06_0311 is a transitional Part 3A project and the proposed modification may be made under the now repealed Section 75W of the EP&A Act. Section 75W enables a proponent to request the Minister (or PAC under delegation from the Minister) to modify a project approval granted under Part 3A.

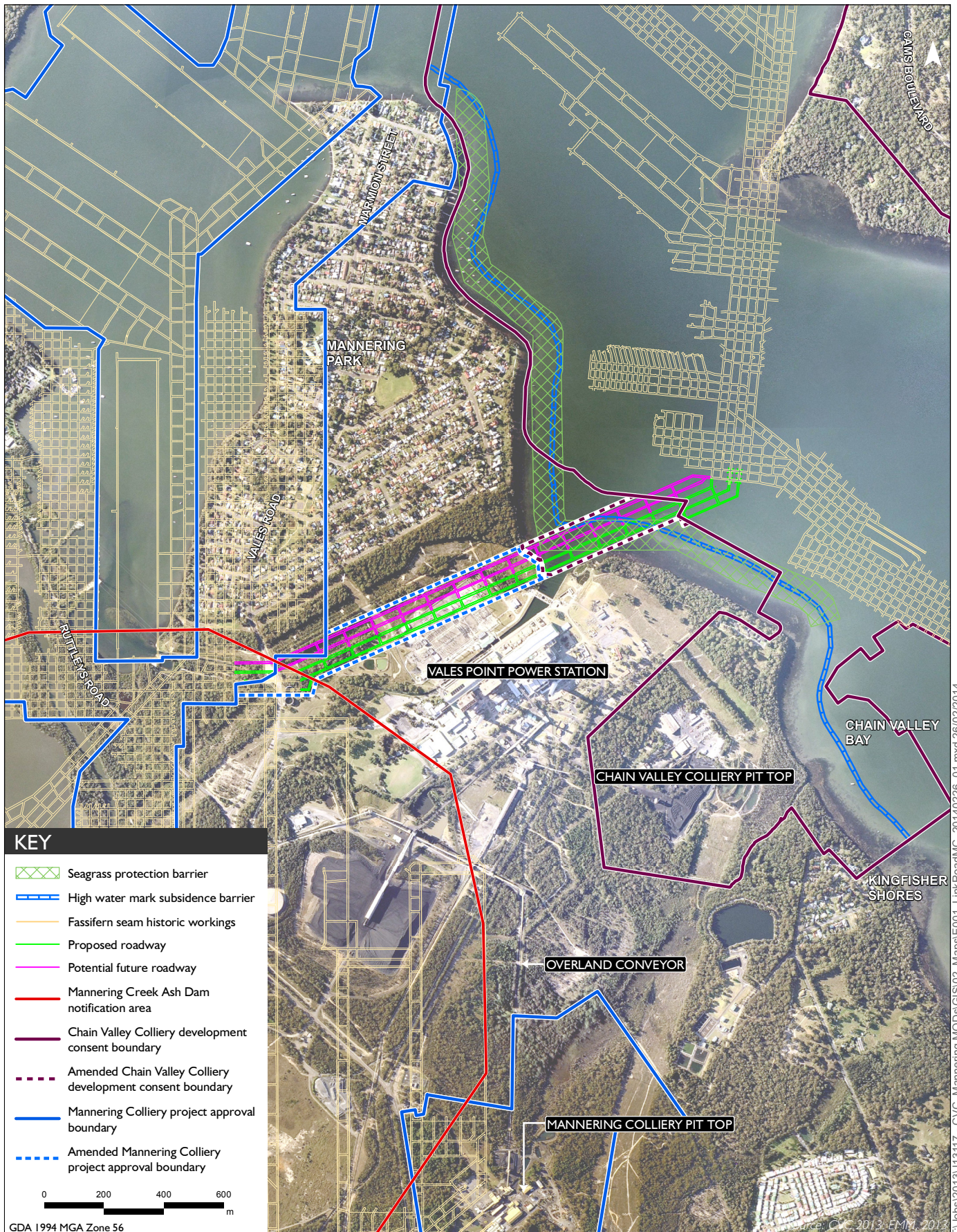
The proposed modification meets the relevant provisions of the following instruments:

- State Environmental Planning Policy (Mining, Petroleum Production and Extractive Industries) 2007;
- State Environmental Planning Policy (Major Development) 2005
- Wyong Local Environmental Plan 2013;
- Lake Macquarie Local Environmental Plan 2004; and
- Draft Lake Macquarie Local Environmental Plan 2013.

Consideration has been given to State and Commonwealth legislation relevant to the proposed modification. Ministerial approval will be required for the proposed modification under the *Dams Safety Act 1978*, *Mining Act 1992* and *Coal Mine Health and Safety Act 2002*. The proposed modification will not require variation to existing MC licences granted under the *Water Act 1912* and the *Protection of the Environment Operations Act 1997*. The underground linkage is located beneath the Swansea North Entrance Mine Subsidence District which was established under Section 15 of the *Mine Subsidence Compensation Act 1961*. The proposed modification will not significantly impact threatened species, endangered populations, ecological communities and other matters listed under the *Fisheries Management Act 1994*, *Threatened Species Conservation Act 1995*, or the *Environment Protection and Biodiversity Conservation Act 1999*.



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ES3 Existing operations

ES3.1 Mannering Colliery

The MC is owned by Centennial Mannering Pty Limited, a wholly owned subsidiary of Centennial Coal Company (Centennial). The MC pit top area is located approximately 1.1 km south of CVC's pit top area with access provided from Ruttleys Road.

The MC's approved operations under MP06_0311 include:

- extraction of up to 1.1 million tonnes per annum (Mtpa) of run-of-mine (ROM) coal from the Fassifern and Great Northern Seams until 31 March 2018;
- first workings only using bord-and-pillar mining methods;
- supply of coal to Delta Electricity's Vales Point Power Station (VPPS) for domestic energy generation via a dedicated covered overland conveyor;
- employment of 170 full time personnel; and
- operation 24 hours, seven days a week.

The MC was placed on care and maintenance in November 2012. In late 2013, the owners of the MC and CVC entered into an agreement which enables LakeCoal to operate the MC until 2022. LakeCoal became the operator of MC effective 17 October 2013.

ES3.2 Chain Valley Colliery

The CVC is an underground coal mine located at the southern end of Lake Macquarie, managed and operated by LakeCoal on behalf of the Wallarah Coal Joint Venture. Underground mining has occurred at CVC since 1962 extracting coal from three seams – the Wallarah, Great Northern and Fassifern Seams, with current mining activities limited to the Fassifern Seam. The CVC currently operates under project approval SSD-5465 which was granted by the Minister for Planning and Infrastructure on 23 December 2013. Project approval SSD-5465 allows for extraction of up to 1.5 Mtpa of ROM coal from the Fassifern Seam until 31 December 2027. Transport of coal is undertaken by trucks with coal deliveries to VPPS transported by private road and coal deliveries to other domestic customers and for export transported by public roads.

ES4 Proposed modification

ES4.1 Overview

LakeCoal seeks approval to modify MP06_0311 under Section 75W of the EP&A Act to allow:

- the development and use of up to four first working headings within the Fassifern Seam to connect the MC and CVC;
- the installation and use of an underground conveyor belt system and ancillary services, enabling ROM coal to be transferred between CVC's and the MC's conveyors; and
- the use of existing MC infrastructure to transport coal from the CVC underground workings to the VPPS at a rate not greater than 1.1 Mtpa (as currently approved under MP06_0311).

The construction of the underground linkage will necessitate a minor adjustment to the project approval and development consent boundaries for MC and CVC as identified in MP06_0311 and SSD-5465, respectively. All other components of the MC, as approved under MP06_0311, will remain unchanged.

It is noted that a separate application to modify CVC's development consent SSD-5465 has been lodged under Section 96 of the EP&A Act to enable construction of the underground linkage and will be assessed concurrently with this application.

ES4.2 Need for proposed modification

The MC has approval to produce 1.1 Mtpa of ROM coal all of which is sold domestically to VPPS. The existing infrastructure at the MC allows coal to be transported by overland conveyor to VPPS. Transport is approved to occur 24 hours a day, seven days a week. Historically, the MC has provided a secure source of predictably priced thermal coal to help supply the State's electricity needs.

CVC currently delivers coal to VPPS by trucks via the private, sealed access road and Construction Road and unsealed roads within the VPPS. The connection between MC and CVC, and subsequent installation of an underground conveyor belt system and ancillary services, will enable coal from the CVC to be transferred to VPPS via the MC conveyors for the duration of the agreement between the owners of MC and CVC. This activity will result in improved amenity outcomes from CVC and operational cost savings for LakeCoal which will enhance the viability of the CVC and provide for additional employment at the MC above the current care and maintenance levels (currently less than five permanent employees and a limited number of part time support staff/contractors). The modification of MP06_0311 is necessary to allow for this activity.

ES4.3 Alternatives considered

A number of options were considered during project development as alternatives to the proposed modification.

1. Do nothing – this option was discounted as, if the proposed modification did not proceed, coal designated for the VPPS would continue to be transported from the CVC via private haul roads, as currently approved. Consequently, the improved amenity outcomes, operational cost savings and employment benefits at MC that can be achieved with little to no adverse environmental impact would not be realised.
2. Surface conveyor connection – construction of a surface conveyor between CVC and VPPS as an alternative to road haulage was discounted due to the capital cost implications for CVC and Delta Electricity, and the potential environmental impacts resulting from construction and operation of a surface conveyor.
3. Roadway configuration and location alternatives – the preferred route alignment and number of roadways were chosen to address the relevant safety requirements, geological constraints, and the location of underground and surface infrastructure.

The proposed modification is considered the most appropriate option which will have socio-economic and environmental benefits with little to no adverse impacts.

ES4.4 Stakeholder engagement

During development of the proposed modification, consultation was undertaken by LakeCoal in accordance with its Environment and Community Policy. LakeCoal consulted with relevant State and local government agencies, special interest groups, local landholders and members of the local community.

Relevant government agencies and special interest groups were sent a letter briefing them on the proposed modification and inviting them to meet with LakeCoal to discuss the project further. Feedback was incorporated into the project design and environmental impact assessment.

Consultation with local landholders and members of the local community is ongoing and has to date included the presentation of information specific to the project on CVC's and MC's websites and presentations made to CVC and MC community consultative committees. The community will be notified of the project through an advertisement placed in a local newspaper following lodgement and through the public exhibition process where community members will be invited to comment on the proposed modification.

ES5 Impact assessment

An assessment of the potential environmental, social and economic impacts from the proposed modification was undertaken. The assessment considers holistically the impacts of both the MC and CVC operations to assist the reader in their understanding of the proposed modification's impacts without reference to multiple documents. Therefore, the assessment may consider aspects of the proposed modification which are not relevant to both MC and CVC.

ES5.1 Subsidence

A subsidence assessment of the proposed modification was prepared by Ditton Geotechnical Services (DGS). The proposed workings underlie several significant features including the Lake Macquarie foreshore and high voltage transmission towers. The proposed headings will also pass beneath mapped seagrass beds, the seagrass protection barrier (SPB), and high water mark subsidence barrier, and an area of dry sclerophyll woodland and lake foreshore vegetation. A small portion of the proposed workings are located within the Notification Area for the Mannering Creek Ash Dam, a prescribed dam under the *Dams Safety Act 1978*. Consultation with the Dams Safety Committee, Delta Electricity and TransGrid occurred during assessment preparation. The outcomes of consultation are reflected in the DGS assessment.

The proposed first workings have been designed to limit additional subsidence to less than 20 mm. However, due to prior mining in the area completed in the 1970s, including above the proposed workings, a consideration in the subsidence assessment was the interaction of existing and proposed workings to determine potential cumulative impacts. Historical vertical subsidence within these areas is predicted to have ranged between 20 mm and 33 mm and 88 mm to 106 mm above the first and second workings panels, respectively.

The outcomes of the modelling undertaken by DGS indicate that vertical subsidence from the proposed underground linkage will range from 5 mm to 20 mm where first and second workings in the Great Northern Seam occur, respectively. When added to the predicted historic subsidence levels described above, total (cumulative) subsidence is predicted to range from 25 mm to 38 mm above areas of first workings and 113 mm to 126 mm above areas of second workings. Vertical subsidence in the vicinity of the SPB will increase by up to 5 mm, resulting in cumulative vertical subsidence with the areas of historic workings of up to 31 mm.

It is considered unlikely that the proposed first workings will impact upon surface features. Minor cracking may develop in the VPPS hardstand areas and concrete slabs which would be readily repairable. A number of measures to confirm assessment results and manage potential subsidence impacts were recommended by DGS and these will be implemented as part of the proposed modification.

ES5.2 Groundwater

The underground linkage between the two collieries through a series of roadways necessitates a limited amount of additional first workings within the Fassifern Seam. Considering the low permeability of the strata, the minimal additional predicted subsidence (5 to 20 mm), the relatively small additional area to be mined and the narrow width (5.4 m) of the roadways, it is concluded that any additional groundwater inflow as a result of this proposed modification will be negligible and within the uncertainty margin of current estimates for the approved operations. The negligible groundwater inflow associated with the underground linkage is to be managed under CVC's existing *Water Act 1912* licence.

Negligible impacts on local groundwater users and groundwater dependent ecosystems are anticipated from the approved MC operations due to the very limited lateral drawdown impacts. Construction of the underground linkage is similarly anticipated to have negligible impact.

Groundwater impacts associated with the MC are managed under its existing Water Management Plan. No additional management or monitoring measures are warranted as a result of the proposed modification.

ES5.3 Other environmental aspects

An assessment of other environmental, social and economic aspects was completed commensurate with the outcomes of a risk assessment undertaken for the proposed modification and the negligible levels of projected impacts on each of these aspects.

The proposed modification does not involve any intensification of activities or above ground surface disturbance and, therefore, impacts to land based aspects including surface water, terrestrial biodiversity, Aboriginal and historic heritage, visibility, waste, hazards, rehabilitation, geology and soils are unlikely.

The assessment of aquatic biodiversity considered the potential impacts resulting from subsidence. Vertical subsidence of 5 mm above the underground linkage in the vicinity of the SPB is predicted as a result of the proposed modification. This is within natural variations in ground level and is highly unlikely to adversely impact seagrasses. Further, surveys of this area have recorded no seagrasses present. Benthic communities and threatened turtle species, which have the potential to occur in the area, are also unlikely to be impacted by the predicted levels of subsidence.

The proposed modification will comply with the provisions of the Coal Mine Health and Safety Regulation 2006. Potential inrush and ventilation hazards will be managed in accordance with the relevant management plans for both mines which will be reviewed in the context of the proposed modification. Further, a detailed operational risk assessment will be undertaken by LakeCoal prior to construction of the underground linkage to identify potential risks and recommend appropriate controls.

Approval of the proposed modification will enhance the economic viability of the CVC, and provide for employment at MC above current 'care and maintenance' levels, which will have positive socio-economic outcomes. The proposed modification will result in a reduction in transport related noise, dust and greenhouse gas emissions, through the reduction of coal haulage by trucks to VPPS, which will generally result in approved amenity.

ES6 Justification and conclusion

LakeCoal is seeking approval to develop an underground linkage between the CVC and MC, which LakeCoal has an agreement to operate until 2022, and use existing MC infrastructure to transport coal from the underground workings to the VPPS. All other components of the MC, as approved under MP06_0311, will remain unchanged.

The modification is a minor alteration to the approved MC operations which will result in improved amenity outcomes (noise, dust and greenhouse gas emissions) in the local area due to changes in CVC operations, operational cost savings and employment benefits that can be achieved with little to no adverse environmental impact and is aligned with the principles of ecologically sustainable development.

Table of Contents

Executive Summary	E.1
Chapter 1 Introduction	1
1.1 Background	1
1.2 The proponent	1
1.3 Site and surrounds	3
1.4 The proposed modification	3
1.5 Modification need	5
1.6 Purpose and context	5
Chapter 2 Statutory approval framework	7
2.1 Introduction	7
2.2 Planning approval history	7
2.3 State approvals	7
2.3.1 NSW Environmental Planning and Assessment Act 1979	7
2.3.2 Other state legislation	7
2.3.3 Environmental planning instruments	9
2.4 Commonwealth approvals	11
Chapter 3 Existing project approval and proposed modification	13
3.1 Approved operations	13
3.1.1 Mining methods	13
3.1.2 Environmental management	14
3.1.3 Chain Valley Colliery	14
3.2 Proposed modification	15
3.2.1 Underground linkage	15
3.2.2 Use of infrastructure for CVC product coal transportation	17
3.3 Alternatives considered	17
3.3.1 Do nothing option	17
3.3.2 Surface conveyor connection	17
3.3.3 Roadway configuration and location alternatives	18
Chapter 4 Stakeholder engagement	19
4.1 Introduction	19
4.2 Consultation with government	19
4.3 Consultation with community and special interest groups	20
Chapter 5 Environmental assessment and management	21
5.1 Introduction	21
5.2 Subsidence	21

Table of Contents *(Cont'd)*

5.2.1	Introduction	21
5.2.2	Existing environment	21
5.2.3	Impact assessment	22
5.2.4	Mitigation and management	23
5.2.5	Conclusion	27
5.3	Groundwater	27
5.3.1	Existing environment	27
5.3.2	Impact assessment	28
5.3.3	Legislative considerations	29
5.3.4	Mitigation and management	29
5.3.5	Conclusion	30
5.4	Other social and environmental aspects	30
<hr/>		
Chapter 6	Statement of commitments	33
<hr/>		
Chapter 7	Modification justification and conclusion	35
7.1	Introduction	35
7.2	Objects of the Environmental Planning and Assessment Act 1979	35
7.3	Conclusion	36
<hr/>		
Abbreviations		
<hr/>		
References		
<hr/>		

Appendices

A	Project Approval MP06_0311	
B	Preliminary risk assessment	
C	Subsidence assessment	
D	Review of Ruttleys Road intersection upgrade commitments	

Tables

2.1	Assessment of the proposed modification against Mining SEPP non-discretionary development standards for mining	9
3.1	Summary of approved operations at MC	13
4.1	Summary of government consultation	19
5.1	Stratigraphy of the site	27
5.2	Other environmental, social and economic aspects	30
6.1	Commitments	33
B.1	Environmental assessment matrix	B.2
B.2	Environmental risk rating	B.3

Figures

E.1	Regional context	E.2
E.2	Proposed underground linkage	E.3
1.1	Regional context	2
1.2	The Site	4
3.1	Proposed underground linkage	16
5.1	Existing surface features	24
5.2	Predicted incremental subsidence contours	25
5.3	Predicted cumulative subsidence contours	26

1 Introduction

1.1 Background

Mannering Colliery (MC) is an underground coal mine located on the southern side of Lake Macquarie approximately 60 km south of Newcastle (refer Figure 1.1). Underground mining commenced at the MC in 1960 extracting coal using both the bord and pillar and longwall mining methods in the Great Northern and Fassifern coal seams.

The MC was granted project approval (MP06_0311) on 12 March 2008 for the continued production of up to 1.1 million tonnes per annum (Mtpa) of run-of-mine (ROM) coal until 31 March 2018 (see Appendix A). The project approval was granted under Part 3A of the *Environmental Planning and Assessment Act 1979* (EP&A Act). Coal from MC is transported via a dedicated overland conveyor to Vales Point Power Station (VPPS) for domestic energy generation.

This Environmental Assessment (EA) has been prepared to accompany an application to modify MP06_0311 under Section 75W of the EP&A Act to enable construction of an underground linkage between MC and Chain Valley Colliery (CVC) within the Fassifern Seam workings. The elements of the proposed modification are outlined in Section 1.3 and detailed in full in Section 3.2. This EA was prepared by EMGA Mitchell McLennan Pty Limited (EMM) on behalf of the proponent, LakeCoal Pty Limited (LakeCoal).

1.2 The proponent

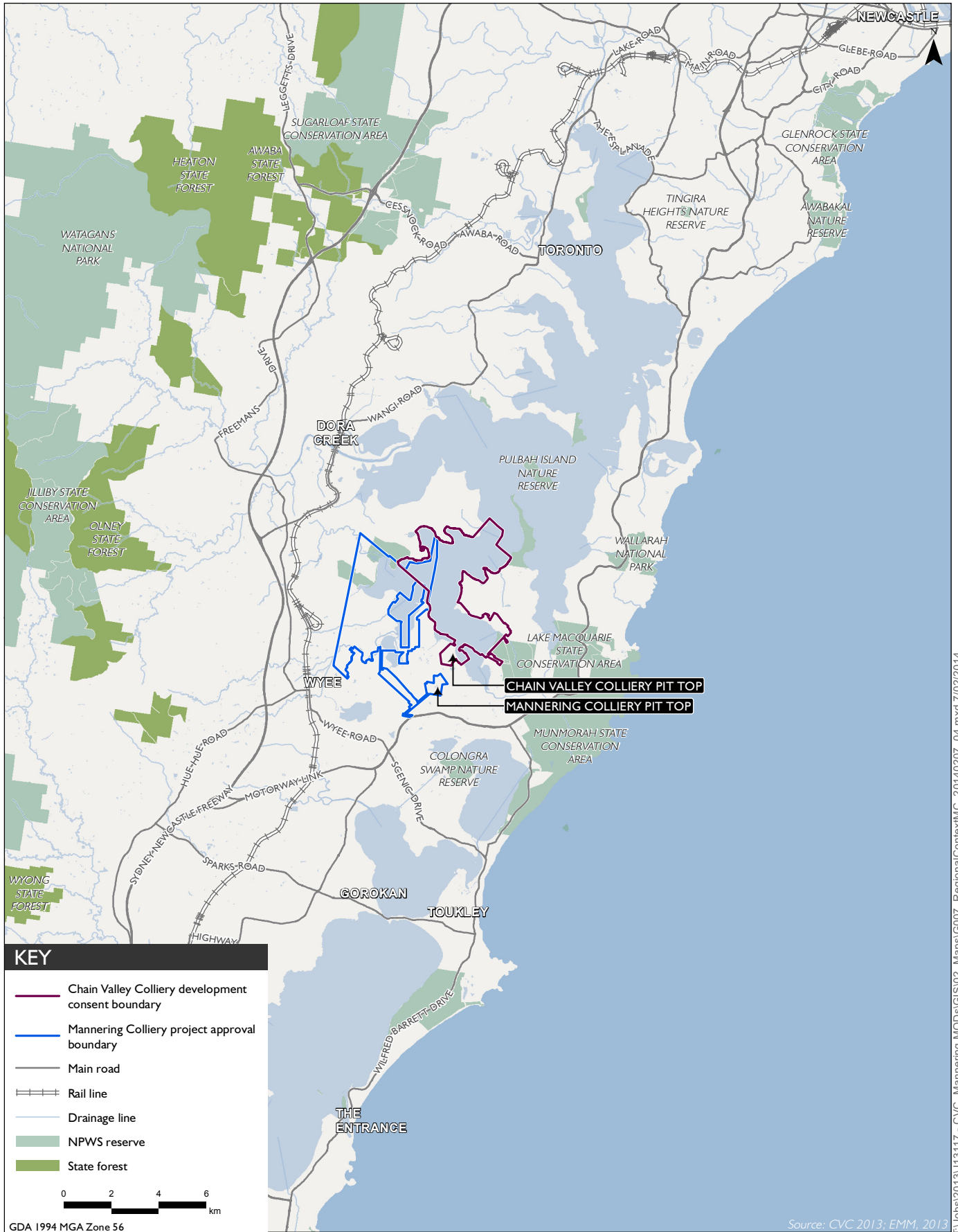
The MC is owned by Centennial Mannering Pty Limited, a wholly owned subsidiary of Centennial Coal Company (Centennial). Centennial is in turn a wholly owned subsidiary of Banpu Public Company Limited, who purchased Centennial in 2010. The MC was placed on care and maintenance in November 2012 and in 2013 the owners of MC and CVC entered into an agreement which enables LakeCoal to operate the MC until 2022. LakeCoal became the operator of MC effective 17 October 2013.

The proponent is LakeCoal, the operator of MC and CVC. LakeCoal's contact details are as follows:

LakeCoal Pty Ltd
16 Spitfire Place, Rutherford
NSW 2320
Phone (02) 4358 0800

Further information on the MC and CVC and their operations can be found at:

- <http://www.manneringmine.com.au>; and
- <http://www.chainvalleymine.com.au>.



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1.3 Site and surrounds

The MC, formerly known as Wyee State Mine, has been in operation since 1960. The MC pit top area is located within the Wyong local government area (LGA), approximately 3 km south of Mannering Park at the southern extent of Lake Macquarie west of Chain Valley Bay (see Figure 1.2). The pit top is accessed from Ruttleys Road. Mining operations at the MC occur within Consolidated Coal Lease (CCL) 721 and CCL 719.

The VPPS and the CVC pit top area are located to the north and north-east of the pit top area, respectively. The closest residential areas are the Macquarie Shores mobile home village, Kingfisher Shores and Chain Valley Bay to the east and Mannering Park beyond the VPPS to the north. The areas to the north, south and west generally comprise industrial facilities and vegetation.

The land subject to the application includes the land shown in Appendix 1 of MP06_0311 as well as the following land which is located above the underground linkage:

- Lot A DP 368634;
- Lot 100 DP 1065718;
- Lot 102 DP 1065718;
- Lot 20 DP 1113256; and
- Lot 7329 DP 1148149.

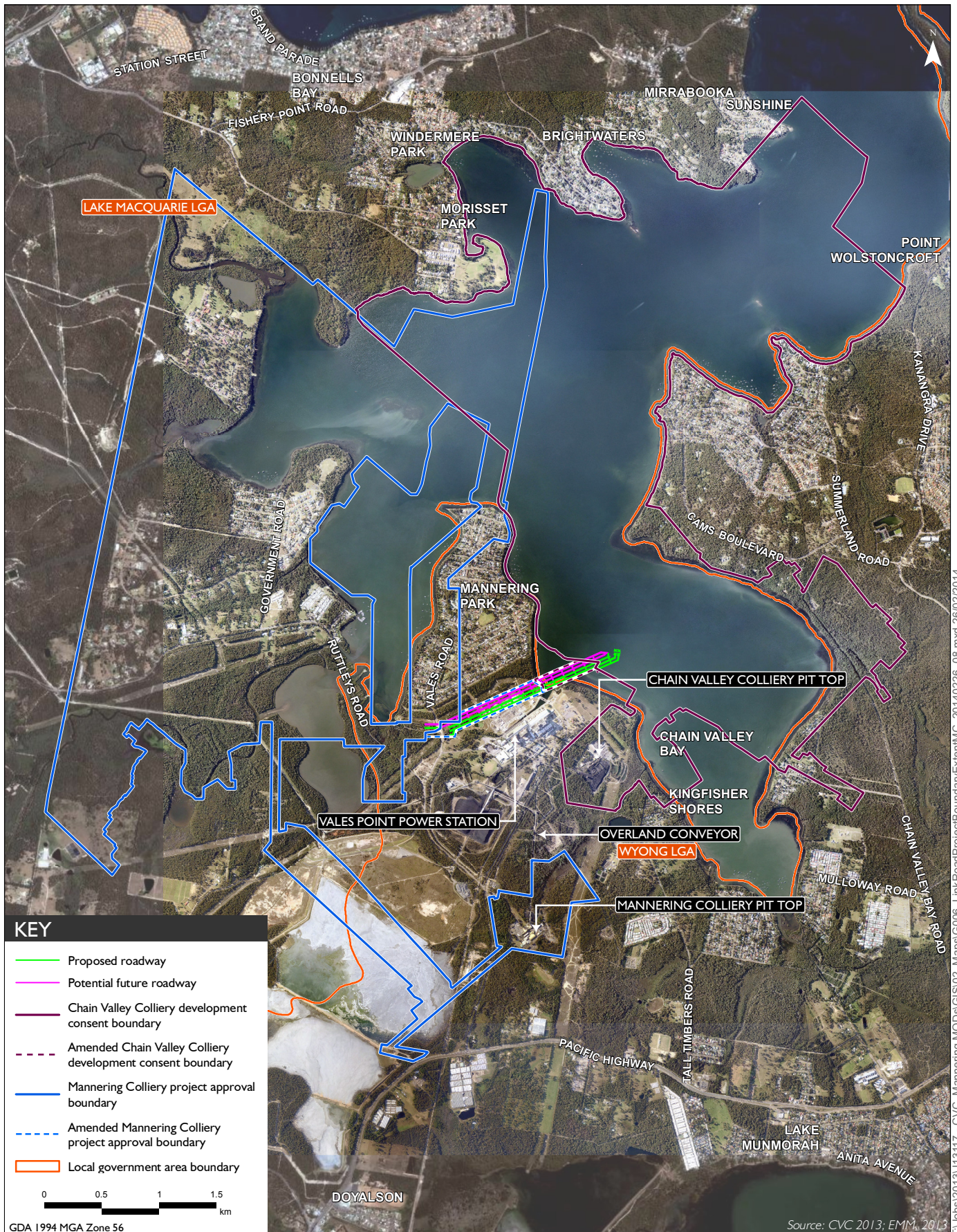
1.4 The proposed modification

LakeCoal seeks approval to modify MP06_0311 under Section 75W of the EP&A Act to allow for:

- the development and use of up to four first working headings within the Fassifern Seam to connect the MC and CVC;
- the installation and use of an underground conveyor belt system and ancillary services, enabling ROM coal to be transferred between CVC and the MC conveyors; and
- the use of existing MC infrastructure to transport coal from the CVC underground workings to the VPPS at a rate not greater than 1.1 Mtpa (as currently approved under MP06_0311).

The construction of the underground linkage will result in a minor adjustment to the development consent and project approval boundaries for CVC and MC as identified in SSD-5465 and MP06_0311, respectively. All other components of the MC, as approved under MP06_0311, will remain unchanged.

It is noted that a separate application to modify CVC's development consent SSD-5465 has been lodged under Section 96 of the EP&A Act to enable construction of the underground linkage and will be assessed concurrently with this application.



1.5 Modification need

The MC has approval to produce 1.1 Mtpa of ROM coal all of which is sold domestically to VPPS. The existing infrastructure at the MC allows coal to be transported by overland conveyor to VPPS. Transport is approved to occur 24 hours a day, seven days a week. Historically, the MC has provided a secure source of predictably priced thermal coal to help supply the State's electricity needs.

As described in Section 1.2, the MC was placed on care and maintenance in November 2012. In late 2013, the owners of the MC and CVC entered into an agreement which enables LakeCoal to operate the MC until 2022.

CVC currently delivers coal to VPPS by trucks via its access road and Construction Road both of which are private, sealed roads. The proposed linkage between MC and CVC, and subsequent installation of an underground conveyor belt system and ancillary services, will enable coal from the CVC to be transferred to VPPS via the MC conveyors. This activity will result in improved amenity outcomes from CVC and operational cost savings for LakeCoal which will enhance the viability of the CVC and provide for additional employment at the MC above the current care and maintenance levels (currently less than five permanent employees and a limited number of part time support staff/contractors). The modification of MP06_0311 is necessary to allow for this activity.

1.6 Purpose and context

This EA describes the proposed modification, provides an assessment of its potential impacts and details measures that will be implemented to prevent, minimise and/or offset those impacts. This information will be used by NSW Planning & Infrastructure (P&I), and relevant government agencies, to assess the merits of the proposed modification and make recommendations to the determining authority about whether or not to grant approval.

The impacts of both the MC and CVC operations are considered in this EA to assist the reader in their understanding of the proposed modification's impacts without reference to multiple documents. Therefore, the assessment may consider aspects of the proposed modification which are not relevant to both MC and CVC. Nevertheless, the commitments detailed in Chapter 6 that have arisen from the outcomes of the impact assessment are specific to the relevant application; in this instance, the modification to MP06_0311.

2 Statutory approval framework

2.1 Introduction

This chapter describes the relevant Commonwealth and State legislation and regulatory framework under which the proposed modification has been assessed and will be determined.

2.2 Planning approval history

MP06_0311 was granted by the Minister for Planning on 12 March 2008. Prior to this the MC operated under Section 74 of the *Mining Act 1992* (Mining Act) which exempted underground mines which had been operating under a mining lease prior to the implementation of the EP&A Act from the provisions of both environmental planning instruments and the EP&A Act. Section 74 of the Mining Act was repealed in December 2005 and an amendment of the EP&A Regulation meant that an approval under the EP&A Act was required for the MC's continued operation.

An application to modify MP06_0311 was lodged 8 August 2011. The modification sought approval to extend the underground mining operations within the Fassifern Seam and to employ an additional 80 people (170 in total). The modification was approved by the Planning Assessment Commission (PAC) under delegation from the Minister for Planning on 25 October 2012.

2.3 State approvals

2.3.1 NSW Environmental Planning and Assessment Act 1979

MP06_0311 was granted under Part 3A of the EP&A Act. Part 3A was repealed by the *Environmental Planning and Assessment Amendment (Part 3A Repeal) Act 2011* (Part 3A Repeal Act). However, transitional provisions were introduced (Schedule 6A of the EP&A Act) enabling 'transitional Part 3A projects' to continue to be subject to Part 3A of the EP&A Act (as in force immediately before the repeal and as modified by the Part 3A Repeal Act). Transitional Part 3A projects include certain projects that were the subject of an existing approval under Part 3A. Therefore, MP06_0311 is a transitional Part 3A project and the proposed modification may be made under the now repealed Section 75W of the EP&A Act. Section 75W enables a proponent to request the Minister (or PAC under delegation from the Minister) to modify a project approval granted under Part 3A.

2.3.2 Other state legislation

The following Acts are relevant to the proposed modification.

i Dams Safety Act 1978

As shown in Figure 1.2, part of the first workings associated with the underground linkage (closest to MC at the linkage's western edge) will be undertaken within 1 km of the Mannering Creek Ash Dam which is a prescribed dam under the *Dams Safety Act 1978*. This is within the Mannering Creek Notification Area as defined by the Dams Safety Committee (DSC) under Section 369 of the Mining Act. Notification of the DSC will be required for the proposed modification and Ministerial approval will be required prior to undertaking any mining activities within the Notification Area. LakeCoal has advised DSC both verbally and in writing of the nature of the proposed modification (see Table 4.1).

ii Fisheries Management Act 1994

The *Fisheries Management Act 1994* (FM Act) declares and lists threatened species of fish and marine vegetation and endangered populations and ecological communities. It contains measures to conserve those identified species, populations and communities and to promote ecologically sustainable development (ESD). The potential impacts of the proposed modification on threatened species of fish and marine vegetation and endangered populations and ecological communities listed under the FM Act are discussed in Table 5.2.

iii Threatened Species Conservation Act 1995

The *Threatened Species Conservation Act 1995* (TSC Act) aims to conserve biological diversity in NSW through the protection of threatened and endangered flora and fauna species and ecological communities (EECs). The potential impacts of the proposed modification on threatened species and EECs listed under the TSC Act are discussed in Table 5.2.

iv Water Act 1912 and Water Management Act 2000

The *Water Act 1912* (Water Act) and *Water Management Act 2000* (WM Act) regulate the use and interference with surface and groundwater in NSW. Centennial currently holds bore licence 20BL172016 issued under the Water Act, for the purposes of mine dewatering up to a maximum rate of 450 ML per annum. LakeCoal is currently preparing a licence application under the Water Act to allow for predicted groundwater inflows under the approved operations. No approvals under the WM Act are required for the MC's approved operations.

An assessment of aquifer impacts resulting from the proposed modification is provided in Section 5.3. The proposed modification will not result in any water take from sources regulated by the WM Act.

v Mining Act 1992

The underground linkage will pass within MC's leases (CCL 721 and CCL 719) issued under the Mining Act. These leases include a condition requiring consent from the Minister for Resources and Energy for conducting mining operations within the highwater level subsidence control zone (referred to in this EA as the high water mark subsidence barrier – HWMSB).

Development of a portion of the underground linkage will involve mining within the HWMSB and, therefore, the modification application will be referred to NSW Trade and Investment, Division of Resources and Energy (DRE) for Ministerial approval to satisfy the conditions of the leases. LakeCoal has advised DRE both verbally and in writing of the nature of the proposed modification (see Table 4.1).

A similar condition is stipulated in CVC's mining lease (ML 1052) within which parts of the underground linkage will be located. Approval from the Minister for mining within this lease will also be sought for the modification to SSD-5465.

vi Coal Mine Health and Safety Act 2002

The *Coal Mine Health and Safety Act 2002* applies the principles of work health and safety in NSW to coal mining operations. Section 86 of the Act states:

(1) The operator of a coal operation that is a mine must not mine or cause to be mined any seam of coal in the mine without leaving a barrier of the specified width:

(a) against the external boundaries of the colliery holding in which the mine is situated,

...

(2) For the purposes of subsection (1), the specified width is 20 metres or any other distance that the Minister may specify in a direction given to the operator of the coal operation.”

Section 89 of the Act states that the Minister may grant approval, subject to conditions, to mine a barrier specified in Section 86. As with the requirements under the Mining Act, the modification application will be referred to DRE for Ministerial approval to satisfy this condition.

vii Protection of the Environment Operations Act 1997

The *Protection of the Environment Operations Act 1997* (POEO Act) is the principal NSW environmental protection legislation and is administered by the Environmental Protection Authority (EPA). The MC has an existing environment protection licence (EPL) No. 191 issued under the POEO Act. The proposed modification will not require variation to MC’s EPL. Further, no variations will be required to CVC’s EPL 1770.

viii Mine Subsidence Compensation Act 1961

The *Mine Subsidence Compensation Act 1961* establishes a mechanism for the payment of compensation for damage by subsidence resulting from the mining of coal or shale. Mine Subsidence Districts can be established by the Mine Subsidence Board under Section 15 of the Act, within which approval for alteration or erection of improvements and subdivision is required from the Board. The land based areas above the underground linkage are located within the Swansea North Entrance Mine Subsidence District. Potential subsidence impacts resulting from the proposed modification are detailed in Section 5.2.

2.3.3 Environmental planning instruments

Underground mining operations at the MC are permissible by virtue of Clause 7 of State Environmental Planning Policy (Mining, Petroleum Production and Extractive Industries) 2007 (the Mining SEPP) which states that development for the purposes of underground coal mining is permissible on any land. Clause 12AB of the Mining SEPP identifies non-discretionary development standards for mining. Subclause (1) states that if a proposed development for the purposes of mining satisfies a development standard set out in this clause, the consent authority cannot require more onerous standards for those matters but does not prevent the consent authority granting consent even though any such standard is not complied with. The proposed modification satisfies the non-discretionary development standards for mining as detailed in Table 2.1.

Table 2.1 Assessment of the proposed modification against Mining SEPP non-discretionary development standards for mining

Development standard	Comments on compliance
The development does not result in a cumulative amenity noise level greater than the acceptable noise levels, as determined in accordance with Table 2.1 of the Industrial Noise Policy, for residences that are private dwellings.	The proposed modification will not result in additional noise emissions that will result in a cumulative amenity noise level greater than the acceptable noise levels. See Table 5.2 for further information. Therefore, this development standard is satisfied.
The development does not result in a cumulative annual average level greater than 30 µg/m ³ of PM ₁₀ for private dwellings.	The proposed modification will not result in additional dust emissions that would result in a cumulative annual average level greater than 30 µg/m ³ of PM ₁₀ for private dwellings. See Table 5.2 for further information. Therefore, this development standard is satisfied.

Table 2.1 Assessment of the proposed modification against Mining SEPP non-discretionary development standards for mining

Development standard	Comments on compliance
Airblast overpressure caused by the development does not exceed: (a) 120 dB (Lin Peak) at any time, and (b) 115 dB (Lin Peak) for more than 5% of the total number of blasts over any period of 12 months, measured at any private dwelling or sensitive receiver.	The proposed modification will not involve any surface blasting. Limited underground blasting may be required in the development of the roadways but will be of low charge weight and will not result in any exceedance of the nominated criteria. Therefore, this development standard is satisfied.
Ground vibration caused by the development does not exceed: (a) 10 mm/sec (peak particle velocity) at any time, and (b) 5 mm/sec (peak particle velocity) for more than 5% of the total number of blasts over any period of 12 months, measured at any private dwelling or sensitive receiver.	As above.
Any interference with an aquifer caused by the development does not exceed the respective water table, water pressure and water quality requirements specified for item 1 in columns 2, 3 and 4 of Table 1 of the Aquifer Interference Policy for each relevant water source listed in column 1 of that Table.	The proposed modification does not exceed the respective water table, water pressure and water quality requirements of the Aquifer Interference Policy as detailed in Section 5.3.3. Therefore, this development standard is satisfied.

Part 3A projects were defined within Schedule 1 of the State Environmental Planning Policy (Major Development) 2005 (Major Development SEPP). Clause 6 and Schedule 1 of Major Development SEPP provides that coal mining is declared to be a project to which Part 3A of the Act applies. This SEPP was amended by SEPP (State and Regional Development) 2011 in accordance with the repeal of Part 3A, though it is still relevant to the proposed modification as it continues to apply to transitional Part 3A projects.

The areas of proposed mining to form the linkage will occur within land zoned SP2 Infrastructure and W2 Recreational Waterways under Wyong Local Environmental Plan 2013. Development not identified as being permissible with or without consent in the land use table for these zones is prohibited. Mining is not listed as being permissible with or without consent and, therefore, mining operations at the MC would be prohibited under these instruments. However, as mentioned above, underground mining on any land is permissible under the Mining SEPP. In the event of an inconsistency, Section 36 of the EP&A Act stipulates that there is a general presumption that a State Environmental Planning Policy prevails over a Local Environmental Plan. Therefore, the prohibition under the local instruments does not affect permissibility.

The areas of proposed mining to form the linkage beneath Lake Macquarie are zoned No. 11 (Lakes and Waterways Zone) under Lake Macquarie Local Environmental Plan 2004. Mining is permissible with consent in this zone. A draft local environmental plan for Lake Macquarie (Draft Lake Macquarie LEP 2013) has been publically exhibited though, at the time of writing, has not been gazetted. Under the draft local environmental plan for Lake Macquarie the areas of proposed mining will occur within land zoned W1 Natural Waterways. Mining is not listed as being permissible with or without consent in this zone. However, this does not affect permissibility due to the provisions of the Mining SEPP.

2.4 Commonwealth approvals

The *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) aims to protect matters deemed to be of national environmental significance (NES) including:

- world heritage properties;
- places listed on the National Heritage Register;
- Ramsar wetlands of international significance;
- threatened flora and fauna species and ecological communities;
- migratory species;
- Commonwealth marine areas;
- nuclear actions (including uranium mining); and
- actions of development for coal seam gas or large coal mining on water resources

If an action (or proposal) will, or is likely to, have a significant impact on any matters of NES, it is deemed to be a Controlled Action and requires approval from the Commonwealth Environment Minister or the Minister's delegate. To determine whether a proposed action would or is likely to be a Controlled Action, an action may be referred to the Department of the Environment.

The matters of NES that have the potential to be impacted by the proposed modification include threatened flora and fauna species and ecological communities and water resources. The proposed modification is unlikely to significantly impact on these matters of NES, as discussed in Section 5.3 and Table 5.2, and a referral to the Department of the Environment is not required.

3 Existing project approval and proposed modification

3.1 Approved operations

A summary of the current operations at the MC approved under MP06_0311, as modified, is provided in Table 3.1. The key aspects of the approved operations relevant to the proposed modification are considered in further detail below.

Table 3.1 Summary of approved operations at MC

Aspect	Summary
Mining and reserves	Extraction of up to 1.1 Mtpa of ROM coal from the Fassifern and Great Northern Seams, from a total resource of approximately 14.8 million tonnes of ROM coal.
Mining methods	Bord-and-pillar mining methods where coal recovery is limited to first workings only.
Project life	Approved for 10 years of mining until 31 March 2018.
Existing surface infrastructure	Coal crushing facility, overland conveyor between the MC's pit top area and VPPS, worker's amenities, workshops, offices, carparks, ventilation fans.
Coal processing	No coal processing other than use of coal crushing facility to reduce the top size of ROM coal.
Water demand and supply	Licensed daily discharge of 4 megalitres (ML). Potable water for use in surface facilities and underground operations supplied by Wyong Shire Council via a direct-metered pipeline.
Hours of operation	24 hours, 7 days a week.
Product coal transport	All coal produced at the MC is supplied directly to VPPS via a purpose built dedicated overland conveyor which is operated, maintained and located on land held by Delta Electricity.
Mine access	Road access from Ruttleys Road.
Employment	Employment of 170 full time personnel.

It is noted that coal extracted at the MC does not require washing or additional treatment. As a result, ROM coal production equates to product coal production from the MC.

3.1.1 Mining methods

Prior to being placed on care and maintenance, coal was extracted at the MC using bord-and-pillar mining methods with coal recovery limited to first workings. The bord-and-pillar method uses a regular grid of mining tunnels and involves progressively cutting panels into the coal seam whilst leaving behind pillars of coal to support the mine.

At the MC, roadways are driven and pillars created, with mining limited to the coal cut from the first workings roadways. While the quantity of coal recovered using this mining method is less than that achieved with other methods, it has the advantage of long-term pillar stability and ensures no noticeable surface subsidence impacts. Centennial has successfully mined under portions of Mannering Park residential area, VPPS and Lake Macquarie using this method.

The bord-and-pillar mining method utilises a continuous miner system to develop panels with five to seven headings and associated cut-throughs, resulting in long-term stable pillars on 30 m centres (24.5 m coal), with width to height ratios in excess of 8:1. The panels are separated by substantial barrier pillars that are approximately 54 m wide. The roadways are generally maintained at 5.5 m wide and 2.9 m high.

Mined coal is transported via a drift conveyor system to the surface and into the on-site coal crushing facility before being conveyed to VPPS.

The MC utilises a range of mining equipment to carry out the bord-and-pillar mining operations, facilitate personnel and materials access from the surface to the underground workings and undertake coal handling operations at the surface facilities area. Primary equipment items include continuous miners, roof bolters, shuttle cars, and drift conveyor systems.

3.1.2 Environmental management

Environmental management at the MC is undertaken in accordance with:

- project approval MP06_0311, as modified;
- commitments made in EAs prepared for the MC;
- MC's Environmental Management Strategy and associated documents;
- various environmental management plans;
- MC's EPL 191; and
- MC's Mining Operations Plan (MOP).

The existing environmental management processes and procedures are referred to where relevant in the environmental assessment and management chapter (Chapter 5).

3.1.3 Chain Valley Colliery

The CVC is an underground coal mine located at the southern end of Lake Macquarie, managed and operated by LakeCoal on behalf of the Wallarah Coal Joint Venture. Underground mining has occurred at CVC since 1962 extracting coal from three seams – the Wallarah, Great Northern and Fassifern Seams, with current mining activities limited to the Fassifern Seam. The CVC currently operates under project approval SSD-5465 which was granted by the Minister for Planning and Infrastructure on 23 December 2013. Development Consent SSD-5465 allows for extraction of up to 1.5 Mtpa of ROM coal from the Fassifern Seam until 31 December 2027. Transport of coal is undertaken by trucks with coal deliveries to VPPS transported by private roads and coal deliveries to other domestic customers and for export transported by public roads.

Mining parameters at CVC have been specifically designed to ensure protection of the Lake Macquarie foreshore and land based infrastructure by the use of the HWMSB, and seagrass communities by the use of a seagrass protection barrier (SPB).

The application of the HWMSB is required as a condition of the relevant mining tenements and has been developed to protect foreshore areas and the boundary of water bodies from mining induced subsidence. The width of the HWMSB is determined by a 35° angle of draw lakewards from the High Water Mark and from the point 2.44 m AHD above the High Water Mark landward to the depth of the workings.

The SPB was adopted by LakeCoal to protect the seagrass beds of Lake Macquarie from any potential impacts from underground mining at the CVC. The width of the SPB is determined by a 26.5° angle of draw from the surveyed boundary of the seagrass beds to the depth of the workings.

3.2 Proposed modification

3.2.1 Underground linkage

The construction of an underground linkage between the collieries will be completed by the driveage of headings (roadways) that will be developed between the southern extent of Fassifern Seam workings at the MC north-east for approximately 1.6 km to join Fassifern Seam workings at the CVC (Figure 3.1). Initially, two roadways will be constructed with the future development of up to another two roadways to occur to enable increased ventilation flows between the two collieries.

The assessment of potential environmental impacts presented in Chapter 5 assumes all four roadways are developed.

Of the two roadways to be developed initially, one will be used for a belt system connecting the MC belt system into the CVC belt system and the other for the movement of personnel and equipment between the two mines (ie a travel road). The development of two roadways initially also removes the high risk activity of single entry development, defined in the Coal Mine Health and Safety Regulation 2006 as “development of a roadway or a drift for more than 200 m without the formation of an intersection”.

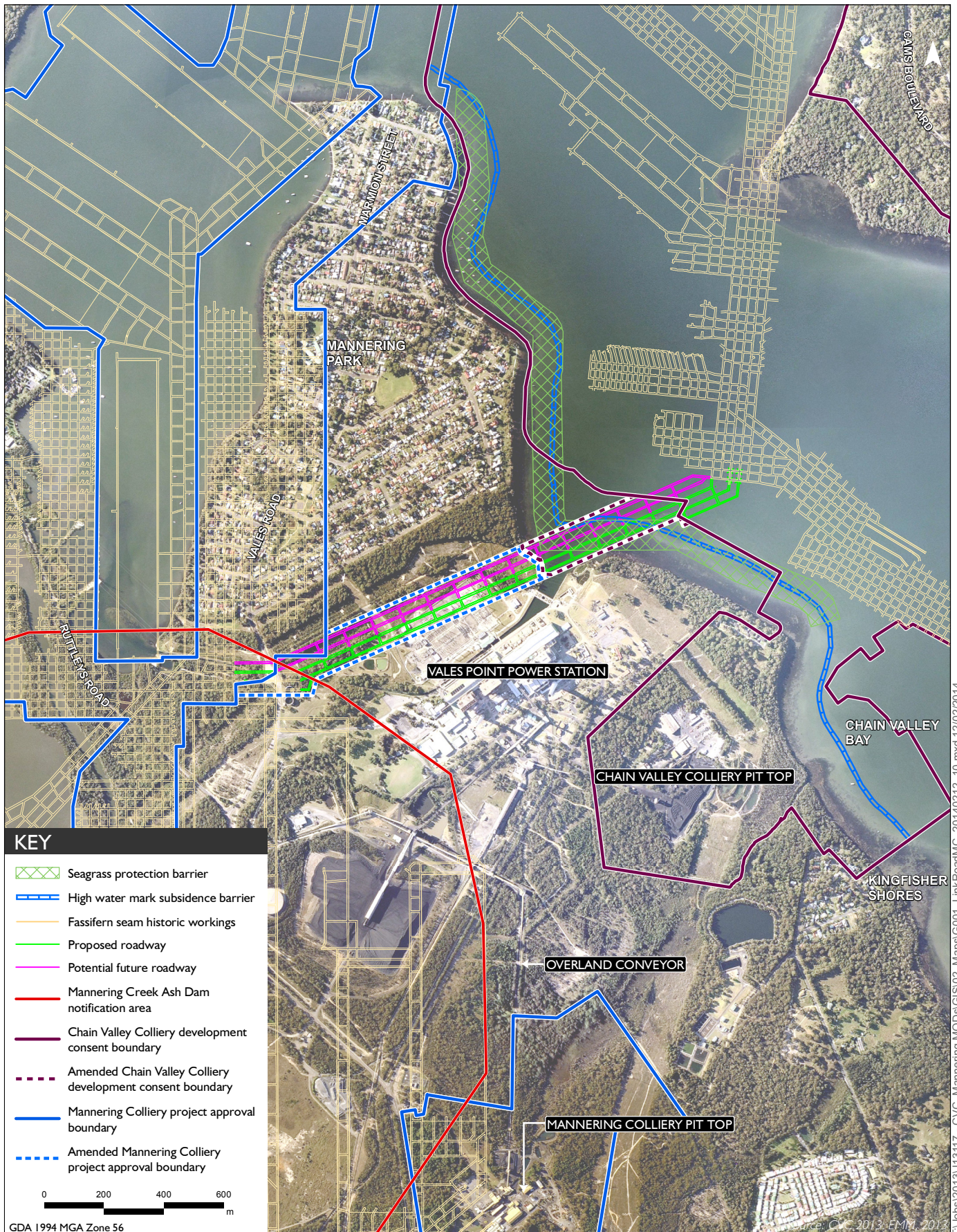
The roadways will be constructed within the coal seam using a wide head continuous miner with the coal produced transferred from the continuous miner to shuttle cars and then onto a conveyor will transport the coal to the surface facilities. Blocks of coal, or pillars, will be left in the roadways to maintain the stability of the roof. The main equipment to be used for construction of the headings (ie the continuous miner) is currently in use at Chain Valley Colliery, and would be available for the proposed work following the return of another continuous miner which is currently being overhauled. Construction of the underground linkage, including remedial works at the MC, will take approximately 12 months.

The underground linkage headings will be located at a cover depth of approximately 195 m and pass 22.5 m below existing first and second workings panels in the Great Northern Seam associated with historic mining at MC. The underground linkage will also pass beneath a section of the HWMSB and SPB as shown in Figure 3.1.

Maximum vertical subsidence from the roadway development will not exceed 20 mm (see Section 5.2 and Appendix C).

Following construction, any groundwater inflows to the roadways will drain to the CVC workings and be managed by the existing water management system. As identified in Section 5.3, water make is predicted to be negligible and, therefore, will have no measureable impact on CVC’s existing water management system which is currently operating well within capacity.

Ventilation management will likely involve maintaining segregation between the two mines through the installation of ventilation control devices at the CVC end of the underground linkage once the roadways have been constructed. The ventilation control devices will be designed to handle pressure changes from either direction. Gas concentration and ventilation (pressure and flow) monitoring will be undertaken within the underground linkage roadways. Further ventilation devices and monitoring may be required following completion of the ventilation modelling and detailed risk assessment, which will be completed prior to commencing development work.



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The construction of the underground linkage will result in a minor adjustment to the MC's project approval boundary identified in MP06_0311 extending it approximately 770 m to the north-east from the existing boundary limit to the foreshore adjacent to the VPPS where it is proposed to meet the amended CVC development consent boundary (see Figure 3.1). The amended MC project approval boundary is also coincident with the boundaries of CCL 719 and ML 1052.

3.2.2 Use of infrastructure for CVC product coal transportation

Once the underground connection of the conveyor systems is established, a portion of ROM coal extracted from CVC (ie the volume to be delivered to VPPS) will be transported to the MC surface facilities via the drift conveyor where it will be crushed, screened and conveyed to the existing 1,000 tonne product bin, consistent with the activities approved under MP06_0311. It is noted that during periods when VPPS is unable to accept coal deliveries due to scheduled maintenance or conveyor break-downs, a small ROM coal stockpile with a capacity to hold up to 25,000 tonnes is available on-site. As was the case during prior MC operations, reclamation from the stockpile is undertaken using an excavator or front end loader to load the ROM hopper.

The underground linkage headings may be constructed from either the MC or CVC workings. During construction approximately 40 full time employees would be required at MC. Should the majority of the linkage headings be driven from CVC, a lower number would be required for remedial activities. Following completion, approximately 20 full time positions will be required at MC to maintain and operate the MC infrastructure to permit coal transport through the mine to VPPS. The number of CVC operational employees will not change, though the reduced truck transport will result in a reduction of up to nine full time contractor positions. Overall, however, there will be a net increase in employment.

The total rate of ROM coal transported to MC's surface facilities will not exceed 1.1 Mtpa (ie the currently approved limit of extraction under Schedule 2 Condition 6 of MP06_0311).

All coal conveyed to the MC surface facilities will be transported by overland conveyor to the VPPS, consistent with Schedule 2 Condition 7 of MP06_0311.

All other components of MC, as modified, will remain unchanged.

It is noted that MC has approval to operate until 31 March 2018. It is anticipated that this approval would be extended until at least 2022, which is the full term of the agreement between LakeCoal and Centennial for operation of MC. This extension would form part of a separate application which would be lodged prior to cessation of operations at MC.

3.3 Alternatives considered

3.3.1 Do nothing option

If the proposed modification did not proceed, coal designated for the VPPS would continue to be transported from CVC via private haul roads in accordance with SSD-5465. Consequently, the improved amenity outcomes, operational cost savings and employment benefits that can be achieved with little to no adverse environmental impact as described in Chapter 5 would not be realised.

3.3.2 Surface conveyor connection

An alternative considered included the construction of an overland conveyor from CVC to VPPS to facilitate the direct transport of product coal without the need for truck haulage. A number of factors

were considered in deciding to proceed with the underground connection over construction of a new surface conveyor, including:

- the reliability and age of the existing cable belt and coal handling and processing facilities at CVC;
- the capacity of CVC's coal clearance system; and
- the need for new surface conveyor infrastructure and associated impacts of its construction including vegetation clearance requirements.

Utilising the MC coal clearance system reduces the risk of lost production due to plant or equipment failure; removes an existing bottleneck due to the existing capacity of CVC cable belt system; does not cause direct impacts to native vegetation communities; and removes potential air quality, noise and light impacts associated with an additional overland conveyor system. Therefore, an underground connection of the conveyor systems was preferential over the surface option.

Construction of a surface conveyor would also require Delta Electricity to spend significant capital on infrastructure upgrades at VPPS to receive coal directly from CVC.

3.3.3 Roadway configuration and location alternatives

A number of roadway configuration and location alternatives were considered during the development of the preferred project. These included development of two roadways only and a number of alignments either to the north or south of the preferred route. The assessment of options considered:

- safety, including requirements under the Coal Mine Health and Safety Regulation 2006;
- geological constraints;
- the location of underground MC and CVC infrastructure and distance between mining areas; and
- the location of significant surface features including prescribed dams and VPPS exclusion zone.

The preferred configuration and alignment the subject of the current application represents the most appropriate balance between the above considerations.

4 Stakeholder engagement

4.1 Introduction

As stated in its Environment and Community Policy, LakeCoal is committed to communicating and engaging with the community and other stakeholders regarding its activities. Consistent with this commitment, community consultation for the MC is ongoing and includes the MC website (manneringmine.com.au), information line and a community consultative committee (CCC).

As outlined in the subsequent sections, consultation has been, and will continue to be, supplemented by activities that relate specifically to the proposed modification. The nature and extent of these stakeholder consultation activities reflect the modest nature and scale of the proposed modification and its potential impacts.

4.2 Consultation with government

A summary of consultation undertaken with government agencies is given in Table 4.1. The outcomes of this consultation are reflected in the proposed modification's scope and matters addressed in this EA.

Table 4.1 Summary of government consultation

Agency	Date and method of consultation	Description of outcomes
P&I	Face-to-face meeting held on 6 November 2013	Items discussed during the meeting included project briefing, planning pathway, stakeholder engagement, and matters requiring consideration.
DRE	Briefing letter sent on 19 November 2013 Face-to-face meeting held on 5 December 2013	DRE identified a number of information requirements to be included in the subsidence assessment. These items have been addressed in Appendix C. No feedback additional to that given at the 5 December 2013 meeting has been provided to date.
Office of Environment and Heritage (OEH)	Briefing letter sent on 19 November 2013	OEH advised that there were no major concerns and no formal response will be provided.
Environment Protection Authority	Briefing letter sent on 19 November 2013	No response received to date.
NSW Office of Water (NOW)	Briefing letter sent on 19 November 2013	No response received to date.
Wyong Shire Council	Briefing letter sent on 19 November 2013	No response received to date.
Lake Macquarie City Council	Briefing letter sent on 19 November 2013 Briefing meeting held on 3 February 2014	A number of questions were raised and addressed during the Councillors briefing meeting. These questions were addressed during the meeting and no further response was required.
DSC	Phone call on 21 November 2013 Briefing letter sent on 19 November 2013	Discussed proposed linkage and agreed it was a minor incursion into the Dam Notification Area. Copy of subsidence assessment is to be provided when complete (now attached as Appendix C) to confirm minor subsidence impacts and pillar stability.

4.3 Consultation with community and special interest groups

As noted above, community consultation for the MC is ongoing. Information specific to the proposed modification is presented on the MC website (manneringmine.com.au) and presentations related to the proposed modification were made to the MC CCC.

The MC CCC meetings during the development of the EA were held on 18 November 2013 and 11 February 2014. In the earlier meeting, LakeCoal representatives outlined its agreement with Centennial, described the proposed modification, its needs and matters being considered. A preliminary plan showing the proposed roadways connecting the two collieries was also shown. It is noted that a meeting was also held with CVC's CCC on the same day which covered the same information relating to the proposed modification. The meeting in February 2014 covered the modification in more detail including subsidence assessment results. No matters were raised by community representatives, Wyong Shire Council or Lake Macquarie City Council representatives during the CCC meetings.

The community will also be notified of the proposed modification through an advertisement placed in a local newspaper following lodgement and through the public exhibition process where community members will be invited to comment.

Due to potential subsidence impacts on surface features, consultation was undertaken with TransGrid and Delta Electricity. A meeting between LakeCoal and Delta Electricity to discuss the proposed modification was held on 22 January 2014. Items discussed at the meeting included the development in general, mine design, timing and exhibition requirements. Delta Electricity also identified a number of surface features, and provided specific details and locations of this infrastructure which enabled it to be incorporated into the subsidence assessment (see Appendix C). Delta raised no major concerns in relation to the proposed modification. TransGrid was contacted by LakeCoal with detailed correspondence on the proposed modification provided 14 January 2014. TransGrid confirmed receipt of the correspondence and no further comments on the proposed modification were received.

5 Environmental assessment and management

5.1 Introduction

This chapter assesses the potential environmental, social and economic impacts from the proposed modification. A preliminary risk assessment was completed for the proposed modification (Appendix B). All risks were rated as low. However, it was considered that a more detailed assessment of potential subsidence and groundwater impacts was warranted given the nature of the proposed modification. These aspects are addressed below. Other environmental aspects are addressed in Section 5.4.

As noted previously, the assessment of the proposed modification's impacts considers both the MC and CVC operations to assist the reader in their understanding of the proposed modification's impacts without reference to multiple documents. Therefore, the assessment may consider aspects of the proposed modification which are not relevant to both MC and CVC.

5.2 Subsidence

5.2.1 Introduction

A subsidence assessment of the proposed modification was prepared by Ditton Geotechnical Services (DGS). The assessment is presented in full in Appendix C and a summary provided below.

5.2.2 Existing environment

The proposed workings underlie several significant features including the Lake Macquarie foreshore and high voltage transmission towers.

The proposed headings will also pass beneath mapped seagrass beds, the SPB, and HWMSB as described in Section 3.1.3 and shown in Figure 3.1. The proposed first workings within these areas have been designed to limit additional subsidence to less than 20 mm, which is widely adopted as being imperceptible. However, due to prior mining in the area, including above the proposed workings, a consideration in the subsidence assessment was the interaction of existing and proposed workings to determine potential cumulative impacts. As detailed in Section 2.3.2, approval from the Minister for Resources and Energy is required to mine within the HWMSB under CCL 719 and CCL 721 and within 20 m of the lease boundaries.

The existing built surface features above the proposed underground linkage headings are listed below with the major features shown on Figure 5.1. The majority of these are within the VPPS site boundary.

- Intake and outfall canals with 300 mm wide reinforced concrete walls and invert slab.
- Outlet tunnel with reinforced concrete arch roof, walls and invert slab.
- Six TransGrid tension towers with varying conductor angles (30° to 83°).
- Four TransGrid suspension towers.
- Two steel lattice switchyard conductor support frames on raft slab footings.
- Several elevated switchyard transformers supported on steel box frames on raft slab footings.

- Jointed and reinforced concrete pavement and bitumen sealed hardstand areas.
- Sewage treatment works comprising primary and secondary treatment tanks with one oxidation tank (Pasveer Channel), sludge pond, three earth embankment ponds or dams with several buried rising main and gravity pipelines, buried power line conduits and trenches.
- Buried return water pipelines that connect the main ash dam pumps to the southern reservoir tank adjacent to Vales Road and then back to VPPS.
- Underground power and services (including a fibre optic line) to light poles and ancillary control room buildings.
- Bitumen access roads and stormwater drainage lines.
- Two steel framed and sheet metal clad storage sheds on slab footings.
- Steel post and chain wire mesh fences and security gates.

The proposed workings will also occur beneath an area of dry sclerophyll woodland and lake foreshore vegetation, and a small portion are located within the Notification Area for the Mannering Creek Ash Dam, a prescribed dam under the *Dams Safety Act 1978* (see Figure 3.1).

The proposed underground linkage is predominately beneath historic first and second workings within the Great Northern Seam associated with the MC, which were completed in the 1970s. Historical vertical subsidence within these areas is predicted to have ranged between 20 mm and 33 mm; and 88 mm to 106 mm above the first and second workings panels, respectively.

Vertical subsidence from the historic workings above the underground linkage in the vicinity of the SPB is estimated to have measured up to 26 mm.

Subsidence monitoring lines are survey lines located across a subsidence area used to measure changes in the ground surface level. Survey Line 24 was used previously to measure vertical subsidence from the historic Great Northern Seam workings and is the most relevant survey line to the proposed underground linkage (refer to Section 5.2.4).

5.2.3 Impact assessment

The outcomes of the modelling undertaken by DGS indicate that vertical subsidence from the proposed underground linkage will range from 5 mm to 20 mm where first and second workings in the Great Northern Seam occur, respectively. When added to the predicted historic subsidence levels described above, total (cumulative) subsidence is predicted to range from 25 mm to 38 mm above areas of first workings and 113 mm to 126 mm above areas of second workings.

DGS predicts that vertical subsidence in the vicinity of the SPB will increase by up to 5 mm, resulting in cumulative vertical subsidence with the areas of historic workings of up to 31 mm and that net and cumulative tilts are likely to be less than 0.2 mm/m at sensitive features, with curvatures less than 0.02 km⁻¹, and strains less than 0.3 mm/m.

It is not clear at this stage whether the construction of some of the surface features occurred before or after the completion of the Great Northern Seam panels in the 1970s or during the period of subsidence development up to 1995 (at which time the final survey was undertaken). If the former is the case then the cumulative subsidence contours should be adopted for impact assessment purposes. For surface

features constructed after 1995, it is considered reasonable to assume the incremental subsidence contours for the proposed Fassifern Seam contours should be adopted for impact assessment purposes. Incremental and cumulative subsidence contours are shown in Figures 5.2 and 5.3.

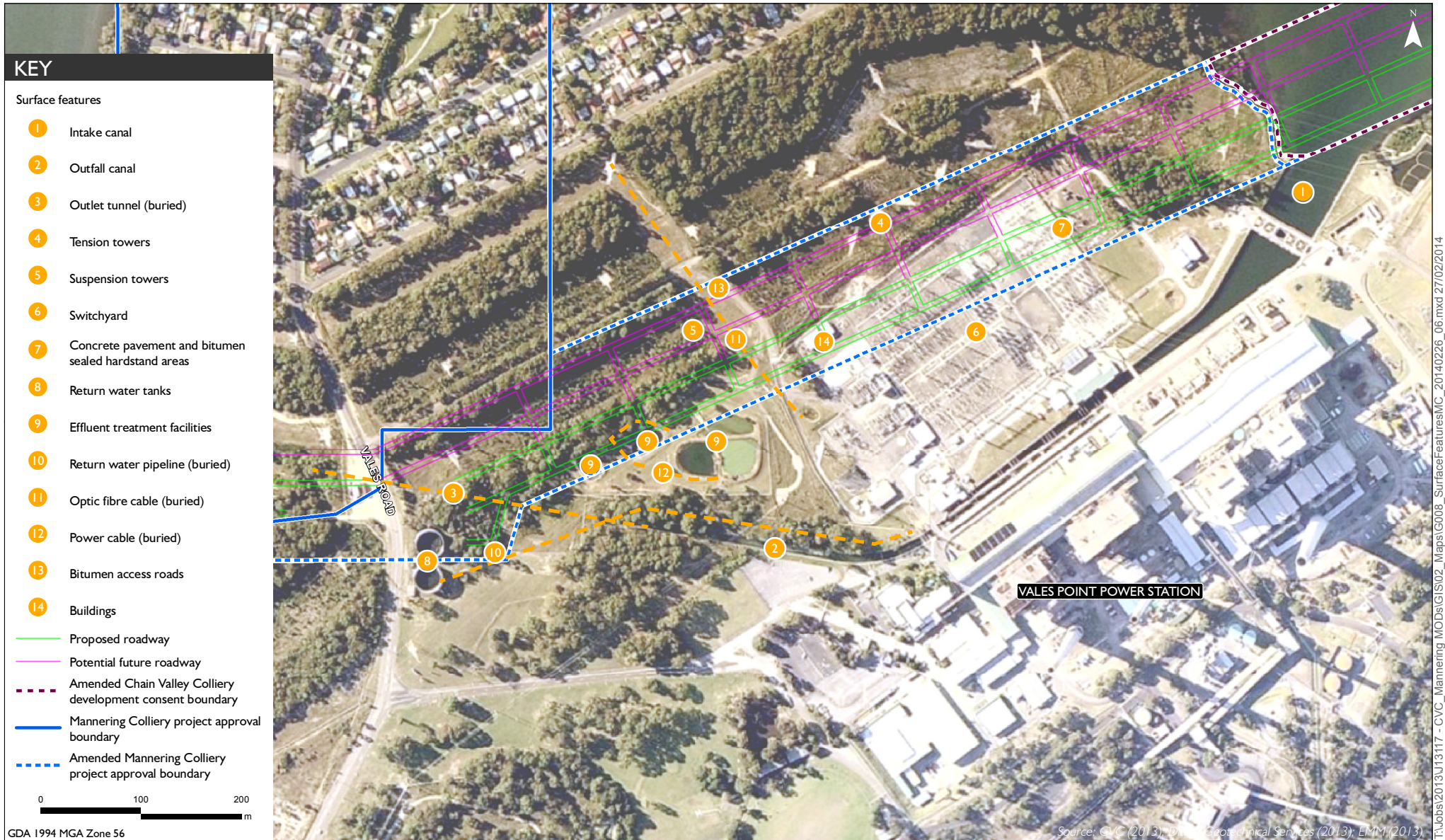
It is considered unlikely that, under both incremental and cumulative scenarios, the proposed first workings will impact upon the existing transmission towers, switchyard, treatment works, rigid pavement, underground power cables and all other surface infrastructure listed in Section 5.2.2. It is noted, however, that minor cracking may develop in the hard stand areas and concrete slabs which would be readily repairable.

As described in Table 5.2 the change in subsidence levels from the proposed first workings is not predicted to adversely impact seagrasses, dry sclerophyll woodland or lake foreshore vegetation. As noted in Section 5.2.2, a small portion of the proposed workings are located within the Notification Area for the Mannering Creek Ash Dam which is a prescribed dam under the *Dams Safety Act 1978*. Consultation with the DSC has been undertaken in this regard. The DSC noted that incursion was minor and impacts unlikely. The subsidence assessment will be provided for its consideration and it is noted that a separate approval will be required prior to undertaking any mining activities within the Notification Area.

5.2.4 Mitigation and management

Measures proposed to manage potential subsidence impacts are provided below. It is noted that the subsidence assessment includes a recommendation to survey the seagrass in the area of the SPB prior to undermining. Surveys of this area were undertaken in late March/early April 2014 and no seagrasses were recorded.

- Develop infrastructure monitoring and management plans in consultation with infrastructure owners and other relevant stakeholders.
- Re-establish and re-survey Survey Line 24.
- Install a new foreshore survey line above the first and second workings panels where the underground headings pass beneath the foreshore, possibly extending from the foreshore to the point of connection with the MC workings.
- Install a suitable survey line at the starting end above Great Northern Seam first workings to provide early warning monitoring data for the tension towers and switchyard structures.
- Monitor tension and suspension towers and switchyard conductor suspension frames directly above the panels, as well as the foreshore and adjacent inlet canal walls.
- Inspect existing conditions in the Fassifern Seam and undertake geotechnical and geological mapping in the roadways proximate to the proposed linkage in both CVC and MC workings.
- Complete representative borehole core drilling and sampling of the Fassifern Seam floor at the start and finishing ends of the underground linkage and where the headings pass beneath the SPB. Development below the foreshore will be limited to two headings only until floor conditions can be confirmed.

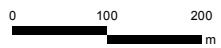


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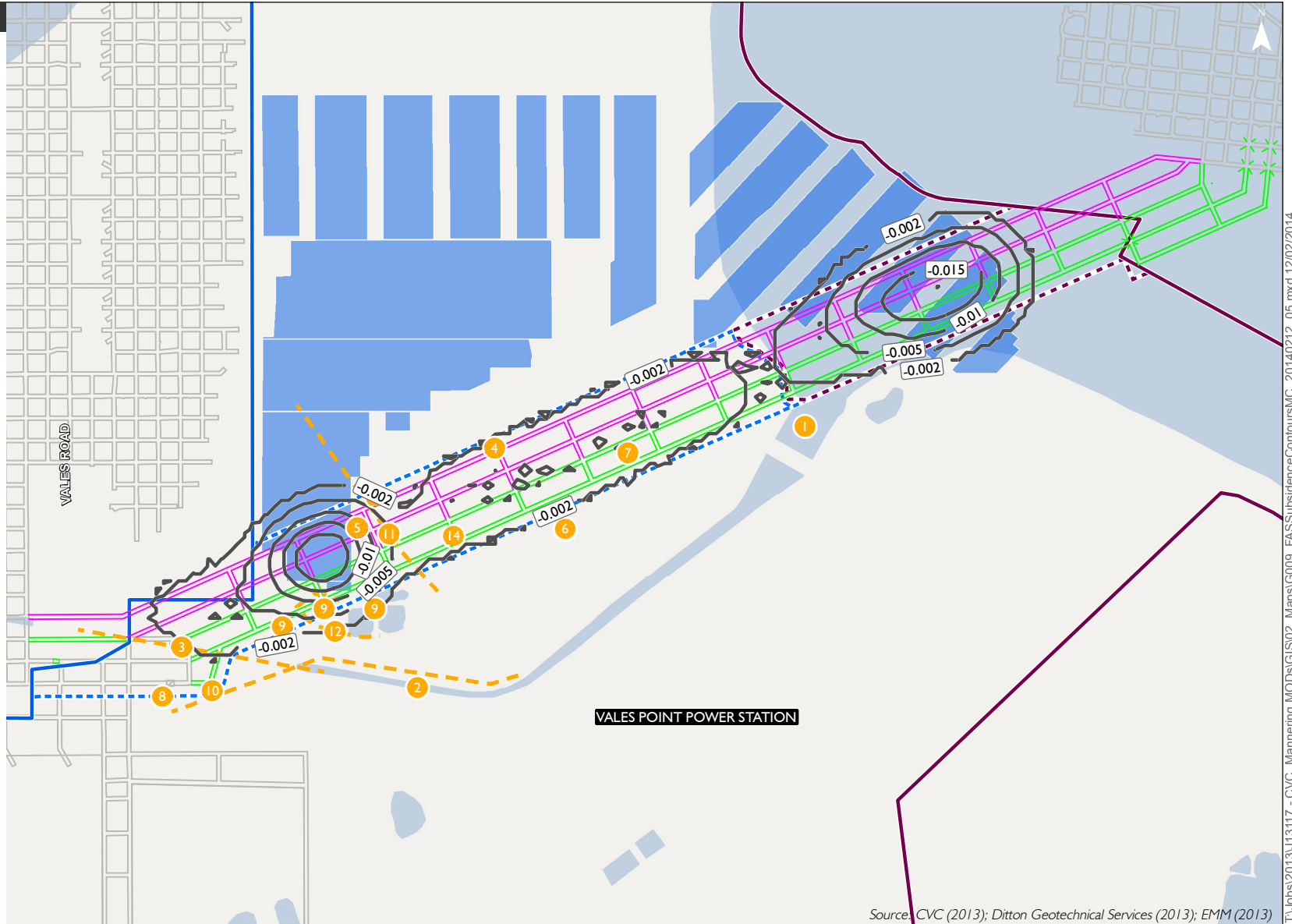
Surface features

- ① Intake canal
- ② Outfall canal
- ③ Outlet tunnel (buried)
- ④ Tension towers
- ⑤ Suspension towers
- ⑥ Switchyard
- ⑦ Concrete pavement and bitumen sealed hardstand areas
- ⑧ Return water tanks
- ⑨ Effluent treatment facilities
- ⑩ Return water pipeline (buried)
- ⑪ Optic fibre cable (buried)
- ⑫ Power cable (buried)
- ⑬ Bitumen access roads
- ⑭ Buildings

- Subsidence contours (m)
- Existing second workings in GN seam
- Fassifern seam historic workings
- Proposed roadway
- Potential future roadway
- Chain Valley Colliery development consent boundary
- Amended Chain Valley Colliery development consent boundary
- Manning Colliery project approval boundary
- Amended Manning Colliery project approval boundary



GDA 1994 MGA Zone 56



Source: CVC (2013); Ditton Geotechnical Services (2013); EMM (2013)

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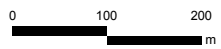
Predicted incremental subsidence contours
Manning Colliery – Modification 2
Figure 5.2

KEY

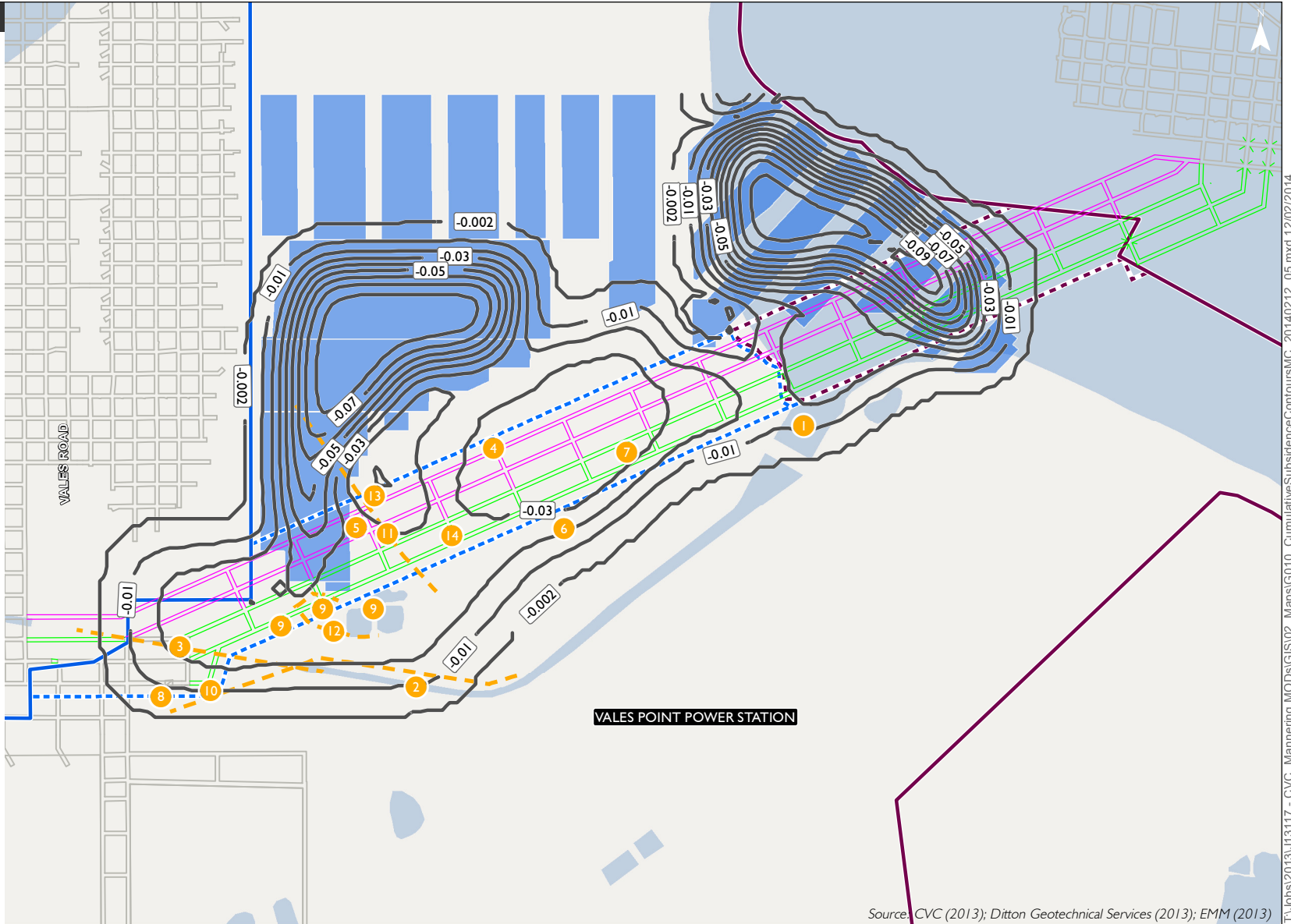
Surface features

- 1 Intake canal
- 2 Outfall canal
- 3 Outlet tunnel (buried)
- 4 Tension towers
- 5 Suspension towers
- 6 Switchyard
- 7 Concrete pavement and bitumen sealed hardstand areas
- 8 Return water tanks
- 9 Effluent treatment facilities
- 10 Return water pipeline (buried)
- 11 Optic fibre cable (buried)
- 12 Power cable (buried)
- 13 Bitumen access roads
- 14 Buildings

- Subsidence contours (m)
- Existing second workings in GN seam
- Fassifern seam historic workings
- Proposed roadway
- Potential future roadway
- Chain Valley Colliery development consent boundary
- Amended Chain Valley Colliery development consent boundary
- Manning Colliery project approval boundary
- Amended Manning Colliery project approval boundary



GDA 1994 MGA Zone 56



Source: CVC (2013); Ditton Geotechnical Services (2013); EMM (2013)

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Predicted cumulative subsidence contours
Manning Colliery – Modification 2
Figure 5.3

5.2.5 Conclusion

Vertical subsidence as a result of the underground linkage development will range from 5 mm to 20 mm where first and second workings in the Great Northern Seam occur, respectively. This is commonly considered to be 'zero' subsidence. When considered together with subsidence already experienced from historic workings, the combined vertical subsidence levels range from a maximum of 38 mm to 126 mm.

A number of significant features are located above and within relative proximity to the underground linkage including the Lake Macquarie foreshore and high voltage transmission towers. The assessment concludes that the proposed modification will not adversely impact on these features.

A number of measures are proposed to confirm assessment results and minimise/negate the risks from subsidence.

5.3 Groundwater

5.3.1 Existing environment

i Geology

The MC lies within the Hunter Coalfield of the northern Sydney Basin. The Sydney Basin is the southern portion of the greater Sydney-Gunnedah-Bowen Basin.

The stratigraphy of the site consists of Triassic rocks of the Narrabeen Group Formation which in places is overlain by Quaternary deposits of terrestrial, lacustrine and marine origin. Underlying the Triassic sediments are the Permian Newcastle Coal Measures (see Table 5.1). The target seam for this assessment is the Fassifern Seam of the Newcastle Coal Measures which is approximately 195 m below ground in this area.

Table 5.1 Stratigraphy of the site

Age	Group	Formation	Unit
Quaternary		Terrestrial and lacustrine marine sediments	
Triassic	Narrabeen Group (Clifton Sub Group)	Munmorah Conglomerate	
		Dooralong Shale	
Permian	Newcastle Coal Measures		Vales Point Seam
			Karignan Conglomerate
			Wallahah Seam
		Moon Island Beach Formation	Mannering Park Tuff
			Teralba Conglomerate
			Great Northern Seam
		Karingal Conglomerate	
		Awaba Tuff	
		Boolaroo	Fassifern Seam

ii Hydrogeology

The hydrogeology of the site comprises:

- a Quaternary terrestrial and marine/estuarine alluvial/colluvial aquifer system; and
- underlying Permian strata with low permeability interburden units (sandstone, siltstone, conglomerate and tuff) and low to moderately permeable coal seams.

The terrestrial alluvial aquifers are recharged by rainfall and hydraulically independent of the deeper Permian Coal aquifers (Geoterra 2013).

The permeability of the Permian strata is very low, with the main pathway for groundwater flow being lateral bedding planes, faults and cleats in the coal seams. Vertical percolation through the Permian strata is minimal and most recharge to deeper strata is likely to be via lateral flow through the coal seams themselves. The groundwater extraction records for mines in the area indicate that the Fassifern Seam is the driest of the seams that have been mined (Geoterra 2013).

The coal seams historically mined at the MC and CVC comprise the Wallarah, Great Northern and Fassifern Seams of the Newcastle Coal Measures which are generally interbedded with tuffaceous claystone. The coal seams generally have a low primary or inter-granular porosity and permeability, with bedding planes, joints, fractures and cleating imparting an enhanced secondary permeability.

Historical and ongoing underground mining around Lake Macquarie has created a significant groundwater sink and generated a regional zone of depressurisation within the Permian Coal Measures.

iii Groundwater chemistry

Water quality sampling of the groundwater within the coal seams conducted in June 2012 indicates the Fassifern Seam has a salinity of 2,390 mg/L and has a possible seawater component of 7%. This compares with the shallower Great Northern Seam which has a salinity of 11,800 to 28,200 mg/L and a possible seawater component of between 33 and 79%. As reported by Geoterra 2013, the water quality aligns to the conceptual and numerical hydrogeological model which indicates that the Fassifern Seam has only very limited vertical connection with the overlying shallower formations.

5.3.2 Impact assessment

The most recent groundwater assessment for the MC was undertaken by GHD (2011) as part of the application to modify MP06_0311. The assessment included development of a hydrogeological model of the Fassifern and Great Northern seam workings and a site water balance.

The assessment assumed a groundwater inflow rate of approximately 1.1 ML/day in 2011 and predicted that this will increase to 1.6 – 1.8 ML/day under the modification. Groundwater monitoring data for 2013 recorded an average inflow of 0.95 ML/day (ie while the MC was under care and maintenance). These dewatering rates are relatively consistent with historic rates and increased inflows are not expected until mining commences within the extension areas approved under the modification to MP06_0311.

The underground link between the two collieries through a series of roadways represents a limited amount of additional first workings within the Fassifern Seam. Considering the low permeability of the strata, the minimal additional predicted subsidence of 5 to 20 mm, the relatively small additional area to be mined and the narrow width (5.4 m) associated with the roadways, it is concluded that the additional groundwater inflow as a result of this proposed modification will be negligible and within the uncertainty

margin of current estimates for the approved operations. As noted in Section 5.3.1, the terrestrial alluvial aquifers are recharged by rainfall and hydraulically independent of the deeper Permian Coal aquifers. The proposed modification will not impact terrestrial alluvial aquifers.

The assessment identified eight licensed groundwater bores within a 3 km radius of the MC workings which are predominantly used for domestic and stock purposes. No alluvial bores were identified. Several groundwater dependent ecosystems (GDEs) were identified in the vicinity of the MC's lease area. The assessment found that the MC's operations were not likely to impact local users or GDEs and the construction of the underground linkage is anticipated to have negligible additional impacts.

5.3.3 Legislative considerations

Water management in NSW is governed by both the Water Act, and the WM Act, with the main trigger for transitioning of licences from the Water Act to the WM Act being the commencement of a Water Sharing Plan for a water source.

There is currently no gazetted water sharing plan for the porous rock water source in the MC leases holdings (which includes the Triassic and Permian rocks), and, therefore, the Water Act is the relevant legislation. The alluvial sediments, however, are managed under the WM Act via the Hunter Unregulated and Alluvial Water Management Plan which commenced in 2009.

The Aquifer Interference Policy (NOW 2012) under the WM Act provides the mechanism for NOW to clarify the requirements for obtaining water licences for aquifer interference activities and also considers and defines minimal harm criteria for productive and less productive aquifers. In those areas not under the WM Act the principles of the Aquifer Interference Policy will still apply, but are not yet legislated.

The Aquifer Interference Policy classifies the Triassic and Permian rocks at the site as less productive based on the groundwater salinity being in excess of 1,500 mg/L and bore yields lower than 5 L/sec.

To allow for groundwater extraction at the MC, bore licence 20BL172016, issued under the Water Act, is valid until 30 November 2016 for the purposes of mine dewatering and industrial use, with a volumetric limit of 450 ML in any 12 month period. LakeCoal intends to submit a new licence application to allow for the predicted groundwater inflow under the previous modification to MP06_0311 which was approved in 2012.

The groundwater inflow associated with the underground linkage is proposed to be managed under CVC's existing licence under the Water Act.

To determine if the proposed modification will have any impacts on matters of NES under the EPBC Act, including impacts on water resources, a review was undertaken against the *Significant Impact Guidelines 1.3: Coal Seam Gas and Large Coal Mining Developments – Impacts on Water Resources* (Department of the Environment 2013). No impacts to groundwater levels and quality are expected from the development of the underground linkage. Therefore, a referral of the proposed modification under the EPBC Act is not considered necessary.

5.3.4 Mitigation and management

Groundwater impacts associated with the MC are managed under a Water Management Plan which contains a site water balance, an Erosion and Sediment Control Plan, Surface Water Monitoring Program, and Groundwater Monitoring Program. No additional management or monitoring measures are warranted as a result of the proposed modification.

5.3.5 Conclusion

Based on the outcomes of the groundwater modelling undertaken for the approved MC operations, there will be negligible additional groundwater flows associated with the proposed underground linkage and negligible additional impact on the groundwater systems.

5.4 Other social and environmental aspects

An assessment of the other environmental, social and economic aspects as a consequence of the proposed modification is given in Table 5.2. This assessment is commensurate with the negligible levels of projected impacts arising from the proposed modification on each of these aspects.

No specific management measures regarding these aspects are warranted as a result of the proposed modification. Environmental management for these aspects will continue in accordance with the processes and procedures outlined in Section 3.1.2.

Table 5.2 Other environmental, social and economic aspects

Environmental aspect	Assessment
Surface water	<p>The surface water management system for the MC was most recently assessed as part of the application to modify MP06_0311 (GHD 2011). Water entering the mine is passed through an extensive goaf system prior to being pumped to the pit top area where it is transferred to the sediment pond system or directly to licenced discharge point 1. Water is discharged at a licensed discharge point (EPL 191 LDP001) on Swindles Creek, a tributary of Lake Macquarie.</p> <p>Water inflows to the underground linkage will be managed under CVC's water management system. Additionally, no above ground surface disturbance or alterations to surface infrastructure are proposed which could lead to changes in surface water flows. Therefore, the proposed modification will not have any impacts on surface water.</p>
Geology and soils	<p>Current operations are not likely to have a significant impact on geology or soils as the mine layout prevents surface cracking associated with subsidence. As mentioned in Section 5.3.5, the existing Water Management Plan includes an Erosion and Sediment Control Plan for management of soils.</p> <p>The proposed modification does not involve any above ground surface disturbance and, therefore, geology and soil impacts are unlikely.</p>
Biodiversity (terrestrial)	<p>The proposed modification does not involve any above ground surface disturbance and, therefore, no terrestrial biodiversity impacts are likely. The quality and volumes of mine water discharged under the proposed modification will not be changed. Therefore, no significant impacts on terrestrial ecology are anticipated.</p>
Biodiversity (aquatic)	<p>Potential impacts on aquatic biodiversity can occur as a result of subsidence. The areas of potential subsidence beneath the lake bed are located within CVC's lease boundary. Mapping of seagrass communities within this area has previously been undertaken for the CVC Mining Extension 1 Project (JSA Environmental 2013). A SPB has been adopted by LakeCoal to protect the seagrass beds of Lake Macquarie from any potential impacts from underground mining at CVC (see Figure 3.1).</p> <p>As discussed in Section 5.2, vertical subsidence from the historic workings in the 1970s above the underground linkage in the vicinity of the SPB is predicted to have been a maximum of 26 mm. The 5 mm of subsidence predicted as a result of the proposed modification is within levels of natural variation and is highly unlikely to adversely impact seagrasses if present. Further, surveys conducted for this area recorded no seagrasses present.</p> <p>There is moderate to high potential for 3 endangered marine species to occur above areas of predicted subsidence within Lake Macquarie including the Loggerhead and Green turtles and the seagrass <i>Posidonia australis</i>. These species are unlikely to be impacted by the proposed modification given the minimal subsidence predicted, limited potential for adverse impacts on seagrasses and the highly mobile nature of the turtle species.</p>

Table 5.2 Other environmental, social and economic aspects

Environmental aspect	Assessment
	As noted in the 'surface water' section above, mine water generated will be managed under CVC's water management system. Additionally, no above ground surface disturbance or alterations to surface infrastructure are proposed which could lead to changes in surface water flows. Therefore, detrimental impacts on the surrounding marine environment are not anticipated to occur.
Transport	<p>The MC currently transports all coal via conveyor to VPPS. No truck transport of coal is currently undertaken and there will not be any changes to coal transport due to the proposed modification. Traffic movements associated with deliveries of plant equipment for the underground linkage would be minimal.</p> <p>Employment levels at MC will increase above care and maintenance levels, though will remain well below approved employment numbers. A number of upgrades at the Ruttleys Road intersection are required to be undertaken under Schedule 3, Condition 21 of MP06_0311 which included the eight recommendations of a road safety audit prepared by Parsons Brinckerhoff in 2008 (see Appendix D). Completion of these upgrades was postponed whilst the MC was under care and maintenance. A review of the road safety audit recommendations has found that these have all been satisfied by road upgrade works undertaken in conjunction with the recent Wyong Shire Council resurfacing works to this section and the adjoining sections of Ruttleys Road (see Appendix D). Further, MP06_0311 includes a commitment to upgrade the Ruttleys Road intersection to a type CHR intersection when employee levels exceed 130. This threshold will not be exceeded by either the construction or operational employment levels under the proposed modification. Therefore, no road upgrade works to Ruttleys Road are warranted due to the proposed modification.</p>
Noise	<p>Noise emissions from the MC's operations are currently managed in accordance with a Noise Monitoring Program which includes quarterly noise monitoring and operator attended surveys at 3 monitoring locations. Noise emissions, prior to the MC being placed under care and maintenance, were considered to be in compliance with the noise criteria specified in MP06_0311 for all receiver locations (GSS Environmental 2012). Noise monitoring undertaken on behalf of LakeCoal in late 2013 (ie during care and maintenance) confirmed compliance at all monitoring locations.</p> <p>The proposed modification will only involve additional operations underground and will not change any aspect of the surface operations or road traffic generation which have the potential to generate noise emissions at potentially sensitive receivers. Subject to the approval of this modification and the equivalent modification of the CVC approval, noise emissions at CVC will be reduced through the use of the MC's existing surface conveyor to transport coal to VPPS (refer to Section 1.4). Therefore, the proposed modification will result in a positive impact with respect to cumulative noise.</p>
Air quality and greenhouse gasses	<p>Air quality and greenhouse gas emissions from the MC are managed in accordance with an Air Quality Management Plan and a Greenhouse and Energy Efficiency Plan. The MC operates a network of five dust deposition gauges in accordance with its Air Quality Monitoring Program. Dust deposition, prior to the MC being placed under care and maintenance, were well below OEH's air quality criteria (GSS Environmental 2012) and continue to be so.</p> <p>The proposed modification will only involve additional operations underground and will not increase plant and equipment types/numbers, coal movements or stockpiling. Further, dust and vehicle emissions from CVC will likely be reduced through the use of the MC's existing surface conveyor to transport coal to VPPS (refer to Section 1.4). Therefore, the proposed modification will result in a positive impact with respect to cumulative air quality. Greenhouse gas emissions associated with the construction of the underground linkage will be minimal and will be managed in accordance with the Greenhouse and Energy Efficiency Plan.</p>
Heritage	There will be no impacts on heritage associated with the proposed modification as no above ground surface disturbance is proposed. Land based subsidence is predicted to be less than 20 mm and will not occur beneath nearby Aboriginal or non-indigenous heritage items identified in heritage assessments which accompanied the application to modify MP06_0311 (RPS 2011).
Visibility	The proposed modification does not involve any additional above ground surface disturbance, new surface infrastructure nor intensification of activities. Therefore, the proposed modification will not result in additional visual impacts. Potential visual amenity and lighting impacts will continue to be managed in accordance with Schedule 3, Condition 19 of MP06_0311.

Table 5.2 Other environmental, social and economic aspects

Environmental aspect	Assessment
Social and economic	<p>The proposed modification would result in employment at MC of 40 full time employees during construction of the linkage and 20 full time employees during its operation, which is well within the approved 170 employee workforce for MC. This additional employment would also compensate for the loss of up to nine full time contractor positions at CVC. Approval of the proposed modification will also enhance the economic viability of CVC. Continued operation of CVC has positive socio-economic outcomes associated with revenue contributions and community support.</p> <p>Potential amenity impacts relating to noise, dust and visual are addressed in this table. The proposed modification will generally result in an approved amenity through the reduction of coal haulage by trucks to VPPS.</p>
Waste management	<p>No production waste or reject material is generated at the MC. Non-production waste streams are managed in accordance with Schedule 3, Condition 23 of MP06_0311 and EPL 191.</p> <p>The proposed modification will not generate any additional waste streams or increase existing waste volumes.</p>
Hazards/risks	<p>The MC's surface facilities are on land mapped by Wyong Shire Council as bushfire prone. The proposed modification will not increase bushfire risk as there will not be any additional above ground surface disturbance or intensification of activities.</p> <p>The proposed modification will comply with the provisions of the Coal Mine Health and Safety Regulation 2006. Potential inrush hazards will be managed in accordance with the inrush hazard management plans for both mines which will be reviewed in the context of the proposed modification. Potential ventilation hazards will be managed in accordance with ventilation arrangements management plans for both mines. Further, a detailed operational risk assessment will be undertaken by LakeCoal prior to construction of the underground linkage to identify potential risks and recommend appropriate controls. Ventilation models for each mine will be updated and combined to develop simulations of the expected ventilation flows and pressures for possible scenarios (ie. normal operation and during main fan failures). Depending on the results of the simulations the installation of appropriate ventilation control devices and monitoring to reduce risks may be implemented. Further, approval from DRE will be required prior to construction of the underground linkage which will consider, amongst other matters, safety.</p> <p>Should CVC and MC require physical separation in the future, the proposed headings between the collieries could be sealed through the installation of large plugs in the connection roadways, most likely at the lease boundaries. These plugs can be constructed, for example, by building concrete seals a set distance apart (for example 20m from either lease boundary or 40m apart) and then pumping the void between the seals with a foaming cement or similar product.</p>
Rehabilitation	<p>The mine closure and rehabilitation measures for the MC are described in a Mine Closure Plan which is appended to the MC's MOP. Mine closure and rehabilitation will be in accordance with Conditions 13 and 15 of Schedule 3 in MP06_0311, with the surface facilities to be rehabilitated to the satisfaction of the Executive Director of Mineral Resources.</p> <p>As the proposed modification does not entail changes to the surface infrastructure or approved areas of surface disturbance, there will be no impact on mine rehabilitation.</p>

6 Statement of commitments

This chapter provides commitments made to negate or minimise potential environmental impacts from the proposed modification. Environmental management under the proposed modification will continue in accordance with the processes and procedures outlined in Section 3.1.2. Table 6.1 provides commitments specific to aspects of the proposed modification relevant to MC, and are additional to those identified in MP06_0311.

Table 6.1 **Commitments**

Aspect	Commitment
Subsidence	Develop infrastructure monitoring and management plans in consultation with infrastructure owners and other relevant stakeholders.
	Re-establish and re-survey Survey Line 24.
	Install a new foreshore survey line above the first and second workings panels where the underground headings pass beneath the foreshore, possibly extending from the foreshore to the point of connection with the MC workings.
	Install a suitable survey line at the starting end above Great Northern Seam first workings to provide early warning monitoring data for the tension towers and switchyard structures.
	Monitor tension and suspension towers and switchyard conductor suspension frames directly above the panels, foreshore and adjacent inlet canal wall.
	Inspect existing conditions in the Fassifern Seam and undertake geotechnical and geological mapping in the roadways proximate to the proposed linkage in both CVC and MC workings.
	Complete representative borehole core drilling and sampling of the Fassifern Seam floor at the start and finishing ends of the underground linkage and where the headings pass beneath the SPB. Development below the foreshore will be limited to two headings only until floor conditions can be confirmed.

7 Modification justification and conclusion

7.1 Introduction

This chapter considers the proposed modification against the relevant objects of the EP&A Act and provides a justification for its development.

7.2 Objects of the Environmental Planning and Assessment Act 1979

The relevant objects of the EP&A Act are given below, followed by a discussion on their application to the proposed modification.

- (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

The proposed modification involves a minor amendment of the mine plan enabling the connection of the MC with CVC, thereby providing an opportunity to improve the operational efficiency and economic viability of CVC and enable employment at MC above care and maintenance levels.

The minimal/negligible potential environmental impacts associated with the proposed modification will be managed in accordance with the MC's contemporary approval and the additional commitments identified in Table 6.1 of this report.

- (ii) the promotion and co-ordination of the orderly and economic use and development of land

The modification is a minor alteration to an approved coal mine operation which represents an orderly and economic use of a resource approved for extraction for domestic and export uses. The underground linkage will be developed by first workings which have been designed to limit additional subsidence to less than 20 mm. The proposed modification will not impinge on land uses within and surrounding the MC.

- (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

The proposed modification will not adversely affect native animals and plants, including threatened species, populations and ecological communities and their habitats beyond that approved under MP06_0311.

- (vii) ecologically sustainable development

The principles of ESD are outlined in Section 6 of the NSW *Protection of the Environment Administration Act 1991* and Schedule 2 of the Environmental Planning and Assessment Regulation 2000. The consistency of the modification with each of these principles is discussed below.

Precautionary principle:

As noted in Section 5.2.2, the underground linkage development has been designed to limit subsidence to less than 20 mm to minimise the potential impact on sensitive environments, including the Lake Macquarie foreshore.

The EA has been prepared on the basis of the most recent and accurate scientific data relevant to the modification. Robust subsidence modelling, based on conservative assumptions was prepared to support the assessment of potential impacts. Where applicable, environmental safeguards and monitoring measures have been developed in accordance with current and accepted best management practice to avoid or minimise any effect on the environment. On this basis, this modification is consistent with the precautionary principle.

Inter-generational equity:

The principle of inter-generational equity puts an onus on society to ensure that the health, diversity and productivity of the environment are maintained, or enhanced, for the benefit of future generations. The modification will have minimal effects on the health, diversity or productivity of the environment and, therefore, will not adversely impact future generations.

Conservation of biological diversity and maintenance of ecological integrity:

An assessment of the ecological impacts of the modification has been undertaken in this EA. The modification will not adversely impact threatened ecological communities, important fauna habitats, movement corridors, or potentially present threatened flora or fauna species or populations.

Improved valuation and pricing of environmental resources:

Potential adverse environmental impacts from the proposed modification are limited. It is anticipated that the alternative mode of transportation for coal from CVC to the VPPS will provide for an improved amenity outcome.

Continued operation of the MC in accordance with MP06_0311 will ensure that environmental resources are valued both during and post mining.

- (b) to promote the sharing of the responsibility for environmental planning between the different levels of government in the State, and

The preparation of this EA has involved engagement with relevant State and local government bodies as described in Chapter 4.

- (c) to provide increased opportunity for public involvement and participation in environmental planning and assessment.

The community has been consulted during the preparation of the EA through existing LakeCoal engagement tools and will continue to be involved and consulted through the MC's CCC and other mechanisms. The community will also have chance to comment on the application during the public exhibition process.

7.3 Conclusion

LakeCoal is seeking approval to develop an underground linkage between CVC and the MC, which LakeCoal has an agreement to operate until 2022, and use existing infrastructure to transport coal from its underground workings to the VPPS. All other components of the MC, as approved under MP06_0311, will remain unchanged.

The proposed first workings have been designed to limit subsidence to less than 20 mm. When considered together with subsidence already experienced from historic workings, vertical subsidence levels range from a maximum of 38 mm to 126 mm. A number of significant features are located above and within

relative proximity to the underground linkage including the Lake Macquarie foreshore and high voltage transmission towers. The assessment concludes that the proposed modification will not adversely impact these features. Notwithstanding, a number of measures are proposed to minimise/negate the risks from subsidence.

The modification is a minor alteration to the approved MC operations which will result in improved amenity outcomes, operational cost savings and additional employment that can be achieved with little to no adverse environmental impact and, as substantiated in this chapter, is aligned with the principles of ESD.

Abbreviations

Centennial Coal Company	Centennial
Chain Valley Colliery	CVC
community consultative committee	CCC
consolidated coal lease	CCL
Dams Safety Committee	DSC
Ditton Geotechnical Services	DGS
Division of Resources and Energy	DRE
ecologically sustainable development	ESD
EMGA Mitchell McLennan Pty Limited	EMM
endangered ecological communities	EECs
<i>Environment Protection and Biodiversity Conservation Act 1999</i>	EPBC Act
Environmental Protection Authority	EPA
Environment Protection Licence	EPL
Environmental Assessment	EA
<i>Environmental Planning and Assessment Act 1979</i>	EP&A Act
<i>Environmental Planning and Assessment Amendment Act 2011</i>	Part 3A Repeal Act
<i>Fisheries Management Act 1994</i>	FM Act
groundwater dependent ecosystems	GDEs
hectares	ha
high water mark subsidence barrier	HWMSB
kilometre	km
LakeCoal Pty Limited	LakeCoal
local government area	LGA
Manning Colliery	MC
metre	m
mega litre	ML
million tonnes per annum	Mtpa
<i>Mining Act 1992</i>	Mining Act
Mining Operations Plan	MOP
national environmental significance	NES
NSW Office of Water	NOW
NSW Planning & Infrastructure	P&I
Office of Environment and Heritage	OEH
Planning Assessment Commission	PAC
Protection of the Environment Operations Act 1997	POEO Act
run-of-mine	ROM
seagrass protection barrier	SPB
State Environmental Planning Policy (Mining, Petroleum and Extractive Industries) 2007	Mining SEPP
State Environmental Planning Policy (Major Development) 2005	Major Development SEPP

Abbreviations (cont.)

Threatened Species Conservation Act 1995

Vales Point Power Station

Water Act 1912

Water Management Act 2000

TSC Act

VPPS

Water Act

WM Act

References

Commonwealth Department of the Environment 2013, *Significant impact guidelines 1.3: Coal Seam Gas and large coal mining developments- Impacts on water resources*.

Geoterra Pty Ltd 2013, *Chain Valley Colliery Mining Extension 1 Project – Groundwater Assessment*. Report prepared for LakeCoal Pty Limited March 2013.

GHD 2011, *Water Management Assessment – Mannering Colliery*. Report prepared for Centennial Coal December 2011.

GSS Environmental 2012, *Mannering Colliery – Extension of Mine Project, Section 75W Modification to Project Approval 06_0311, Environmental Assessment*. Report prepared for Centennial Mannering Pty Limited January 2012.

JSA Environmental 2013, *Chain Valley Colliery Mining Extension 1 Project – Marine Ecology Assessment*. Report prepared for LakeCoal Pty Limited May 2013.

RPS 2011, *Cultural Heritage Assessment – Mannering Colliery*. Report prepared for Centennial Mannering Pty Ltd November 2011.

Appendix A

Project Approval MP06_0311

Project Approval

Section 75J of the *Environmental Planning and Assessment Act 1979*

I approve the project application referred to in Schedule 1, subject to the conditions in Schedules 2 to 5.

These conditions are required to:

- prevent, minimise, and/or offset adverse environmental impacts;
- set standards and performance measures for acceptable environmental performance;
- require regular monitoring and reporting; and
- provide for the ongoing environmental management of the project.

Project Approval signed by Frank Sartor on 12 March 2008

Frank Sartor MP
Minister for Planning

Sydney

2008

SCHEDULE 1

Application No:	06_0311
Proponent:	Centennial Coal Company Limited
Approval Authority:	Minister for Planning
Land:	See Appendix 1
Project:	Mannering Colliery – Continuation of Mining Project

Red text represents Modification 1 of October 2012 (06_0311 MOD 1)

TABLE OF CONTENTS

DEFINITIONS	3
ADMINISTRATIVE CONDITIONS	5
Obligation to Minimise Harm to the Environment	5
Terms of Approval	5
Limits on Approval	
Management Plans / Monitoring Programs	5
Structural Adequacy	5
Demolition	6
Operation of Plant and Equipment	6
Community Enhancement Program	6
SPECIFIC ENVIRONMENTAL CONDITIONS	7
Noise	7
Subsidence	8
Soil and Water	8
Landscape	9
Air Quality	9
Heritage	10
Visual	10
Transport	11
Greenhouse and Energy Efficiency	11
Waste	11
ADDITIONAL PROCEDURES	12
Independent Review	12
ENVIRONMENTAL MANAGEMENT, MONITORING, REPORTING & AUDITING	13
Environmental Management	13
Reporting	14
Independent Environmental Audit	14
Access to Information	15
APPENDIX 1: SCHEDULE OF PROJECT LAND	16
APPENDIX 2: PROJECT LAND	17
APPENDIX 3: STATEMENT OF COMMITMENTS	18
APPENDIX 4: NOISE ASSESSMENT LOCATIONS	20
APPENDIX 5: INDEPENDENT DISPUTE RESOLUTION	22

DEFINITIONS

Annual review	The review required by Condition 3 of Schedule 5
Affected councils	Wyong Shire Council and Lake Macquarie City Council
Built features	Includes any building or work erected or constructed on land, and includes dwellings and infrastructure such as any formed road, street, path, walk, or driveway; and any pipeline, water, sewer, telephone, gas or other service main
BCA	Building Code of Australia
CCC	Community Consultative Committee
Conditions of this approval	Conditions contained in Schedules 2 to 5 inclusive
Day	The period from 7am to 6pm on Monday to Saturday, and 8am to 6pm on Sundays and Public Holidays
Department	Department of Planning and Infrastructure
Director-General	Director-General of the Department, or nominee
DRE	Division of Resources and Energy within the Department of Trade and Investment, Regional Infrastructure and Services
EA	Environmental Assessment titled <i>Mannering Colliery Environmental Assessment</i> , dated March 2007, including the response to submissions, dated 27 July 2007
EA (Mod 1)	Environmental Assessment titled <i>Mannering Colliery – Extension of Mine Project Section 75W Modification to Project Approval 06_0311</i> , as modified by the associated response to submissions dated 4 September 2012
EPA	Environment Protection Authority
EP&A Act	<i>Environmental Planning and Assessment Act 1979</i>
EP&A Regulation	<i>Environmental Planning and Assessment Regulation 2000</i>
EPL	Environment Protection Licence issued under the <i>Protection of the Environment Operations Act 1997</i>
Evening	The period from 6pm to 10pm
Feasible	Feasible relates to engineering considerations and what is practical to build
First workings	Extraction of coal by bord and pillar workings and the like
Incident	A set of circumstances that: <ul style="list-style-type: none"> • causes or threatens to cause material harm to the environment; and/or • breaches or exceeds the limits or performance measures/criteria in this approval
Land	As defined in the EP&A Act, except for where the term is used in the noise and air quality conditions in Schedules 3 and 4 of this approval where it is defined to mean the whole of a lot, or contiguous lots, owned by the same landowner, in a current plan registered at the Land Titles Office at the date of this approval
LMCC	Lake Macquarie City Council
Mining operations	Includes all extraction, processing, handling, storage and transportation of coal carried out on the site
Minister	Minister for Planning and Infrastructure, or delegate
Minor	Not very large, important or serious
Negligible	Small and unimportant, such as to be not worth considering
Night	The period from 10pm to 7am on Monday to Saturday, and 10pm to 8am on Sundays and Public Holidays
NOW	NSW Office of Water within the Department of Primary Industries
OEH	Office of Environment and Heritage within the Department of Primary Industries
Privately-owned land	Land that is not owned by a public agency, Vales Point Power Station or a mining company (or its subsidiary)
Proponent	Centennial Coal Company Limited or any other person or persons who rely on this approval to carry out the project that is subject to this approval
Project	Mannering Colliery Continuation of Mining Project as described in the EA
Reasonable	Reasonable relates to the application of judgement in arriving at a decision, taking into account: mitigation benefits, cost of mitigation versus benefits provided, community views and the nature and extent of potential improvements
ROM	Run-of-mine
RMS	Roads and Maritime Services
Second workings	Extraction of coal by pillar extraction methods
Site	Land referred to in Appendix 1

SMP
Statement of Commitments
Subsidence
WSC

Subsidence Management Plan
The Proponent's commitments in Appendix 3
Subsidence of the land surface caused by underground coal mining
Wyong Shire Council

SCHEDULE 2 ADMINISTRATIVE CONDITIONS

Obligation to Minimise Harm to the Environment

1. The Proponent shall implement all practicable measures to prevent and/or minimise any harm to the environment that may result from the construction, operation or rehabilitation of the project.

Terms of Approval

2. The Proponent shall carry out the project generally in accordance with the:
 - (a) EA;
 - (b) EA (Mod 1);
 - (c) Revised Statement of Commitments (see Appendix 3); and
 - (d) conditions of this approval.

Notes:

- The general layout of the project is shown in Figure 1 of Appendix 2.
- The statement of commitments is reproduced in Appendix 3.

3. If there is any inconsistency between the above documents, the latter document shall prevail to the extent of the inconsistency. However, the conditions of this approval shall prevail to the extent of **any inconsistency**.
4. The Proponent shall comply with any reasonable requirement/s of the Director-General arising from the Department's assessment of:
 - (a) any reports, plans, programs or correspondence that are submitted in accordance with the conditions of this approval; and
 - (b) the implementation of any actions or measures contained in these reports, plans, programs or correspondence.

Limits on Approval

5. Mining operations may take place until 31 March 2018.

Note: Under this approval, the Proponent is required to rehabilitate the site to the satisfaction of the Director-General and DRE. Consequently this approval will continue to apply in all other respects other than the right to conduct mining operations until the site has been rehabilitated to a satisfactory standard.

6. The Proponent shall not extract more than 1.1 million tonnes of ROM coal a year from the site.
7. The Proponent shall ensure all coal produced on the site is transported by overland conveyor to Vales Point Power Station.

Management Plans / Monitoring Programs

8. With the approval of the Director-General, the Proponent may submit any management plan or monitoring program required by this approval on a progressive basis.

Structural Adequacy

9. The Proponent shall ensure that all new buildings and structures, and any alterations or additions to existing buildings and structures, are constructed in accordance with the relevant requirements of the BCA.

Notes:

- Under Part 4A of the EP&A Act, the Proponent is required to obtain construction and occupation certificates for the proposed building works.
- Part 8 of the EP&A Regulation sets out the requirements for the certification of the project.

Demolition

10. The Proponent shall ensure that all demolition work is carried out in accordance with *Australian Standard AS 2601-2001: The Demolition of Structures*, or its latest version.

Operation of Plant and Equipment

11. The Proponent shall ensure that all plant and equipment used on site is:
 - (a) maintained in a proper and efficient condition; and
 - (b) operated in a proper and efficient manner.

Community Enhancement Program

12. The Proponent shall pay the affected councils \$0.02 for each tonne of ROM coal produced by the project for the purpose of improving water quality in the Lake Macquarie catchment. This payment shall be:
 - (a) shared equally by the affected councils;
 - (b) made by the end of March 2009, and at yearly intervals thereafter;
 - (c) calculated on the ROM coal produced in the previous calendar year; and
 - (d) subject to indexation by the Implicit Price Deflator, as published by the Australian Bureau of Statistics.

SCHEDULE 3 SPECIFIC ENVIRONMENTAL CONDITIONS

NOISE

Noise Impact Criteria

- The Proponent shall ensure that the noise generated by the project does not exceed the noise impact assessment criteria in Table 1 at any residence on privately owned land.

Table 1: Noise limits dB(A)

Day <i>L_{Aeq}(15 min)</i>	Evening <i>L_{Aeq}(15 min)</i>	Night		Location (as listed in Appendix 4)
		<i>L_{Aeq}(15 min)</i>	<i>L_{A1}(1 min)</i>	
49	49	35	49	4 – di Rocco
47	47	35	49	5 – Keighran
44	44	35	49	6 – Swan
43	43	43	50	7 – Druitt
46	46	46	50	8 – May
45	45	45	52	9 – Jeans
40	40	40	52	11 – Jeans
43	43	43	52	18 – Jeans
44	44	44	52	20 – Knight and all other Chain Valley Bay residences

However, if the Proponent has a written negotiated noise agreement with any landowner of the land listed in Table 1, and a copy of this agreement has been forwarded to the Department and EPA, then the Proponent may exceed the noise criteria in Table 1 in accordance with the negotiated noise agreement.

Notes:

- The receiver references in Table 1 are shown in the figure in Appendix 4.
- To determine compliance with the *L_{Aeq}(15 minute)* noise limits, noise from the project is to be measured at the most affected point within the residential boundary, or at the most affected point within 30 metres of a dwelling (rural situations) where the dwelling is more than 30 metres from the boundary. Where it can be demonstrated that direct measurement of noise from the development is impractical, the Department and EPA may accept alternative means of determining compliance (see Chapter 11 of the NSW Industrial Noise Policy). The modification factors in Section 4 of the NSW Industrial Noise Policy shall also be applied to the measured noise levels where applicable.
- To determine compliance with the *L_{A1}(1 minute)* noise limits, noise from the project is to be measured at 1 metre from the dwelling façade. Where it can be demonstrated that direct measurement of noise from the project is impractical, the Department and EPA may accept alternative means of determining compliance (see Chapter 11 of the NSW Industrial Noise Policy).
- These limits apply under the relevant meteorological conditions outlined in the assessment procedures in Chapter 5 of the NSW Industrial Noise Policy.

Noise Mitigation

- The Proponent shall prepare a report on potential noise mitigation measures for noisy equipment and activities undertaken on the site to the satisfaction of the Director-General. This report must be:
 - prepared by a suitably qualified acoustic expert;
 - submitted to the Director-General by the end of September 2008; and
 - accompanied by an action plan for the implementation of any reasonable and feasible recommendations of the report.

Noise Monitoring

- The Proponent shall prepare and implement a Noise Monitoring Program for the project to the satisfaction of the Director-General. This program must:
 - be submitted to the Director-General by the end of September 2008; and
 - include the use of attended noise monitoring measures to monitor the performance of the project.

SUBSIDENCE

4. The Proponent shall limit its coal extraction methods on the site to first workings only, and shall not undertake second workings.
5. Deleted.

SOIL AND WATER

Discharge

6. The Proponent shall only discharge water from the site as expressly provided for by its EPL.
7. The Proponent shall investigate, assess and report on the ecological interactions of minewater discharged from the site with the aquatic ecology of the unnamed creek and wetlands (and associated vegetation) between the minewater discharge point/s and Lake Macquarie. This report must:
 - (a) be prepared in consultation with EPA by suitably qualified expert/s whose appointment/s have been approved by the Director-General;
 - (b) be submitted to the Director-General by the end of March 2009; and
 - (c) assess the probable alterations in the local ecology attributable to previous and proposed minewater discharges and any future cessation of minewater discharge flows.

Water Management Plan

8. The Proponent shall prepare and implement a Water Management Plan for the project to the satisfaction of the Director-General. This plan must:
 - (a) be prepared in consultation with NOW by suitably qualified expert/s whose appointment/s have been approved by the Director-General;
 - (b) be submitted to the Director-General by the end of March 2009; and
 - (c) include a:
 - Site Water Balance;
 - Erosion and Sediment Control Plan;
 - Surface Water Monitoring Plan; and
 - Groundwater Monitoring Program.

Site Water Balance

9. The Site Water Balance must:
 - (a) include details of:
 - sources and security of water supply;
 - water use on site;
 - water management on site; and
 - (b) investigate, assess and report on measures to minimise water use by the project, particularly potable water from the Wyong Shire town water supply.

Erosion and Sediment Control

10. The Erosion and Sediment Control Plan must:
 - (a) be consistent with the requirements of *Managing Urban Stormwater: Soils and Construction* (Landcom 2004, or its latest version);
 - (b) identify activities that could cause soil erosion and generate sediment;
 - (c) describe measures to minimise soil erosion and the potential for transport of sediment from the site;
 - (d) describe the location, function, and capacity of erosion and sediment control structures; and
 - (e) describe what measures would be implemented to monitor and maintain the structures over time.

Surface Water Monitoring Program

11. The Surface Water Monitoring Plan must include:
 - (a) detailed baseline data on surface water flows and quality in creeks and other waterbodies that could be affected by the project;
 - (b) surface water impact assessment criteria;
 - (c) a program to monitor the impact of the project on surface water flows and quality; and
 - (d) procedures for reporting the results of this monitoring.

Groundwater Monitoring Program

12. The Groundwater Monitoring Program must include:
- (a) detailed baseline data to benchmark the natural variation in groundwater levels, yield and quality;
 - (b) groundwater impact assessment criteria;
 - (c) a program to monitor the impact of the project on groundwater levels, yield and quality; and
 - (d) procedures for reporting the results of this monitoring.

LANDSCAPE

Rehabilitation

13. The Proponent shall rehabilitate the site to the satisfaction of the Director-General and DRE.

Land Management Plan

14. The Proponent shall prepare and implement a detailed Land Management Plan for the site to the satisfaction of the Director-General and DRE. This plan must:
- (a) be submitted to the Director-General by the end of September 2008;
 - (b) be prepared by suitably qualified expert/s whose appointment/s have been endorsed by the Director-General;
 - (c) be prepared in consultation with DRE, OEH and affected councils; and
 - (d) include measures to:
 - minimise visual impacts;
 - control weeds, feral pests and access; and
 - manage bushfires; and
 - (e) provide details of who is responsible for monitoring, reviewing and implementing the plan.

Mine Closure Plan

15. The Proponent shall prepare and implement a Mine Closure Plan for the site to the satisfaction of the Director-General and DRE. This plan must:
- (a) be submitted to the Director-General by the end of March 2013;
 - (b) be prepared by suitably qualified expert/s whose appointment/s have been endorsed by the Director-General;
 - (c) define the objectives and criteria for mine closure including proposed rehabilitation objectives, performance, completion criteria and responsibilities;
 - (d) investigate options for the future use of the site;
 - (e) investigate ways to minimise the adverse socio-economic effects associated with mine closure, including the reduction in local and regional employment levels;
 - (f) describe the measures that would be implemented to minimise or manage the on-going environmental effects of the project; and
 - (g) describe how the performance of these measures would be monitored over time.

AIR QUALITY

Impact Assessment Criteria

16. The Proponent shall ensure that dust generated by the project does not cause exceedances of the criteria listed in Table 2 at any residence on privately-owned land.

Table 2: Long term impact assessment criteria for deposited dust

Pollutant	Averaging period	Maximum increase in deposited dust level	Maximum total deposited dust level
Deposited dust	Annual	2 g/m ² /month	4 g/m ² /month

Note: Deposited dust is assessed as insoluble solids as defined by Standards Australia, 1991, AS/NZS 3580.10.1-2003: Methods for Sampling and Analysis of Ambient Air - Determination of Particulates - Deposited Matter - Gravimetric Method.

Monitoring

17. The Proponent shall prepare and implement an Air Quality Monitoring Program for the project to the satisfaction of the Director-General. This program must:
- be submitted to the Director-General by the end of September 2008; and
 - use dust deposition gauges to monitor the performance of the project.

HERITAGE

Heritage Management Plan

18. The Proponent shall prepare and implement a Heritage Management Plan for the project to the satisfaction of the Director-General. This Plan must:
- be prepared in consultation with any relevant Aboriginal stakeholders;
 - be submitted, prior to 31 March 2013, for approval to the Director-General;
 - include consideration of the Aboriginal and non-Aboriginal cultural context and significance of the site;
 - detail the responsibilities of all stakeholders; and
 - include programs/procedures and management measures for:
 - dealing with previously unidentified Aboriginal objects (excluding human remains), including any need to halt works in the vicinity, assessment of significance, determination of appropriate mitigation measures (by a qualified archaeologist in consultation with Aboriginal stakeholders), re-commencement of works, notifying OEH, and registering the new site(s) in the OEH AHIMS register;
 - dealing with any human remains which may be discovered, including halting of works in the vicinity; notifying NSW Police, OEH, the Department and Aboriginal stakeholders; and not re-commencing any works in the vicinity unless authorised;
 - heritage induction for construction personnel (including procedures for keeping records of inductions);
 - ongoing Aboriginal consultation and involvement (including procedures for keeping records of this);
 - appropriate identification, management, conservation and protection of both Aboriginal and non-Aboriginal heritage items identified on the site; and
 - dealing with previously unidentified non-Aboriginal heritage items which may be discovered during the project.

VISUAL

19. The Proponent shall:
- ensure no outdoor lights shine above the horizontal;
 - ensure that all external lighting associated with the project complies with *Australian Standard AS4282 (INT) 1995 – Control of Obtrusive Effects of Outdoor Lighting*;
 - take all practicable measures to mitigate off-site lighting impacts from the project; and
 - minimise the visual impacts of the project, to the satisfaction of the Director-General.

TRANSPORT

Monitoring of Coal Transport

20. The Proponent shall keep records of the amount of coal transported from the site each year, and include these records in the **Annual Review**.

Rutleys Road Intersection

21. The Proponent shall:
- complete a road safety audit of the intersection of Rutleys Road and Mannering Colliery Access Road by the end of March 2009;
 - provide copies of this audit to RTA, WSC and the Director-General within one month of its completion; and

- (c) prior to 30 June 2013, or as otherwise agreed by the Director-General, implement all works recommended in Table 4-1 of the road Safety audit (Parsons Brinckerhoff, 2008), in consultation with WSC, and to the satisfaction of the Director-General.

GREENHOUSE AND ENERGY EFFICIENCY

22. The Proponent shall prepare and implement a Greenhouse and Energy Efficiency Plan for the project to the satisfaction of the Director-General. This plan must:
- (a) be prepared in consultation with EPA and generally in accordance with the *Guidelines for Energy Savings Action Plans* (DEUS 2005, or its latest version);
 - (b) be submitted to the Director-General for approval by the end of September 2008;
 - (c) include a program to monitor greenhouse gas emissions and energy use generated by the project;
 - (d) include a framework for investigating and implementing measures to reduce greenhouse gas emissions and energy use at the site; and
 - (e) describe how the performance of these measures would be monitored over time.

WASTE

23. The Proponent shall:
- (a) monitor the amount of waste generated by the project;
 - (b) investigate ways to minimise waste generated by the project;
 - (c) implement reasonable and feasible measures to minimise waste generated by the project; and
 - (d) report on waste management and minimisation in the *Annual Review*, to the satisfaction of the Director-General.

SCHEDULE 4 ADDITIONAL PROCEDURES

INDEPENDENT REVIEW

1. If a landowner considers the project to be exceeding the impact assessment criteria in schedule 3, then he/she may ask the Director-General in writing for an independent review of the impacts of the project on his/her land.

If the Director-General is satisfied that an independent review is warranted, the Proponent shall within 2 months of the Director-General's decision:

- (a) consult with the landowner to determine his/her concerns;
 - (b) commission a suitably qualified, experienced and independent person, whose appointment has been approved by the Director-General, to conduct monitoring on the land, to:
 - determine whether the project is complying with the relevant impact assessment criteria in schedule 3; and
 - identify the source(s) and scale of any impact on the land, and the project's contribution to this impact; and
 - give the Director-General and landowner a copy of the independent review.
2. If the independent review determines that the project is complying with the relevant impact assessment criteria in schedule 3, then the Proponent may discontinue the independent review with the approval of the Director-General.
 3. If the independent review determines that the project is not complying with the relevant impact assessment criteria in schedule 3, and that the project is primarily responsible for this non-compliance, then the Proponent shall:
 - (a) take all reasonable and feasible measures, in consultation with the landowner, to ensure that the project complies with the relevant criteria; and
 - (b) conduct further monitoring to determine whether these measures ensure compliance.

If the additional monitoring referred to above subsequently determines that the project is complying with the relevant criteria in schedule 3, or the Proponent and landowner enter into a negotiated agreement to allow these exceedances, then the Proponent may discontinue the independent review with the approval of the Director-General.

4. If the independent review determines that the relevant criteria in schedule 3 are being exceeded, but that more than one project is responsible for this non-compliance, then the Proponent shall, together with the relevant project/s:
 - (a) take all reasonable and feasible measures, in consultation with the landowner, to ensure that the relevant criteria are complied with; and
 - (b) conduct further monitoring to determine whether these measures ensure compliance; or
 - (c) secure a written agreement with the landowner and other relevant projects to allow exceedances of the criteria in schedule 3,to the satisfaction of the Director-General.

If the additional monitoring referred to above subsequently determines that the projects are complying with the relevant criteria in schedule 3, then the Proponent may discontinue the independent review with the approval of the Director-General.

5. If the landowner disputes the results of the independent review, either the Proponent or the landowner may refer the matter to the Director-General for resolution.

If the matter cannot be resolved within 21 days, the Director-General shall refer the matter to an Independent Dispute Resolution Process.

SCHEDULE 5
ENVIRONMENTAL MANAGEMENT, MONITORING, AUDITING AND REPORTING

ENVIRONMENTAL MANAGEMENT

Environmental Management Strategy

1. The Proponent shall revise and implement an Environmental Management Strategy for the project to the satisfaction of the Director-General. This strategy must:
 - (a) be submitted for approval to the Director-General prior to 30 June 2013;
 - (b) provide the strategic framework for the environmental management of the project;
 - (c) identify the statutory approvals that apply to the project;
 - (d) describe the role, responsibility, authority and accountability of all key personnel involved in the environmental management of the project;
 - (e) describe the procedures that would be implemented to:
 - keep the local community and relevant agencies informed about the operation and environmental performance of the project;
 - receive, handle, respond to, and record complaints;
 - resolve any disputes that may arise during the course of the project;
 - respond to any non-compliance; and
 - respond to emergencies; and
 - (f) include:
 - copies of any strategies, plans and programs approved under the conditions of this approval; and
 - a clear plan depicting all the monitoring required to be carried out under the conditions of this approval.

Management Plan Requirements

2. The Proponent shall ensure that the management plans required under this approval are prepared in accordance with any relevant guidelines, and include:
 - (a) detailed baseline data;
 - (b) a description of:
 - the relevant statutory requirements (including any relevant approval, licence or lease conditions);
 - any relevant limits or performance measures/criteria;
 - the specific performance indicators that are proposed to be used to judge the performance of, or guide the implementation of, the project or any management measures;
 - (c) a description of the measures that would be implemented to comply with the relevant statutory requirements, limits, or performance measures/criteria;
 - (d) a program to monitor and report on the:
 - impacts and environmental performance of the project;
 - effectiveness of any management measures (see (c) above);
 - (e) a contingency plan to manage any unpredicted impacts and their consequences and to ensure that ongoing impacts reduce to levels below relevant impact assessment criteria as quickly as possible;
 - (f) a protocol for managing and reporting any:
 - incidents;
 - complaints;
 - non-compliances with statutory requirements; and
 - exceedances of the impact assessment criteria and/or performance criteria; and
 - (g) a protocol for periodic review of the plan.

Note: The Director-General may waive some of these requirements if they are unnecessary for particular management plans.

Annual Review

3. By the end of February 2013, and annually thereafter, the Proponent shall review the environmental performance of the project to the satisfaction of the Director-General. This review must:
 - (a) describe the development (including any rehabilitation) that was carried out in the past calendar year, and the development that is proposed to be carried out over the current financial year;
 - (b) include a comprehensive review of the monitoring results and complaints records of the project over the past calendar year, which includes a comparison of these results against the:

- the relevant statutory requirements, limits or performance measures/criteria;
 - requirements of any plan or program required under this approval;
 - the monitoring results of previous years; and
 - the relevant predictions in the EA and EA (Mod 1);
- (c) identify any non-compliance over the past year, and describe what actions were (or are being) taken to ensure compliance;
- (d) identify any trends in the monitoring data over the life of the project;
- (e) identify any discrepancies between the predicted and actual impacts of the project, and analyse the potential cause of any significant discrepancies; and
- (f) describe what measures will be implemented over the current financial year to improve the environmental performance of the project.

Revision of Strategies, Plans and Programs

4. Within 3 months of:
- (a) the submission of an annual review under Condition 3 above;
 - (b) the submission of an incident report under Condition 6 below;
 - (c) the submission of an audit under Condition 8 below; and
 - (d) any modification to the conditions of this approval (unless the conditions require otherwise), the Proponent shall review, and if necessary revise, the strategies, plans, and programs required under this approval to the satisfaction of the Director-General.

Note: This is to ensure the strategies, plans and programs are updated on a regular basis, and incorporate any recommended measures to improve the environmental performance of the project.

Community Consultative Committee

5. The Proponent shall continue to operate a Community Consultative Committee (CCC) for the project in general accordance with the *Guidelines for Establishing and Operating Community Consultative Committees for Mining Projects* (Department of Planning, 2007, or its latest version), and to the satisfaction of the Director-General.

Notes:

- *The CCC is an advisory committee. The Department and other relevant agencies are responsible for ensuring that the Proponent complies with this approval; and*
- *In accordance with the guideline, the Committee should be comprised of an independent chair and appropriate representation from the Proponent, Councils and the local community.*

REPORTING

Incident Reporting

6. The Proponent shall notify, at the earliest opportunity, the Director-General and any other relevant agencies of any incident that has caused, or threatens to cause, material harm to the environment. For any other incidents associated with the project, the Proponent shall notify the Director-General and any other relevant agencies as soon as practicable after the Proponent becomes aware of the incident. Within 7 days of the date of the incident, the Proponent shall provide the Director-General and any relevant agencies with a detailed report on the incident, and such further reports as may be requested.

Regular Reporting

7. The Proponent shall provide regular reporting on the environmental performance of the project on its website, in accordance with the reporting arrangements in any plans or programs approved under the conditions of this approval.

INDEPENDENT ENVIRONMENTAL AUDIT

8. By the end of March 2013 and every three years thereafter, unless the Director-General directs otherwise, the Proponent shall commission and pay the full cost of an Independent Environmental Audit of the project. This audit must:
- (a) be conducted by a suitably qualified, experienced and independent team of experts whose appointment has been endorsed by the Director-General;
 - (b) include consultation with the relevant agencies;

- (c) assess the environmental performance of the project and assess whether it is complying with the requirements in this approval and any relevant EPL or Mining Lease (including any assessment, plan or program required under these approvals); and
- (d) recommend appropriate measures or actions to improve the environmental performance of the project, and/or any assessment, plan or program required under the abovementioned approvals.

Note: This audit team must be led by a suitably qualified auditor and include experts in any field specified by the Director-General.

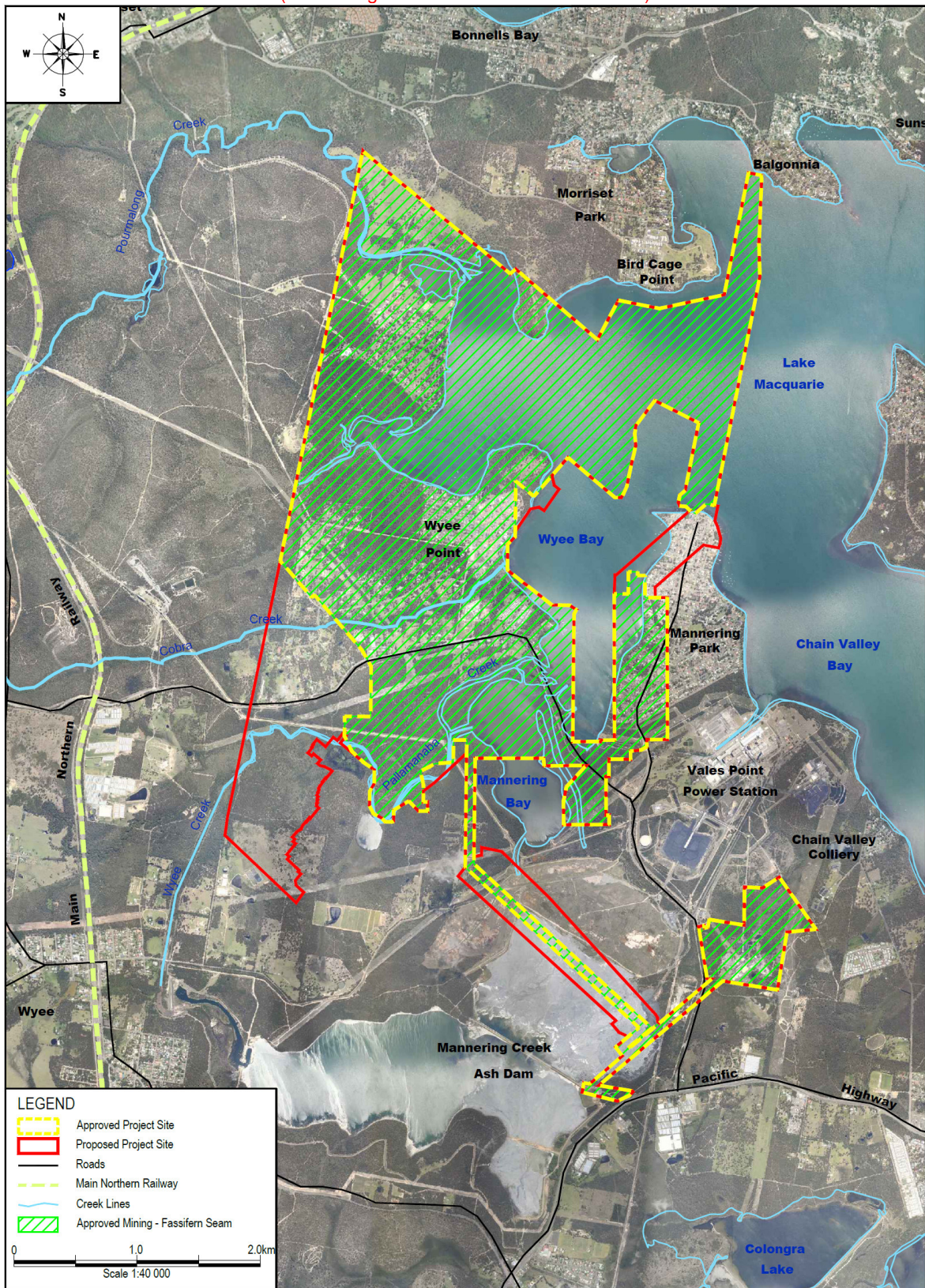
- 9. Within 6 weeks of the completion of this audit, or as otherwise agreed by the Director-General, the Proponent shall submit a copy of the audit report to the Director-General, together with its response to any recommendations contained in the audit report.

ACCESS TO INFORMATION

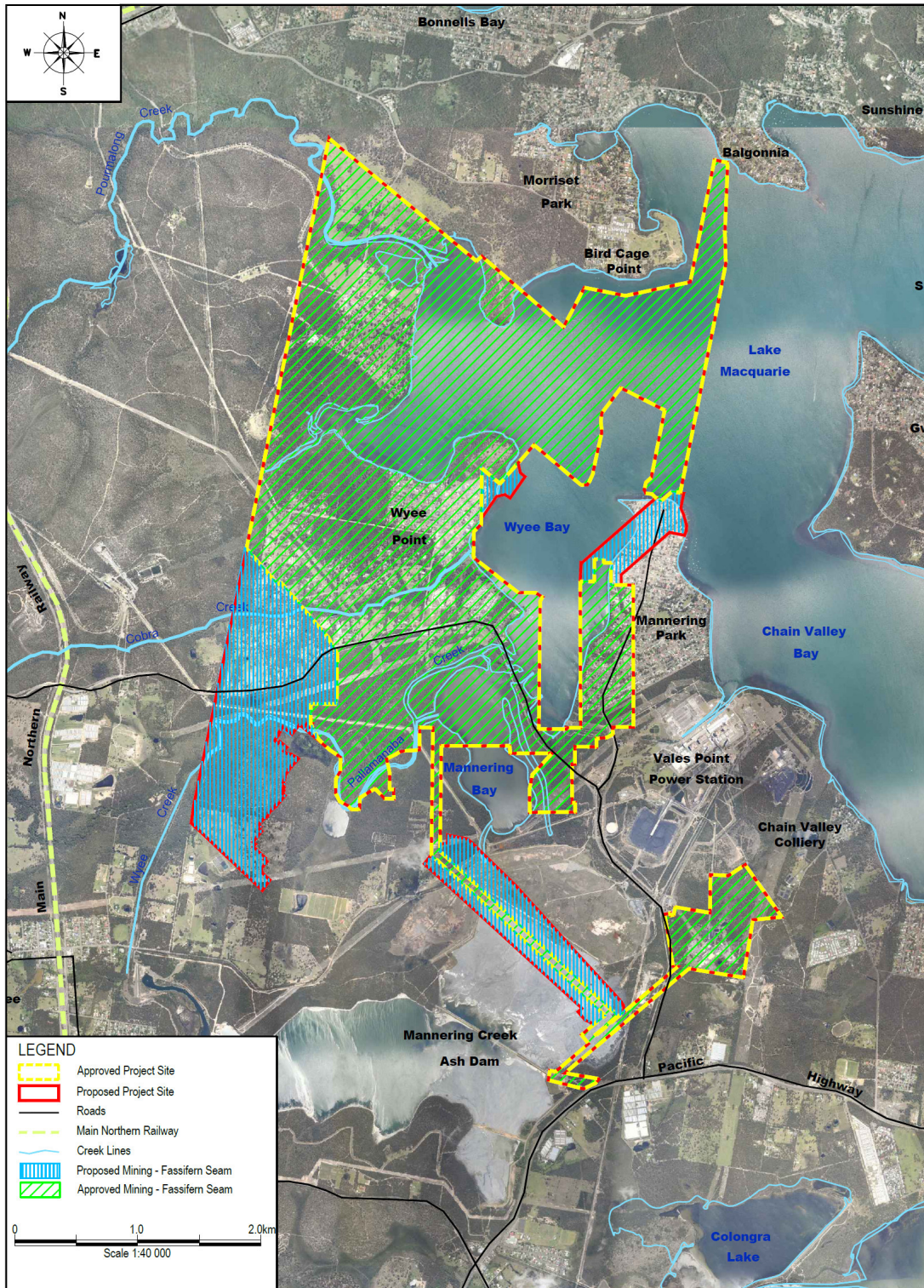
- 10. The Proponent shall:
 - (a) make copies of the following publicly available on its website:
 - the documents referred to in condition 2 of Schedule 2;
 - all relevant statutory approvals for the project;
 - all approved strategies, plans and programs required under the conditions of this approval;
 - a comprehensive summary of the monitoring results of the project, reported in accordance with the specifications in any approved plans or programs required under the conditions of this or any other approval;
 - a complaints register, which is to be updated on a monthly basis;
 - minutes of CCC meetings;
 - the annual reviews required under this approval;
 - any independent environmental audit of the project, and the Proponent's response to the recommendations in any audit; and
 - any other matter required by the Director-General; and
 - (b) keep this information up-to-date, to the satisfaction of the Director-General.

APPENDIX 1: PROJECT LAND

Manning Colliery – Land to which the Project Approval Applies
(shown edged in solid and dashed red lines)



APPENDIX 2: PROJECT MAPS



To be printed A4



Mannerling Colliery - Extension of Mine Project
Proposed Mine Plan (Revised July 2012)

Figure 1: Revised Mine Plan for Fassifern Seam

APPENDIX 3: STATEMENT OF COMMITMENTS

Revised Statement of Commitments (August 2012)

Table 2 – Revised Statement of Commitments

Subsidence
Mining to be limited to the approved bord-and-pillar method where coal recovery is limited to first workings only.
Monitoring of the existing subsidence monitoring marks will continue and additional subsidence monitoring marks will be installed above the proposed mining areas to measure the subsidence and verify that subsidence is within the predicted levels.
If it is identified that subsidence levels are greater than the predicted maximum of 20 millimetres, the DTIRIS Minerals Division will be consulted to determine appropriate management and mitigation actions.
Water Management
The water level within the sediment pond system will be monitored and kept at a relatively low operating level, such that the ponds can provide a detention function in a significant rainfall event.
A visual assessment of the unnamed creek will be undertaken every 6 months to monitor stability and erosion.
Where practicable, underground water levels will be recorded to monitor changes in the level of water stored in underground depressions and to verify that the rate of extraction is sufficient.
The extraction of underground water from the mine workings will be undertaken in accordance with the Bore License (20BL172016) issued under the Water Act 1912.
To enable on-going assessment of the quality of water discharged, the existing monitoring program will be maintained for the life of the Project with the following enhancements:
<ul style="list-style-type: none">• An assessment of the surrounding catchments summarising land uses and other background information to characterise an appropriate water quality; and• Annual monitoring of heavy metals at the monitoring location identified as 'Downstream'.
Terrestrial Ecology
If monitoring indicates that mine-induced subsidence levels exceed 20 millimetres, a review will be undertaken to identify any potential impacts to terrestrial ecology.
Aquatic Ecology
If monitoring indicates that mine-induced subsidence levels exceed 20 millimetres, a review will be undertaken to identify any potential impacts to aquatic ecology.
Aboriginal Heritage
If monitoring indicates that mine-induced subsidence levels exceed 20 millimetres, a review will be undertaken to identify any potential impacts to cultural heritage in consultation with OEH.
All relevant Centennial Mannering staff and contractors will be made aware of their statutory obligations for Aboriginal cultural heritage under the NP&W Act as part of the existing mine induction process.

<p>An Aboriginal Cultural Heritage Management Plan (ACHMP) will be developed and implemented for the identified Aboriginal heritage items within the Project Site in consultation with the relevant Aboriginal stakeholders. If additional sites are identified they will be assessed for cultural significance and be incorporated into the ACHMP.</p>
<p>In the unlikely event that skeletal remains are identified, the NSW Police Coroner will be contacted to determine if the material is of Aboriginal origin. If determined to be Aboriginal, contact will be made with the OEH, a suitably qualified archaeologist and representatives of the relevant Aboriginal stakeholder groups to determine an action plan for the management of the skeletal remains and formulate management recommendations if required.</p>
<p>European Heritage</p>
<p>If monitoring indicates that mine-induced subsidence levels exceed 20 millimetres, a review will be undertaken to identify any potential impacts to non-indigenous heritage.</p>
<p>All relevant Centennial Mannering staff and contractors will be made aware of their statutory obligations for European cultural heritage under the Heritage Act 1977 as part of the existing mine induction process.</p>
<p>If, during the course of development works, significant non-indigenous cultural heritage material is uncovered within the Project Site, the Heritage Branch of OEH will be notified and any required monitoring or management strategies instigated.</p>
<p>Air Quality</p>
<p>A review of dust management strategies and mitigation measures will be undertaken against the best practice dust mitigation measures identified in the NSW Coal Mining Benchmarking Study: International Best Practice Measures to Prevent and/or Minimise Emissions of Particulate Matter from Coal Mining (Katestone Environmental Pty Ltd 2011), which was prepared for OEH. The review will identify any additional dust management practices that are reasonable and feasible for implementation at Mannering Colliery and will be undertaken generally in accordance with any requirements of a pollution reduction program that may be imposed by the OEH on the Manning Colliery EPL in the future.</p>
<p>Traffic</p>
<p>Centennial Mannering will upgrade the Rutleys Road - Mannering Colliery Access Road intersection to improve safety and operational efficiency.</p>
<p>Socio-Economic</p>
<p>Centennial Mannering is committed to on-going community consultation and will continue to engage the community for the purposes of providing information relating to on-going operations and the Extension of Mine Project.</p>
<p>Rehabilitation</p>
<p>The Mining Operations Plan will be amended to reflect the proposed modification and will include integrated rehabilitation and environmental management.</p>
<p>Monitoring</p>
<p>The Environmental Monitoring Program will be reviewed and updated, as required, to incorporate the commitments made in the Environmental Assessment and any additional consent conditions.</p>

APPENDIX 4: NOISE ASSESSMENT LOCATIONS

Private Property Surrounding Mannerling (Location of ID numbers are shown on following figure)

ID	Owner	ID	Owner	ID	Owner
1	Energy Australia	27	H Gleeson	53	H & J Beukers
2	Alcevski Investments	28	C Stead & M Garner	54	A Taylor-Stewart
3	Eaton & Sons Pty Ltd	29	A O'Keefe	55	G Kettles
4	O & J di Rocco	30	P Groen	56	R & E Brokenshire
5	A & M Keighran	31	M Parkin	57	B & S Fowler
6	Swan HydroPonics Pty Ltd	32	I Maclaren	58	B Sneddon
7	R Druitt	33	P Kranz	59	J & P Hanson
8	D & M May	34	T & V Wilding	60	L Crook & L Kelly
9	L F Jeans	35	G Williams	61	P & G Becker
10	L & J Jeans	36	P & C Byrnes	62	B Clover & R Alaban
11	L & J Jeans	37	G Holmes	63	T & O Becker
12	L & J Jeans	38	R & B Croucher	64	R Harris & D Kingsford
13	L & J Jeans	39	R & C Calvert	65	N Singleton
14	L & J Jeans	40	T & D Stolz	66	M Smith
15	L & J Jeans	41	A & S Whitbread	67	D & B Johnston
16	L & J Jeans	42	B Kelly	68	R & B Amos
17	L & J Jeans	43	L Preston	69	H & C Strand
18	L & J Jeans	44	G Bain	70	PhystonPty Ltd
19	L & J Jeans	45	C Clarke	71	R Howland
20	E & K Knight	46	W Carpenter	72	R & D Shannon
21	Jonita Homes Pty Ltd	47	S Mackay	73	P & B Williams
22	W & D Buchmasser	48	R Allen	74	P Batten
23	P McKee	49	S Jopp	75	G & A Dyer
24	J Farrell	50	P & M Davie	76	S Harrison & N Robertson
25	P Kretchmer & E Castle	51	D Olsen		
26	A Mearns	52	D Poulson & K Toope		

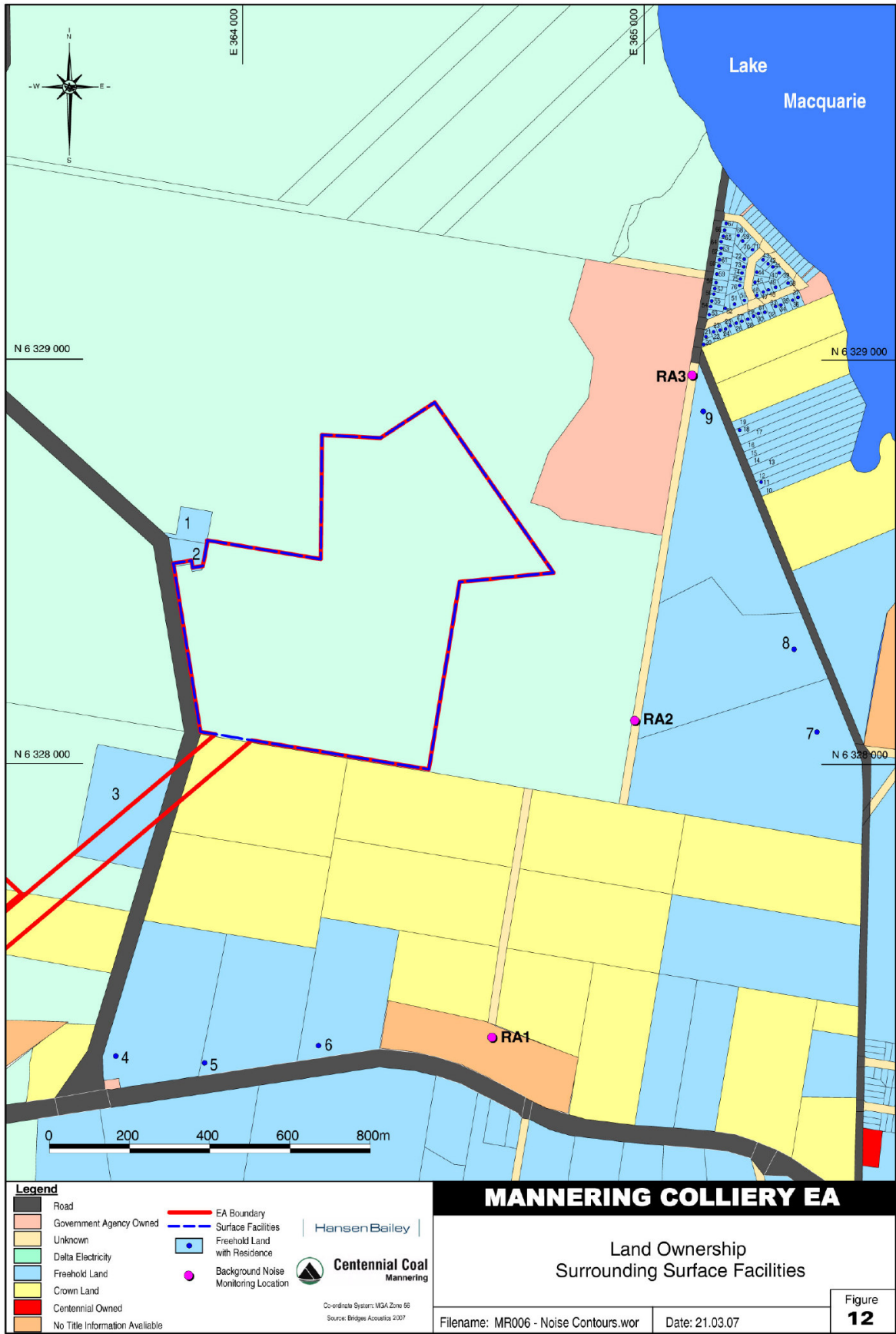
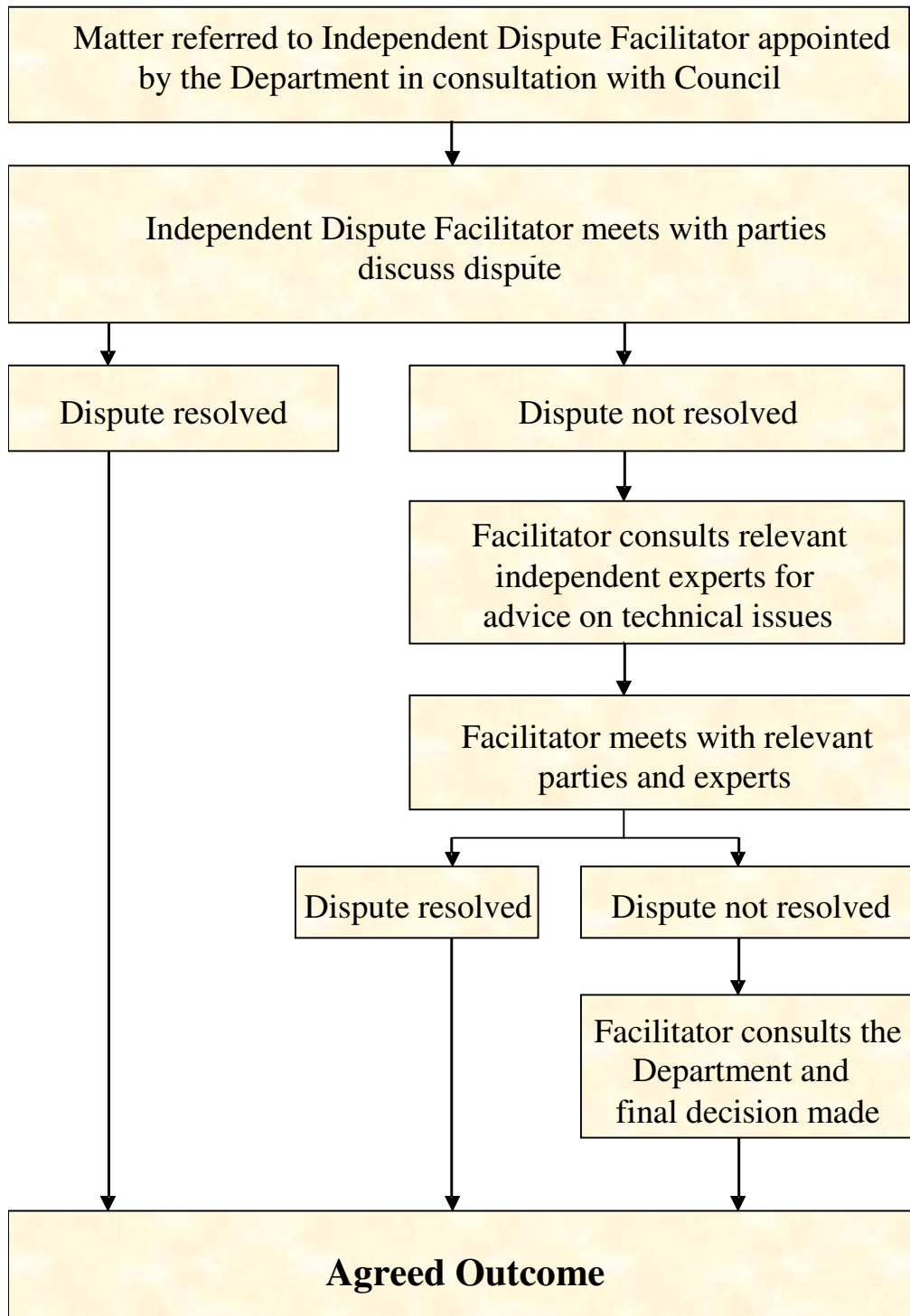


Figure 3: Land Ownership (noise assessment locations)

**APPENDIX 5:
INDEPENDENT DISPUTE RESOLUTION**

**Independent Dispute Resolution Process
(Indicative only)**



Appendix B

Preliminary risk assessment

B.1 Methodology

An environmental risk assessment was undertaken for the proposed modification. It should be noted that the risk assessment and ranking applied relate only to the proposed modification and does not reflect the overall environmental risks related to each aspect considered (which was covered in previous assessments).

The risk assessment was undertaken using two variables, namely:

- the potential severity or consequences of the impact; and
- the likelihood of the impact occurring.

The variables were evaluated, assuming that appropriate mitigation measures would be in place.

The following definitions were applied.

Severity or consequences of impact:

- Minor: Near-source confined and promptly reversible impact on-site with little or no off-site impact expected.
- Medium: Near source confined and short-term reversible impact on-site with little promptly reversible off-site impact.
- Serious: Near-source confined and medium-term recovery impact on-site with near-source and short-term reversible off-site impact.
- Major: Impact that is unconfined and requiring long-term recovery, leaving residual damage on-site with near-source confined and medium-term recovery of off-site impacts.
- Catastrophic: Impact that is widespread and unconfined and requiring long-term recovery, leaving major residual damage on-site with off-site impact that is unconfined and requiring long-term recovery and leaving residual damage.

Likelihood of impact:

- Rare: Impact that is very unlikely to occur during the lifetime of the project.
- Unlikely: Impact that is unlikely to occur during the lifetime of the project.
- Possible: Impact that may occur during the lifetime of the project.
- Likely: Impact that may occur frequently during the lifetime of the project.
- Almost Certain: Recurring event during the lifetime of the project.

Table B.1 below shows the risk matrix used to identify environmental risks that were used to determine priorities for the EA. In each case, a score of 1 to 5 is given for the consequence and likelihood of impact and the scores are added to determine environmental risk. There are four classes of environmental risk utilised in this assessment, as indicated below.

- Low: Risks that are below the risk acceptance threshold and do not require active management. Certain risks could require additional monitoring.
- Moderate: Risks that lie on the risk acceptance threshold and require active monitoring. The implementation of additional measures could be used to reduce the risk further.
- High: Risks that exceed the risk acceptance threshold and require proactive management. Includes risk for which proactive actions have been taken, but further risk reduction is impractical.
- Critical: Risks that significantly exceed the risk acceptance threshold and need urgent and immediate action.

Table B.1 Environmental assessment matrix

		<i>Consequence</i>				
		1 Minor	2 Medium	3 Serious	4 Major	5 Catastrophic
<i>Likelihood of Impact</i>	5 Almost Certain	6 (Moderate)	7 (High)	8 (Critical)	9 (Critical)	10 (Critical)
	4 Likely	5 (Moderate)	6 (High)	7 (High)	8 (Critical)	9 (Critical)
	3 Possible	4 (Low)	5 (Moderate)	6 (High)	7 (Critical)	8 (Critical)
	2 Unlikely	3 (Low)	4 (Low)	5 (Moderate)	6 (High)	7 (Critical)
	1 Rare	2 (Low)	3 (Low)	4 (Moderate)	5 (High)	6 (High)

B.2 Results

The results of the environmental risk assessment are provided in Table B.2. The risks were based on the premise that subsidence from the proposed modification would be less than 20 mm. All risks were rated low.

Table B.2 Environmental risk rating

Environmental Attribute	Likelihood	Consequence	Assessment
Subsidence			
Impacts on VPPS and prescribed dams	2 (Unlikely)	1 (Minor)	3 (Low)
Impacts on general infrastructure	1 (Rare)	1 (Minor)	2 (Low)
Impacts on terrestrial ecology	1 (Rare)	1 (Minor)	2 (Low)
Impacts on heritage	1 (Rare)	1 (Minor)	2 (Low)
Impacts on aquatic ecology	1 (Rare)	1 (Minor)	2 (Low)
Impacts on foreshore area	1 (Rare)	1 (Minor)	2 (Low)
Noise			
Operation/construction of link road	1 (Rare)	1 (Minor)	2 (Low)
Operation of surface infrastructure	1 (Rare)	1 (Minor)	2 (Low)
Road noise impacts	1 (Rare)	1 (Minor)	2 (Low)
Traffic			
Public road traffic impacts	1 (Rare)	1 (Minor)	2 (Low)
Private road traffic impacts	1 (Rare)	1 (Minor)	2 (Low)
Ecology			
Subsidence impacts on terrestrial ecology	1 (Rare)	1 (Minor)	2 (Low)
Subsidence impacts on aquatic ecology	1 (Rare)	1 (Minor)	2 (Low)
Aboriginal/historic heritage			
Subsidence impacts on heritage	1 (Rare)	1 (Minor)	2 (Low)
Air quality and greenhouse gases			
Operational dust impacts	1 (Rare)	1 (Minor)	2 (Low)
Construction of link road	1 (Rare)	1 (Minor)	2 (Low)
Greenhouse gas emissions	1 (Rare)	1 (Minor)	2 (Low)
Surface water			
Water from underground workings	1 (Rare)	1 (Minor)	2 (Low)
Surface water management	1 (Rare)	1 (Minor)	2 (Low)
Groundwater			
Impacts on beneficial aquifers	1 (Rare)	1 (Minor)	2 (Low)
Volumes of mine water inflows	2 (Unlikely)	1 (Minor)	3 (Low)
Impacts on GDEs and other groundwater users	1 (Rare)	1 (Minor)	2 (Low)
Depressurisation impacts	1 (Rare)	1 (Minor)	2 (Low)
Water quality impacts	1 (Rare)	1 (Minor)	2 (Low)
Rehabilitation and land suitability			
Rehabilitation	1 (Rare)	1 (Minor)	2 (Low)
Land suitability	1 (Rare)	1 (Minor)	2 (Low)
Visual amenity			
Link road	1 (Rare)	1 (Minor)	2 (Low)
Operations	1 (Rare)	1 (Minor)	2 (Low)

Table B.2 Environmental risk rating

Environmental Attribute	Likelihood	Consequence	Assessment
Socio-economic			
Impacts to services from direct and indirect employment	1 (Rare)	1 (Minor)	2 (Low)
General amenity impacts to local community	1 (Rare)	1 (Minor)	2 (Low)
Waste management			
Creation of new waste streams	1 (Rare)	1 (Minor)	2 (Low)

Appendix C

Subsidence assessment

Ditton Geotechnical Services Pty Ltd
82 Roslyn Avenue Charlestown NSW 2290
PO Box 5100 Kahibah NSW 2290

DgS

Ditton Geotechnical Services

27 January 2014

Mr Michael Callan
Technical Services Manager - Chain Valley Colliery
LDO Group
16 Spitfire Place
Rutherford NSW 2320

Report No. CHV-002/3

Dear Michael,

Subject: Subsidence Assessment for the Proposed Underground Headings between Chain Valley Colliery and Mannering Colliery

1.0 Introduction

This letter provides a subsidence assessment on the proposed main headings development in the Fassifern (FAS) Seam between Chain Valley Colliery and Mannering Colliery (formerly Wyee Colliery).

The mine connection headings or 'linkage' will extend for approximately 1.57 km between existing first workings at each end and consist of three rows of pillars and four headings using a 30.4 m wide centre spacing. The headings will be 5.4 m wide and 3.2 m high and the pillars will be 25 m wide x 94.6 m long; see **Figure 1a**.

Two headings would initially be constructed along the southern side with the future development of up to another two headings to the north to enable increased ventilation flows between the two Collieries. This assessment assumes all four headings are constructed.

A small portion of the proposed workings are located within the notification zone for the Mannering Creek Ash Dam, which is a prescribed Dam under the *Dams Safety Act 1978*. The proposed workings are located outside the 35° angle of draw buffer zone to the Vales Point Power Station, but underlie other significant features including the Lake Macquarie foreshore and high voltage transmission towers ; see **Figure 1b**.

The headings will be located at a cover depth of approximately 195 m and pass 22.5 m below existing first and second workings panels in the Great Northern (GN) Seam, Chain Valley Bay and its western foreshore; see **Figures 2, 3 and 4**. The proposed headings will also pass beneath mapped seagrass beds and the seagrass protection barrier as required under Conditions 19 and 20 of the existing Subsidence Management Plan approval and defined in the Environmental Impact Statement for the Chain Valley Mining Extension 1 Project (**EMGA Mitchell McLennan, 2013**) and the High Water Mark Subsidence Barrier as defined

in relevant mining tenements. The proposed first workings within the foreshore buffer zone have been designed to limit additional subsidence to < 20 mm.

It is noted that subsidence of 20 mm to 57 mm has developed along the foreshore approximately 1 km to the south above first and second workings in the GN Seam (Line 24). The subsidence took approximately 5 years to develop after completion of the workings. Moisture sensitive claystone of up to 3 m thick may exist beneath the workings floor at this location.

Subsidence development in the first workings recently completed in the FAS Seam under GN and Wallarah Seam mine workings below Summerland Point (Line 23) have resulted in an additional 5 mm of subsidence (refer to **DgS, 2013b**). Moisture sensitive claystone is known to exist in the floor of the FAS Seam and are interbedded with non-sensitive coaly shale and shaley coal in the first 2 to 3 m.

It is also noted that up to 1 m of subsidence has occurred along the foreshore approximately 2.7 km to the south and above partial pillar extraction panels in old Newvale Colliery mine workings. The old workings are located in the GN Seam and the subsidence appears to have been related to claystone floor bearing failure that occurred within 6 to 12 months after mining was completed. Extensive re-leveling works were necessary after inundation of several residential lots and parkland occurred.

The above information has been used to estimate subsidence due to the existing workings in the GN Seam and the likely increases in subsidence due to the proposed first workings in the FAS Seam.

2.0 Method

The assessment has included the following:

- (i) development of a geotechnical model for the proposed mine workings connection area;
- (ii) review of previous subsidence performances along the Chain Valley Bay foreshore;
- (iii) a review of the existing mine workings pillar, roof and floor stability in the GN Seam;
- (iv) an assessment of the stability of the proposed first workings pillars, roof and floor strata in the FAS Seam;
- (v) prediction of net and cumulative subsidence (and contours) due to the proposed first workings in the FAS Seam and existing GN Seam mine workings;
- (vi) assessment of potential subsidence effects at existing infrastructure.

- (vii) subsidence management strategies that could be adopted by the mine to minimise the potential for additional foreshore subsidence to exceed 20 mm after the proposed development headings are completed.

3.0 Available Information

The available information considered relevant to this study included:

- digital plans of first and second mine workings (FW and SW) and their completion dates in the GN Seam;
- overburden geology from borehole logs (refer to **DgS, 2013a**);
- geotechnical knowledge of mine workings geometry and strata behaviour from mine site personnel;
- the time dependant subsidence assessment for MWs 41 and 45 prepared for the Mining Extension 1 Project (refer to **DgS, 2013b**); and
- inspection of surface features above the proposed mine linkage headings (site inspection conducted 17/12/13).

4.0 Surface Features

The existing natural and man-made surface features above the proposed linkage headings are listed below. The majority of these are within Delta Electricity's Vales Point Power Station site boundary and include:

- Lake Macquarie foreshore with dry sclerophyll woodland and lake foreshore vegetation.
- Lake Macquarie foreshore seagrass protection barrier.
- Intake and outfall canals with 300 mm wide reinforced concrete walls and invert slab.
- Outlet tunnel with reinforced concrete arch roof, walls and invert slab.
- Six Transgrid tension towers with varying conductor angles (30° to 83°). *Note: Two of the towers have conductors installed from the power station to one side only. It is unknown when the conductors will be extended beyond the towers.*
- Four Transgrid suspension towers.
- Two steel lattice Switchyard conductor support frames on raft slab footings.

- Several elevated Switchyard transformers supported on steel box frames on raft slab footings.
- Jointed reinforced concrete pavements and bitumen sealed hardstand areas.
- Sewage treatment works comprising primary and secondary treatment tanks with one oxidation tank (Pasveer Channel), sludge pond, three earth embankment ponds or dams) with several buried rising main and gravity pipelines, buried power line conduits and trenches. One dam has reinforced concrete walls and one dam is pvc-lined. The treatment works takes raw sewage from the power station and then pumps treated water to the ash dam.
- There is a buried return water pipeline from the main ash dam pumps that connects to the southern Reservoir tank. The reservoir tank(s) are the large tanks adjacent to Vales Road. The northern most tank is currently unused (but may be in the future). Gravity-fed lines discharge from the Reservoir to Vales Point Power Station. A rising main line also returns water to the Reservoir tank(s) from the Power Station.
- Underground power services to light poles and ancillary control room buildings.
- Bitumen access roads and stormwater drainage lines.
- Two steel framed and sheet metal clad storage sheds on slab footings, and
- Steel post and chain wire mesh fences and security gates.

It was estimated during the site inspection that the lake foreshore and tops of the canal inlet walls were 600 ~ 800 mm above the High Water Level for the lake.

The seagrass protection barrier above the proposed linkage headings extends 35 m to 57 m out from the foreshore. The mine plan indicates that first workings in the GN Seam (Pillar Group B workings in **Table 1**) exist between 15 m and 130 m from the foreshore and are adjacent to second workings panels (Pillar Group A workings in **Table 1**). The second workings panels exist 24 m to 63 m from the northern limits of the locations of the proposed headings and are within an angle of draw range of 8° to 20° from it. Four Group A panels exist directly below the foreshore and are 24 m to 382 m to the north of the proposed linkage route.

5.0 Mining Geometry and Timing

Mining of the GN Seam beneath the south western side of Chain Valley Bay foreshore commenced in the early 1970s and ceased in the late 1970s. There are first and second workings at 170 m depth beneath the foreshore where the proposed headings will pass 22.5 m below them in the FAS Seam.

The second workings in the GN Seam consisted of total pillar extraction panels ranging between 48 m and 120 m wide. The shorter width panels are located 74 m to 338 m inbye of the foreshore. The larger width panel is 581 m to 708 m outbye of the foreshore; see **Figure 5**.

The geometry of the mining workings are summarised in **Table 1**.

Table 1 - Existing Mine Workings Pillar Geometries in the GN Seam and Proposed Headings in the Fassifern Seam

Pillar Group (see Figure 5)	Proposed Headings Chainage (m)	Distance from Foreshore* (m)	Mine Workings Type	Pillar Dimensions (width x length x height) (m)	Void Width (m)	e.r. %
Great Northern Seam Pillars						
A	337 - 601	338 to 74	SW	26.5 x 27.5 x 2.5	48	70.4
B	601 - 660	130 to 15	FW	20.5 x 22.5 x 2.5	5.4	36.6
C	712 - 803	-37 to -128	FW	22.6 x 22.7 x 2.5	5.4	35.3
D	803 - 1078	-128 to -403	FW	18.2 x 26.7 x 2.5	5.4	37.3
E	1078 - 1172	-403 to -497	FW	21.7 x 22.2 x 2.5	5.4	36.1
F	1172 - 1256	-497 to -581	SW	20.6 x 22.4 x 2.5	120	36.6
F	1256 - 1383	-708 to -736	SW	20.6 x 22.4 x 2.5	120	36.6
G	1411 - 1471	-736 to -796	FW	39.7 x 55.2 x 2.5	5.4	20.1
H	1471 - 1577	-796 to -902	FW	16.8 x 37.7 x 2.5	5.4	34.3
Fassifern Seam Pillars						
I	0 - 1577	675 to -902	FW	25 x 94.6 x 3.2	5.4	22.2

* - positive distances are above Chain Valley Bay and inbye of the foreshore; negative distances are over land and outbye of the foreshore relative to existing Chain Valley Mine access drifts.

FW = First Workings; SW = Second Workings.

italics - minimum width for parallel piped pillars with short side of 21m and acute rib side angle of 60°.

e.r. = plan area extraction ratio.

6.0 Subsurface Conditions

Reference to the closest available exploration borehole logs (shown in **Figure 1**) above the lake (JMQ2) and over land (WSM6 and JCV4) indicates the following stratigraphic profile exists above and below the proposed headings:

Lake Macquarie: Maximum depth of 6 m, overlying

Lake sediments & weathered rock: Sand, silt and clay to a depth of 9 m to 12 m, overlying

Munmorah Conglomerate: Conglomerate and sandstone 20 m to 36 m thick; grey, medium to coarse grained with minor claystone / shale beds to depths ranging from 112 m to 114 m, overlying

Dooralong Shale:	Interbedded shale and coal seams; dark grey brown to black with minor sandstone to a depth ranging from 121 m to 130 m, overlying
Vales Point Seam:	Minor seam < 0.5 m thick; with some shale and siltstone overlying
Karignan Conglomerate:	Conglomerate and sandstone; grey, medium to coarse grained, 10 m to 15 m thick to a depth of 142 m, overlying
Wallarah Seam:	Coal; 1.8 m to 3.2 m thick, to depths ranging from 143 m to 149 m, overlying
Teralba Conglomerate:	Conglomerate and sandstone; grey, medium to coarse grained and minor claystone and coal, 24 m to 34 m thick, to depths ranging from 181 m to 187 m, overlying
Great Northern Seam:	Coal with carbonaceous shale bands; 2.5 to 3.0 m thick, to depths ranging from 183 m to 190 m, overlying
Awaba Tuff:	Tuffaceous claystone; waxy to cherty, hard to soft, 19 m to 20 m thick, overlying
Chain Valley Formation:	Interbedded shale, coal and claystone; 1.7 m to 4.3 m thick, hard to soft, to depths ranging from 195 m to 215 m, overlying
Fassifern Seam:	Coal, shale and claystone; 4.7 m thick, overlying
Lower Fassifern & Pilot Seam:	Interbedded shaley coal, sideritic and claystone, grey to grey brown, soft to hard; comprising 0.15 m to 0.35 m thick beds of claystone with a total thickness of 0.67 m to 0.87 m within 2.0 m to 2.7 m below the mine workings floor overlying
Croudace Bay Conglomerate:	Sandstone, shale and conglomerate, grey.

The representative lithological profile of the overburden and immediate mine workings roof and floor strata is presented in **Figure 6**.

6.1 Geotechnical Properties of Rock Mass

Geotechnical testing results of some of the Narrabeen Group and Permian Newcastle Coal Measures conglomerate and sandstone units have been summarised by **McNally, 1995** and **Ives, 1995** and are presented in **Table 2**.

Table 2 - Uniaxial Compressive Strength of the Stratigraphy in the Narrabeen Group and Newcastle Coal Measures

Formation/Unit	Mean (MPa)	Range (MPa)	No. of Tests
Munmorah Conglomerate*	40 / 55	27 - 53 / 37 - 73	26
Wallarrah Coal	16	14 - 19	4
Teralba Conglomerate	67	12.5 - 175	68
Great Northern Coal	23	12 - 61	32
Awaba Tuff [^] & Chain Valley Claystone (moisture sensitive)	66 (10)	20 - 254 (2 - 20)	54 (37)
Fassifern Seam	32	16 - 43	29
Australasian Coal	26	14 - 39	5

* - Conglomerate / Sandstone Units. MPa - Mega Pascals.

[^] - increases in moisture content can decrease strength of claystone units significantly. Strengths > 100 MPa are likely to be siliceous cherty beds.

The test results indicate that the conglomerate and sandstone units typically have medium to high material strength (i.e. UCS between 25 MPa and 75 MPa) based on the International Society of Rock Mechanics (ISRM) Classification System (ISRM, 1981).

The properties of the Awaba tuff and other claystone units tend to be moisture sensitive and may lose ~50% of their strength and stiffness once they are stress relieved and exposed to humid mine workings atmosphere and groundwater; see **Figure 7**. Field and laboratory testing results on core samples from another mine (DgS, 2012) indicate that the claystone in the FAS Seam floor is similar to Awaba Tuff in regards to its time-dependant softening behaviour and material strength response to moisture content changes.

Estimates of claystone material properties after softening due to moisture ingress and excessive strain (i.e. shear failure under applied pillar stresses) have been assessed for long-term subsidence predictions.

Laboratory Young's Modulus (E) have been derived from UCS data, $E_{\text{laboratory}} = 300 \times \text{UCS}$ (units are in gigapascals [GPa]).

Average rock mass elastic moduli for spanning conglomerate and the floor and roof materials within the significant area of influence of the pillars (i.e. approximately the pillar width above and below the mine workings) are estimated below based on the laboratory modulus and their relationship with the Geological Strength Index (GSI), refer to **Hoek and Diederichs, 2006**:

$$E_{\text{rockmass}} = E_{\text{laboratory}}(0.02+1/(1+e^{(60-GSI)/11}))$$

Undrained, jointed rock mass Youngs Moduli (E_u) were estimated from UCS values for the range of lithologies presented in **Table 2** based on the following GSI values presented in **Marinos and Hoek, 2000**.

- GSI = Geological Strength Index for blocky, jointed rock mass.
- = 55 for claystone with fair to poor bedding parting surfaces.
- = 65 for sandstone / shale with good to fair bedding parting surfaces.

= 80 for massive conglomerate / sandstone with widely spaced joints and good to very good bedding parting surfaces.

The rock mass Young's Modulus (E_{rockmass}) for the roof, floor and coal materials have been estimated for an assessed GSI ranges as follows:

$$\begin{aligned} E_{\text{rockmass}} &= 0.4 E_{\text{laboratory}} \text{ for Claystone/Mudstone} \\ &= 0.5 E_{\text{laboratory}} \text{ for Shale/Coal/Siltstone} \\ &= 0.9 E_{\text{laboratory}} \text{ for Conglomerate} \end{aligned}$$

The overall strengths and stiffness properties for the roof, floor and coal pillars have been derived using the above formula and are summarised in **Table 3**.

Table 3 - Strength and Stiffness Properties for GN and FAS Seam, Roof and Floor Units

Seam	Materials	In-situ UCS (MPa)	Softened UCS (MPa)	Insitu Undrained Youngs Modulus E_u (GPa)	Insitu Drained Youngs Modulus E' (GPa)
GN	Conglomerate Roof	60	60	15	15
	GN Seam Coal	23	15	3.45	2.3
	Weak Awaba Tuff (Claystone)	5 - 10	3 - 5	0.6 - 1.2	0.35 - 0.6
	Strong Awaba Tuff (Cherty Claystone)	66	66	10	10
FAS	FAS Coal Pillars + Claystone Bands	15	10	2.25	1.5
	Shaley Coal/Claystone Floor	10	5	1.2	1.0
	Sandstone/Shale Floor and roof	40	40	6	6

The Undrained Young's Modulus value for the first 2.0 m to 2.5 m, interbedded claystone and coal in the floor of the FAS Seam were derived based on the weighted average stiffness and thicknesses of individual units (E_i and t_i) described in **Li and Smith, 1998** as follows:

$$E_{u(\text{floor})} = \sum E_i t_i / t \text{ where } t = \text{combined thickness of individual units.}$$

Drained Moduli for the claystone units were assumed to be similar in magnitude to laboratory tests (oedometer tests) results for the Awaba Tuff floor at Mandalong Mine (ref to **Coffey, 1998**) which ranged from 450 to 750 MPa (mean of 600 MPa).

For the weak FAS Seam floor, which is a combination of moisture softening claystone and non-sensitive shaley coal, the combined softened (or drained) modulus for the weak floor is as follows:

$$E_1 = (E_{\text{claystone}} \times t_1 + E_{\text{shaley coal}} \times t_2) / (t_1 + t_2) = (0.6 \times 0.87 + 1.2 \times 1.85) / 2.724 = 1.0 \text{ GPa}$$

Note: Laboratory derived values may be determined if adequate core samples can be retrieved from the floor.

Estimates of pillar-roof-floor system properties have also been correlated with measured subsidence along Line 24 at the completion of the FWs and SWs panels in the GN Seam approximately 1 km to the south; see **Figures 8a** and **8b**. Details of the subsidence data and mine workings are provided in **Section 7**.

6.2 Observed Floor Heave Considerations

The mining experiences at Chain Valley Colliery to-date with GN and FAS Seam floor claystone indicate only minor floor heave has occurred in development headings around geologically structure affected areas, which are usually associated with wetter conditions; see **Figure 9**. The development of floor heave does not necessarily indicate surface subsidence will develop and depends on the presence of massive spanning conglomerate and panel width as demonstrated in **Figure 10**.

The time-dependent subsidence development apparent above the foreshore of Chain Valley Bay without significant floor heave indicates that the GN and FAS claystone units probably have been (i) softening due to moisture ingress and volume change and then (ii) consolidating under the applied loading for over 5 to 15 years since mining was completed.

7.0 Mine Workings Stability Assessment

The proposed first workings in the FAS Seam will pass beneath first and second pillar workings in the GN Seam. The pillars in the GN Seam are likely to have been subject to Full Tributary Area Loading (FTA) and abutment loads as described in **ACARP, 1998a** and **ACARP, 1998b** respectively; see **Figures 11a** and **11b**.

The potential interaction between the proposed and existing mine workings pillars has been assessed using the 2-D boundary element numerical modelling software (*LaM2D*). Details of the program are described in **DgS, 2013**.

Provided the bearing capacity of the claystone floor strata is not exceeded after softening and multi-seam loading conditions develop, subsidence may be predicted using classical soil mechanics theories that have been calibrated to measured subsidence to-date.

7.1 Pillar Loading and Stability

Representative stress profiles have been derived using analytical and numerical modelling techniques (*LaM2D*) to estimate the pillar stresses for the GN Seam workings and their effect on the FAS Seam (for model calibration purposes) and are shown in **Figures 12a** and **12b**. The interaction between the existing workings and the proposed workings in the FAS Seam are shown in **Figures 13a** and **13b**.

The Factor of Safety (FoS) of the pillars under worst-case stress conditions were then estimated by dividing the pillar strength, S_p , with the average pillar stress, σ .

A summary of the single and multi-seam pillar stresses and minimum FoS in the existing and proposed mine workings is presented in **Table 4**. The pillar stress increases assessed for pillars in the FAS Seam include the load reducing effect of the Teralba Conglomerate spanning for 97 m across the linkage headings and pillars (i.e. the linkage ‘panel’ will have a sub-critical W/H ratio of 0.5)

Table 4 - Pillar Stresses and Stability in Existing GN and Proposed FAS Workings

Pillar Group (+2nd Seam)	Workings Type (+2nd Seam)	Cover Depth (m)	Pillar Dimensions (w x l x h) (m)	Pillar Strength (MPa)	Single Seam Pillar Stress (MPa)	Multi-Seam Pillar Stress	Pillar FoS
Great Northern Seam Pillars							
A (I)	SW (FW)	170	26.5 x 27.5 x 2.5	31.98	15.0	15.18	1.59
B (I)	FW (FW)	170	20.5 x 22.5 x 2.5	22.48	6.71	6.78	3.32
C (I)	FW (FW)	170	22.6 x 22.7 x 2.5	25.00	6.56	6.63	3.77
D (I)	FW (FW)	170	18.2 x 26.7 x 2.5	20.28	7.83	7.90	2.57
E (I)	FW (FW)	170	21.7 x 22.2 x 2.5	23.77	6.65	6.71	3.54
F (I)	SW (FW)	170	20.6 x 22.4 x 2.5	24.13	12.9	13.08	1.84
G (I)	FW (FW)	170	39.7 x 55.2 x 2.5	71.11	5.32	5.34	13.3
H (I)	FW (FW)	170	16.8 x 37.7 x 2.5	20.87	6.46	6.52	3.20
Fassifern Seam Pillars							
I (B)	FW (FW)	195	25 x 94.6 x 3.2	24.13	6.27	6.66	3.63
I (C-E, G-H)	FW (FW)	195	25 x 94.6 x 3.2	24.13	6.05 - 7.83	6.54 - 6.66	3.62 - 3.69
I (F)	FW (SW)	195	25 x 94.6 x 3.2	24.13	6.27	7.37 - 7.32	3.28 - 3.30

italics - load on pillars is likely to be lower due to spanning conglomerate units.

The results of the pillar stress modelling indicate the following:

- The existing stresses on the pillars in the GN seam range between 5.32 MPa and 15.0 MPa. The proposed first workings pillars in the FAS Seam are likely to increase the GN pillar stresses by 0.02 MPa to 0.18 MPa.

- The GN Seam first workings pillars may increase the stress acting on the FAS Seam pillars by 0.27 MPa to 0.39 MPa. The SWs pillars may increase the stress on the FAS pillars directly below goaf edges from 1.05 to 1.10 MPa.
- Total stresses on the FAS pillars are estimated to range from 6.54 MPa to 6.66 MPa below GN Seam FWs pillars and between 7.32 MPa to 7.37 MPa below the GN Seam SWs pillars.

Estimates of pillar strength based on **ACARP, 1998a** indicate that the FoS for the proposed pillars in the FAS Seam will range from 3.28 to 3.69; and from 1.59 to 13.3 in the GN Seam.

As was discussed in **DgS, 2013a**, it is assessed that provided the estimated FoS of the pillars remain above an FoS greater than 1.6 and the pillars retain 'squat' pillar geometries with w/h ratios greater than 5, it is considered very unlikely that the 'squat' pillars will go into yield in the long-term.

The results of the pillar stress increase analysis have been used to estimate the long-term subsidence due to consolidation of softened claystone in **Section 7**. Before this long-term subsidence mechanism is further assessed, the bearing capacity of the claystone materials should be considered. The potential for bearing failure in softened claystone below the GN and FAS Seam pillars has been assessed in **Section 7.2**.

7.2 Bearing Capacity of Roof and Floor Strata

The bearing capacity of the GN Seam's claystone floor strata has been estimated from a floor failure that occurred in partial pillar extraction workings at Newvale Colliery in 1987; refer **Yee et al, 1991**. The failure site was located 180 m beneath the south-western foreshore of Chain Valley Bay and resulted in initial subsidence of approximately 500 mm occurring from November 1986 to January 1987 (second workings were commenced in March, 1986). By June, 1991, subsidence had increased to almost 900 mm, but the rate of subsidence development had decreased significantly. The foreshore was subsequently affected by flooding and required re-levelling works to Lloyd Avenue and adjacent residential lots and dwellings. Subsidence of 150 mm had been predicted for the second workings areas.

A review of the mine workings geometry indicated that the pillars were initially 30.6 m x 30.6 m (solid) and had a mining height of 2.5 m. The pillar stress after first workings was estimated to be 6.26 MPa. The second workings followed the 'take a row - leave a row' technique and resulted in remnant pillars with dimensions of 25 x 30.6 m with a void width of 48 m. Pillar stresses were estimated to have increased up to 15.5 MPa on completion of mining.

Reference to **Pells et al, 1998** indicates that the bearing capacity of sedimentary rock under shallow footing type loading conditions is 3 to 5 times its UCS strength. Using back analysis techniques, the claystone floor was estimated to have an average UCS of 3 to 5 MPa for an assumed bearing capacity of 15 MPa.

It should be noted that tuffaceous claystone beds associated with the GN and FAS Seam interburden can soften to 50% of their undisturbed UCS on exposure to humid mine atmosphere, stress relief and increased groundwater ingress (**Li and Smith, 1998** and **Marino and Choi, 1999**).

The claystone beds in the FAS Seam are usually ‘sandwiched’ between stronger shaley coal units with strengths > 10 MPa, thus giving a higher average bearing capacity for the floor beneath the pillars themselves. The moisture sensitive nature of the claystone and its UCS strength is presented in **Li and Smith, 1998** was presented earlier in **Figure 7**.

By also applying 2-layered bearing capacity theory presented in **Brown & Meyerhof, 1969** for a square footing on a weak layer overlying a stronger one. It is possible to estimate the likely claystone bed thicknesses for a range of material strengths. The theory indicates that the overall bearing capacity of the weaker layer will be increased if the stronger unit is within 0.5 times the width of the pillar as follows:

$$q_u = N'_{\text{square}} \times \text{UCS}_1/2 = [5.14 + 0.33(w/t)] \text{UCS}_1/2$$

where

- N'_{square} = Modified bearing capacity coefficient for a square footing
- w = pillar width;
- UCS_1 = claystone or mudstone strength;
- t = thickness of weaker claystone layer.

For the case where pillars are longer than they are wide, it was considered reasonable to adopt the two-layered floor strength formula for a strip footing as follows:

$$q_u = N'_{\text{strip}} \times \text{UCS}_1/2 = [4.14 + 0.5(w/t)] \text{UCS}_1/2$$

The above theory has been applied successfully in the Lake Macquarie coalfield to explain observed floor heave and pillar punching failures into softened claystone layers that tend to shear laterally, rather than undergo deep seated bearing failures; see **Figure 9**. It is noted that in one case study at the Coorombong Mine (**Li et al, 2001**), the existence of floor heave was due to swelling of unconfined claystone units below the roadways between pillars and not from pillar punching failures. The subsidence above the workings was < 100 mm. What is clear from these observations is that floor heave does not necessarily indicate that the floor below the pillars has failed; however, the onset of floor failure may ensue if softening of the claystone reduces the bearing capacity of the floor below the applied pillar stress.

Surface subsidence above pillar workings where floor heave has developed has been observed to be either < 0.2 m or range between 0.5 m and 0.9 m. The latter displacement generally confirms a pillar punching event has occurred through lateral displacement of one or more claystone layers within the active wedge zone, which develops beneath the pillar for depths equal to 0.5 to 1 times the pillar width.

Using the two-layered floor material equations, the maximum claystone unit thickness (t) that may have been present below the 25 m wide pillars to achieve a bearing strength of 15 MPa is estimated to range between 1.2 m and 3.7 m for a softened claystone UCS range of 2 MPa to 4 MPa. A UCS of 3.6 MPa is estimated for a claystone unit thickness of 3.0 m.

It was assessed in **DgS, 2013b** that existing pillars in the workings at Chain Valley Colliery with stresses greater than 15 MPa may therefore experience local bearing or lateral squeezing failures in the roof or floor strata and increase surface subsidence to between 200 mm and 900 mm.

The bearing strength and stability of the claystone affected floor units in the GN Seam workings below the western foreshore and the proposed FAS headings have also been estimated based on the back-analysed UCS and thickness values determined above for the Newvale Colliery Workings. The results are summarised in **Table 5**.

In regards to limit state design practices used in civil engineering structures, provided the FoS based on worst case pillar loading and claystone bearing strength exceeds 1.0 in this study, it is considered unlikely that a bearing failure will occur in the long-term. Indicative FoS values < 1.0 represent an area where pillar or floor failure may occur and appropriate management strategies should be developed to (i) monitor the surface, (ii) investigate the conditions underground and (iii) consider modifying the mine plan to limit the impact of subsidence > 200 mm occurring in the long term.

The results indicate that the pillar loads acting on the floor between the 61 to 70 m wide SWs panels are likely to be < 13.8 MPa due to the absence of significant subsidence above the foreshore workings below Line 24. *Note: The survey data only covers data up to March, 1995, however, and it is therefore recommended that the line be re-surveyed or re-established if necessary.*

Table 5 - Claystone Strength and Stability Assessment Summary for GN Seam Workings beneath the Western Foreshore

Survey Line	Workings Type	Cover Depth H (m)	Pillar Dimensions w x l (m)	Total Pillar Stress (MPa)	Claystone Floor Unit [^]			
					UCS (MPa)	Thickness (m)	Bearing Strength (MPa)	Bearing FoS
Line 24	FWs	190	19.7 x 26	6.6 - 7.43	2.0	1.15	12.7	1.9 - 2.02
					3.0	2.13	13.1	2.2 - 1.94
					3.6	3.0	13.3	2.0 - 1.79
					4.0	3.7	13.6	2.1 - 1.83
	SWs	190	30.4 x 30.7 (Panel W= 65 m)	10.5* 15.3* *	2.0	1.15	13.8	1.3 - 0.90
					3.0	2.13	14.8	1.4 - 0.97
					3.8	3.0	15.3	1.5-1.00
					4.0	3.7	15.7	1.5-1.03

Bold - Estimated FoS < 1 for worst-case, lower bound material strengths and upper bound pillar loading conditions.

* - Barrier pillar stress due to single abutment loading; ** - Barrier pillar stress due to double abutment loading.

[^] - Range of claystone UCS and thickness values back-analysed from claystone floor failure review at Newvale Colliery.

italics - estimated claystone thickness below western foreshore.

The lower than predicted SWs pillar loads is likely to be due to several massive conglomerate units that appear to be able to span 150 m. This span across the panels also corresponds to a critical panel W/H ratio of 0.78, which is just outside the expected W/H range for natural arching of 0.7.

The predicted pillar stresses in the vicinity of the existing GN Seam and proposed FAS Seam panels are therefore likely to be conservative for panel widths up to 150 m and W/H < 0.8. The results of the pillar stability assessment for the existing and proposed workings are summarised in **Table 6**.

Table 6 - Pillar Stresses and Stability in Existing GN and Proposed FAS Workings

Pillar Group (2nd Seam)	Workings Type (Panel Width)	Cover Depth (m)	Pillar Dimensions (w x l x h) (m)	Multi-Seam Pillar Stress (MPa)	Claystone Floor Unit			
					UCS (MPa)	Thickness (m)	Bearing Strength (MPa)	FoS
Great Northern Seam Pillars								
A (I)	SW (W=48 m)	170	26.5 x 27.5 x 2.5	15.18	3.6	3	14.5	0.96
B (I)	FW	170	20.5 x 22.5 x 2.5	6.78	3.6	3	13.3	1.96
C (I)	FW	170	22.6 x 22.7 x 2.5	6.63	3.6	3	13.7	2.07
D (I)	FW	170	18.2 x 26.7 x 2.5	7.90	3.6	3	12.9	1.63
E (I)	FW	170	21.7 x 22.2 x 2.5	6.71	3.6	3	13.5	2.01
F (I)	SW (W=122m)	170	20.6 x 22.4 x 2.5	13.08	3.6	3	13.3	1.02
G (I)	FW	170	39.7 x 55.2 x 2.5	5.34	3.6	3	19.3	3.61
H (I)	FW	170	16.8 x 37.7 x 2.5	6.52	3.6	3	12.5	1.92
Fassifern Seam Pillars								
I (A-H)	FW (W=97m)	195	25 x 94.6 x 3.2	6.27-7.37	3.6	3	14.2	1.9 - 2.2
					1.0*	0.35	20.0	2.7 - 3.2

(SW) - SWs panels 0 m - 44 m to east of foreshore survey line.

italics - load on pillars is likely to be lower due to spanning conglomerate units > 20 m thick above GN Seam.

* - worst-case softening on claystone in immediate floor of workings.

Bold - Estimated FoS < 1 for worst-case, lower bound material strengths and upper bound pillar loading conditions.

The outcomes of the stability assessment on worst case pillar loading and claystone floor bearing strength suggest that softened claystone floor units below the GN Seam's first workings pillars could develop FoS values against lateral bearing failure ranging between 1.63 and 3.61. At present the measured subsidence along the western foreshore (Line 24) ranges between 20 mm and 57 mm, which is considered to be within the normal range for the multi-seam stress environment with consolidating claystone strata units as discussed in **DgS, 2013b** (i.e. subsidence is < 200 mm). Ninety-five percent of full subsidence appears to have taken ~ 7 years to develop since the maximum stresses due to the GN Seam workings were applied to the pillars.

If the estimated stresses of 13 to 15 MPa develop on the pillars adjacent to the SWs panels and the assumed floor conditions exist in the GN Seam, there is potential for lateral bearing failures to occur. It is however assessed that the maximum pillar loads are unlikely to reach the magnitudes indicated for this to occur due to the spanning capability of the conglomerate units mentioned earlier for panels with W/H < 0.8. Further sub-surface investigations should

therefore be undertaken in the sensitive areas (i.e. below the foreshore) and before the full panel width development is completed (see **Section 9** for further discussion).

The prediction of long-term subsidence above the proposed first workings in the FAS Seam beneath the GN seam workings are assessed in **Section 8**.

8.0 Subsidence Development Mechanisms

Several pillar panel mines in the Lake Macquarie area have claystone floors below the Wallarah, GN and FAS seams that are noted for their sensitivity to moisture content and stress changes (**Seedsman and Gordon, 1992**).

The changes in pillar stress that occur during first and second workings generally cause an initial elastic response from the strata. The increases in pillar stress can also develop excess pore pressures in the previously exposed claystone, due to its low permeability. This usually results in consolidation settlements or time-dependent subsidence that decreases gradually as the load carried by the pore water initially, transfers to the soft rock matrix (and compresses it) as the water drains away.

Based on a review of subsidence data in **DgS, 2013b**, the development of subsidence above first and second pillar panel workings at Chain Valley appear to have been influenced by the following mechanisms:

- Immediate pillar and roof and floor compression under applied loading from the overburden (Full Tributary Area and abutment loading from adjacent second workings or goaf).
- Pillar stress interaction between multi-seam mine workings.
- Time-dependent consolidation and/or softening of over-consolidated claystone beds below GN and FAS Seams after mine workings completed.
- Bearing or lateral squeezing failures of softened claystone layers.

The magnitude of subsidence has also likely to have been influenced by the spanning capability of massive strata units such as the Teralba Conglomerate above the GN Seam and thickness of moisture sensitive claystone below (or above the standing pillars). The spanning strata units have the potential to transfer load across relatively narrow mine workings with W/H ratios < 0.8 and reduce the stress acting upon the pillars. Reference to borehole log data in the vicinity of the Chain Valley Bay area indicates at least three conglomerate units exist above the GN Seam and are consistently > 20 m thick; see **DgS, 2013a**.

The 20 m to 30 m thick interburden between the GN and FAS seams consists of several layers of moisture sensitive claystone that are hard when first cored and then swell and soften with time due to stress relief and exposure to humid mine workings atmospheres and concentrated

groundwater. The total thickness of moisture sensitive claystone is estimated to range between 0.8 m and 3.5 m, based on back analysis of available data (see **Section 7.2**). Recent experience obtained by the mine during the construction of a shaft between the GN and FAS seams in the south-eastern area of Chain Valley Bay confirmed the presence of swelling / puggy claystone in at least 15 m of the shot firing holes drilled upwards from the FAS Seam. Observed floor heave of first workings headings in the GN and FAS seams also indicates moisture sensitive claystone is present in the area.

Based on the subsidence monitoring along Lines 23 and 24, the on-going development of subsidence after first and second workings in the Wallarah and GN seams for 7 to 15 years indicates the first three of the above mechanisms have been occurring beneath the foreshore of Chain Valley Bay. Based on the magnitude of subsidence observed to-date, it is considered that lateral bearing failures have not developed beneath the workings assessed in this study.

8.1 Softened Claystone Prediction Model

Using the post-mining pillar stresses and the softened claystone material properties presented in **Section 7**, the total subsidence has been predicted for the GN and FAS Workings based on elastic solid mechanics theories and the material properties defined in **Table 3** for current and softened claystone floor conditions as follows:

$$S_{\max} = S_{\text{pillar}} + S_{\text{roof}} + S_{\text{floor}}$$

where

$$S_{\text{pillar}} = \sigma_{\text{net}} h / E_{\text{coal}} = \text{compression of pillar}$$

$$S_{\text{roof}} = \sigma_{\text{net}} w I(1-\nu^2) / E_{\text{roof}} = \text{compression roof strata units}$$

$$S_{\text{floor}} = \sigma_{\text{net}} w I(1-\nu^2) / E_{\text{floor}} = \text{compression of floor strata units}$$

$\sigma_{\text{net}1,2}$ = net pillar stress (ie. Pillar stress - pre-mining stress) - see below for explanation

E_{coal} = Young's Modulus for coal

E_{roof} = Average Young's Modulus for the roof strata units within one pillar width of the roof

E_{floor} = Average Young's Modulus for the floor strata units with one pillar width of the floor

ν = Poisson's Ratio = 0.25 for roof and floor strata

I = shape factor for square footing = ~ 1 (for a semi-rigid footing and Young's Modulus uncertainty)

w = pillar width

h = pillar height.

For the assessment of subsidence due multi-seam interaction effects, the net increases in pillar stress due to the GN and FAS seams have been determined based on the GN and FAS seams cover depths (H_1 and H_2), rock mass density γ , pillar extraction ratios in each seam (e_1 and e_2) and Boussinesq pillar stress theory (**Das, 1998**) as follows:

Mining Step 1 - For GN Seam workings, subsidence above the pillars was initially estimated based on:

$$\sigma_{net1} = \gamma H_1 e_1 / (1 - e_1)$$

Mining Step 2 - For FAS Seam workings, incremental subsidence development above the pillars due to the existing GN stress pillars were estimated based on:

$$\sigma_{net2} = [\gamma(H_2 - H_1) + a \cdot \sigma_{net1}] e_2 / (1 - e_2)$$

Note: $a = 0.3$ for estimating stress decay between GN and FAS seams and square pillars;
 $= 0.5$ for estimating stress decay between GN and FAS seams and chain pillars;

Mining Step 3 - For GN Seam workings, incremental subsidence development above the pillars due to additional stress from the proposed FAS pillars were estimated based on:

$$\sigma_{net12} = \sigma_{net2} e_1 / (1 - e_1)$$

The incremental subsidence increase due to the proposed FAS Seam workings were subsequently derived by adding the results for each seam in Mining Steps 2 and 3. The cumulative subsidence estimates were determined by adding the results for all three Mining Steps. The above analysis outcomes were validated against Lam-2D[®] modelling results, which are conservative and do not allow for massive conglomerate spanning behaviour to reduce pillar loading.

8.2 Time Dependent Subsidence Prediction Model

The time taken for full load transfer or primary consolidation is dependent on the magnitude of stress and the length of the drainage pathway through the consolidating claystone. The presence of permeable sandstone or fractured rock mass beds above and below the claystone unit could theoretically halve if pore water pressure can be relieved in two directions (i.e. two-way drainage). Once primary consolidation is complete, the strata may continue to undergo secondary consolidation or creep movements as the strata continues to adjust plastically under maximum load. Secondary consolidation represents <10% of the primary consolidation movements.

In soil mechanics, the amount of consolidation that occurs is highly dependent on the pre-consolidation pressure or maximum loading history of the rock mass. If the applied loading is less than the pre-consolidation pressure, the rock mass will behave as an over-consolidated soil on the rebound and have a relatively low settlement response. Should the applied load exceed the pre-consolidation pressure, then the rock mass may behave like a normally

consolidated soil and show a markedly increased settlement response once the pre-consolidation pressure is exceeded.

The development of subsidence due to primary consolidation in saturated, over-consolidated claystone is presented in **Das, 1998** as follows:

For overconsolidated claystone where $\sigma_o + d\sigma < \sigma_p$ then:

- Primary Consolidation = $h_c/(1+e_o) [C_s \log(\sigma_o + d\sigma)/\sigma_o]$ (1)

For overconsolidated claystone where $\sigma_o + d\sigma > \sigma_p$ then:

- Primary Consolidation = $h_c/(1+e_o) [C_s \log(\sigma_p/\sigma_o) + C_c \log((\sigma_p + d\sigma)/\sigma_p)]$ (2)

where

e_o = initial void ratio of claystone = wGs = in-situ moisture content for saturated claystone and the specific gravity = $0.18 \times 2.65 = 0.50$ (see **Figure 7**)

C_s = swell index = $0.0463 (LL/100)Gs = 0.06 - 0.085$ (after **Nagaraj & Murty, 1985**)

C_c = compression index = $0.2343 (LL/100)Gs = 0.31 - 0.43$ (after **Nagaraj & Murty, 1985**)

LL = Liquid Limit = 50 - 70; an Atterberg Limit Index measured by laboratory testing of material samples, and is a measure of the degree of clay plasticity and moisture adsorption properties

$d\sigma$ = increase in pillar stress after the completion of first or second workings that is applied to the strata

σ_o = pre-mining stress

σ_p = initial pillar stress

h_c = total thickness of claystone units.

8.2.1 Pre-consolidation pressure

The pre-consolidation pressure for the GN Seam floor has been estimated based on horizontal stress testing for the F3 Freeway in a ridge to the north west of the Chain Valley Colliery (refer to **Lohe & Dean Jones, 1995**). The test result at 24 m depth indicated a horizontal stress of 10.2 MPa for a vertical stress of 0.6 MPa. If the rock mass was overlain by a greater depth of soil and rock at some point in the past, then based on a horizontal to vertical stress ratio of 2 the pre-consolidation pressure at a depth of 24 m was approximately 5.2 MPa (due to a cover depth of 208 m). The over consolidation ratio (OCR) has therefore been estimated as follows:

$$\text{OCR} = \sigma_{vo} / \sigma_v = 5.2 / 0.6 = 8.7 \text{ or } H_o / H = 208 / 24 = 8.7.$$

The pre-consolidation pressure (σ_p) at a depth of 170 m in GN Seam and 195 m in the FAS Seam may then be estimated as follows:

$$\begin{aligned} &= \sigma_{vo (H=24m)} + \gamma(H - 24) \\ &= 5.2 + 0.025(170 - 24) = 8.9 \text{ MPa (GN Seam)} \\ &= 5.2 + 0.025(195 - 24) = 9.5 \text{ MPa (FAS Seam)} \end{aligned}$$

To-date, the floor below the GN Seam pillars would have been subject to a pre-mining stress of 4.25 MPa, followed by a development load of 6 to 8 MPa, and finally a second workings load of approximately 12 to 13 MPa. Based on the above assessment, it is possible that the pre-consolidation pressure for the claystone units was exceeded, resulting in normally consolidated behaviour conditions once pillar stress exceeded 9 MPa. Primary consolidation displacements for the pillars have therefore been estimated using equations (1) and (2).

The proposed FAS pillars are estimated to have maximum pillar stress between 4.4 and 9.0 MPa below GN Seam second workings and 6.27 MPa below GN Seam first workings panels. Primary consolidation displacements for the pillars have therefore been estimated using equation (1) only as predicted stresses are below the pre-consolidation pressure of 9.5 MPa.

8.2.2 Subsidence Development

The time rate of primary consolidation may be estimated from the following formula:

$$t_{95\%} = T_v * (d/n)^2 / C_v \quad (3)$$

where

- d = thickness of claystone unit in m
- n = 1 for one-way drainage and 2 for 2-way drainage.
- C_v = coefficient of consolidation ($1.5 \text{ m}^2/\text{a}$ for Awaba Tuff from **Li and Smith, 1998**)
- T_v = Dimensionless Time factor (1.125 for 95% of primary consolidation settlement)

Based on a maximum claystone unit thickness of 3 m (estimated in **Section 6.2**) below the GN Seam with one-way drainage, the time for 95% of the primary consolidation phase to occur after completion of a mining stage is 7 years.

For individual claystone unit thicknesses of 0.35 m below the FAS Seam with two-way drainage conditions, the time for 95% of the primary consolidation phase to occur after completion of a mining stage is 8 and 34 days respectively.

The C_v value is also affected by the permeability of the claystone and applied stress, and depending on the location and number of consolidating claystone units, could see a significant increase or decrease in primary consolidation time occurring in-situ.

The primary consolidation development curves can subsequently be derived from the following equation that links the Time Factor to the percentage of total primary consolidation as follows:

$$U = S_t/S_{\max} = 1 - (2/M^2) e^{-M^2Tv}$$

where

U = average consolidation ratio

S_t = subsidence at time t

S_{\max} = maximum subsidence due to primary consolidation (Equation (1))

$M = \pi/2$

8.3 Back Analysis of Line 24 Subsidence Data

Based on the above theories, the primary consolidation curves were fitted to the observed settlement plots to back-analyse the assumed claystone thickness (t) and C_v values for the first and second pillar workings beneath Line 24. The fitted curves required the following input parameters to provide a good fit to the majority of subsidence measurements (and allowing for surface environmental effects):

- $C_v = 1.5 \text{ m}^2/\text{a}$ (Li and Smith, 1998);
- $T_v = 1.125$ (95% consolidation);
- t = 3 m of claystone (one-way drainage path);

The results are plotted in **Figure 14** and summarised in **Table 7**.

Table 7 - Back Analysis Results for Line 24

Workings Type in GN Seam	Cover Depth H (m)	Pillar Dimensions w x l x h (m)	Pre-Mining Stress (MPa)	Total Pillar Stress (MPa)	Pillar Stress Increase (MPa)	Measured GN Seam Workings Subsidence (Predicted for fully softened claystone case) (mm)			Predicted Final Subsidence based on last survey [Mar 1995] (mm)
						Elastic	Time Dependent	Total	
FWs	190	19.7 x 26 x 2.5	4.75	7.43	2.68	3 (2)	12 - 18 (23)	15 - 21 (26)	26
SWs	190	30.4 x 30.7 x 2.5 (Panel W= 65 m)	4.75	10.5*	5.75	3 (27)	28 - 32 (41)	31 - 35 (68)	44
			4.75	15.3**	10.55	10 (66)	42 - 47 (61)	52 - 57 (127)	73

* - single abutment loading; ** - double abutment loading conditions.

The results indicate that subsidence above the first workings panels ~ 7 years after mining was completed ranged between 15 mm and 21 mm, and may have increased to 26 mm based on the 1-D consolidation model of softened claystone under the assumed FTA loading conditions.

Subsidence above the second workings ranged from 31 mm to 57 mm by March 1995, and may have increased to 44 mm and 73 mm, based on the 1-D consolidation model of softened claystone under the assumed abutment loading conditions.

A review of longer records of subsidence data for the eastern side of Chain Valley Bay in **DgS, 2013b** suggests that further softening of claystone may have occurred beyond that indicated by the Line 24 data, with final subsidence above the second workings possibly increasing to a range between 68 mm and 127 mm. It may also be possible that full abutment loading conditions have not developed above the second workings below Line 24 due to spanning conglomerate units.

8.4 Subsidence Predictions for Proposed Headings

Predicted subsidence development curves above Pillar Areas A to H have been derived using the 1-D consolidation model for fully softened claystone under the assumed loading conditions with spanning conglomerate above the 97 m wide panel. The results are presented in **Table 8**.

It is considered that the assumption of full tributary area loading conditions for the linkage panel is unlikely, based on measured increase in subsidence of 5 mm above the 126 m wide access headings panel in the FAS Seam below Summerland Point with GN and WAL mine workings present (see Survey Line 23, Peg 67 in **DgS, 2013b**).

Total subsidence predictions for fully softened claystone units below the GN Seam workings range between 20 mm and 33 mm above the first workings and from 88 mm to 106 mm above the second workings panels. The predictions are shown graphically in **Figure 15**.

Based on the estimated stress increases due to the proposed workings in the FAS Seam, subsidence is likely to increase by a further 5 mm above existing FWs in the GN Seam and ~20 mm where SWs panels exist; see **Figure 16**.

The subsidence above the proposed workings in the vicinity of the seagrass protection barrier is estimated to have already been subsided by up to 26 mm by the GN Seam workings and may increase to 31 mm due to the proposed pillar development.

The cumulative subsidence above the second workings panels in the GN Seam may therefore range from 113 mm to 126 mm after the linkage between the collieries is completed; see Figure 17.

8.5 Predicted Subsidence Effect Contours

Cumulative and net subsidence effect contours have been derived for the mine workings in the GN and FAS Seams using SDPS[®] contouring software (Surface Deformation Prediction System). The model applies a 3-D influence function that considers the digitised cover depth, panel mining limits, mining height and maximum predicted subsidence as presented in **Table 8**.

Subsidence contour predictions have been made for each seam by importing the first and second workings panel outlines in .dxf format into the **SDPS[®]** model and applying the appropriate maximum subsidence values for each panel. The subsidence contours were then transformed into a 10 x 10 m grid in **Surfer8[®]** using data 'kriging' techniques.

The predicted net subsidence contours for the GN and FAS workings are presented in **Figures 18a** and **18b**. The multiple seam outcome was then determined by adding the contours for each seam together and are presented in **Figure 18c**. It is not clear at this stage whether the construction of some or all of the surface features occurred before or after the completion of the GN Seam panels in the 1970s or during the period of subsidence development up to 1995. If the former is the case then the cumulative subsidence contours should be adopted for impact assessment purposes. For surface features constructed after 1995, it is considered reasonable to assume the net subsidence contours for the proposed FAS contours.

The associated tilt, curvature and horizontal strain contours have been derived for the above three cases and are presented in **Figures 19a-b**; **20a-b** and **21a-c**, respectively.

The tilt and curvature contours were derived from the subsidence contours using differential calculus techniques available in the **Surfer8[®]**. The horizontal strain contours have been derived by multiplying the curvature contours by an appropriate K factor for the near surface geology. If deep sandy soils or alluvium cover is present, a K Factor of 7.5 is considered appropriate for relatively 'smooth' subsidence profiles. For the case of shallow rock cover or

very stiff clays, strains may be concentrated at a joint or fresh fracture due to the curvature. The 'smooth' profile strains may be assumed to double where cracks occur, or a K Factor of 15 may be adopted in relatively flat terrain.

Based on the location of the site, it is assessed that it would be reasonable to assume that stiff clays and weathered rock is likely to exist within 3 m of the surface and that a K factor of 10 would provide adequate strain predictions for the sensitive site features.

The results indicate that net and cumulative tilts are likely to be < 0.2 mm/m at sensitive features; with curvatures < 0.03 km⁻¹ and strains < 0.3 mm/m.

It is considered unlikely that the proposed first workings will impact upon the existing transmission towers, switchyard, treatment works, rigid pavement, OFC cable and all other surface infrastructure listed in **Section 4.0**. It is noted, however, that minor hairline cracking may develop in the hard stand areas and concrete slab, which should be readily repairable.

As described in Chapter 5 of the **EMGA Mitchell McLennan (2014)** Statement of Environmental Effects the change in subsidence levels from the proposed first workings is not predicted to adversely impact seagrasses, dry sclerophyll woodland or lake foreshore vegetation.

Table 8 - Predicted Maximum Subsidence above Existing Pillars in the GN Seam and Proposed FAS Pillars along the Linkage Headings

Pillar Group (2nd Seam)	Workings Type (2nd Seam)	Cover Depth (m)	Nominal Pillar Dimensions* w x l x h (m)	Total Pillar Stress (MPa)	Initial Pillar Stress (MPa)	Pillar Stress Increase (MPa)	p _c (MPa)	Predicted Subsidence with Fully Softened Claystone (mm)				Predicted Subsidence after FAS Linkage Headings (mm)	
								Pillar	Roof	Floor	Total	Increase	Total
GN Seam Workings													
<i>A (I)</i>	<i>SW (FW)</i>	<i>170</i>	<i>26.5 x 27.5 x 2.5</i>	<i>15.18</i>	<i>4.25</i>	<i>0.17</i>	<i>8.9</i>	<i>11</i>	<i>15</i>	<i>80</i>	<i>106</i>	<i>19</i>	<i>125</i>
B (I)	FW (FW)	170	20.5 x 22.5 x 2.5	6.78	4.25	0.07	8.9	3	3	20	26	5	31
C (I)	FW (FW)	170	22.6 x 22.7 x 2.5	6.63	4.25	0.06	8.9	2	3	18	24	5	29
D (I)	FW (FW)	170	18.2 x 26.7 x 2.5	7.90	4.25	0.07	8.9	4	4	25	33	6	39
E (I)	FW (FW)	170	21.7 x 22.2 x 2.5	6.71	4.25	0.06	8.9	2	3	18	24	6	30
F (I)	SW (FW)	170	20.6 x 22.4 x 2.5	13.08	4.25	0.18	8.9	9	13	67	88	25	113
G (I)	FW (FW)	170	39.7 x 55.2 x 2.5	5.34	4.25	0.02	8.9	2	5	19	25	4	29
H (I)	FW (FW)	170	16.8 x 37.7 x 2.5	6.52	4.25	0.06	8.9	2	2	15	20	6	26
FAS Seam Workings													
I (B)	FW (FW)	195	25 x 94.6 x 3.2	6.66	4.88	0.39	9.5	1	1	3	5	5	31
I (C-E, G-H)	FW (FW)	195	25 x 94.6 x 3.2	6.54 - 6.66	4.88	0.27 - 0.40	9.5	1	1	2 - 4	4 - 6	4 - 6	29 - 39
I (A, F)	FW (SW)	195	25 x 94.6 x 3.2	7.37 - 7.32	5.81	1.05 - 1.10	9.5	4	4	11 - 17	19 - 25	19 - 25	113 - 125

Bold - Predicted values for seagrass protection barrier.

italics - bearing failure of claystone floor a concern and may cause subsidence > 200 mm.

9.0 Conclusions and Recommendations

The assessment has determined that subsidence above the existing first workings beneath the seagrass protection barrier due to the historic GN Seam workings may have already exceeded 20 mm, but likely to be < 30 mm due to softening claystone beds. The proposed linkage headings may increase the subsidence in this area by a further 5 mm, resulting in a cumulative subsidence of up to 31 mm.

The development of the linkage headings may increase subsidence below the lake bed and inland areas by approximately 20 mm where it passes underneath existing second workings panels in the GN Seam. The subsidence due to GN Seam SWs may have already subsided the surface by 88 mm to 106 mm with final cumulative subsidence up to 125 mm predicted for the assumed pillar loading and claystone floor conditions.

However, it is assessed that the second workings panels above the lake and foreshore to the north and north east of the proposed workings have pillar loading that is similar to the panels that caused the foreshore to subside by ~ 900 mm in 1987. Due to the time since mining was completed (26 years ago), it is considered unlikely that the increase in pillar stress due multi-seam interaction will lead to a claystone floor failure if it hasn't already occurred.

It is considered unlikely that the proposed first workings will impact upon the existing transmission towers, switchyard, treatment works, rigid pavement, OFC cable and all other surface infrastructure listed in **Section 4.0**. It is noted, however, that minor hairline cracking may develop in the hard stand areas and concrete slabs, which should be readily repairable.

It will however be necessary to develop an appropriate monitoring and management plan with infrastructure owners and other relevant stakeholders to:

- (i) establish an infrastructure monitoring program to measure relevant subsidence effects during and after first workings development at sensitive infrastructure located directly above the proposed FAS headings (see below); and
- (ii) enable the detection of higher than anticipated mining effects (and impacts) through the use of early-warning survey lines established at suitable locations to allow adequate mine planning adjustment or mitigation work responses (see below).

Note: The development of time dependant subsidence in the Fassifern Seam mine workings floor will also require medium to long-term monitoring to be conducted for a significant period of time after mine workings development is completed (e.g. 6-monthly surveys for two years).

It is considered that survey monitoring points and lines should be established at the following items of infrastructure to measure levels and strains (see **Figure 22**):

- Transgrid Towers (Towers 1 - 10)
- Sewage Treatment Works (Pasveer Tank and SWs Line)

- Fibre Optic Cable (FoC)
- Steel Lattice Conductor Support Frames in Switchyard (Lattice Frames)
- Rigid Pavement (Pavement)
- Inlet Canal Wall (Inlet Canal Wall)

It is also recommended that the following, or similar, strategies are implemented to monitor and manage potential subsidence higher than predicted occurring along the foreshore:

- Re-establish and re-survey Survey Line 24.
- Install a new survey line above the FWs and SWs panels where the proposed headings pass beneath the foreshore and possibly extending from the foreshore to the point of connection with the Mannering mine workings; see **Figure 22** (Foreshore Survey Line).
- Install a suitable survey line at the starting end above GN Seam first workings to provide early warning monitoring data for the tension towers and switchyard structures; see **Figure 22** (FWs Line).
- Inspect existing conditions in the FAS Seam and undertake geotechnical and geological mapping in the roadways proximate to the proposed linkage in both the Chain Valley Colliery and Mannering Colliery workings.
- Complete representative borehole core drilling and sampling of the FAS Seam floor at the start and finishing ends of the proposed headings and where the headings pass beneath the high water mark subsidence barrier / seagrass protection barrier. *Note: It is recommended that development below the foreshore be limited to two headings only until floor conditions can be confirmed.*

For and on behalf of

Ditton Geotechnical Services Pty Ltd

A handwritten signature in black ink, appearing to read 'Steven Ditton', written in a cursive style.

Steven Ditton
Principal Engineer

Attachments:

Figures 1 - 22

References:

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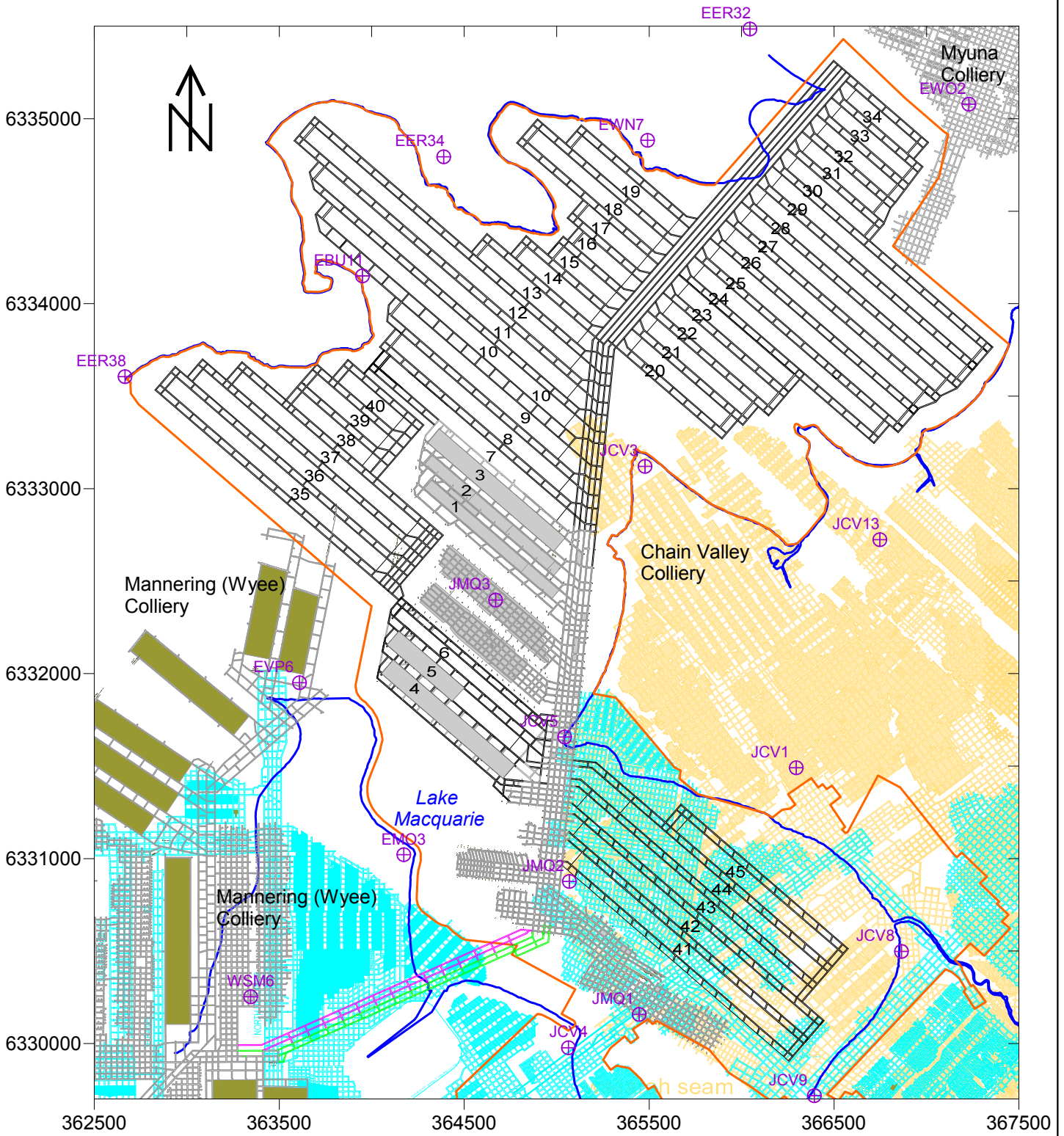
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




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Key

-  Proposed Mine Workings in Fassifern Seam
-  Existing Mine Workings in Fassifern Seam
-  Wallarah Seam Workings
-  GN Seam Workings
-  Chain Valley Extension Project Area Boundary

-  Extracted Chain Valley Panels in Fassifern Seam
-  Extracted Wye Panels in Fassifern Seam
-  Lake Foreshore
-  Borehole Locations & No.
-  Proposed Mine Connection Headings (Green - Stage 1; Magenta - Stage 2)

DgS

Engineer: S.Ditton
 Drawn: S.Ditton
 Date: 05.12.12

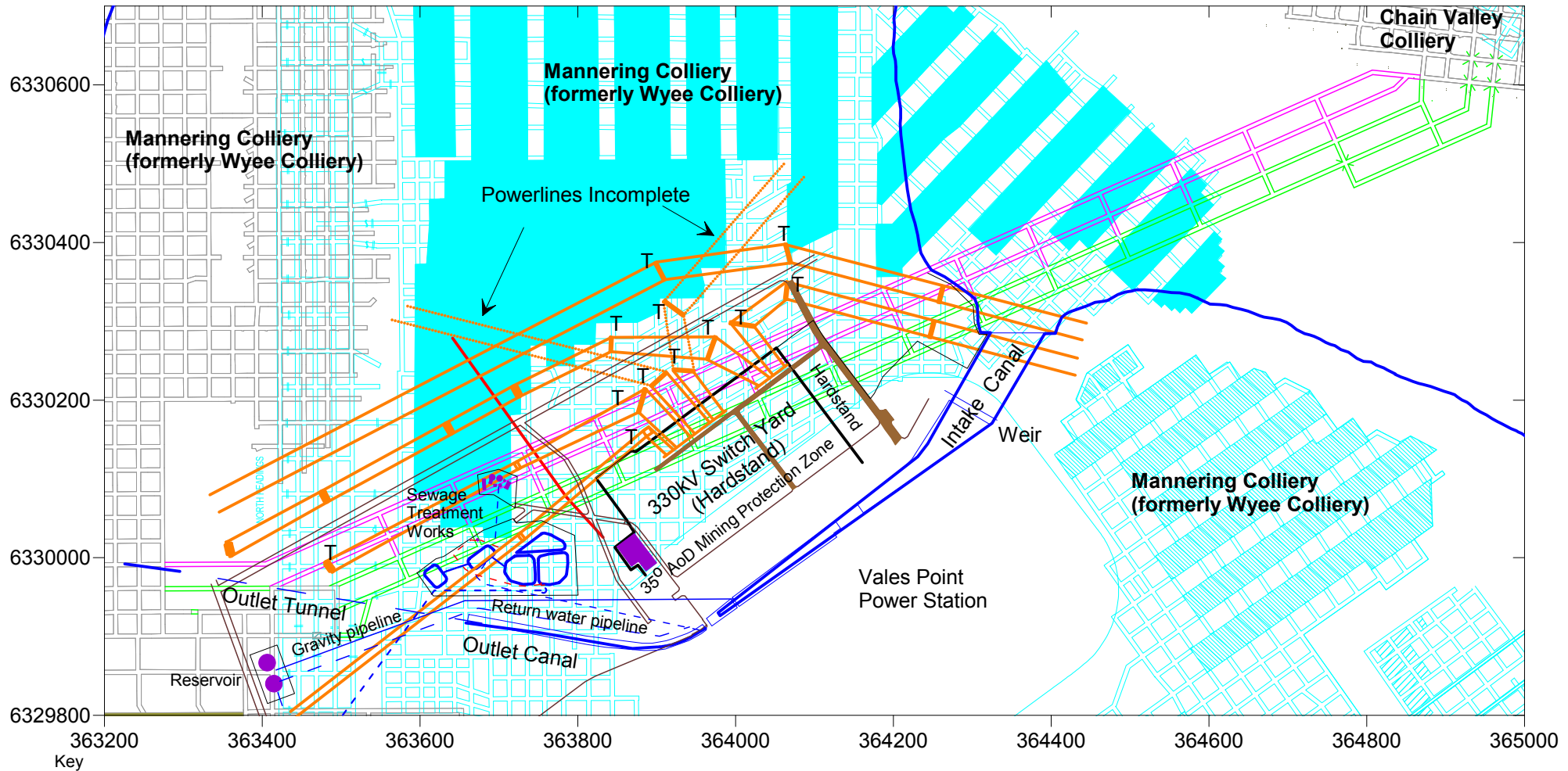
Ditton Geotechnical Services Pty Ltd

Client: LakeCoal - Chain Valley Colliery
 CHV-002/3

Title: Proposed Mine Connection Headings to Mannering Mine in the Fassifern Seam

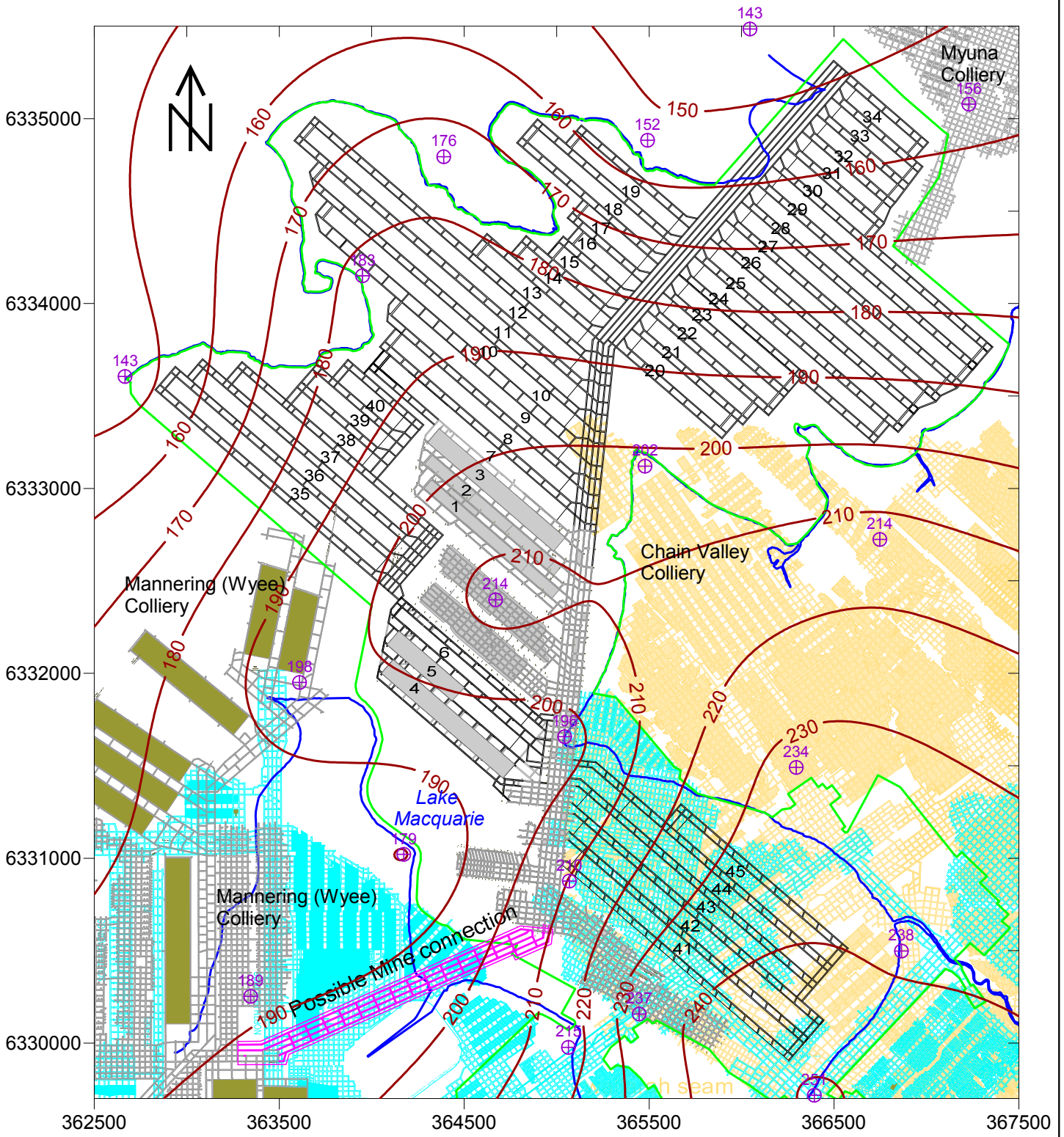
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Figure No: 1a



- Existing First Workings in GN Seam
- Existing Second Workings in GN Seam
- Existing First Workings in FAS Seam
- Proposed Mine Connection Headings in FAS Seam (Green - Stage 1; Magenta - Stage 2)
- Optic Fibre Cable (buried) Power Cable (buried)
- Security Fence Lines Rising Main (buried)
- 330kv Transmission Lines & Towers (Transgrid)
- Effluent Treatment Ponds/Tanks
- Lake Foreshore
- Reinforced Concrete Canal
- Reinforced Concrete Tunnel
- Jointed Reinforced Concrete Pavement
- Bitumen Sealed Access Road
- T Tension Tower (Transgrid)
- Buildings & Tanks

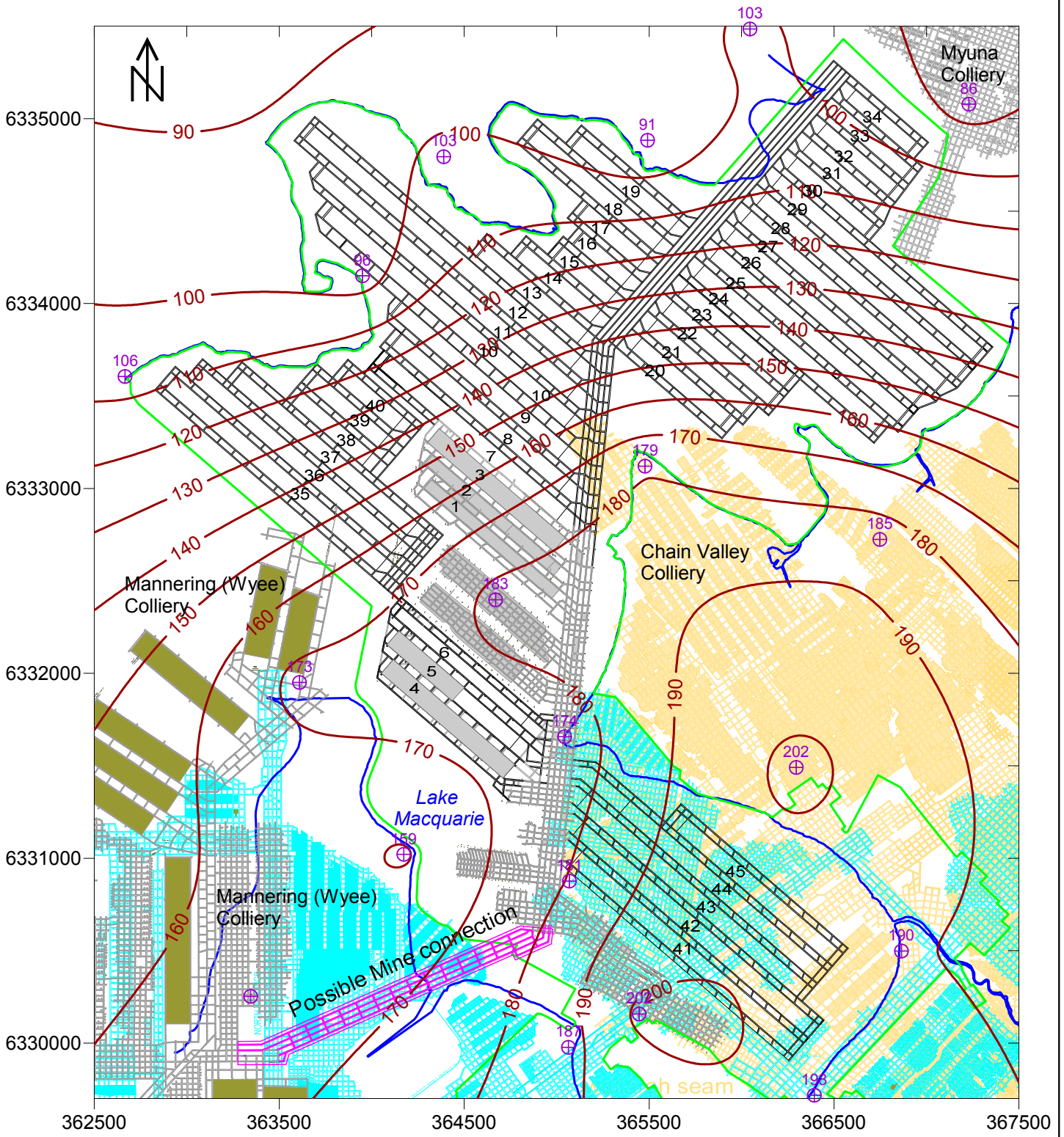
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	Drawn: S.Ditton	
	Date: 25.01.14	Title: Existing Surface Features above Proposed Mine Connection Headings to Mannerling Mine in the Fassifern Seam plus Overlying Great Northern Seam Mine Workings
Ditton Geotechnical Services Pty Ltd	Scale: 1:7,500 (A4)	Figure No: 1b



Key

- Proposed Mine Workings in Fassifern Seam
- Existing Mine Workings in Fassifern Seam
- Cover Depth Contours (m)
- Wallarah Seam Workings
- GN Seam Workings
- Chain Valley Extension Project Area Boundary
- Extracted Chain Valley Panels in Fassifern Seam
- Extracted Wye Panels in Fassifern Seam
- Lake Foreshore
- ⊕ Borehole Locations & No.
- Proposed Mine Connection Headings

	Engineer:	S.Ditton	Client:	LakeCoal - Chain Valley Colliery	
	Drawn:	S.Ditton		CHV-002/3	
	Date:	05.12.12	Title:	Proposed Mine Connection Headings to Mannering Mine in the Fassifern Seam	
	Ditton Geotechnical Services Pty Ltd		Scale:	1:12,000 (A4)	Figure No:

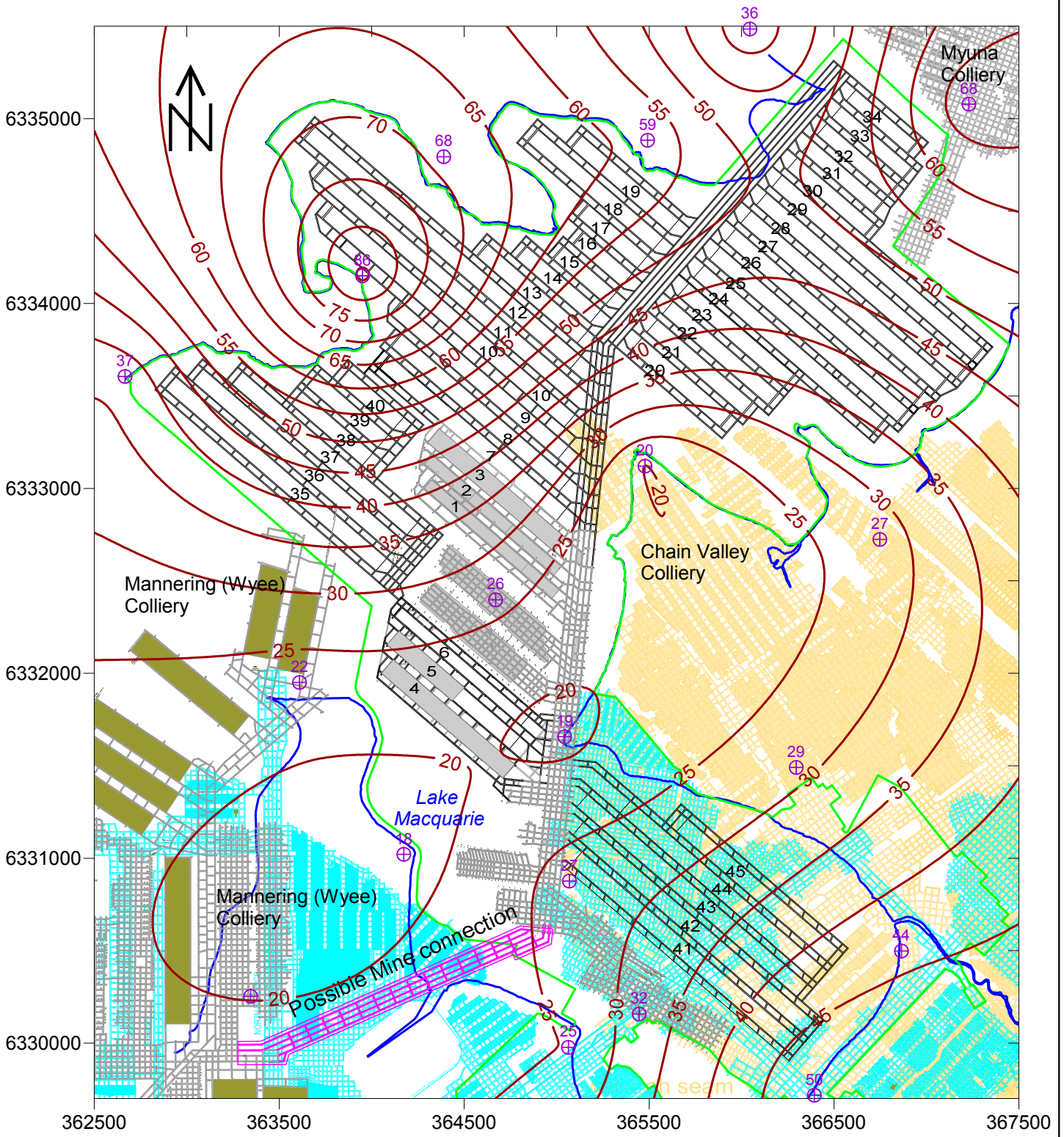


Key

- Proposed Mine Workings in Fassifern Seam
- Existing Mine Workings in Fassifern Seam
- Cover Depth Contours (m)
- Wallarah Seam Workings
- GN Seam Workings
- Chain Valley Extension Project Area Boundary

- Extracted Chain Valley Panels in Fassifern Seam
- Extracted Wye Panels in Fassifern Seam
- Lake Foreshore
- Borehole Locations & Cover Depth
- Proposed Mine Connection Headings

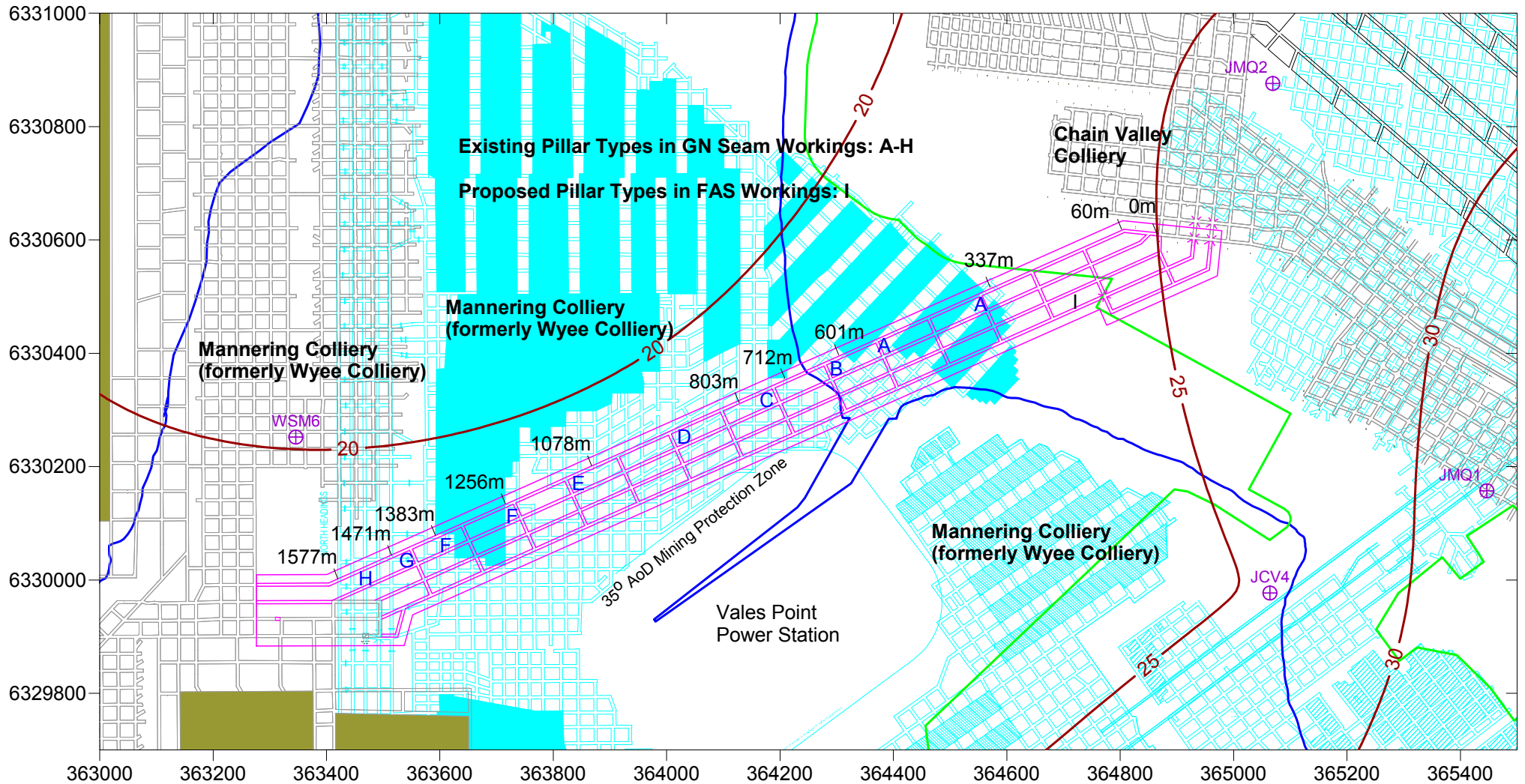
	Engineer: S.Ditton	Client: LakeCoal - Chain Valley Colliery
	Drawn: S.Ditton	CHV-002/3
	Date: 05.12.12	Title: Proposed Mine Connection Headings to Mannering Mine in the Fassifern Seam with Cover Depth Contours to the Great Northern Seam Mine Workings
	Ditton Geotechnical Services Pty Ltd	Scale: 1:12,000 (A4)
		Figure No: 3



Key

- Proposed Mine Workings in Fassifern Seam
- Existing Mine Workings in Fassifern Seam
- Interburden Thickness Contours (m)
- Wallarah Seam Workings
- GN Seam Workings
- Chain Valley Extension Project Area Boundary
- Extracted Chain Valley Panels in Fassifern Seam
- Extracted Wye Panels in Fassifern Seam
- Lake Foreshore
- ⊕ Borehole Locations & Cover Depth
- Proposed Mine Connection Headings

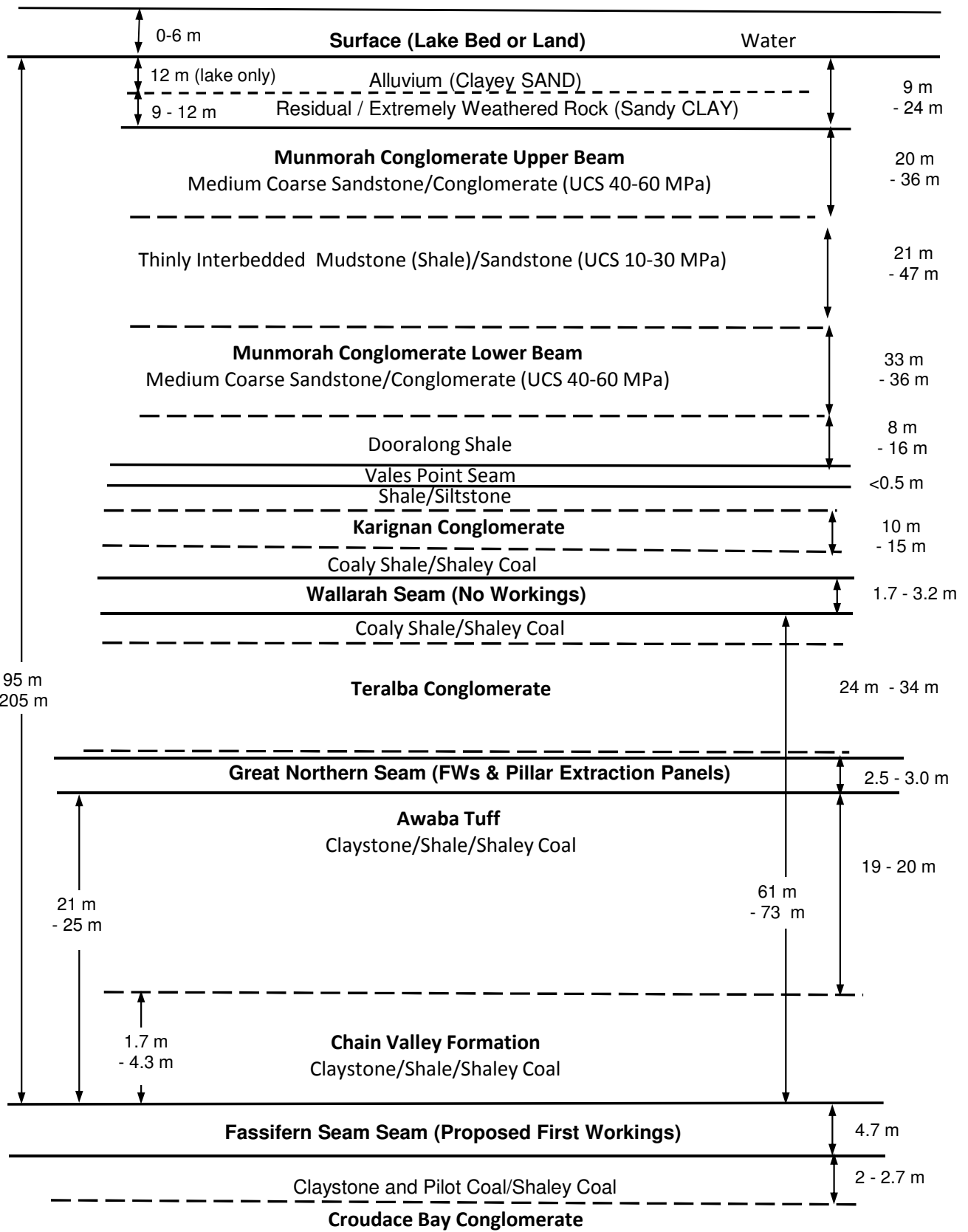
	Engineer: S.Ditton	Client: LakeCoal - Chain Valley Colliery CHV-002/3
	Drawn: S.Ditton	
	Date: 05.12.12	Title: Proposed Mine Connection Headings to Mannering Mine in the Fassifern Seam with Interburden Thickness Contours to the Great Northern Seam Mine Workings
	Ditton Geotechnical Services Pty Ltd	
Scale: 1:12,000 (A4)	Figure No: 4	



Key

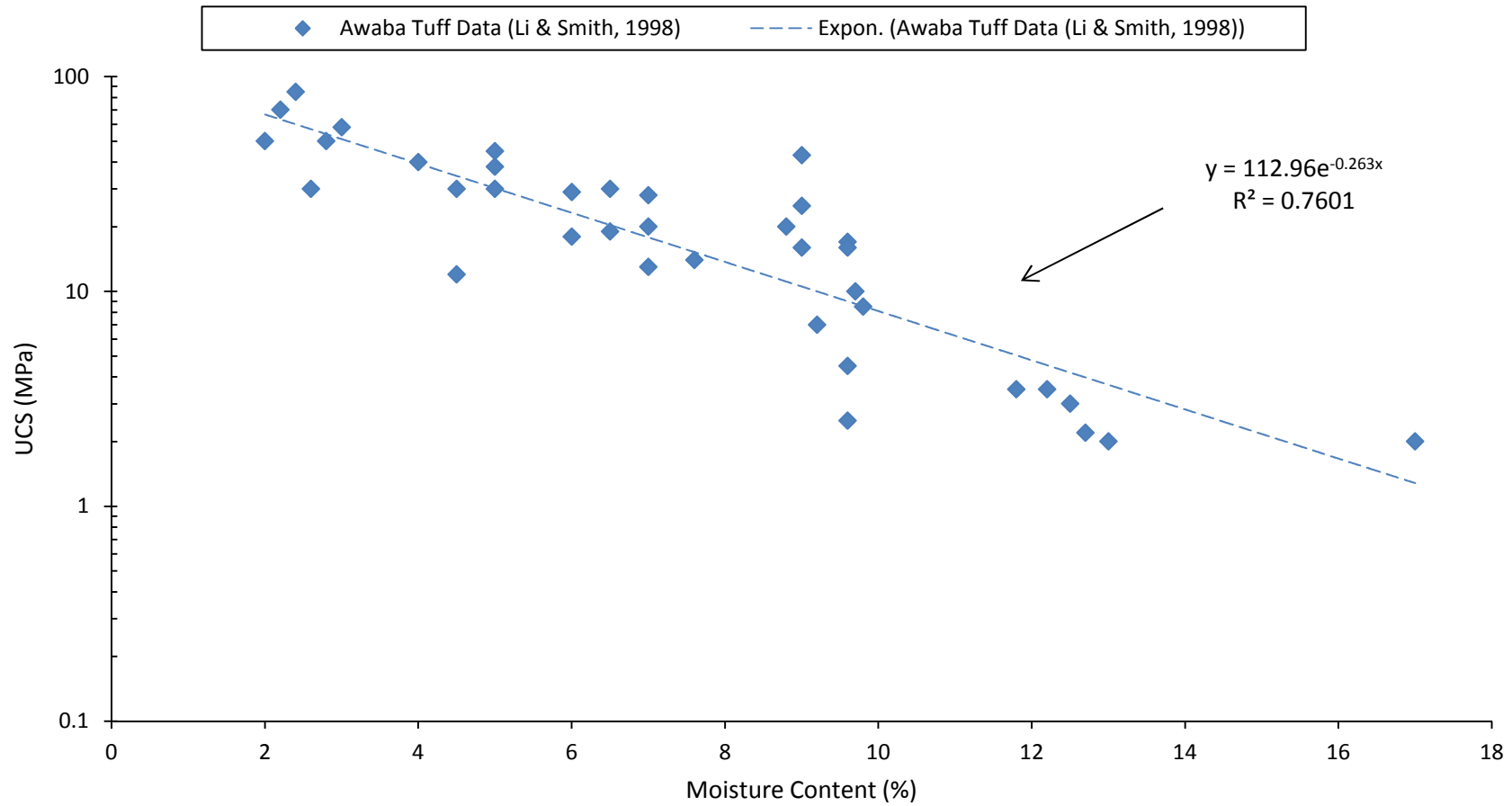
- Existing First Workings in GN Seam
- Existing Second Workings in GN Seam
- Existing First Workings in FAS Seam
- Interburden Thickness Contours (m)
- Chain Valley Extension Project Area Boundary
- Proposed Mine Connection Headings in FAS Seam
- Extracted Wyee LWs in Fassifern Seam
- Lake Foreshore
- ⊕ Borehole Locations & Cover Depth

	Engineer:	S.Ditton	Client:	LakeCoal - Chain Valley Colliery CHV-002/3	
	Drawn:	S.Ditton		Title:	Proposed Mine Connection Headings to Mannering Mine in the Fassifern Seam with Interburden Thickness Contours to the Great Northern Seam Mine Workings
	Date:	25.11.13	Scale:		1:10,000 (A4)
Ditton Geotechnical Services Pty Ltd					

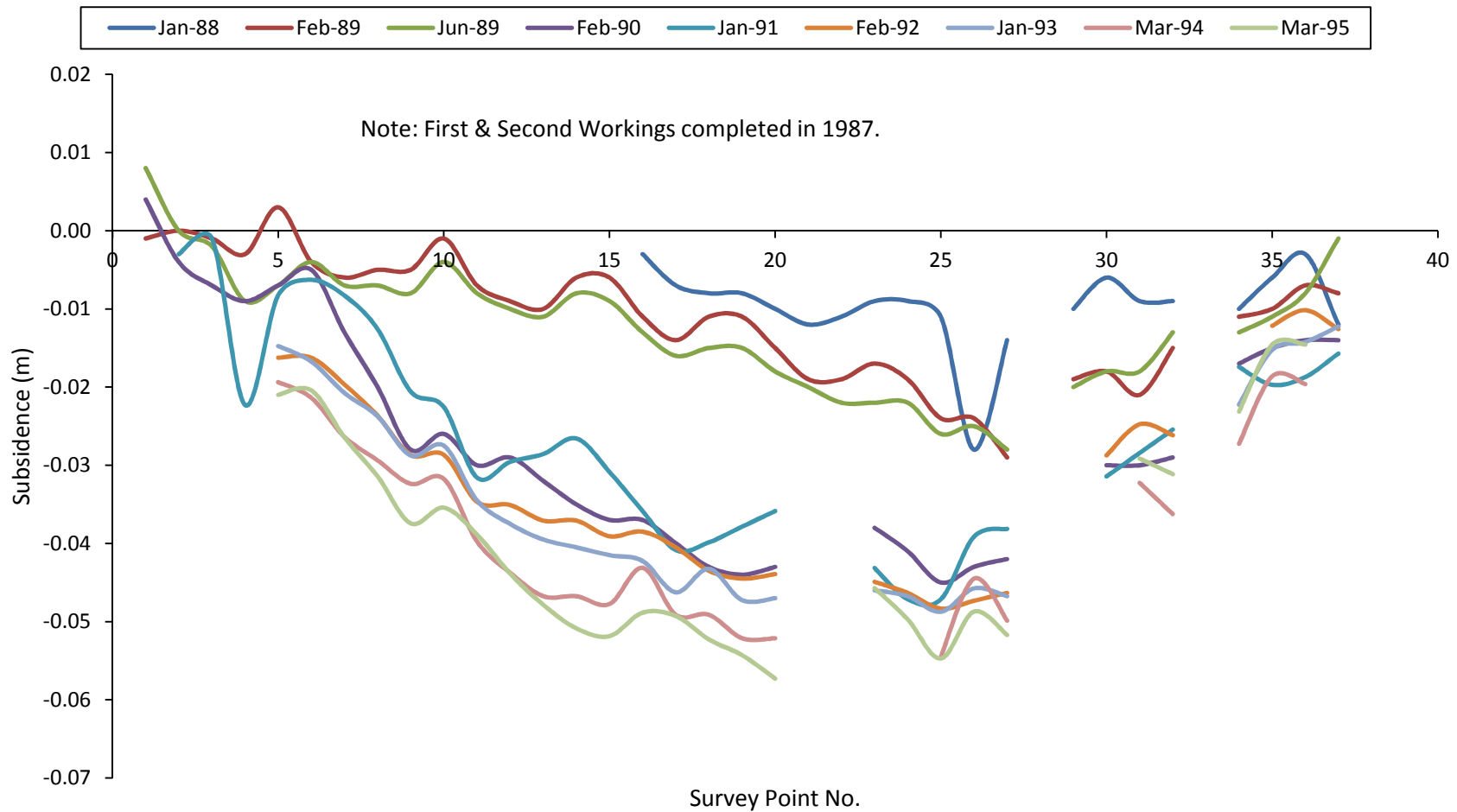



Engineer:	S.Ditton	Client:	LakeCoal - Chain Valley Colliery
Drawn:	S.Ditton		CHV-002/3
Date:	29.11.13	Title:	Geotechnical Model of the Strata Within the Mine Connection Area
Ditton Geotechnical Services Pty Ltd		Scale:	NTS
		Figure No:	6

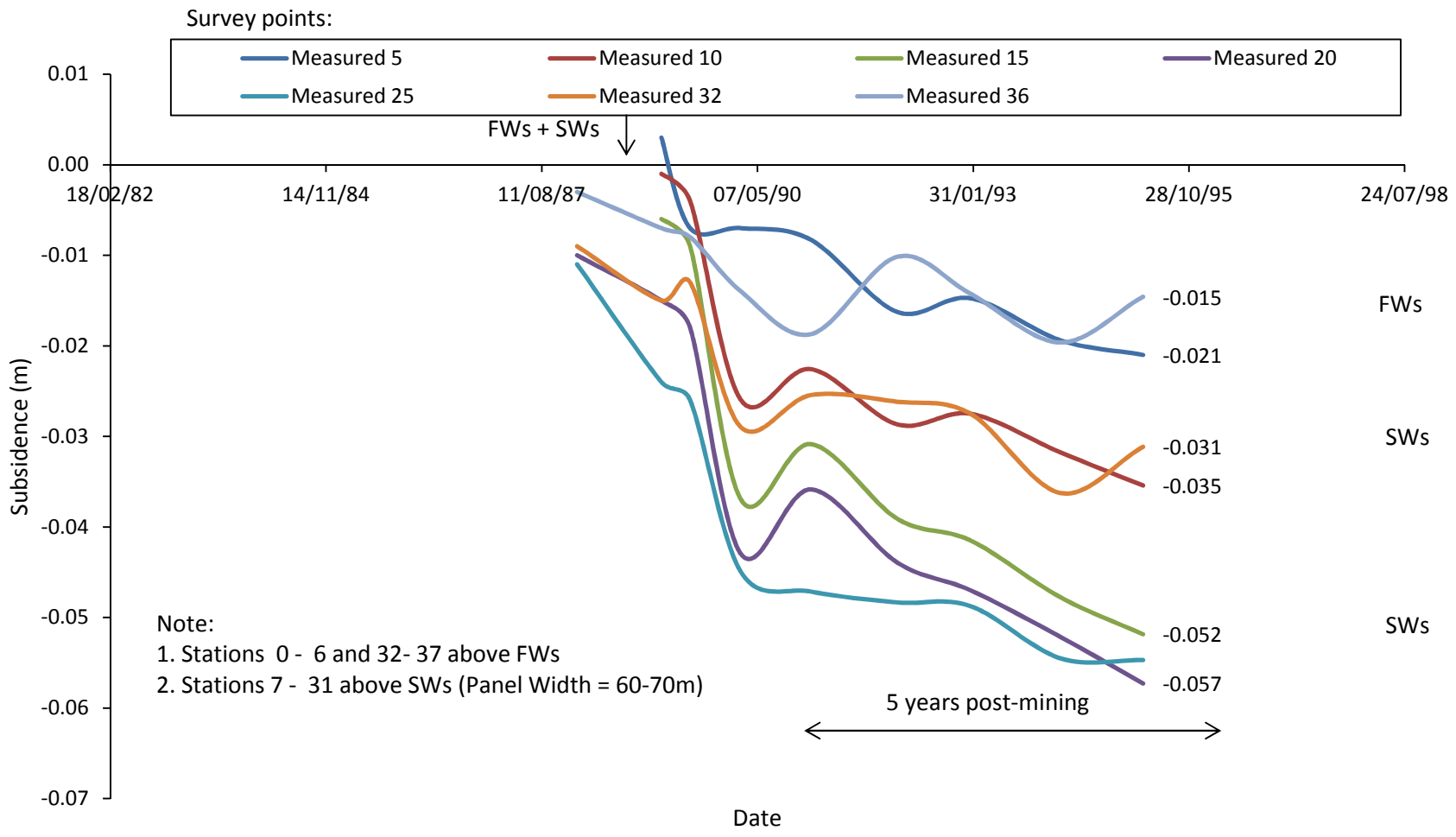
Awaba Tuff Data (Li & Smith, 1998)




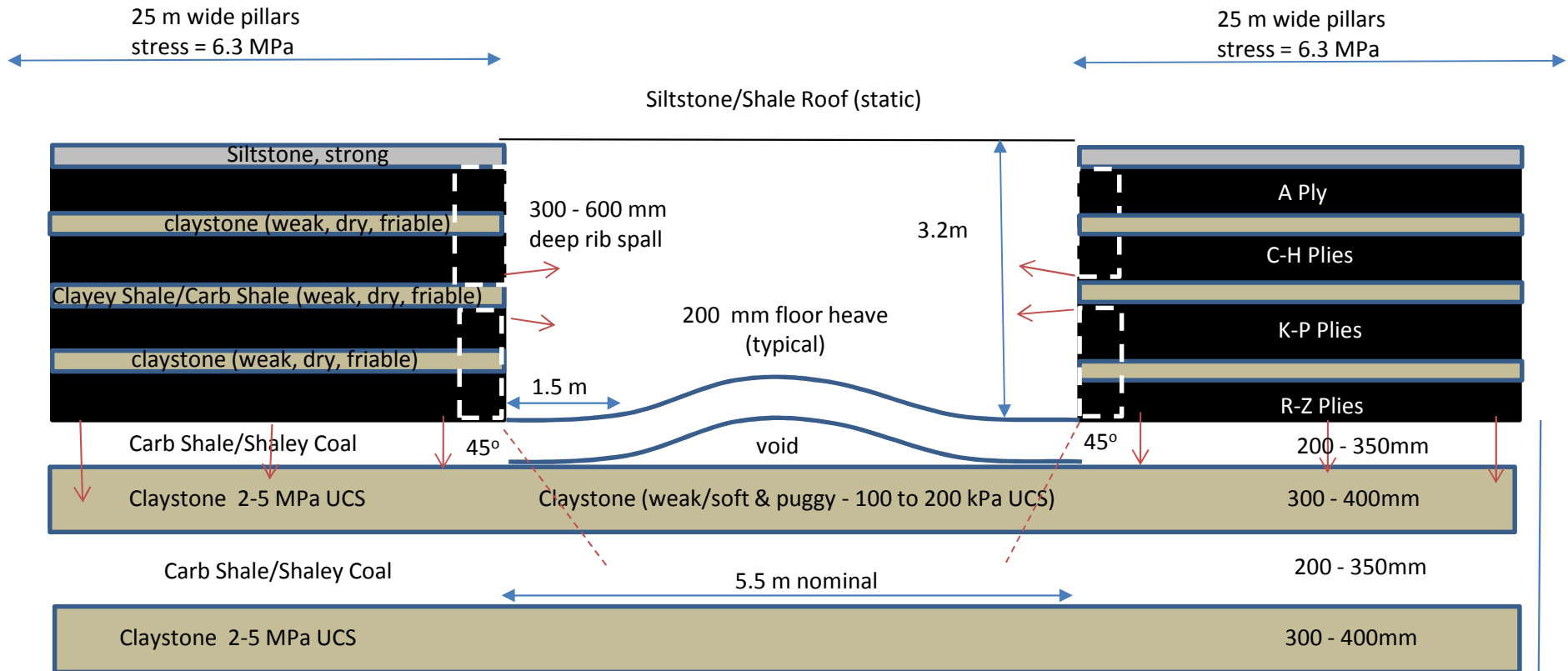
	Engineer:	S.Ditton	Client:	LakeCoal - Chain Valley Colliery	
	Drawn:	S.Ditton		CHV-002/3	
	Date:	20.11.13	Title:	Awaba Tuff Claystone UCS Tests v. Moisture Content	
	Ditton Geotechnical Services Pty Ltd		Scale:	NTS	
			Figure No:	7	



	Engineer:	S.Ditton	Client:	LakeCoal - Chain Valley Colliery	
	Drawn:	S.Ditton		CHV-002/3	
	Date:	20.11.13	Title:	Measured Subsidence Data Along Chain Valley Bay Foreshore (Line 24) Above First and Second Workings Panels in GN Seam, 1km to south of Proposed Connection Workings	
	Ditton Geotechnical Services Pty Ltd		Scale:	NTS	
				Figure No:	8a




	Engineer:	S.Ditton	Client:	LakeCoal - Chain Valley Colliery	
	Drawn:	S.Ditton		CHV-002/3	
	Date:	20.11.13	Title:	Measured Subsidence Data Along Chain Valley Bay Foreshore (Line 24) Above First and Second Workings Panels in GN Seam, 1km to south of Proposed Connection Workings	
	Ditton Geotechnical Services Pty Ltd		Scale:	NTS	
				Figure No:	8b

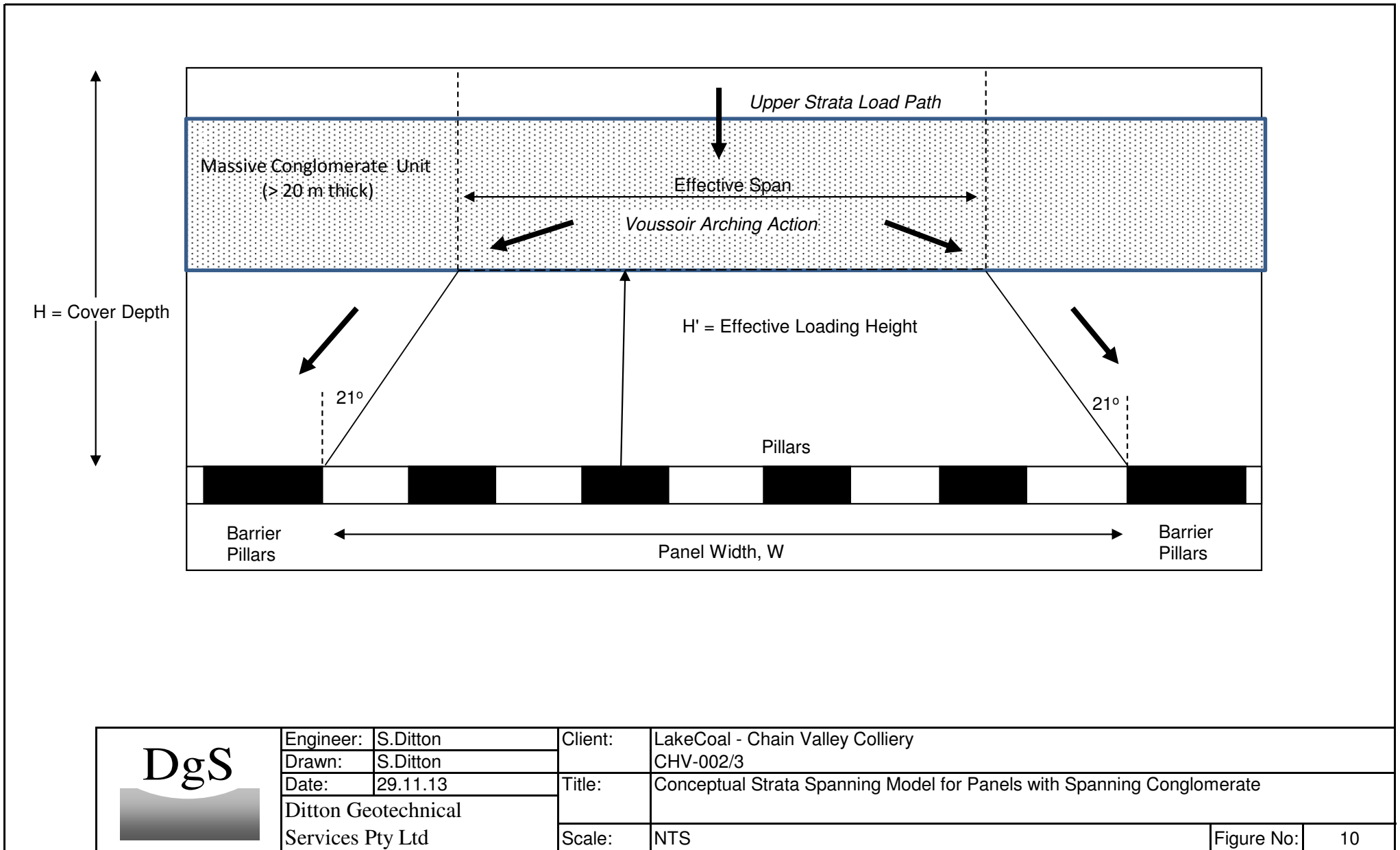


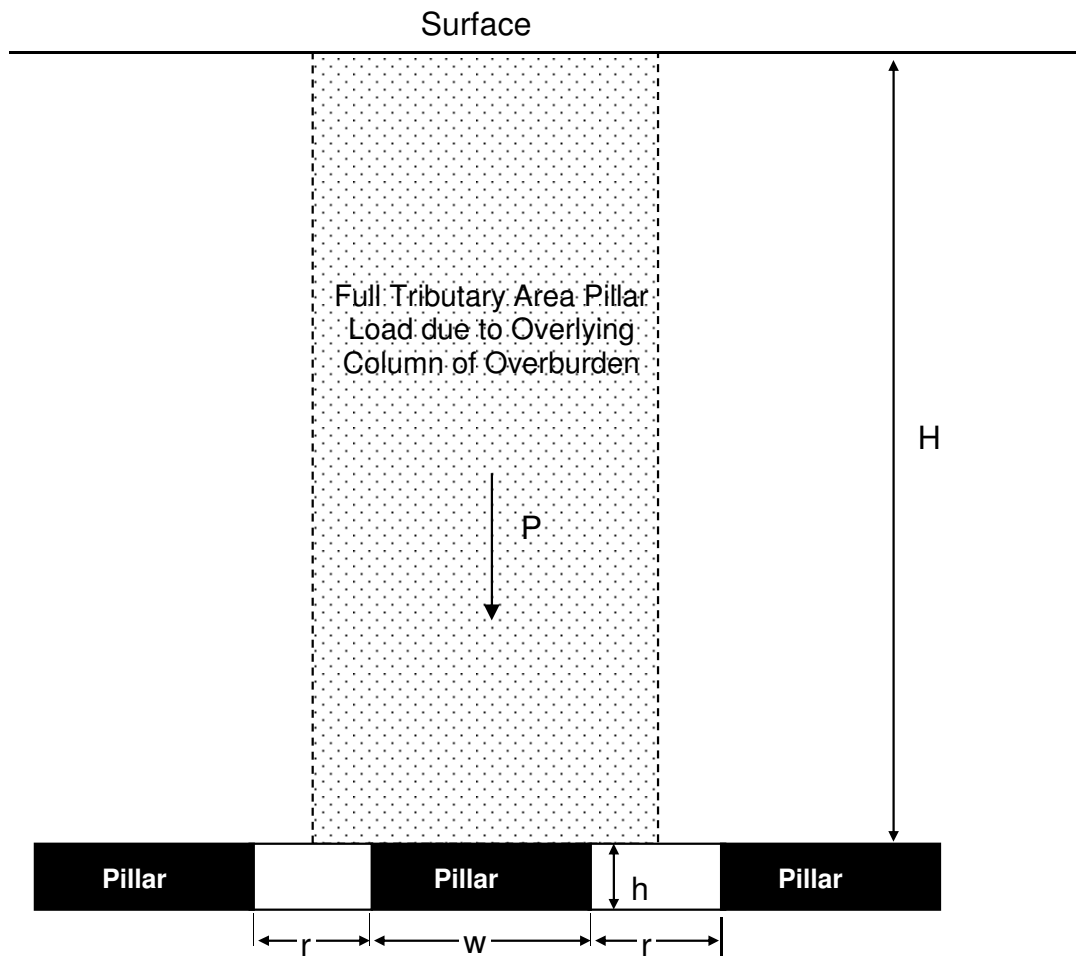
Notes:

1. Headings driven at 3.2 m height on development.
2. Central floor heave occurs typically after development and indicates pillars have either settled into softened claystone and buckled stiffer overlying carb shale and/or swelling of unloaded claystone occurs.
3. Moisture ingress likely to increase, causing further softening and swelling of claystone.
4. Ribs may subsequently be driven upwards and buckled/sheared outwards along mid-height pillar claystone unit.

Alternating Strong/Weak Claystone beds to 2 - 3 m

	Engineer:	S.Ditton	Client:	LakeCoal - Chain Valley Colliery	
	Drawn:	S.Ditton		CHV-002/3	
	Date:	29.11.13	Title:	Typical Roadway Conditions that could occur due to Soft Floor Conditions in the Fassifern Seam	
	Ditton Geotechnical Services Pty Ltd		Scale:	NTS	Figure No:





Notes:

- r = roadway width (m)
- w = pillar width (m)
- l = pillar length (m)
- h = mining height (m)
- H = depth of cover (m)
- e = extraction ratio = $1 - [wr/(w+r)(l+r)]$
- P = Pillar Load = $0.025H/(1-e)$ (MPa)

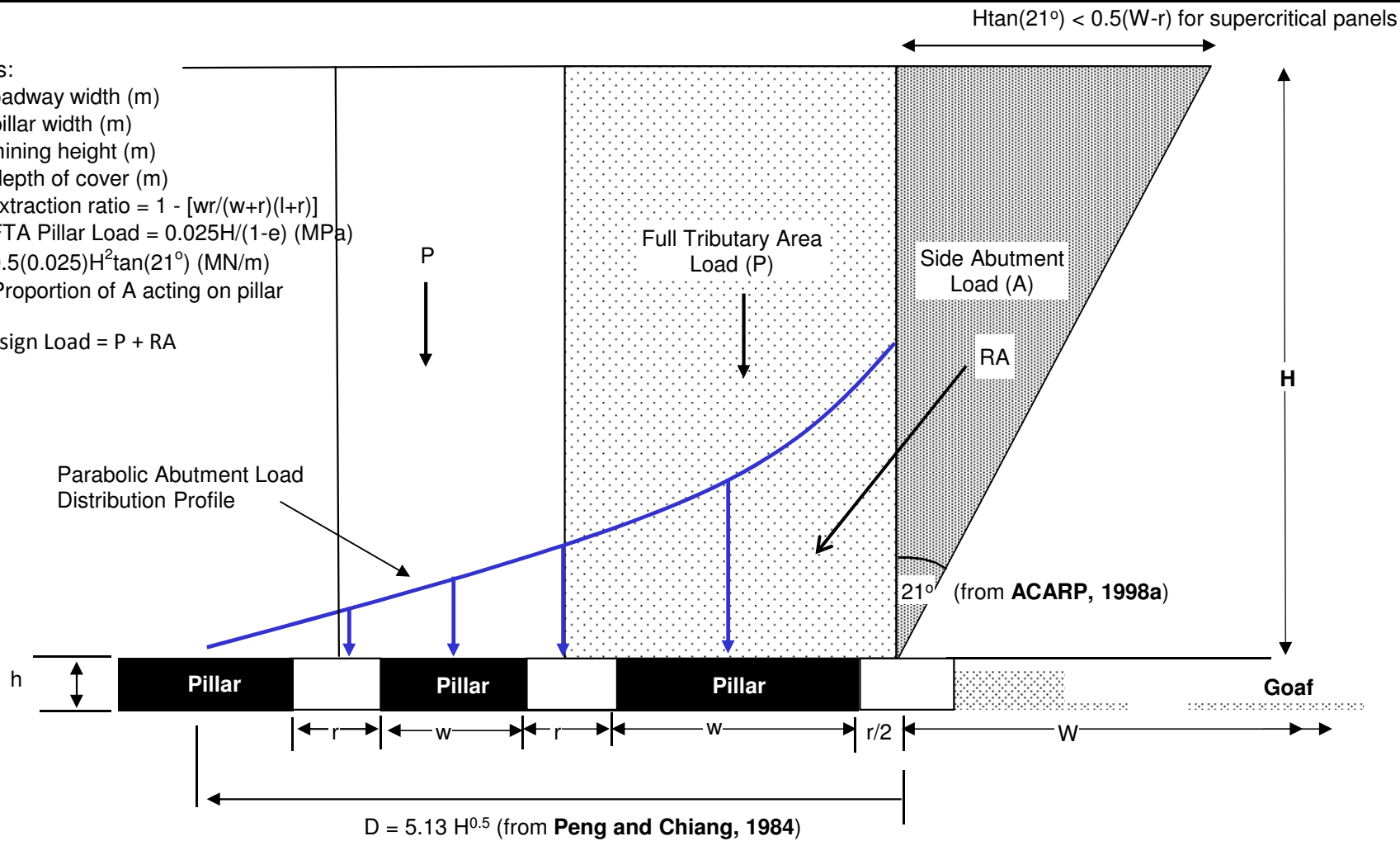



Engineer:	S.Ditton	Client:	LakeCoal - Chain Valley Colliery	
Drawn:	S.Ditton		CHV-002/3	
Date:	30.11.13	Title:	Analytical Model for Calculating Full Tributary Area Loads (worst-case) on Pillars	
Ditton Geotechnical Services Pty Ltd		Scale:	NTS	Figure No: 11a

Notes:

- r = roadway width (m)
- w = pillar width (m)
- h = mining height (m)
- H = depth of cover (m)
- e = extraction ratio = $1 - [wr/(w+r)(l+r)]$
- P = FTA Pillar Load = $0.025H/(1-e)$ (MPa)
- A = $0.5(0.025)H^2 \tan(21^\circ)$ (MN/m)
- R = Proportion of A acting on pillar

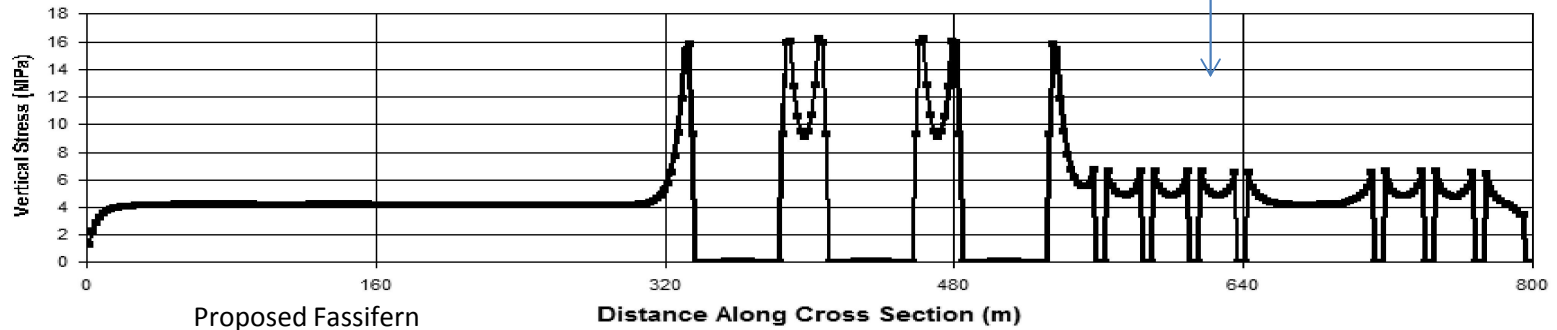
Design Load = P + RA



	Engineer:	S.Ditton	Client:	LakeCoal - Chain Valley Colliery
	Drawn:	S.Ditton		CHV-002/3
	Date:	23.11.13	Title:	Analytical Model for Calculating Worst-Case Abutment Load Acting on Pillars
	Ditton Geotechnical Services Pty Ltd		Pillars adjacent to Pillar Extraction Goaf	
	Scale:	NTS	Figure No:	11b

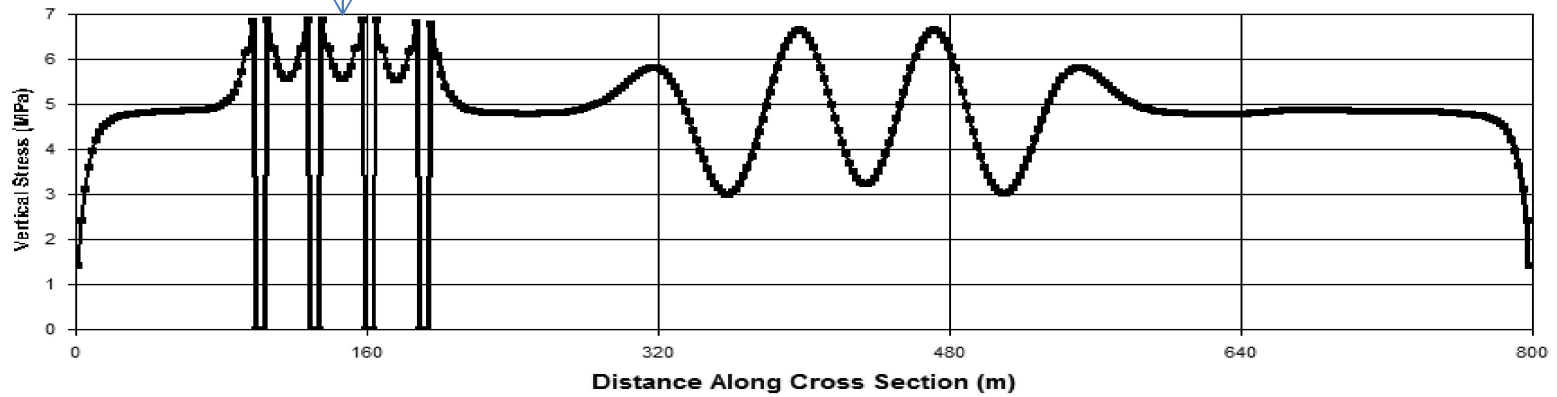
FAS + GN

GN Seam



Proposed Fassifern
Seam Workings below Lake

FAS Seam



DgS



Engineer: S.Ditton

Drawn: S.Ditton

Date: 30.11.13

Ditton Geotechnical
Services Pty Ltd

Client: LakeCoal - Chain Valley Colliery
CHV-002/3

Title: Vertical Stress Profiles due to Great Northern Seam Workings on Fassifern Seam below
(Ch 0 - 800 m from Existing Chain Valley Workings)

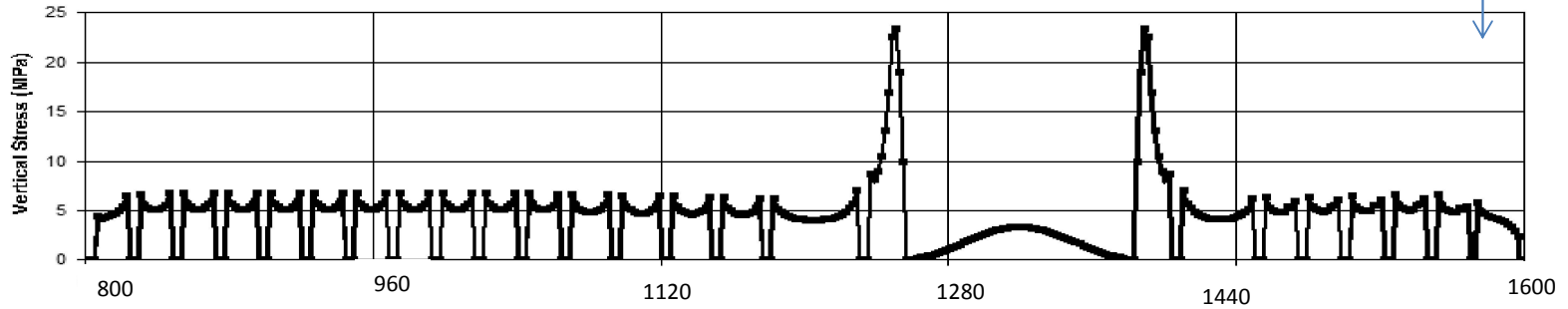
Scale: NTS

Figure No: 12a

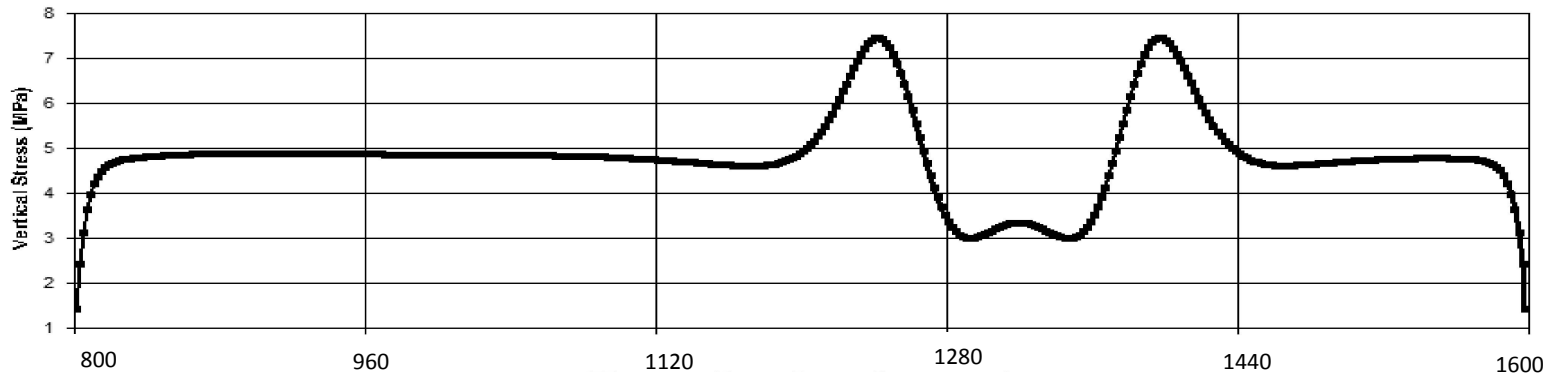
Existing Mannerings Workings in GN and Fassifern Seam below Vales Point

FAS + GN


GN Seam



FAS Seam



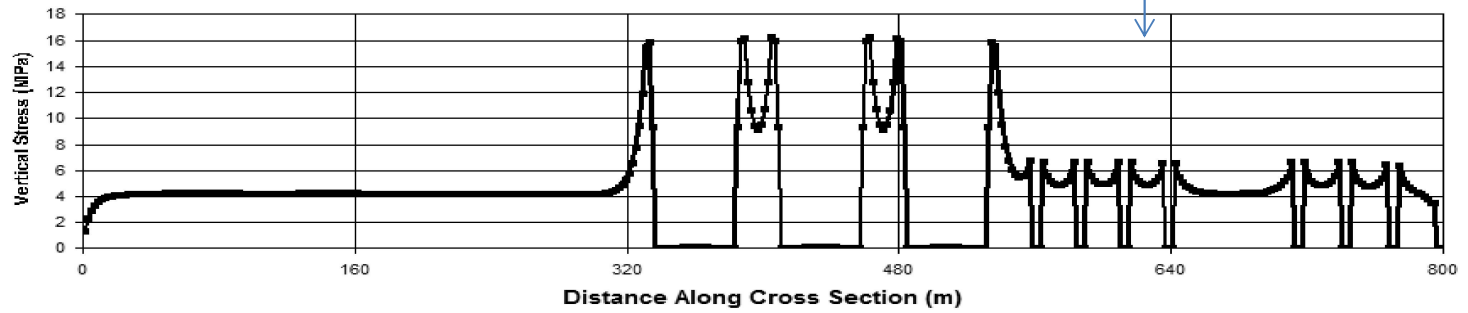
Distance along Cross Section (m)

	Engineer:	S.Ditton	Client:	LakeCoal - Chain Valley Colliery	
	Drawn:	S.Ditton		CHV-002/3	
	Date:	30.11.13	Title:	Vertical Stress Profiles due to Great Northern Seam Workings on Fassifern Seam below	
	Ditton Geotechnical Services Pty Ltd			(Ch 800 - 1600 m from Existing Chain Valley Workings)	
Scale:			NTS	Figure No:	12b

FAS + GN

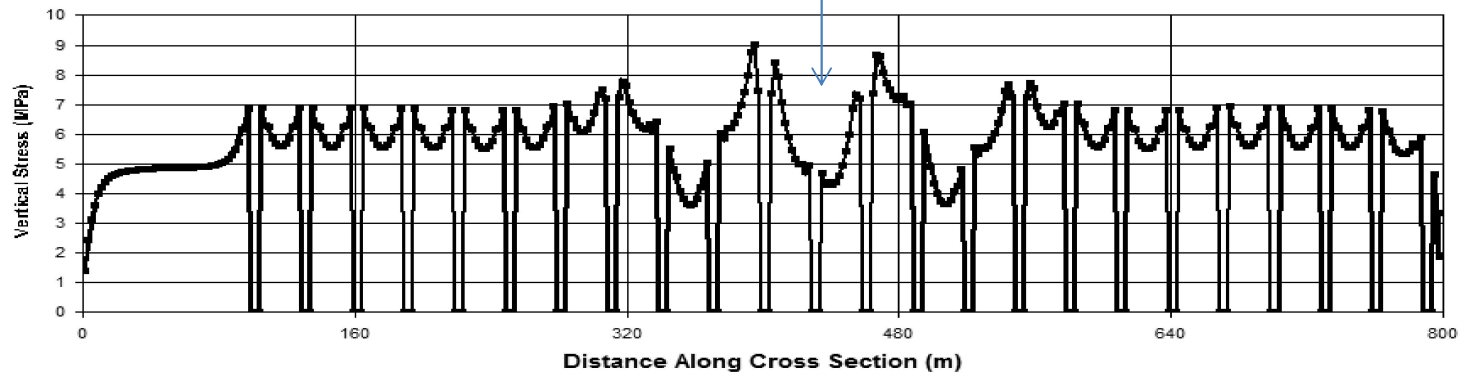
Foreshore

GN Seam



Proposed Fassifern Seam Workings below Vales Point

FAS Seam



DgS



Engineer: S.Ditton

Drawn: S.Ditton

Date: 30.11.13

Ditton Geotechnical

Services Pty Ltd

Client: LakeCoal - Chain Valley Colliery

CHV-002/3

Title: Vertical Stress Profiles due to Great Northern Seam Workings on Proposed Fassifern Seam Workings (Ch 0 - 800 m from Existing Chain Valley Workings)

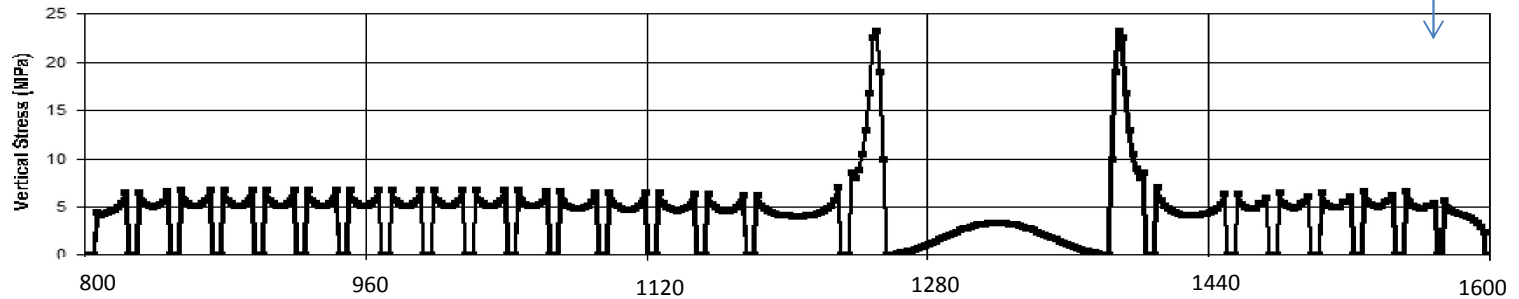
Scale: NTS

Figure No: 13a

Existing Mannering Workings in GN and Fassifern Seam below Vales Point

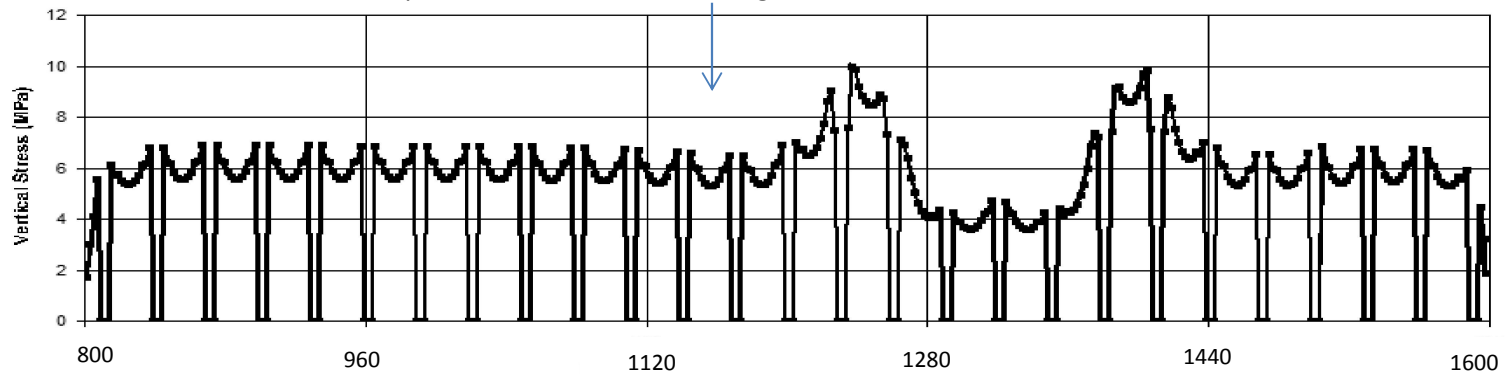
FAS + GN

GN Seam



Proposed Fassifern Seam Workings below Vales Point

FAS Seam



Distance along Cross Section (m)

DgS



Engineer: S.Ditton

Drawn: S.Ditton

Date: 30.11.13

Ditton Geotechnical

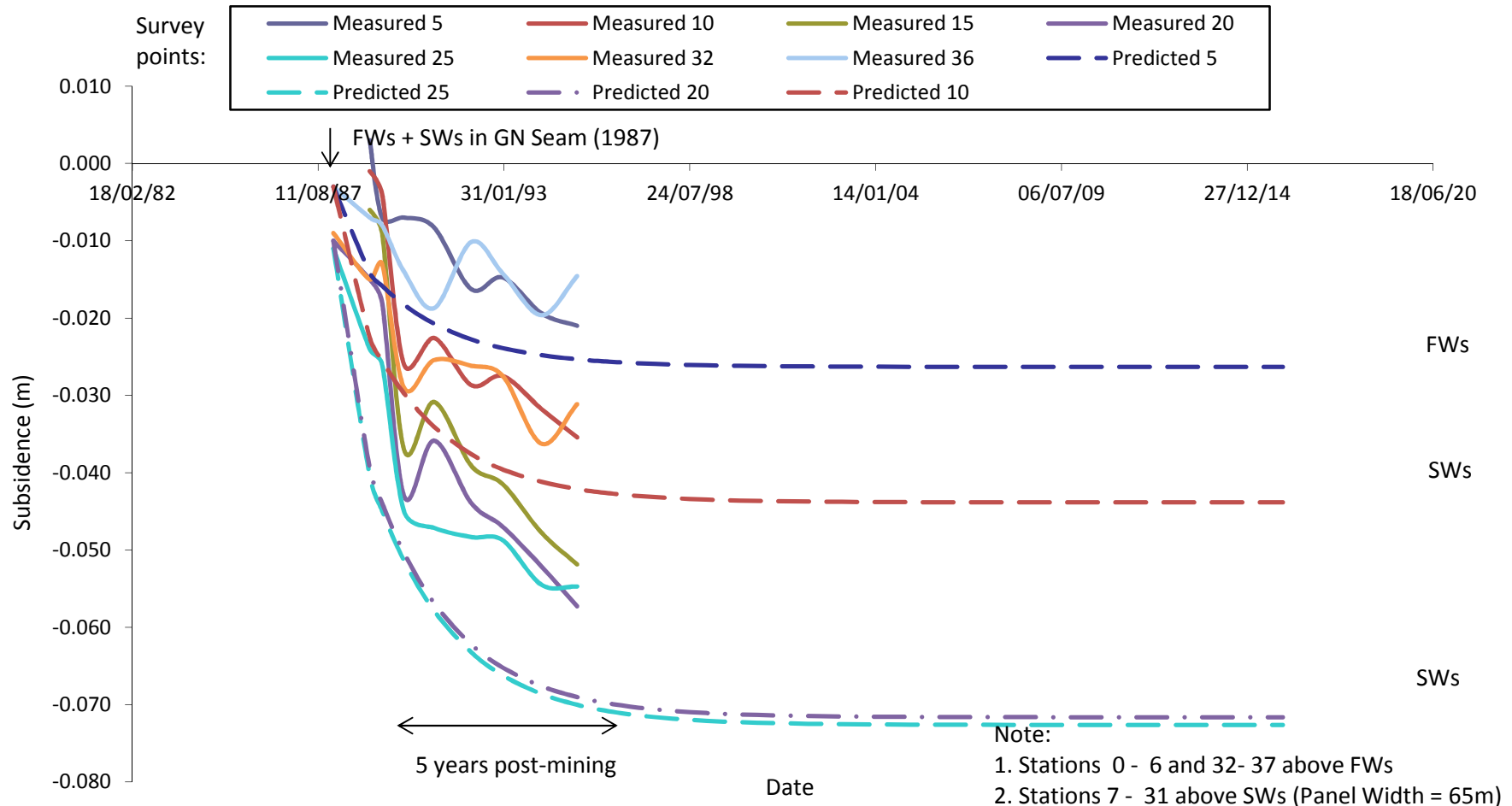
Services Pty Ltd


Client: LakeCoal - Chain Valley Colliery
CHV-002/3

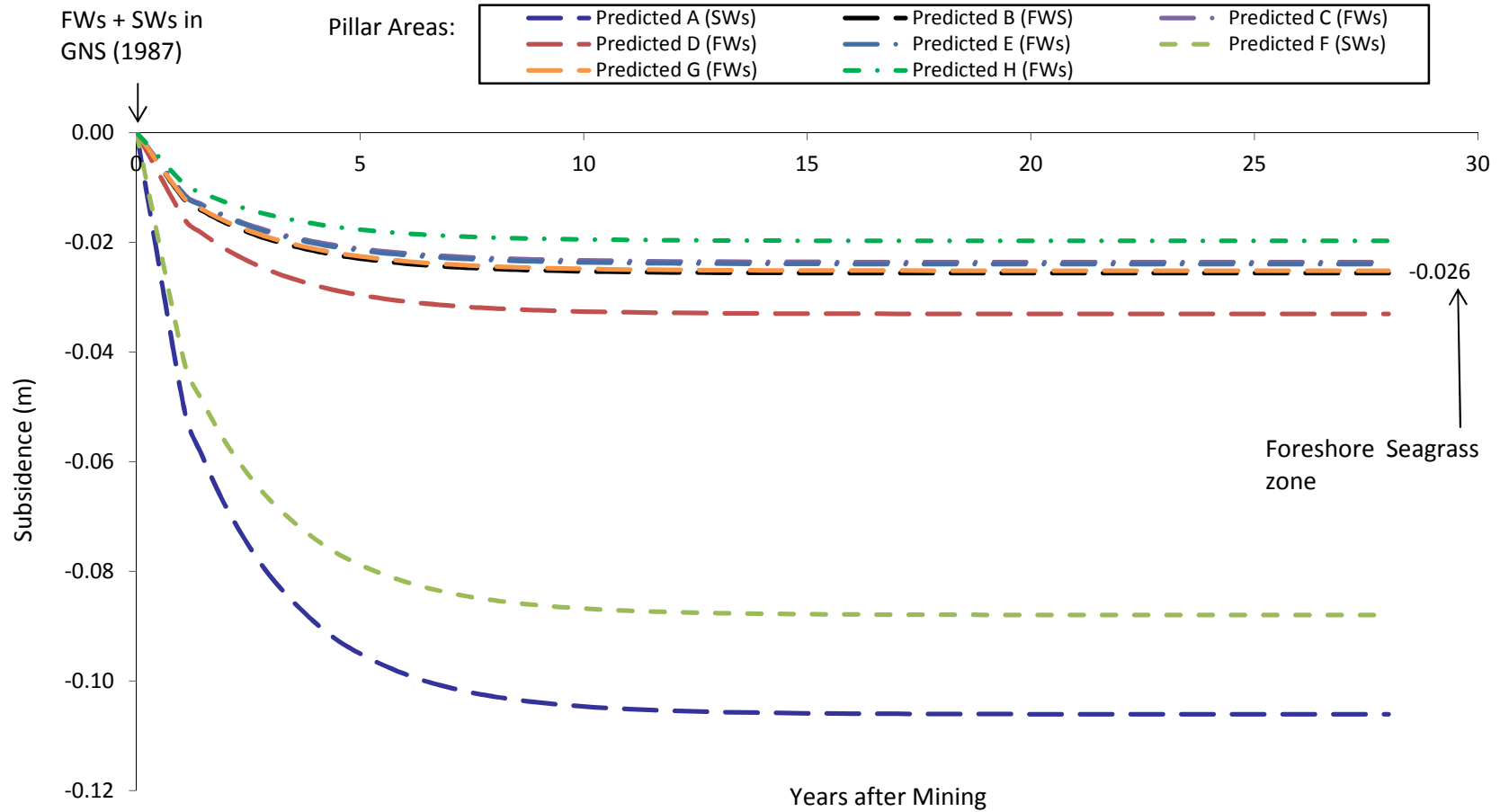
Title: Vertical Stress Profiles due to Great Northern Seam Workings on Proposed Fassifern Seam Workings (Ch 800 - 1600 m from Existing Chain Valley Workings)


Scale: NTS

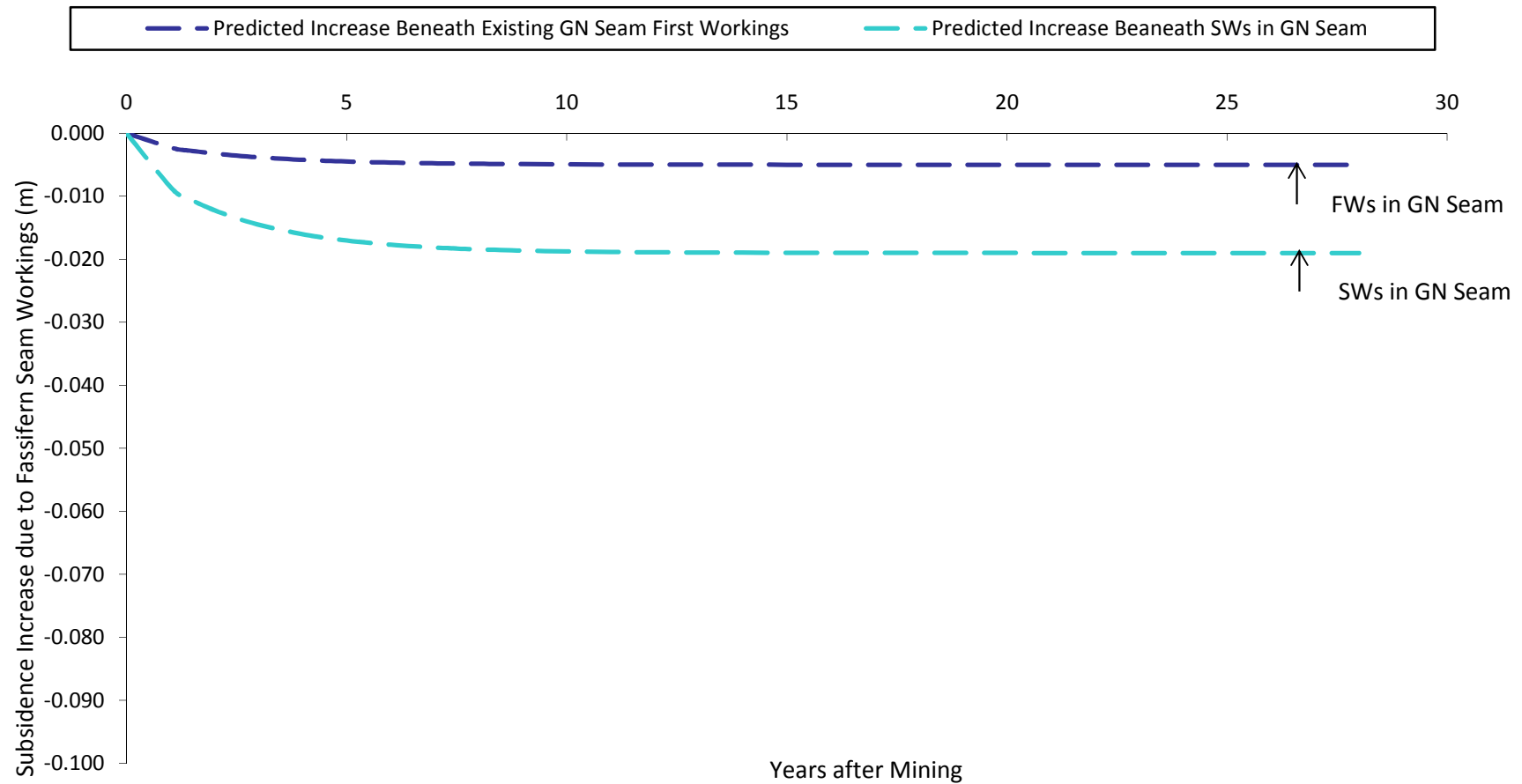
Figure No: 13b




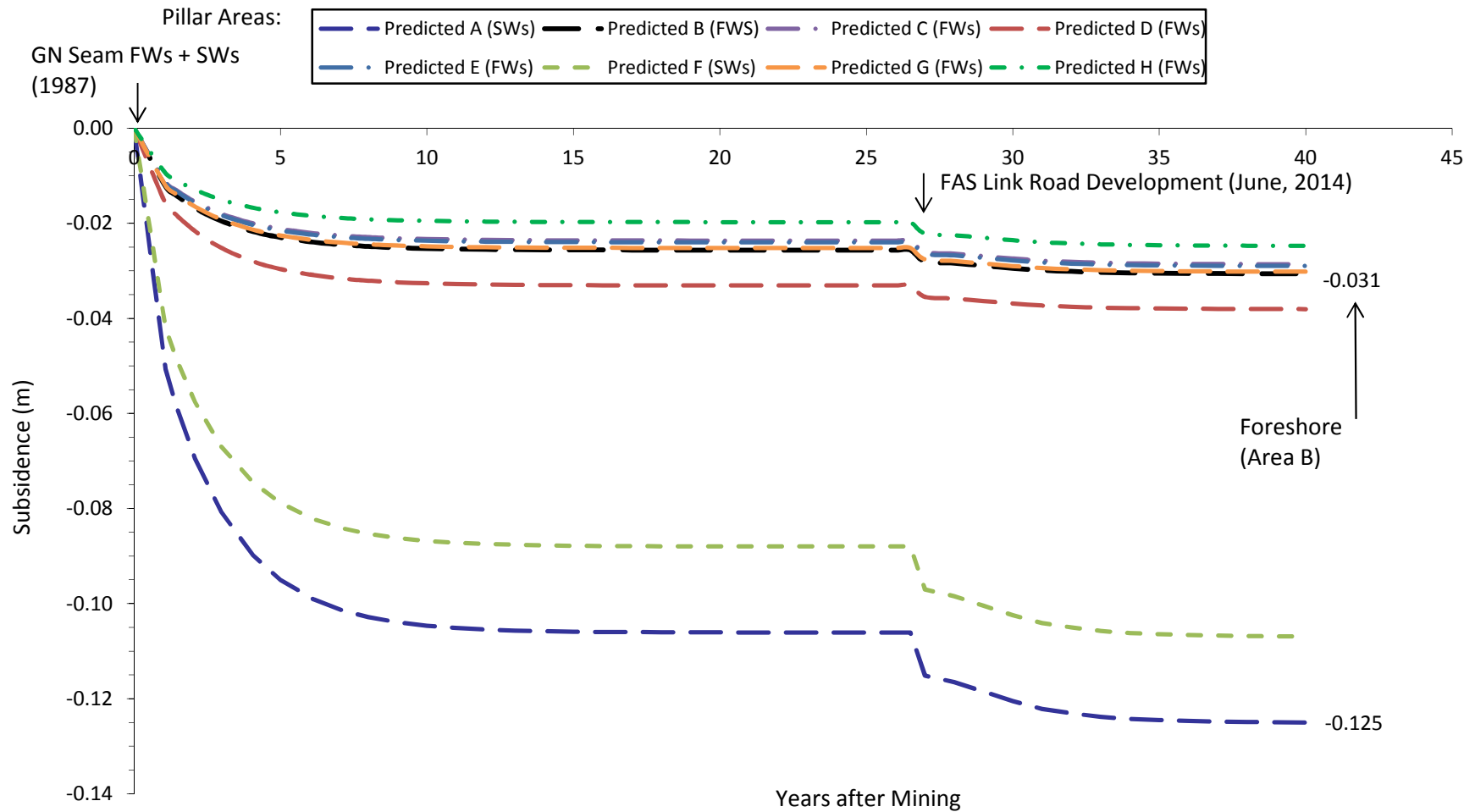
	Engineer:	S.Ditton	Client:	LakeCoal - Chain Valley Colliery
	Drawn:	S.Ditton		CHV-002/3
	Date:	20.11.13	Title:	Predicted Subsidence Along Chain Valley Bay Foreshore (Line 24) Above First and Second Workings Panels in GN Seam, 1km to south of Proposed Connection Workings
	Ditton Geotechnical Services Pty Ltd		Scale:	NTS
				Figure No: 14




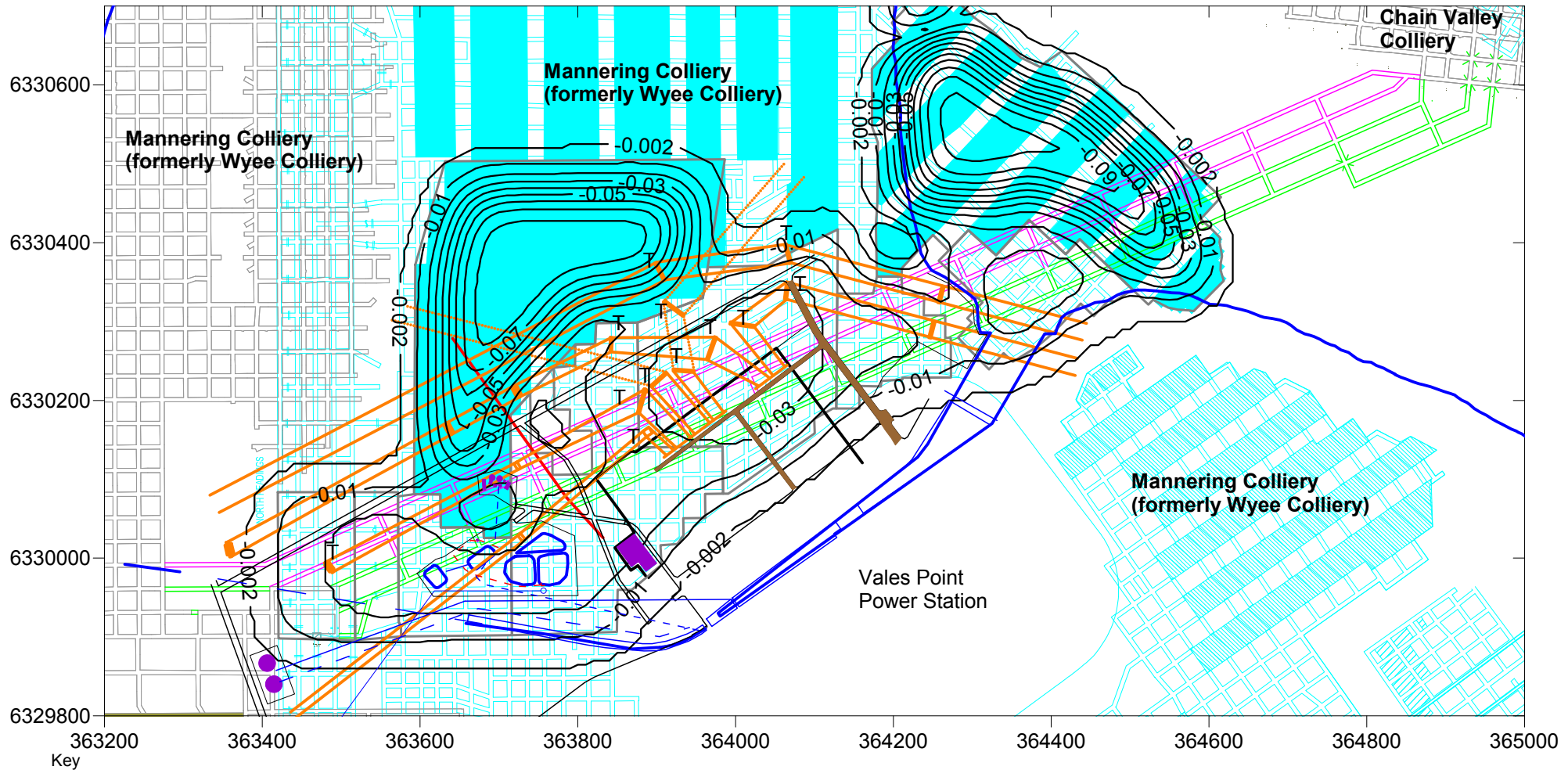
	Engineer:	S.Ditton	Client:	LakeCoal - Chain Valley Colliery	
	Drawn:	S.Ditton		CHV-002/3	
	Date:	20.11.13	Title:	Predicted Subsidence Above Link Road Route after First and Second Workings in the GN Seam	
	Ditton Geotechnical Services Pty Ltd		Scale:	NTS	
				Figure No:	15



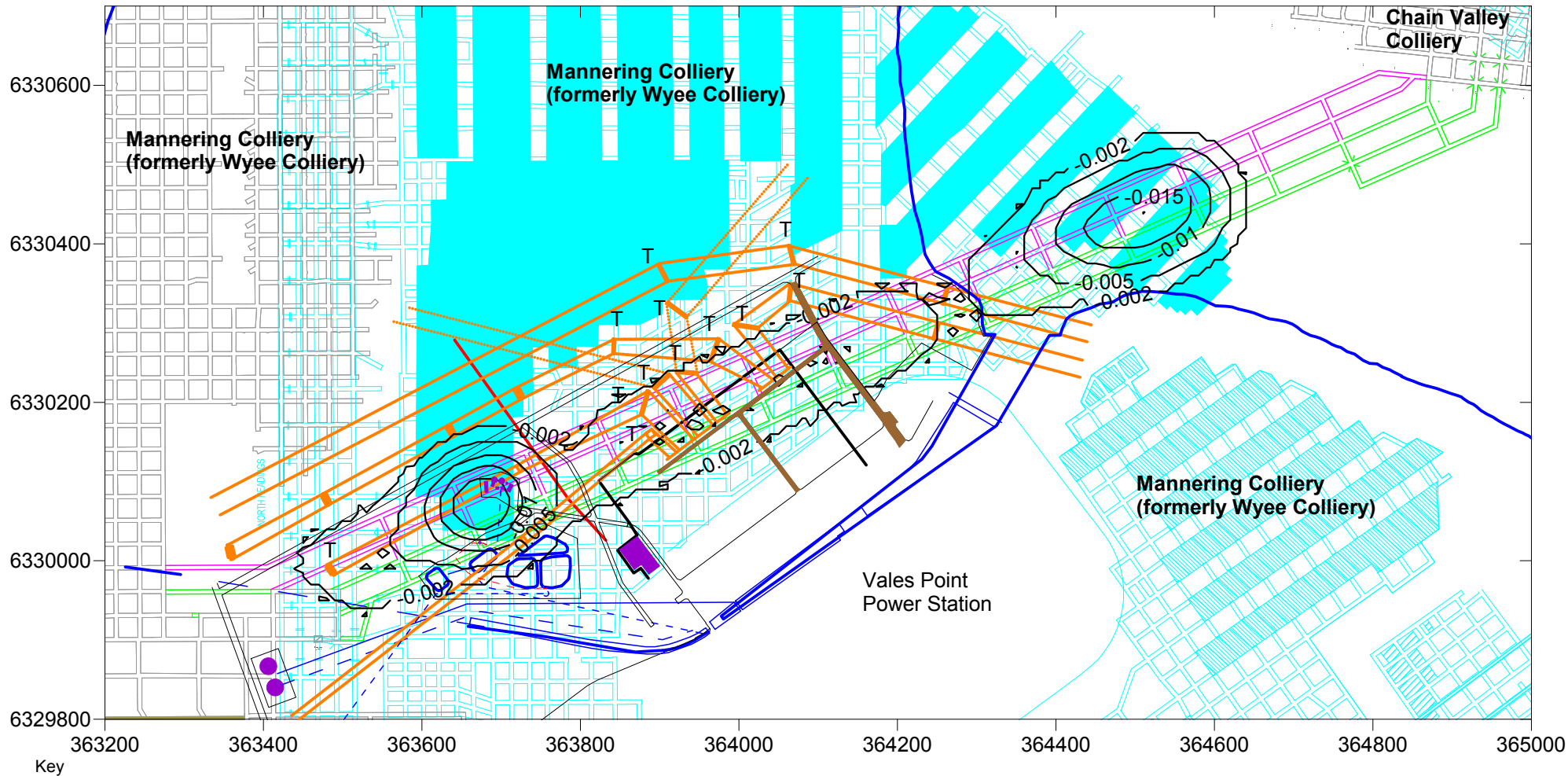
	Engineer:	S.Ditton	Client:	LakeCoal - Chain Valley Colliery	
	Drawn:	S.Ditton		CHV-002/3	
	Date:	20.11.13	Title:	Predicted Subsidence Increases Above Link Road Route after First Workings in the	
	Ditton Geotechnical Services Pty Ltd			Fassifern Seam	
Scale:			NTS	Figure No:	16



	Engineer:	S.Ditton	Client:	LakeCoal - Chain Valley Colliery	
	Drawn:	S.Ditton		CHV-002/3	
	Date:	20.11.13	Title:	Predicted Subsidence Above Link Road Route after First and Second Workings in the GN Seam plus Proposed Link Road Workings in the Fassifern Seam	
	Ditton Geotechnical Services Pty Ltd		Scale:	NTS	
				Figure No:	17

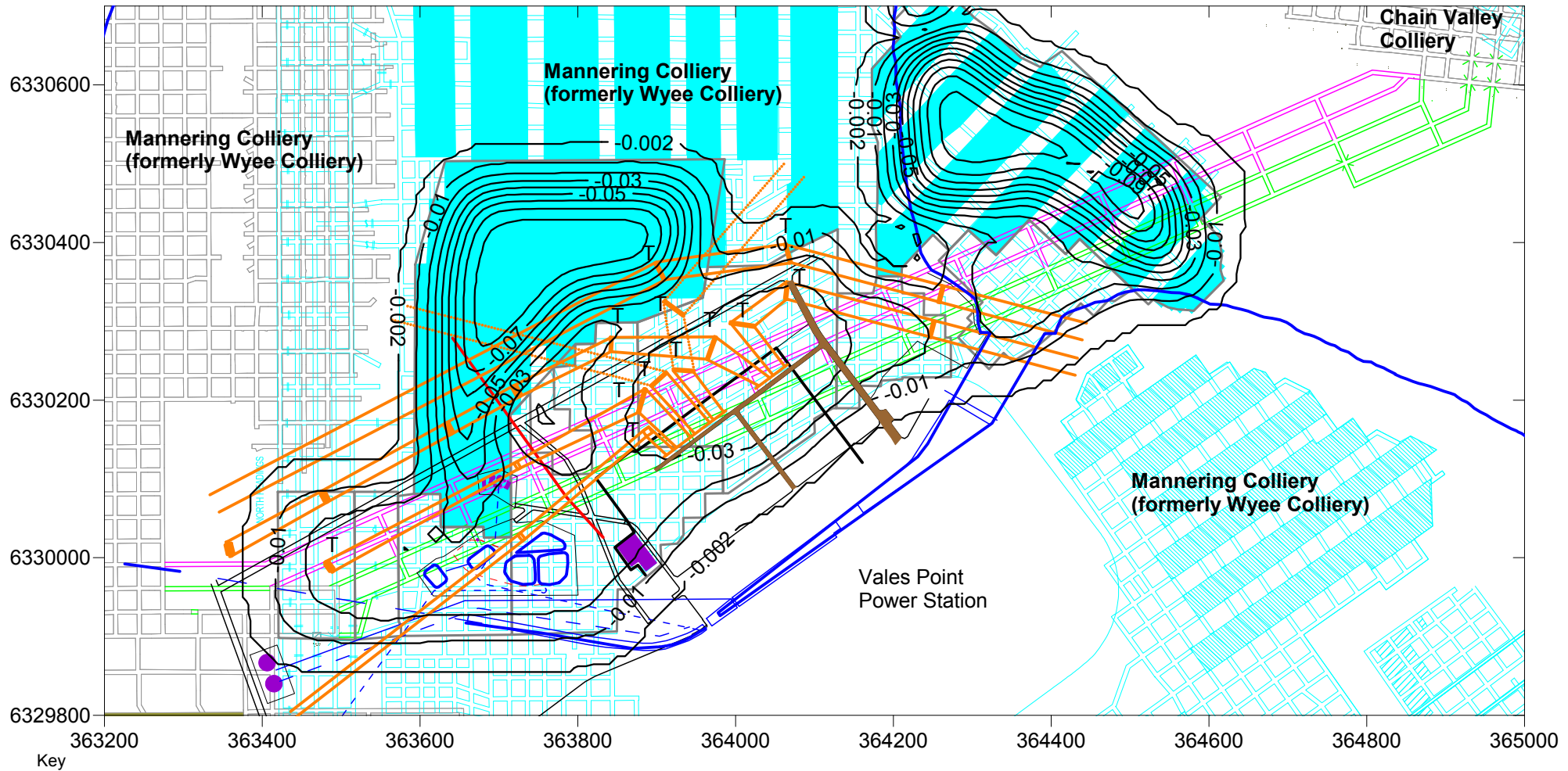


Existing First Workings in GN Seam	Effluent Treatment Ponds/Tanks	Lake Foreshore	Reinforced Concrete Canal	Reinforced Concrete Tunnel	Subsidence Contours (m)
Existing Second Workings in GN Seam	Jointed Reinforced Concrete Pavement	Bitumen Sealed Access Road	Tension Tower (Transgrid)	Buildings & Tanks	
Existing First Workings in FAS Seam	Proposed Mine Connection Headings in FAS Seam (Green - Stage 1; Magenta - Stage 2)	Optic Fibre Cable (buried)	Power Cable (buried)	Security Fence Lines	Rising Main (buried)
330kv Transmission Lines & Towers (Transgrid)		Engineer: S.Ditton	Client: LakeCoal - Chain Valley Colliery		
		Drawn: S.Ditton	CHV-002/3		
		Date: 27.01.14	Title: Predicted Subsidence Contours due to Mine Workings in the GN Seam Only		
		Ditton Geotechnical Services Pty Ltd	Scale: 1:7,500 (A4)	Figure No:	18a



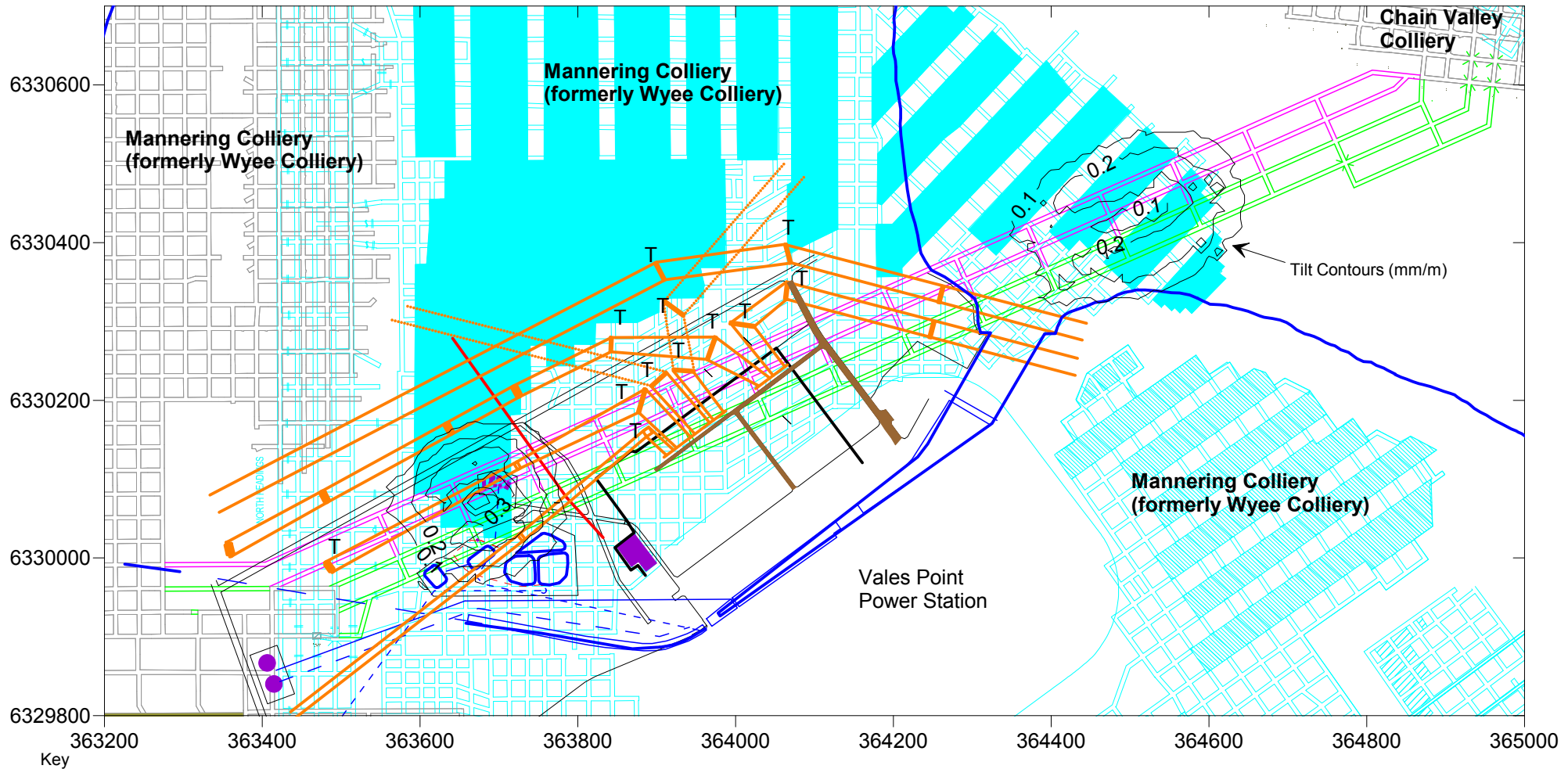
Existing First Workings in GN Seam	Effluent Treatment Ponds/Tanks	Lake Foreshore	Reinforced Concrete Canal	Reinforced Concrete Tunnel	Subsidence Contours (m)
Existing Second Workings in GN Seam	Jointed Reinforced Concrete Pavement	Bitumen Sealed Access Road	Tension Tower (Transgrid)	Buildings & Tanks	
Existing First Workings in FAS Seam					
Proposed Mine Connection Headings in FAS Seam (Green - Stage 1; Magenta - Stage 2)					
Optic Fibre Cable (buried)	Power Cable (buried)				
Security Fence Lines	Rising Main (buried)				
330kv Transmission Lines & Towers (Transgrid)					

	Engineer:	S.Ditton	Client:	LakeCoal - Chain Valley Colliery	
	Drawn:	S.Ditton		CHV-002/3	
	Date:	19.12.13	Title:	Predicted Subsidence Contours due to Mine Workings in the FAS Seam Only	
	Ditton Geotechnical Services Pty Ltd		Scale:	1:7,500 (A4)	Figure No:



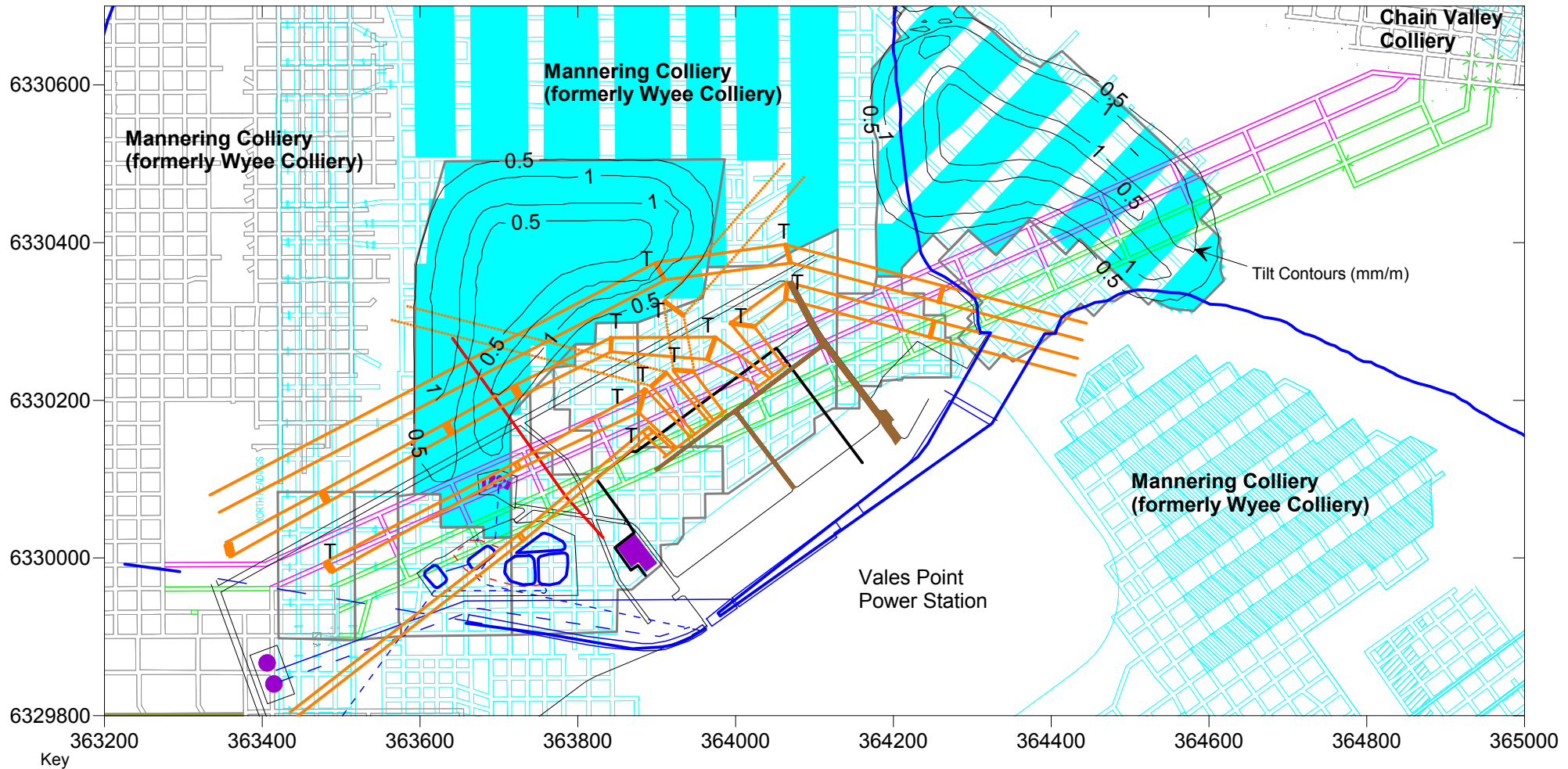
- Existing First Workings in GN Seam
- Existing Second Workings in GN Seam
- Existing First Workings in FAS Seam
- Proposed Mine Connection Headings in FAS Seam (Green - Stage 1; Magenta - Stage 2)
- Optic Fibre Cable (buried) Power Cable (buried)
- Security Fence Lines Rising Main (buried)
- 330kv Transmission Lines & Towers (Transgrid)
- Effluent Treatment Ponds/Tanks
- Lake Foreshore
- Reinforced Concrete Canal
- Reinforced Concrete Tunnel
- Subsidence Contours (m)
- Jointed Reinforced Concrete Pavement
- Bitumen Sealed Access Road
- T Tension Tower (Transgrid)
- Buildings & Tanks

	Engineer:	S.Ditton	Client:	LakeCoal - Chain Valley Colliery	
	Drawn:	S.Ditton		CHV-002/3	
	Date:	25.11.13	Title:	Predicted Cumulative Subsidence Contours due to Mine Workings in the GN & FAS Seams	
	Ditton Geotechnical Services Pty Ltd		Scale:	1:7,500 (A4)	Figure No:

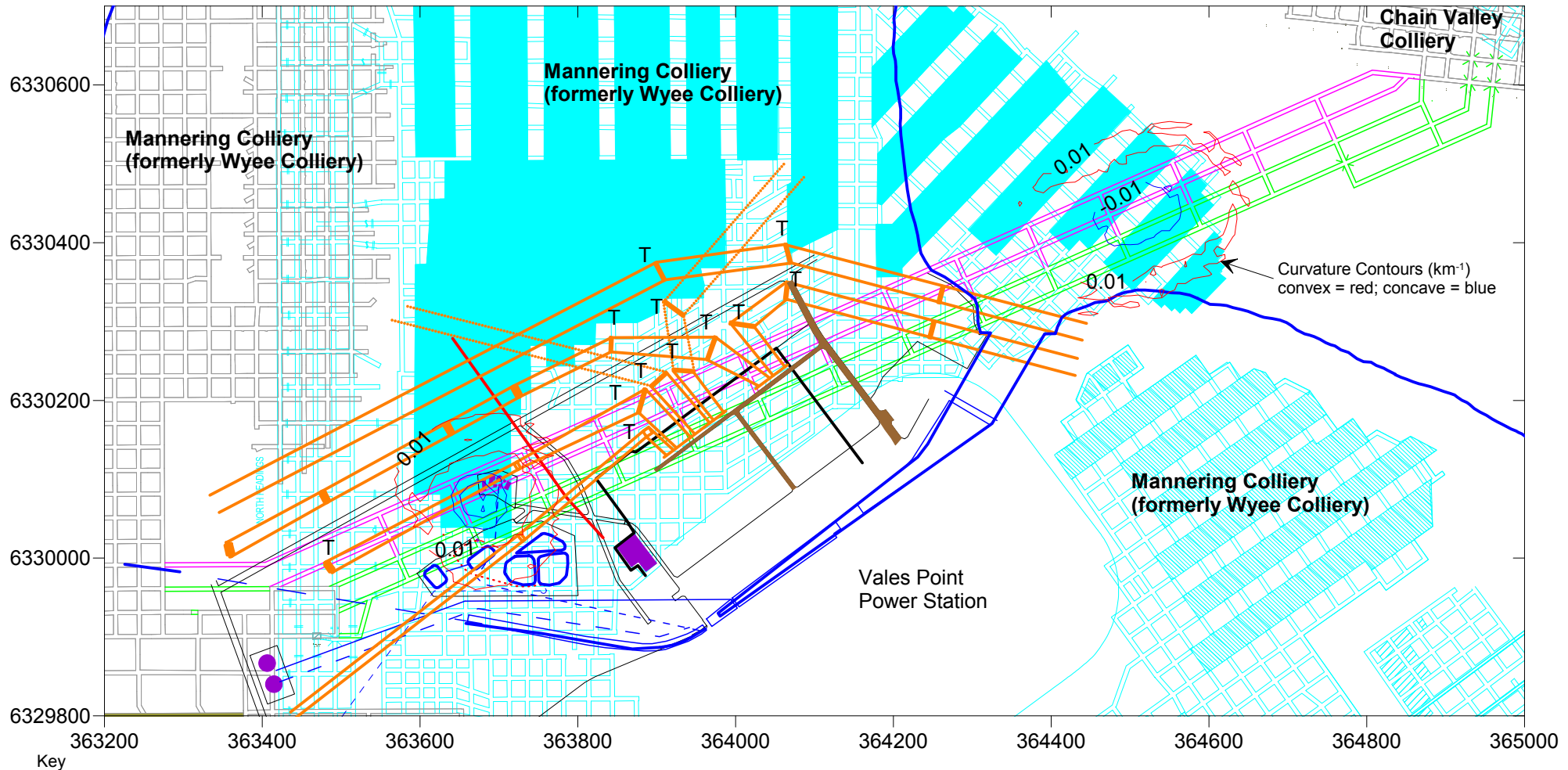


- Existing First Workings in GN Seam
- Existing Second Workings in GN Seam
- Existing First Workings in FAS Seam
- Proposed Mine Connection Headings in FAS Seam (Green - Stage 1; Magenta - Stage 2)
- Optic Fibre Cable (buried) Power Cable (buried)
- Security Fence Lines Rising Main (buried)
- 330kv Transmission Lines & Towers (Transgrid)
- Effluent Treatment Ponds/Tanks
- Jointed Reinforced Concrete Pavement
- Bitumen Sealed Access Road
- Lake Foreshore
- Reinforced Concrete Canal
- Reinforced Concrete Tunnel
- T Tension Tower (Transgrid)
- Buildings & Tanks

	Engineer:	S.Ditton	Client:	LakeCoal - Chain Valley Colliery	
	Drawn:	S.Ditton		CHV-002/3	
	Date:	19.12.13	Title:	Predicted Tilt Contours due to Mine Workings in the FAS Seam Only	
Ditton Geotechnical Services Pty Ltd			Scale:	1:7,500 (A4)	Figure No: 19a

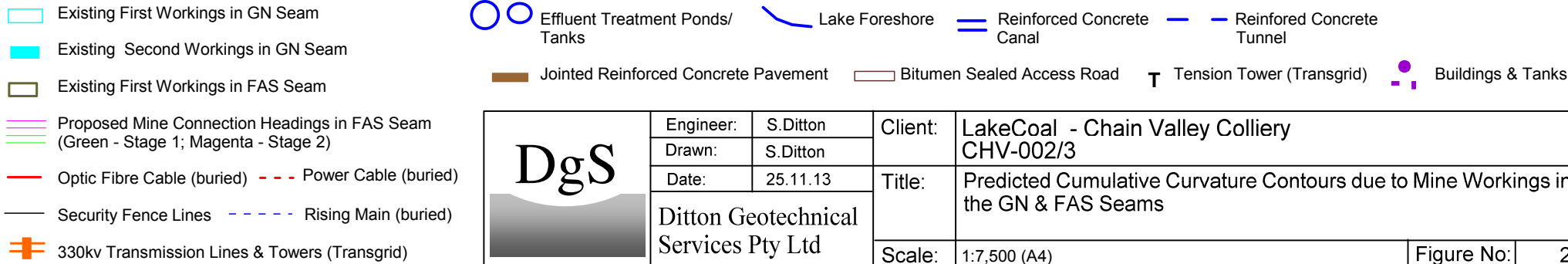
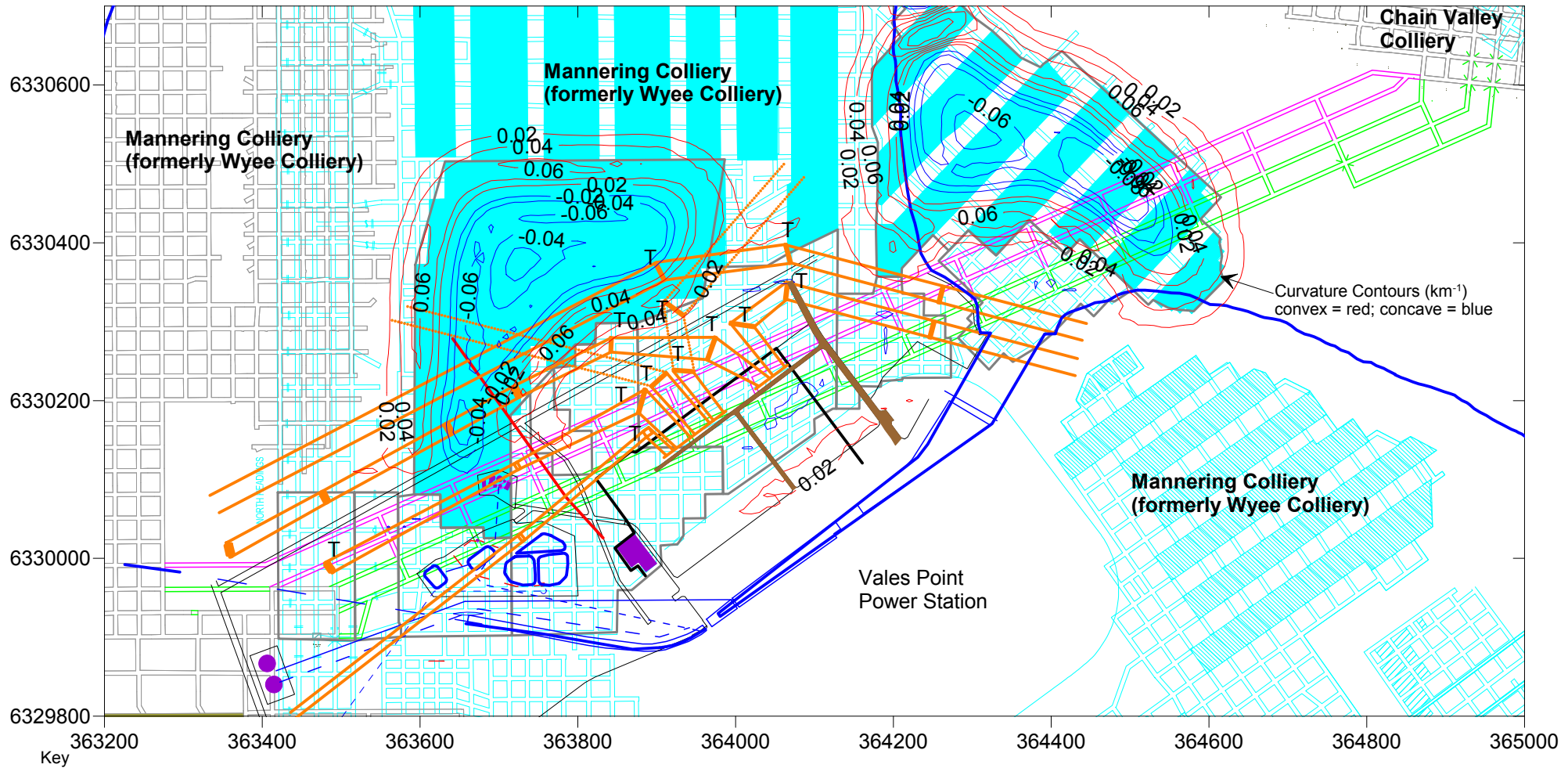


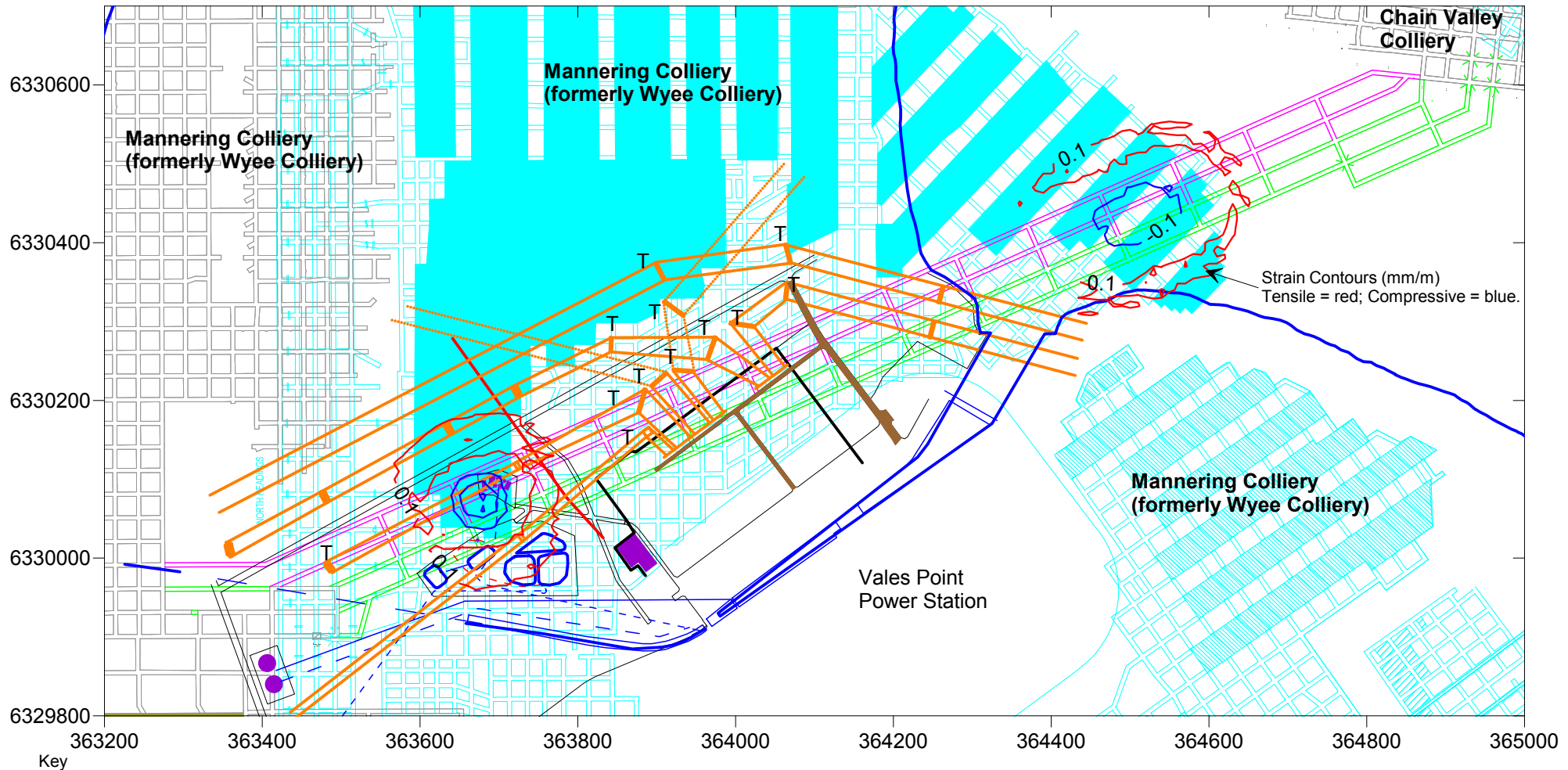
Existing First Workings in GN Seam	Effluent Treatment Ponds/Tanks	Lake Foreshore	Reinforced Concrete Canal	Reinforced Concrete Tunnel
Existing Second Workings in GN Seam	Jointed Reinforced Concrete Pavement	Bitumen Sealed Access Road	Tension Tower (Transgrid)	Buildings & Tanks
Existing First Workings in FAS Seam				
Proposed Mine Connection Headings in FAS Seam (Green - Stage 1; Magenta - Stage 2)	Engineer: S.Ditton	Client: LakeCoal - Chain Valley Colliery	CHV-002/3	
Optic Fibre Cable (buried) Power Cable (buried)	Drawn: S.Ditton	Date: 25.11.13	Title: Predicted Cumulative Tilt Contours due to Mine Workings in the GN & FAS Seams	
Security Fence Lines Rising Main (buried)	Ditton Geotechnical Services Pty Ltd		Scale: 1:7,500 (A4)	Figure No: 19b
330kv Transmission Lines & Towers (Transgrid)				



Existing First Workings in GN Seam	Effluent Treatment Ponds/Tanks	Lake Foreshore	Reinforced Concrete Canal	Reinforced Concrete Tunnel
Existing Second Workings in GN Seam	Jointed Reinforced Concrete Pavement	Bitumen Sealed Access Road	Tension Tower (Transgrid)	Buildings & Tanks
Existing First Workings in FAS Seam	Proposed Mine Connection Headings in FAS Seam (Green - Stage 1; Magenta - Stage 2)	Optic Fibre Cable (buried)	Power Cable (buried)	
Security Fence Lines	Rising Main (buried)	330kv Transmission Lines & Towers (Transgrid)		

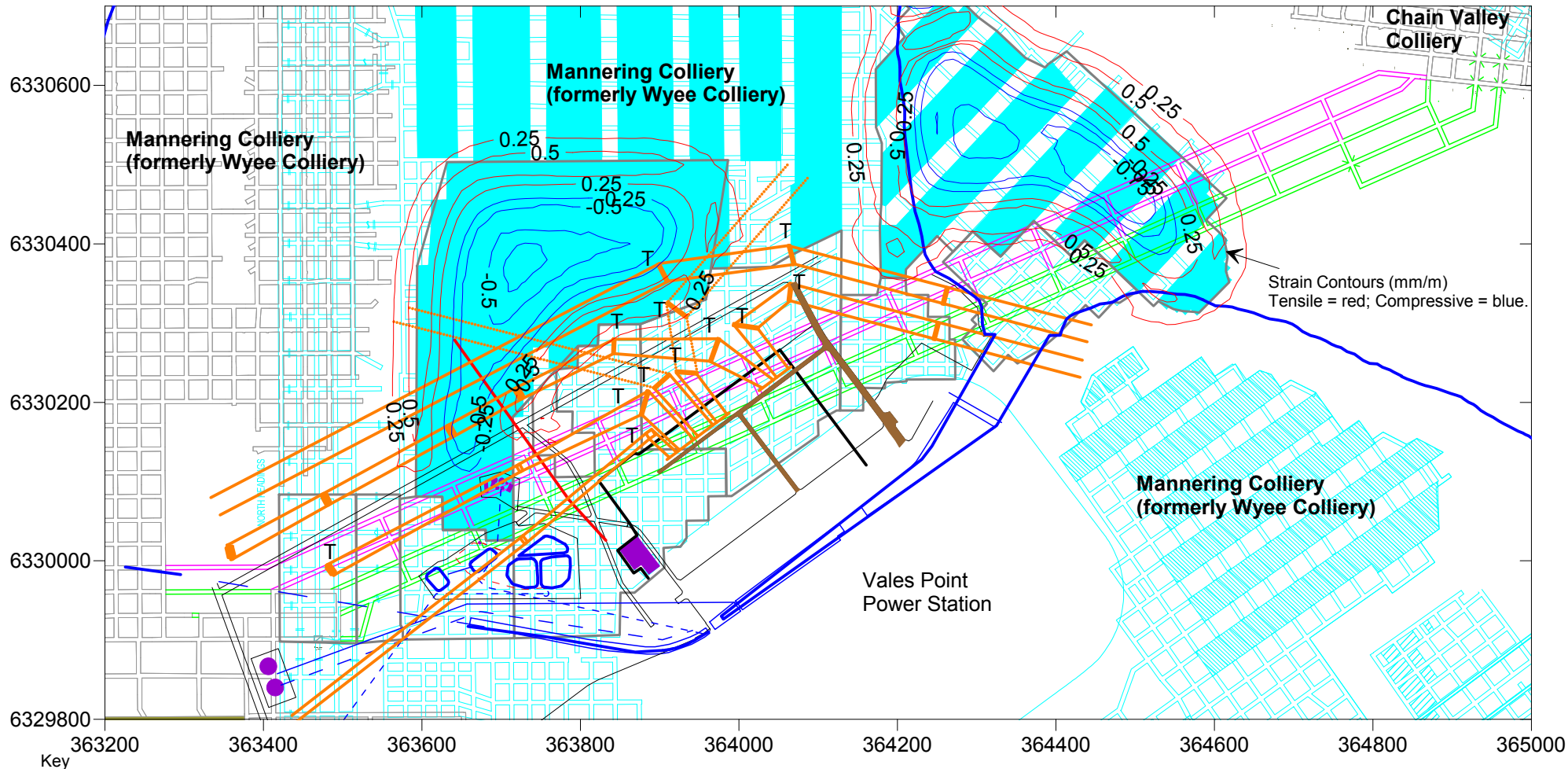
	Engineer:	S.Ditton	Client:	LakeCoal - Chain Valley Colliery	
	Drawn:	S.Ditton		CHV-002/3	
	Date:	19.12.13	Title:	Predicted Curvature Contours due to Mine Workings in the FAS Seam Only	
Ditton Geotechnical Services Pty Ltd			Scale:	1:7,500 (A4)	Figure No: 20a





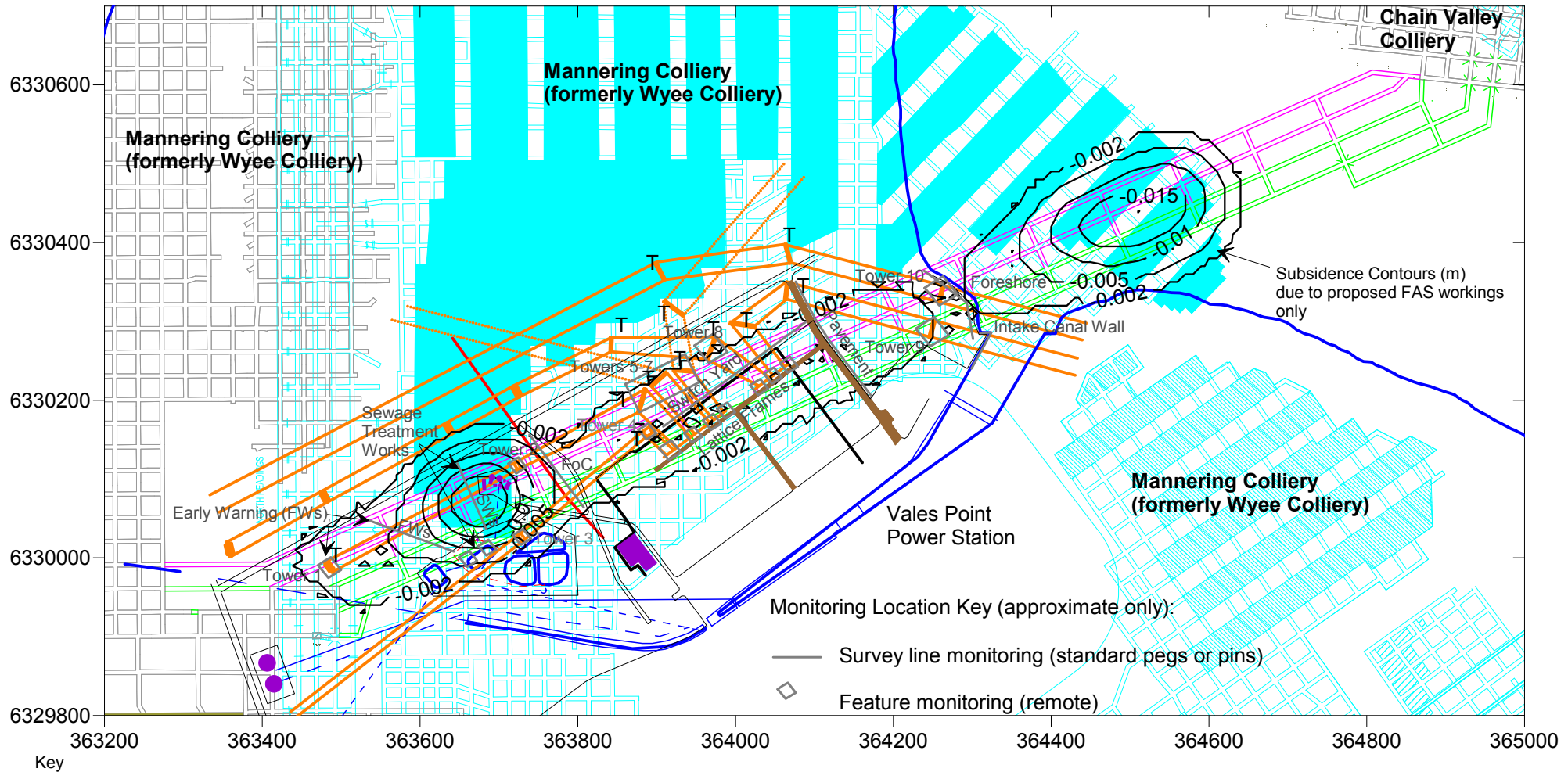
Existing First Workings in GN Seam	Effluent Treatment Ponds/Tanks	Lake Foreshore	Reinforced Concrete Canal	Reinforced Concrete Tunnel
Existing Second Workings in GN Seam	Jointed Reinforced Concrete Pavement	Bitumen Sealed Access Road	Tension Tower (Transgrid)	Buildings & Tanks
Existing First Workings in FAS Seam	Proposed Mine Connection Headings in FAS Seam (Green - Stage 1; Magenta - Stage 2)	Optic Fibre Cable (buried)	Power Cable (buried)	
Security Fence Lines	Rising Main (buried)	330kv Transmission Lines & Towers (Transgrid)		

	Engineer:	S.Ditton	Client:	LakeCoal - Chain Valley Colliery	
	Drawn:	S.Ditton		CHV-002/3	
	Date:	19.12.13	Title:	Predicted Strain Contours due to Mine Workings in the FAS Seam Only	
	Ditton Geotechnical Services Pty Ltd		Scale:	1:7,500 (A4)	Figure No:



Strain Contours (mm/m)
Tensile = red; Compressive = blue.

Existing First Workings in GN Seam	Effluent Treatment Ponds/ Tanks	Lake Foreshore	Reinforced Concrete Canal	Reinforced Concrete Tunnel
Existing Second Workings in GN Seam	Jointed Reinforced Concrete Pavement	Bitumen Sealed Access Road	Tension Tower (Transgrid)	Buildings & Tanks
Existing First Workings in FAS Seam				
Proposed Mine Connection Headings in FAS Seam (Green - Stage 1; Magenta - Stage 2)	Engineer: S.Ditton	Client: LakeCoal - Chain Valley Colliery CHV-002/3		
Optic Fibre Cable (buried) Power Cable (buried)	Drawn: S.Ditton	Title: Predicted Cumulative Strain Contours due to Mine Workings in the GN & FAS Seams		
Security Fence Lines Rising Main (buried)	Date: 25.11.13		Scale: 1:7,500 (A4)	Figure No: 21b
330kv Transmission Lines & Towers (Transgrid)	Ditton Geotechnical Services Pty Ltd			



- Existing First Workings in GN Seam
- Existing Second Workings in GN Seam
- Existing First Workings in FAS Seam
- Proposed Mine Connection Headings in FAS Seam (Green - Stage 1; Magenta - Stage 2)
- Optic Fibre Cable (buried) Power Cable (buried)
- Security Fence Lines Rising Main (buried)
- 330kv Transmission Lines & Towers (Transgrid)
- Effluent Treatment Ponds/Tanks
- Lake Foreshore
- Reinforced Concrete Canal
- Reinforced Concrete Tunnel
- Jointed Reinforced Concrete Pavement
- Bitumen Sealed Access Road
- T Tension Tower (Transgrid)
- Buildings & Tanks

	Engineer:	S.Ditton	Client:	LakeCoal - Chain Valley Colliery	
	Drawn:	S.Ditton		CHV-002/3	
	Date:	25.01.14	Title:	Suggested Surface Monitoring Locations for Surface Features above the Proposed Mine Linkage Headings	
Ditton Geotechnical Services Pty Ltd			Scale:	1:7,500 (A4)	Figure No: 22

Appendix D

Review of Ruttleys Road intersection upgrade commitments

18 February 2014

Chris Ellis
Environmental Officer
LDO Group
16 Spitfire Place
Rutherford, NSW, 2320Re: Mannering Colliery Site Access

Dear Chris,

This letter summarises our review of the current condition of the Mannering Colliery's site access intersection at Ruttleys Road and its suitability for the proposed future modification construction and operations access.

1 Approved traffic generation

Prior to 2008, the Mannering Colliery operated under existing use rights by virtue of the Environmental Planning and Assessment Regulation 2000. Project Approval MP06_0311, granted in 2008, approved the continued operation of the Mannering Colliery with a maximum workforce of 90 full time employees. The proponent, Centennial Coal Pty Limited (Centennial), committed to undertaking a road safety audit of the Ruttleys Road intersection and this was included as a condition of consent in MP06_0311.

An application to modify MP06_0311, and an accompanying Environmental Assessment (EA) report, was lodged in January 2012 which included an increase in maximum employment to 170 full time employees. The modification application included a commitment to undertake the eight recommendations of the road safety audit, prepared by Parsons Brinkerhoff in 2008, as well as construction of a type CHR intersection with a right turning lane treatment at the site access on Ruttleys Road.

Following submission of the EA, Centennial advised the Department of Planning and Infrastructure (DP&I) that it no longer intended to construct the type CHR intersection due to reduction in workforce to 70 full time employees. DP&I stated in its assessment report dated 5 October 2012, that the type CHR intersection upgrades were not warranted with the reduced workforce and that only the eight road safety audit recommendations should be included. DP&I noted that Centennial had committed to undertaking the type CHR intersection upgrades once employee levels exceeded 130. The modification to MP06_0311 was approved in October 2012.

No coal transport by truck is approved for Mannering Colliery.

2 Proposed traffic generation

Since November 2012, production at the Mannering Colliery has ceased and the mine has been under 'care and maintenance' with only minimal traffic (less than five employees) using the intersection. Centennial received approval from DP&I (in a letter dated 4 June 2013) to postpone completion of the Ruttleys Road upgrade works required by MP06_0311 whilst the Mannering Colliery remained under care and maintenance. Completion of the upgrade works would be required prior to any recommencement of operations at the Colliery.

Two modification applications, namely to Mannering Colliery's project approval MP06_0311 and Chain Valley Colliery's development consent SSD-5465, are currently proposed to enable construction of an underground linkage between the two collieries. The surface facilities and conveyor at Mannering will be utilised to transport coal produced at Chain Valley Colliery within the maximum approved production limit under MP06_0311 of 1.1 million tonnes per annum. Construction of the underground linkage will require 40 full time employees (operating in three shifts) at Mannering Colliery for approximately 12 months, and 20 full time employees (operating in three shifts) during operation. The construction employee vehicles and other construction traffic (some deliveries of plant and equipment) will use either the Chain Valley Colliery surface access, via Construction Road or the Mannering Colliery surface access, at the Ruttleys Road intersection. The future usage of the Mannering Colliery Ruttleys Road access intersection, under the proposed modification, will be limited to low traffic volumes such that safe intersection operations can be maintained at the existing intersection.

3 Road safety audit recommendations

The 2008 Parsons Brinkerhoff road safety audit of the existing Ruttleys Road intersection was undertaken at a time at which 90 full time staff were working at the Colliery in three shifts. The road safety audit identified eight safety improvements which were required at the intersection, the majority of which were completed in conjunction with the recent Wyong Shire Council resurfacing of this section and adjoining sections of Ruttleys Road. Since 2008, the improvements to Ruttleys Road now meet the eight recommendations of the road safety audit. A summary of the eight road safety audit recommendations and the improvements completed is shown in Table 1 and also illustrated by the attached Photographs 1-9.

Table 1 Completion of 2008 Road Safety Audit recommendations for Ruttleys Road intersection

Item	Location	Recommendation	Improvement completed
1	Access road approach to Ruttleys Road	Install a hold line (Stop or Give Way line) for traffic which is departing from the access road at the intersection	Yes, although the line is not clearly visible for approaching traffic from the access road.
2	Access road approach to Ruttleys Road	Extend the traffic island in the access road at the intersection, subject to vehicle turning swept path requirements	Yes where feasible. The traffic island has not been extended as this would conflict with turning paths for large vehicles, entering the driveway from the south.
3	Ruttleys Road approaches to the intersection	Further investigate the advisory speed limit for the curve around the intersection and provide additional warning signs and pavement markings as appropriate	Yes, advisory speed limit warning signs are provided to the north of the intersection.
4	Access road left turn in lane	Review vehicle swept paths and adjust the intersection layout accordingly	Yes, the new intersection layout provides a wide swept path for left turn entry movements by large vehicles.
5	Ruttleys Road	Provide improved linemarking including reflective pavement markers and guide posts along Ruttleys Road	Yes, improved linemarking, reflective pavement markers and guide posts have been provided at the required locations on Ruttleys Road.
6	Road pavement and shoulder conditions at the Intersection	Reseal, reconstruct or otherwise repair the Ruttleys Road pavement in the vicinity of the intersection	Yes, new road pavement and shoulders have been provided on Ruttleys Road at the intersection.
7	Ruttleys Road south	Reconstruct/repair the damaged road shoulders on Ruttleys Road, south of the intersection	Yes, new road pavement and shoulders have been provided on Ruttleys Road to both the north and south of the intersection.
8	South eastern corner of the intersection	Improve the run out treatment and/or the guardrail barrier at the intersection	Yes, a new guardrail barrier has been provided on Ruttleys Road to the north of the intersection which will prevent vehicle run off movements at the intersection. It is understood that Wyong Shire Council will be extending this barrier southwards towards the access road intersection in 2014, with

Table 1 **Completion of 2008 Road Safety Audit recommendations for Ruttleys Road intersection**

Item	Location	Recommendation	Improvement completed
			roadwork having commenced in February 2014.

The attached photographs depict the eight implemented road safety improvements recommended in the 2008 road safety audit.

4 CHR intersection upgrades

As detailed above, Centennial had previously committed to constructing a type CHR intersection with a right turning lane treatment, when employee levels at the Colliery exceeded 130 persons. This employment threshold will not be triggered by either the proposed modification construction or operational workforces of 40 and 20 employees, respectively.

5 Conclusion

Given that the recommended road safety improvements of Parsons Brinckerhoff's 2008 road safety audit have been satisfactorily completed and that the proposed underground linkage construction and operation workforce will not exceed 130 persons, no further road upgrades are considered warranted at the Mannering Colliery site access intersection with Ruttleys Road as a result of the proposed modification.

Yours sincerely



Tim Brooker
Senior Transport Planner
tbrooker@emgamm.com

Attachment - Ruttleys Road Intersection Photographs – February 2014

Photograph 1 - Access Road Approach to the intersection (the Give Way line is the edge line of Ruttleys Road, which is barely visible from the angle of this photograph). An additional "Hold Line" could be provided in a more visible location before traffic reaches Ruttleys Road.



Photograph 2 – Traffic Island on Access Road Approach to the intersection



Photograph 3 – Ruttleys Road Northern Approach to the intersection



Photograph 4a –Left Turn in to the Access Road at the intersection (looking south)



Photograph 4b –Left Turn in to the Access Road at the intersection (looking north)



Photograph 5 – Ruttleys Road to the south, showing new linemarking, guardrail and guide posts



Photograph 6 – Ruttleys Road showing new road pavement at the intersection



Photograph 7 – Ruttleys Road showing new guardrail and road shoulder south of the intersection



Photograph 8 - Ruttleys Road showing the end post of the new guardrail which has been installed on the north approach to the intersection. An additional section of guardrail is also now proposed to be constructed by Wyong Council to “fill in” the missing section of guardrail between this location and the masonry wall at the site entrance (see Photograph 9).



Photograph 9 - Existing Masonry Wall at the site entrance





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BRISBANE
Suite 1, Level 4, 87 Wickham Terrace
Spring Hill Queensland 4000
T 07 3839 1800 F 07 3839 1866

LakeCoal