CHAIN VALLEY COLLIERY – MODIFICATION 1
Statement of Environmental Effects

1

Section 96 Modification to SSD-5465

Prepared for LakeCoal Pty Limited
April 2014

LakeCoal

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Chain Valley Colliery - Modification 1

Statement of Environmental Effects | Section 96 Modification to SSD-5465

Prepared for LakeCoal Pty Limited | 22 April 2014

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Chain Valley Colliery - Modification 1

Final

Report J13117001 | Prepared for LakeCoal Pty Limited | 22 April 2014

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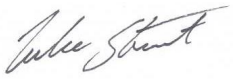
Signature		Signature	
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Executive Summary

ES1 Introduction

The Chain Valley Colliery (CVC) is an underground coal mine located at the southern end of Lake Macquarie, approximately 60 km south of Newcastle (see Figure E.1). Underground mining has occurred at the CVC since 1962 using a combination of bord and pillar and miniwall mining methods. The CVC has extracted coal from three seams – the Wallarah Seam, the Great Northern Seam and the Fassifern Seam, with current mining activities limited to the Fassifern Seam.

The CVC operates under Development Consent SSD-5465 which was granted on 23 December 2013 by the Minister for Planning and Infrastructure under Part 4 Division 4.1 of the *Environmental Planning and Assessment Act 1979* (EP&A Act) which relates to State significant development (SSD). This Statement of Environmental Effects (SEE) has been prepared to accompany an application to modify SSD-5465 under Section 96(2) of the EP&A Act construction of an underground linkage between the CVC and Mannering Colliery (MC) within the Fassifern Seam workings (see Figure E.2).

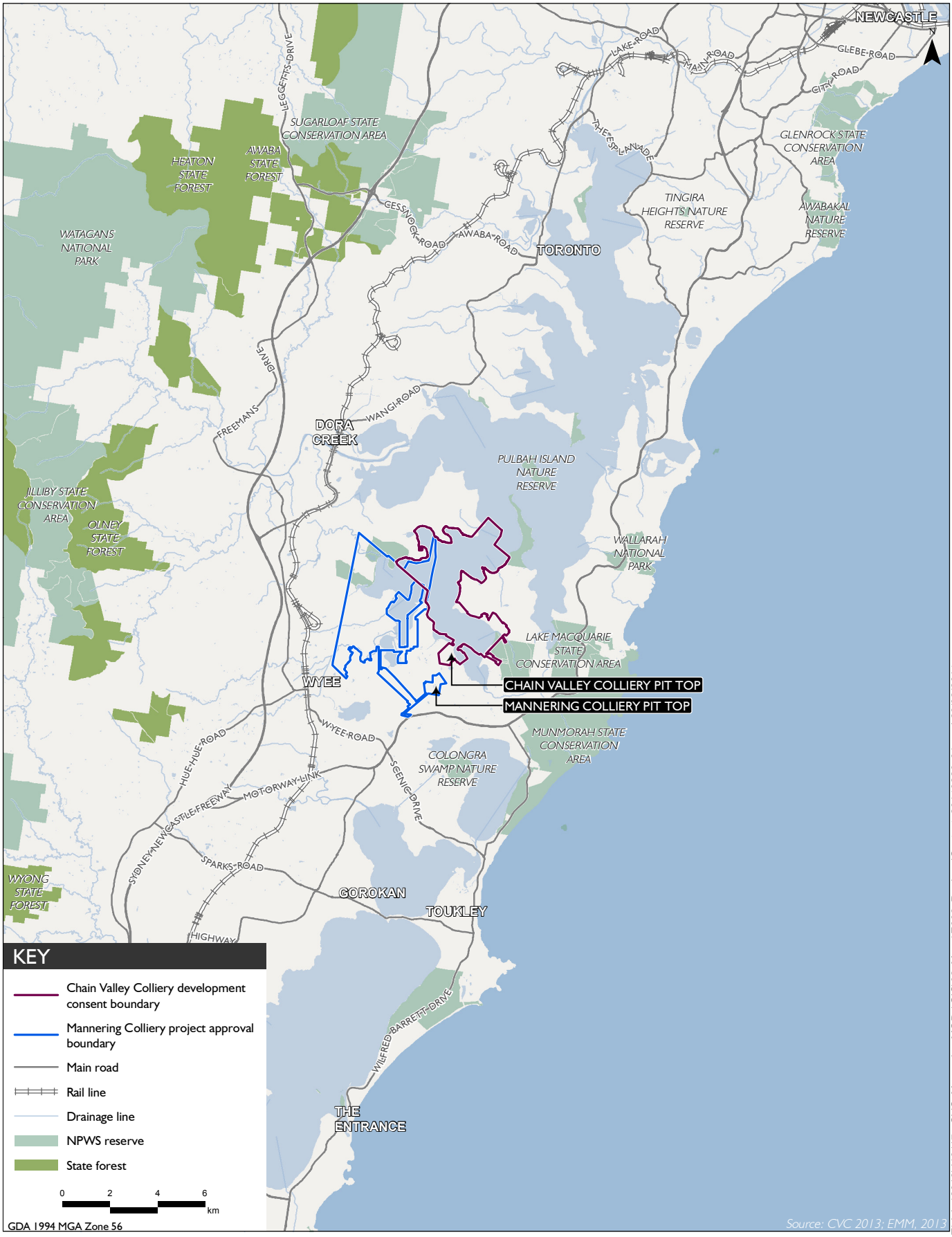
This SEE was prepared by EMGA Mitchell McLennan Pty Limited (EMM) on behalf of the applicant LakeCoal Pty Ltd (LakeCoal). LakeCoal is wholly owned by LDO Coal Pty Limited and is the operator of CVC and MC.

ES2 Statutory approvals framework

Project approvals for SSD may be modified under Section 96 of the EP&A Act provided that the information stipulated in Clause 115 of the Environmental Planning and Assessment Regulation 2000 is contained within the application and that the development (as to be modified) will remain substantially the same as the development that was originally approved.

When assessing an application under Section 96 for modification of a consent, the consent authority is required to take into consideration the relevant matters outlined in Section 79C of the EP&A Act which includes the provisions of any relevant environmental planning instruments. The proposed modification meets the relevant provisions of the following instruments:

- State Environmental Planning Policy (State and Regional Development) 2011;
- State Environmental Planning Policy (Mining, Petroleum Production and Extractive Industries) 2007;
- Wyong Local Environmental Plan 2013;
- Lake Macquarie Local Environmental Plan 2004; and
- Draft Lake Macquarie Local Environmental Plan 2013.



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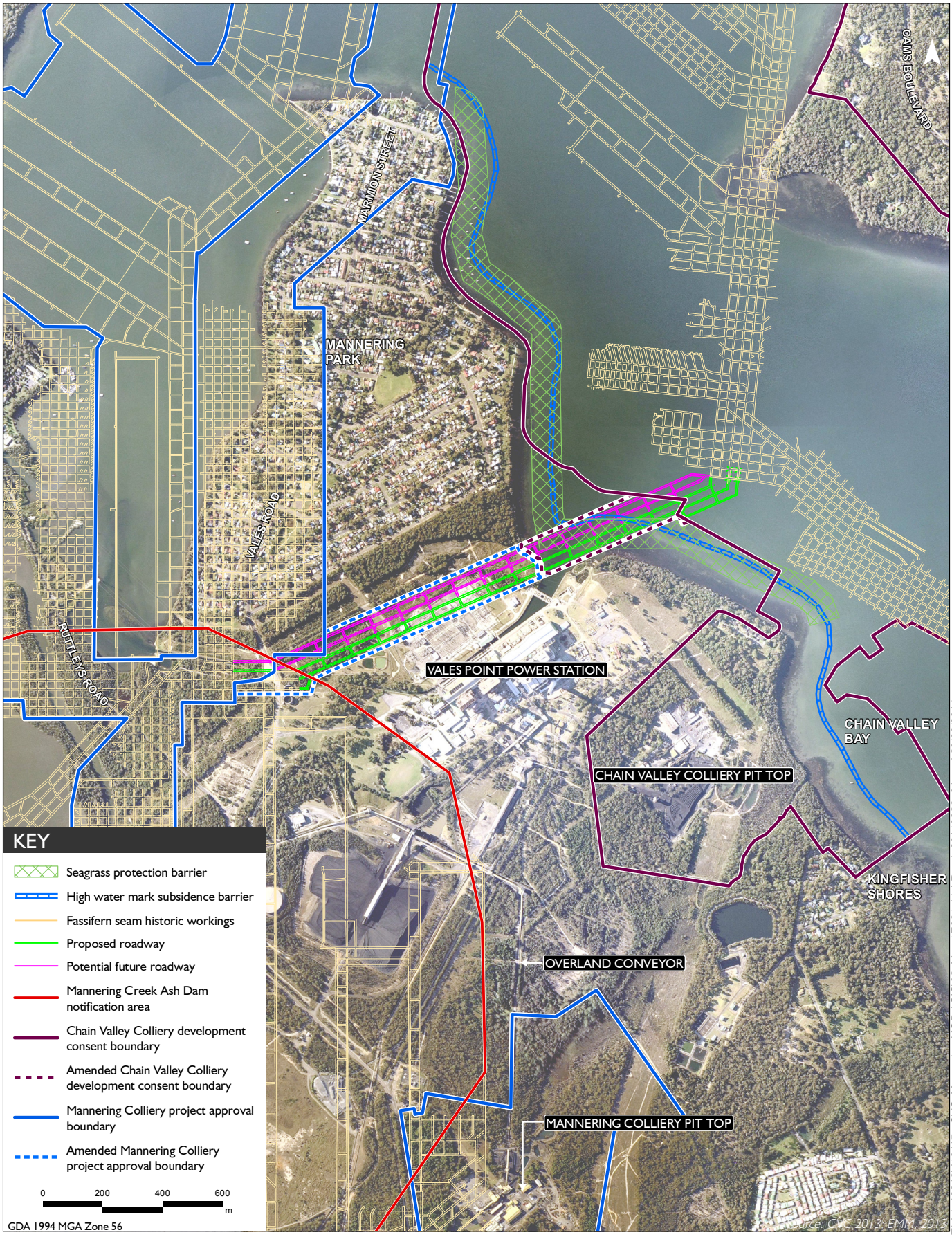
Regional context

Chian Valley Colliery – Modification 1

Figure E.1



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Proposed underground linkage

Chain Valley Colliery – Modification 1

Figure E.2

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 CVC 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*.

ES3 Existing operations

ES3.1 Chain Valley Colliery

The CVC is located near Mannering Park and is accessed via Ruttleys Road and Construction Road, a private road which services the CVC and Delta Electricity's Vales Point Power Station (VPPS). The CVC's mining tenements cover an area of approximately 2,200 hectares (ha) and straddle the boundary of Lake Macquarie and Wyong local government areas (LGAs). The CVC's pit top area is located within the Wyong LGA, adjacent to VPPS in an existing industrial area at the southern extent of Lake Macquarie and west of Chain Valley Bay.

The CVC's approved operations under SSD-5465 include:

- extraction of up to 1.5 million tonnes per annum (mtpa) of run-of-mine (ROM) coal from the Fassifern Seam until 31 December 2027;
- first and second workings using continuous miner and miniwall mining methods;
- all secondary extraction is confined to areas under Lake Macquarie and outside of the high water mark subsidence barrier (HWMSB) and seagrass protection barrier (SPB);
- maximum vertical subsidence of 886 mm where historic workings in the Great Northern and Wallarah seams overlie proposed miniwall panels (MWs 41 to 45) and 620 mm in the remainder of Area 1 where no historic workings overlie proposed panels (MWs 1 to 40);
- sizing and crushing coal at the CVC's Coal Preparation Plant;
- transporting coal by public roads to Port Waratah Coal Services (PWCS) for export; and
- transporting coal by private roads to VPPS and by public roads to other customers for domestic use.

ES3.2 Mannering Colliery

The MC is an underground coal mine located on the southern side of Lake Macquarie approximately 60 km south of Newcastle. 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.

Underground mining commenced at MC in 1960 extracting coal using both the bord and pillar and longwall mining methods in the Great Northern and Fassifern Seams. The MC was granted project

approval (MP06_0311) on 12 March 2008 for the continued production of up to 1.1 mtpa of ROM coal until 31 March 2018, with additional first working mining areas in the Fassifern Seam approved on 25 October 2012 (MP06_0311 MOD 1).

The MC, which has historically provided coal to VPPS for domestic energy generation via a dedicated covered overland conveyor, was placed on care and maintenance in November 2012. In late 2013, the owners of the CVC and MC entered into an agreement which enables LakeCoal to operate the MC until 2022. LakeCoal became the operator of MC effective 17 October 2013.

ES4 Proposed modification

ES4.1 Overview

LakeCoal seeks approval to modify SSD-5465 under Section 96(2) 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 development consent and project approval boundaries for CVC and MC as identified in SSD-5465 and MP06_0311, respectively. All other components of the CVC, as approved under SSD-5465, will remain unchanged.

It is noted that a separate application to modify MC's project approval, MP06_0311, has been lodged under Section 75W of the EP&A Act to enable construction of the underground linkage within MC's leases and will be assessed concurrently with this application.

ES4.2 Need for proposed modification

The CVC has approval to produce 1.5 mtpa of ROM coal, of which up to 660,000 tonnes per annum can be delivered to PWCS for export, and the remainder sold domestically. LakeCoal's primary domestic customer is Delta Electricity's VPPS with coal deliveries to VPPS currently occurring via the CVC access road and Construction Road (both of which are private, sealed roads) and internal unsealed roads with the VPPS. Long term contracts for the delivery of coal to VPPS provide a secure source of predictably priced thermal coal to help supply the State's electricity needs. The existing infrastructure at MC allows coal to be transported by overland conveyor directly to the VPPS. The connection between CVC and MC and subsequent installation of an underground conveyor belt system and ancillary services will enable ROM coal from the CVC to be transferred to the VPPS via the MC conveyors.

This approach, which will enable the replacement of routine road transportation of product coal from the CVC to VPPS, will provide for an improved environmental outcome for the duration of the agreement between the owners of CVC and MC. The improved outcome will primarily result from a reduction in noise and dust emissions from the handling, haulage and unloading of the CVC product coal as currently occurs compared to direct transport via covered conveyor from the MC surface facilities. Though the transportation of coal to the VPPS by conveyor would be the preferred option, it is important that LakeCoal retains the ability to transport that coal to VPPS by the private road network should any circumstances arise which preclude the use of the conveyor system. It is noted that reduced truck

transport will result in the loss of employment for up to nine full time contractor truck driver positions at CVC; however, this will be more than compensated for by additional employment at the MC above the current care and maintenance levels (40 and 20 full time employees during construction and operation, respectively).

Further, by using the existing MC infrastructure, LakeCoal will reduce the operating costs at the CVC associated with the truck transport of coal to VPPS. This will result in material economic benefit, enhancing the viability of the CVC and increase the security of employment for the CVC workforce.

The improved amenity outcomes and operational cost savings can be achieved with little to no adverse environmental impact given that it will utilise existing infrastructure at an approved mining operation.

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 and operational cost savings 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's and MC's 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 CVC and MC 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 CVC and MC.

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 SPB, and HWMSB, 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

Groundwater modelling of CVC's approved operations was previously undertaken by Geoterra (2013). The median annual groundwater inflow to the Fassifern workings is predicted to ultimately increase to 3,832 megalitres (ML) once miniwall mining in Area 1 is approaching its fullest lateral extent. CVC's licence under the *Water Act 1912* allows for extraction of 4,443 ML/year for the purposes of mine dewatering and industrial use.

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 CVC 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 CVC are managed under LakeCoal's Water Management Plan, which includes a commitment that all groundwater extracted will be metered and accounted for within its licensed entitlement and requires annual reporting of groundwater inflow volumes against model predictions and licensed volumetric limits. 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 terrestrial biodiversity, Aboriginal and historic heritage, visibility, waste, hazards, rehabilitation, geology and soils are unlikely.

The assessment of surface water impacts found that inflows to the underground linkage will be managed under CVC's water management system. Mine water inflows are currently pumped to the CVC pit top area and discharged at a licensed discharge point on Swindles Creek, a tributary of Lake Macquarie. The negligible inflow associated with the underground linkage is not projected to materially change the volumes of water discharged and be within the bounds of historic variations.

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 are 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.

Approval of the proposed modification will enhance the economic viability of the CVC. The proposed modification will also 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 CVC, as approved under SSD-5465, will remain unchanged.

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

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1 Introduction

1.1 Background

The Chain Valley Colliery (CVC) is an underground coal mine located at the southern end of Lake Macquarie, approximately 60 km south of Newcastle (see Figure 1.1). The CVC is operated by LakeCoal Pty Ltd (LakeCoal), which is wholly owned by LDO Coal Pty Limited. Underground mining has occurred at the CVC since 1962 using a combination of bord and pillar and miniwall mining methods. The CVC has extracted coal from three seams – the Wallarah Seam, the Great Northern Seam and the Fassifern Seam, with current mining activities limited to the Fassifern Seam.

The CVC operates under Development Consent SSD-5465, granted on 23 December 2013 (see Appendix A) by the Minister for Planning and Infrastructure under Part 4 Division 4.1 of the *Environmental Planning and Assessment Act 1979* (EP&A Act), which relates to State significant development (SSD). The approval pertains to underground miniwall mining in the Fassifern Seam at a maximum rate of production of 1.5 million tonnes per annum (mtpa) of run-of-mine (ROM) coal. All secondary extraction is confined to areas under Lake Macquarie.

This Statement of Environmental Effects (SEE) has been prepared to accompany an application to modify SSD-5465 under Section 96(2) of the EP&A Act to enable construction of an underground linkage between the CVC and Mannering Colliery (MC) 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 SEE was prepared by EMGA Mitchell McLennan Pty Limited (EMM) on behalf of the applicant, LakeCoal.

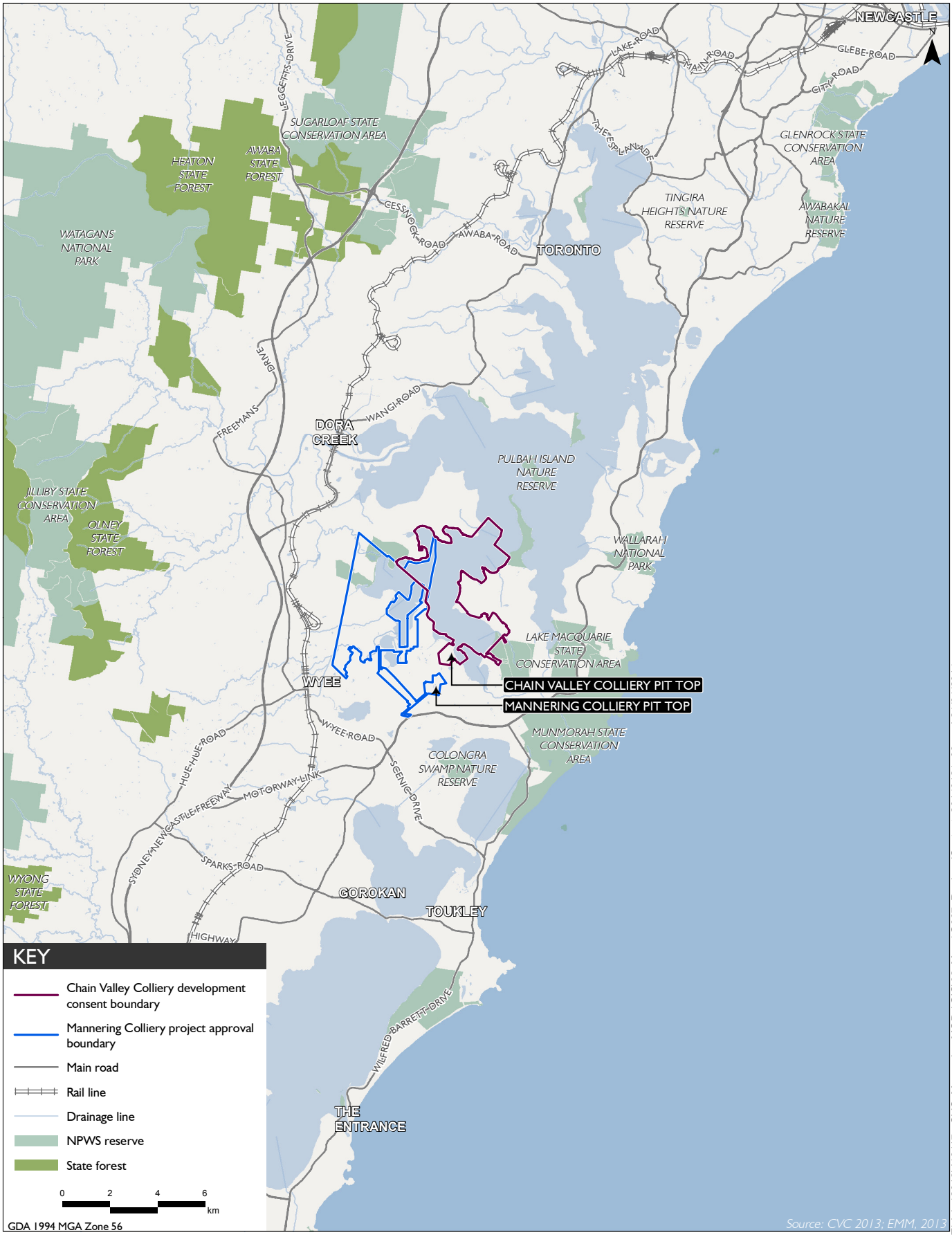
1.2 Site and surrounds

The CVC is located near Mannering Park and is accessed via Ruttleys Road and Construction Road, a private road which services the CVC and Vales Point Power Station (VPPS) (see Figure 1.2). The CVC mining tenements cover an area of approximately 2,200 hectares (ha) and straddle the boundary of Lake Macquarie and Wyong local government areas (LGAs). The CVC's pit top area is located within the Wyong LGA, adjacent to VPPS in an existing industrial area at the southern extent of Lake Macquarie and west of Chain Valley Bay.

Nearby residential areas include Macquarie Shores mobile home village, Kingfisher Shores and Chain Valley Bay to the south-east, Mannering Park to the north-west and Summerland Point and Gwandalan to the north-east. The CVC's ventilation shaft and fans are located at Summerland Point, north-east of the pit top area. 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 land above the underground linkage falls within MC's mining tenements and includes:

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



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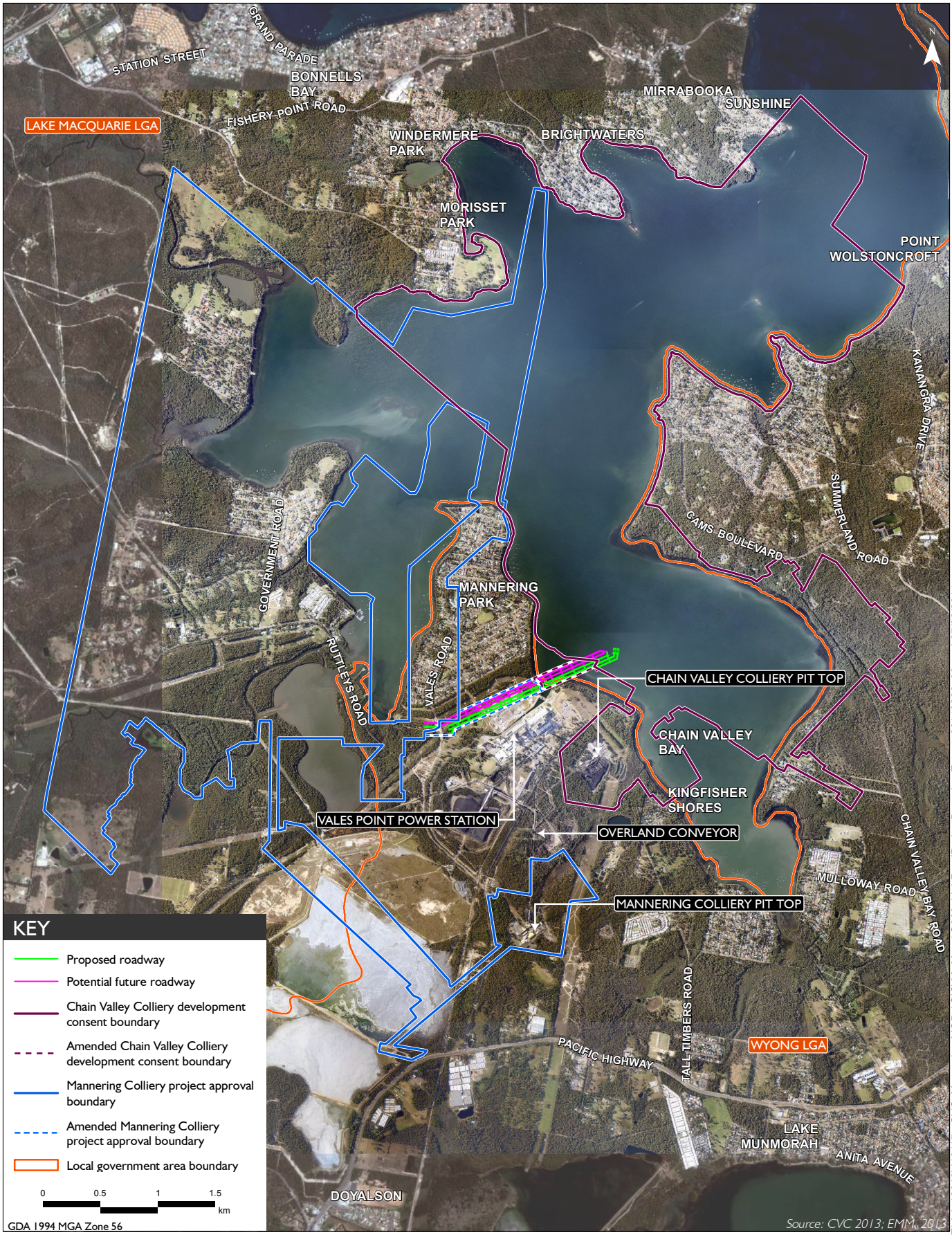
Regional context

Chain Valley Colliery – Modification 1

Figure 1.1



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The Site

Mannering Colliery – Modification 2

Figure 1.2

1.3 The proposed modification

LakeCoal seeks approval to modify SSD-5465 under Section 96(2) 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 CVC and MC;
- the installation and use of an underground conveyor belt system and ancillary services, enabling ROM coal to be transferred between the CVC and MC conveyors; and
- the use of existing MC infrastructure to transport coal from the underground workings to the VPPS at a rate not greater than 1.1 mtpa (as currently approved by MC's project approval MP06_0311).

The construction of the underground linkage will result in a minor adjustment to the project boundary as identified in SSD-5465 (see Figure 3.1). All other components of the CVC, as approved under SSD-5465, will remain unchanged.

It is noted that a separate application to modify MC's project approval MP06_0311 has been lodged under Section 75W of the EP&A Act to enable construction of the underground linkage and will be assessed concurrently with this application.

1.4 Modification need

The CVC has approval to produce 1.5 mtpa of ROM coal, of which up to 660,000 tonnes per annum can be delivered to Newcastle Port for export, and the remainder sold domestically. LakeCoal's primary domestic customer is Delta Electricity's VPPS with coal deliveries to VPPS currently occurring via the CVC access road and Construction Road, both of which are private, sealed roads. Long term contracts for the delivery of coal to VPPS provide a secure source of predictably priced thermal coal to help supply the State's electricity needs.

The MC was placed on care and maintenance in November 2012. In late 2013, the owners of the CVC and MC entered into an agreement which enables LakeCoal to operate the MC until 2022. LakeCoal became the operator of MC effective 17 October 2013. The existing infrastructure at MC allows coal to be transported by overland conveyor directly to the VPPS. The proposed linkage between CVC and MC, and subsequent installation of an underground conveyor belt system and ancillary services, will enable coal from the CVC to be transferred to the VPPS via the MC conveyors.

This approach, which will enable the replacement of routine road transportation of product coal from the CVC to VPPS, will provide for an improved environmental outcome when compared with existing method of transport. The improved outcome will primarily result from a reduction in noise and dust emissions from the handling, haulage and unloading of the CVC's product coal as currently occurs compared to direct transport via covered conveyor from MC's surface facilities. Though the transportation of coal to the VPPS by conveyor would be the preferred option, it is important that LakeCoal retains the ability to transport that coal to VPPS by the private road network should any circumstances arise which preclude the use of the conveyor system. It is noted that reduced truck transport will result in the loss of employment for nine full time contractor positions at CVC. However, this will be more than compensated for by the employment at the MC of an additional 40 full time employees during the construction of the linkage and 20 full time employees during its operation (ie above the current care and maintenance levels).

Further, by using MC's existing infrastructure, LakeCoal will reduce the operating costs at the CVC as a consequence of the reduction in truck transport. This will result in material economic benefit, enhancing the viability of the CVC and increase the security of employment of the CVC workforce.

The improved amenity outcomes and operational cost savings can be achieved with little to no adverse environmental impact given that it will utilise existing infrastructure at an approved mining operation.

1.5 Purpose and context

This SEE describes the proposed modification, provides an assessment of its potential impacts and details measures that will be implemented to prevent and/or minimise 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 CVC and MC operations are considered in this SEE 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 CVC and MC. 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 SSD-5465.

1.6 The applicant

LakeCoal's contact details are as follows:

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

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

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

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

Up until January 2012, the CVC 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 Environmental Planning and Assessment Regulation 2000 meant that an approval under the EP&A Act was required for the CVC's continued operation.

Planning approval for the CVC was granted on 23 January 2012 by the Minister for Planning and Infrastructure under MP10_0161 for the Domains 1 and 2 Continuation Project. This approval was modified on one occasion to enable the revision of the miniwall panel layout and an increase in the maximum extraction width of miniwall panels.

The current approval for the CVC (SSD-5465) was granted by the Minister for Planning and Infrastructure on 23 December 2013. The approval allows for continued mining within the Fassifern Seam and incorporates the operations approved under MP10_0161, as modified. Details of the approved operations are provided in Section 3.1.

2.3 State approvals

2.3.1 NSW Environmental Planning and Assessment Act 1979

Project approvals for SSD may be modified under Section 96 of the EP&A Act. There are three types of modifications under Section 96:

- Section 96(1) modifications involving minor error, misdescription or miscalculation;
- Section 96(1A) modifications involving minimal environmental impact; and
- Section 96(2) other modifications.

The proposed modification is proposed to be made under Section 96(2) as a conservative approach, despite the predicted environmental impacts which are considered to be minimal.

When assessing an application under Section 96 for modification of a consent, the consent authority is required to take into consideration the relevant matters outlined in Section 79C of the EP&A Act. This states:

"(1) Matters for consideration – general

In determining a development application, a consent authority is to take into consideration such of the following matters as are of relevance to the development the subject of the development application:

(a) the provisions of:

(i) any environmental planning instrument, and

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

(iii) any development control plan, and

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

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

(v) any coastal zone management plan (within the meaning of the *Coastal Protection Act 1979*),

that apply to the land to which the development application relates,

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

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

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

(e) the public interest."

The relevant Section 79C matters are considered in this report. Notwithstanding the contents of Section 79C(1)(iii), Clause 11 of the State Environmental Planning Policy (State and Regional Development) 2011 (State and Regional Development SEPP) states that development control plans do not apply to SSD.

2.3.2 NSW Environmental Planning and Assessment Regulation 2000

An application for modification of development consent under Section 96 of the EP&A Act must contain the information stipulated in Clause 115 of the Environmental Planning and Assessment Regulation 2000. The required information, and where it has been addressed in this SEE, is detailed in Table 2.1.

Table 2.1 Clause 115 requirements for Section 96 applications

Requirement	Where addressed in report
The name and address of the applicant.	Section 1.6
A description of the development to be carried out under the consent (as previously modified).	Section 3.1
The address, and formal particulars of title, of the land on which the development is to be carried out.	Section 1.2
A description of the proposed modification to the development consent.	Section 3.2
A statement that indicates either: (i) that the modification is merely intended to correct a minor error, misdescription or miscalculation, or (ii) that the modification is intended to have some other effect, as specified in the statement.	Sections 1.3 and 2.3.1

Table 2.1 Clause 115 requirements for Section 96 applications

Requirement	Where addressed in report
A description of the expected impacts of the modification.	Chapter 5
An undertaking to the effect that the development (as to be modified) will remain substantially the same as the development that was originally approved.	Section 7.2
If the applicant is not the owner of the land, a statement signed by the owner of the land to the effect that the owner consents to the making of the application (except where the application for the consent the subject of the modification was made, or could have been made, without the consent of the owner).	Landowner's consent is not required for SSD mining projects. Landowners will be notified of the application through an advertisement placed in the local newspaper.
A statement as to whether the application is being made to the Court (under section 96) or to the consent authority (under section 96AA).	The application is not being made to the Court (under Section 96) or to the consent authority (under Section 96AA).

2.3.3 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). As identified in Table 5.2, the proposed modification will not have any significant impacts on EECs listed under the TSC Act.

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. LakeCoal currently holds bore licence 20BL173107,

issued under the Water Act, for the purposes of mine dewatering up to a maximum rate of 4,443 ML per annum. No approvals under the WM Act are required for the CVC.

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. Further, no amendment to the Water Act licence will be required.

v Mining Act 1992

The underground linkage will pass within CVC's mining lease (ML 1052) issued under the Mining Act. Condition 34 of ML 1052 states:

> Unless with the consent of the Minister and subject to such conditions as he may stipulate, the registered holder shall not mine for, work, win or remove any coal from within the highwater level subsidence control zone defined in the seam by a line defined by an angle of draw of 35^{o} drawn lakewards from the line drawn vertically beneath the highwater level of Lake Macquarie.

Development of a portion of the underground linkage will involve mining within the highwater level subsidence control zone (referred to in this SEE as the high water mark subsidence barrier – HWMSB). The modification application will be referred to NSW Trade and Investment, Division of Resources and Energy (DRE) for Ministerial approval to satisfy this condition. LakeCoal has advised DRE both verbally and in writing of the nature of the proposed modification (see Table 4.1).

Similar conditions are stipulated in MC's consolidated coal leases (CCL 719 and CCL 721) within which parts of the underground linkage will be located. Approval from the Minister for mining within these leases will also be sought for the modification to MP06_0311.

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 CVC has an existing environment protection licence (EPL) No. 1770 issued under the POEO Act. The licence has been varied several times with a further variation to EPL 1770 to reflect SSD-5465 being submitted on 28 January 2014. The proposed modification will not require further variations to CVC's EPL. Further, no variations will be required to MC's EPL 191.

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.

2.3.4 Environmental planning instruments

Underground mining operations at the CVC 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 2.2.

Table 2.2 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 would 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.
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 or water quality requirements of the Aquifer Interference Policy as detailed in Section 5.3.3. Therefore, this development standard is satisfied.

Operations at the CVC meet the definition of SSD under Schedule 1 of the State and Regional Development SEPP which includes development for the purpose of coal mining.

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 CVC 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 Local Environmental Plan 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 Commonwealth *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 will, 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 development consent and proposed modification

3.1 Approved operations

The approved operations at the CVC were described in the Environmental Impact Statement (EIS) prepared by EMM that accompanied the Mining Extension 1 Project application (SSD-5465) (EMM 2013a). A summary of approved operations at the CVC is given in Table 3.1.

Table 3.1 Summary of approved operations at the CVC

Aspect	Summary
Overview	The CVC's approved operations include: • extraction of up to 1.5 mtpa of ROM coal from the Fassifern Seam until 31 December 2027; • sizing and crushing coal at the CVC's Coal Preparation Plant; • transporting coal by public roads to Port Waratah Coal Services (PWCS) for export; and • transporting coal by private roads to VPPS and by public roads to other customers for domestic use.
Mining and reserves	Underground mining of the Fassifern Seam within Area 1. Estimated additional reserves of 19.5 million tonnes of ROM coal.
Mining methods	Mining undertaken using continuous miner and miniwall mining methods.
Project life	Mining operations are approved until 31 December 2027.
Existing surface infrastructure	Utilisation of existing surface infrastructure, including but not limited to: • personnel-and-material drifts, ROM coal conveyor drift; • upcast and downcast ventilation shaft and fans; • coal handling facilities for breaking, crushing, sizing and storing product coal; • administration and workshop facilities; • water management infrastructure; and • infrastructure upgrades as identified in SSD-5465.
Coal processing	Screening and crushing of ROM coal at the CVC.
Water demand and supply	120 megalitres (ML) per annum in water use, drawn from Wyong Shire Council's potable water supply mains.
Coal reject management	No coal rejects are generated.
Hours of operation	The mining operations are approved 24 hours a day, 7 days a week. Coal transport to VPPS is restricted between 10.00 pm and 5:30 pm to 16 laden trucks per hour during Spring and Autumn, and zero trucks during Winter. Trucks delivering coal on public roads are approved to leave the CVC between 5.30 am and 5.30 pm, Monday to Friday (excluding public holidays).
Product coal transport	The CVC is approved to transport on public roads up to 660,000 tonnes of product coal per annum to PWCS for export and 180,000 tonnes of product coal per annum to domestic customers other than VPPS.
Mine access	Existing road access from Construction Road, off Ruttleys Road.
Rehabilitation	Decommissioning of surface facilities and final rehabilitation following mine closure.
Employment	Employment of 120 full time personnel, as well as 40 full time equivalent contractors.

Additional detail is provided below on the aspects of the CVC relevant to the proposed modification. It is noted that coal extracted at the CVC does not require washing or additional treatment. As a result, ROM coal production equates to product coal production from the CVC.

3.1.1 Mining methods

Underground mining at the CVC consists of two phases: first workings and secondary extraction.

First workings involve the development of roadways, approximately 5.4 m wide and 3.2 m high, by continuous miner methods, with roof and rib support installed as the mining progresses. First workings generally yield low levels of coal extraction and result in negligible surface subsidence.

Secondary extraction involves recovery of the majority of the coal resource through a more efficient extraction method, in this instance miniwall mining, and is therefore the more productive phase of mining. Secondary extraction is generally necessary for the commercial viability of a mine, whereas first workings are necessary to support the secondary extraction through the establishment of roadways for access, conveyor systems, service reticulation, ventilation and other ancillary activities.

Historically, secondary extraction mining methods at the CVC have included both miniwall and bord and pillar mining. Miniwall mining commenced at the CVC in 2011 and is now the sole method of secondary extraction. The miniwall method is similar to the longwall method, where single slices of coal are progressively extracted along a very long face of coal, but involves extraction over a narrower face width (typically less than 100 m) than longwall mining (potentially over 400 m wide). The miniwall method is preferable to the longwall method at the CVC due to the geotechnical, safety and subsidence management considerations, primarily as a consequence of mining activities being undertaken below Lake Macquarie.

First workings for miniwall mining generally consist of the establishment of roadways including main headings and gateroads. The roadways are constructed by mining the coal seam using a wide head continuous miner. The coal produced is then transferred, via electric shuttle car, from the continuous miner onto a conveyor and is conveyed to the surface facilities. Blocks of coal, or pillars, are left in the roadways to create stability in the roof. The main headings (or mains) are a series of roadways (typically four or five) which often run perpendicular to the proposed orientation of miniwall panels and enable the panels to be developed off the main headings. In addition, the mains provide access for equipment and personnel, conveyors, services and are essential for mine ventilation. The gateroads consist of two roads (maingate and tailgate) which run parallel along the sides of the panel. The gateroads are connected at the end of the panel by an installation road which creates the face of the miniwall extraction block. The pillars of coal retained within the gateroads between two panels are referred to as chain pillars.

Secondary extraction involves the mining of the miniwall block which uses two shearing drums (leading and trailing) to cut back and forth across the face. The miniwall block is mined back towards the main headings. As the face is mined, produced coal is dropped onto an armoured conveyor, is crushed and then loaded onto a regular conveyor and transported up the maingate road to the main headings and then to the surface facilities. Hydraulic roof supports known as chocks temporarily hold the roof up where coal has been extracted and provide protection of the operators. As mining progresses, the roof then falls into the void (or goaf) created as the miniwall unit advances, resulting in subsidence. The miniwall block is fully extracted, unless geological or safety considerations require otherwise, back to a solid block (barrier pillar) retained adjacent to the main headings to provide stability in the headings.

No secondary extraction will be undertaken as part of the construction of the underground linkage.

3.1.2 Mining parameters

The mining parameters at CVC have been specifically designed to ensure protection of:

- the Lake Macquarie foreshore – by the use of the HWMSB, consistent with the requirements of the relevant mining leases;
- seagrass communities – by the use of a seagrass protection barrier (SPB) consistent with Conditions 19 and 20 of the existing Subsidence Management Plan approval; and
- land based infrastructure – through the adoption of the HWSMB and confining secondary extraction to areas underlying Lake Macquarie.

LakeCoal has committed to undertaking only first workings within the HWMSB and SPB. Subsidence associated with first workings is generally less than 20 mm. Subsidence less than 20 mm is commonly referred to as 'zero' subsidence as subsidence of less than 20 mm is widely adopted as being imperceptible for all practical purposes because the magnitude of natural, seasonal variations in ground level is commonly greater than 20 mm.

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^{o} 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^{o} angle of draw from the surveyed boundary of the seagrass beds to the depth of the workings.

The maximum vertical subsidence predicted for the CVC, and approved under SSD-5465, is 886 mm where historic workings in the Great Northern and Wallarah seams overlie proposed miniwall panels (MW) (MWs 41 to 45) and 620 mm where no historic workings overlie proposed panels (MWs 1 to 40).

To date mining of MWs 1 to 5 has been completed and MW 6 has been partially extracted. Detailed annual bathymetric surveys have been undertaken since the approval of MP10_0161, having occurred in March 2012 and March 2013 to measure lake depths accurately and calculate subsidence based on comparative analysis between the surveys. The results to date have shown approximately 150 – 200 mm of subsidence in the areas of completed miniwall mining, which is less than the modelled predicted units. Predicted subsidence associated with the proposed modification is detailed in Appendix C and summarised in Section 5.2.

3.1.3 Coal transport

Product coal from the CVC is hauled by truck, either to domestic customers or to the PWCS Carrington Coal Terminal where it is loaded onto ships destined for international customers. Condition 8, Schedule 2 of SSD-5465 permits the transportation of up to 660,000 tonnes to PWCS for export, and up to 180,000 tonnes of product coal to domestic customers other than VPPS.

Haulage of product coal to VPPS does not necessitate trucks travelling on any public roads, with all transport occurring via the CVC's access road and Construction Road, both of which are private, sealed roads.

3.1.4 Environmental management

Environmental management at the CVC is undertaken in accordance with:

- Development Consent SSD-5465 issued on 23 December 2013;
- commitments made in environmental assessments and EISs prepared for the CVC;
- CVC's Environmental Management Strategy and associated documents;
- various environmental management plans, including the CVC's Subsidence Management Plan;
- CVC's EPL; and
- CVC'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).

3.1.5 Mannering Colliery

The MC is an underground coal mine located on the southern side of Lake Macquarie approximately 60 km south of Newcastle (see Figure 1.1). 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, which purchased Centennial in 2010.

Underground mining commenced at 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 mtpa of ROM coal until 31 March 2018, with additional first working mining areas approved on 25 October 2012 (MP06_0311 MOD 1).

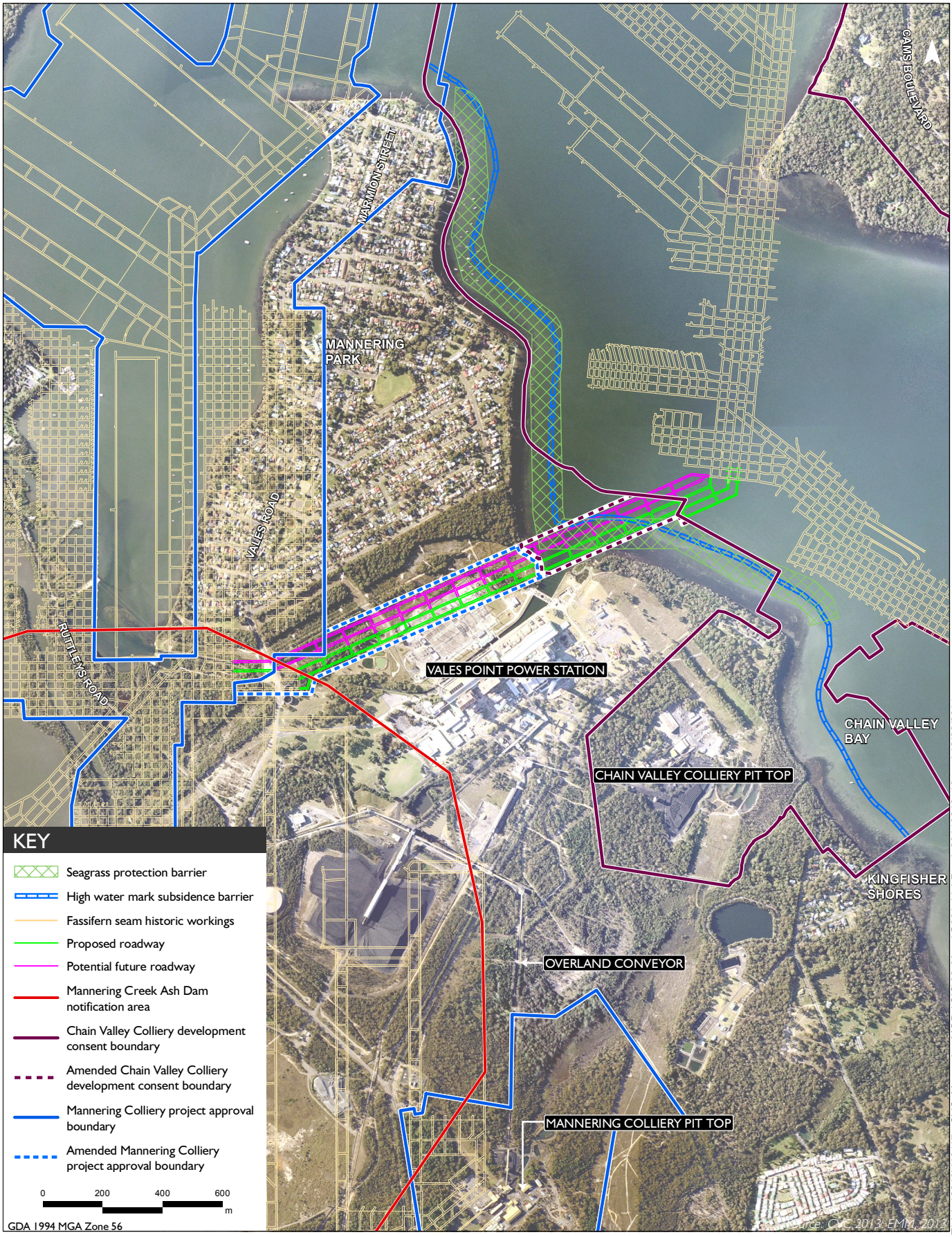
The MC, which has historically provided coal to VPPS for domestic energy generation via a dedicated covered overland conveyor, was placed on care and maintenance in November 2012. As discussed in Section 1.4, LakeCoal has recently entered into an agreement with Centennial which enables LakeCoal to be the operator of MC until 2022. As part of the responsibilities as the operator, LakeCoal also takes on responsibility for the requirements in the existing project approval (MP06_0311) and MC's EPL 191. Accordingly, LakeCoal is responsible for environmental management at the MC, with EPL 191 being transferred from Centennial Mannering Pty Limited to LakeCoal effective 17 October 2013.

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 CVC south-west for approximately 1.6 km to join Fassifern Seam workings at the MC (see 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.



EMM
EMGA Mitchell McLennan

Proposed underground linkage

Chain Valley Colliery – Modification 1

Figure 3.1

Of the two roadways to be developed initially, one will be used for a belt system connecting the CVC belt system into the MC 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 a shuttle car and then onto a conveyor which 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. Remedial and re-commissioning works will be undertaken to ensure MC infrastructure is operational following care and maintenance. The main equipment to be used for construction of the headings (ie the continuous miner) is currently in use at CVC, 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 described in Table 5.2. As identified in Section 5.3, water make is predicted to be negligible and, therefore, will have no measureable impact on the 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.

The construction of the underground linkage will result in a minor adjustment to the CVC's development consent boundary identified in SSD-5465, extending it approximately 500 m to the south-west from the existing boundary limit to the foreshore adjacent to the VPPS where it is proposed to meet the amended MC project approval boundary (see Figure 3.1). The amended development consent boundary is also coincident with the boundaries of ML 1052 and CCL 719.

3.2.2 Utilisation of MC infrastructure

Once the underground connection of the conveyor systems is established, a portion of ROM coal extracted from the 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 MC's project approval (MP06_0311). It is noted that during periods when the 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 will be undertaken using an excavator or front end loader to load the ROM hopper.

The underground linkage headings may be constructed commencing 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 of employees 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 the MC 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.

As described in Section 1.4, truck haulage via internal roads to VPPS from the CVC will become a secondary option, with conveyor transport via the MC workings utilised preferentially. No change to the transport of export coal from the CVC surface facilities is sought under the proposed modification.

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 the CVC via private haul roads in accordance with SSD-5465. Consequently, the improved amenity outcomes, operational cost savings and overall 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 the 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 preparation plant facilities at the CVC;
- the capacity of the 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 the 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 CVC and MC 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 CVC is ongoing and includes the CVC website (chainvalleymine.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 SEE.

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 would be provided.
EPA	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	Briefing letter sent on 19 November 2013 Phone call on 21 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 CVC is ongoing. Information specific to the proposed modification is presented on the CVC website (chainvalleymine.com.au) and presentations related to the proposed modification were made to the CVC CCC.

The CVC CCC meetings during the development of the SEE 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 MC'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 CVC and MC 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 CVC and MC.

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 3.1.2. The proposed first workings within these areas have been designed to limit additional subsidence to less than 20 mm. 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 2.3.3, approval from the Minister for Resources and Energy is required to mine within the HWMSB under ML 1052 and within 20 m of the mine lease boundary.

The existing built surface features above the proposed 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.

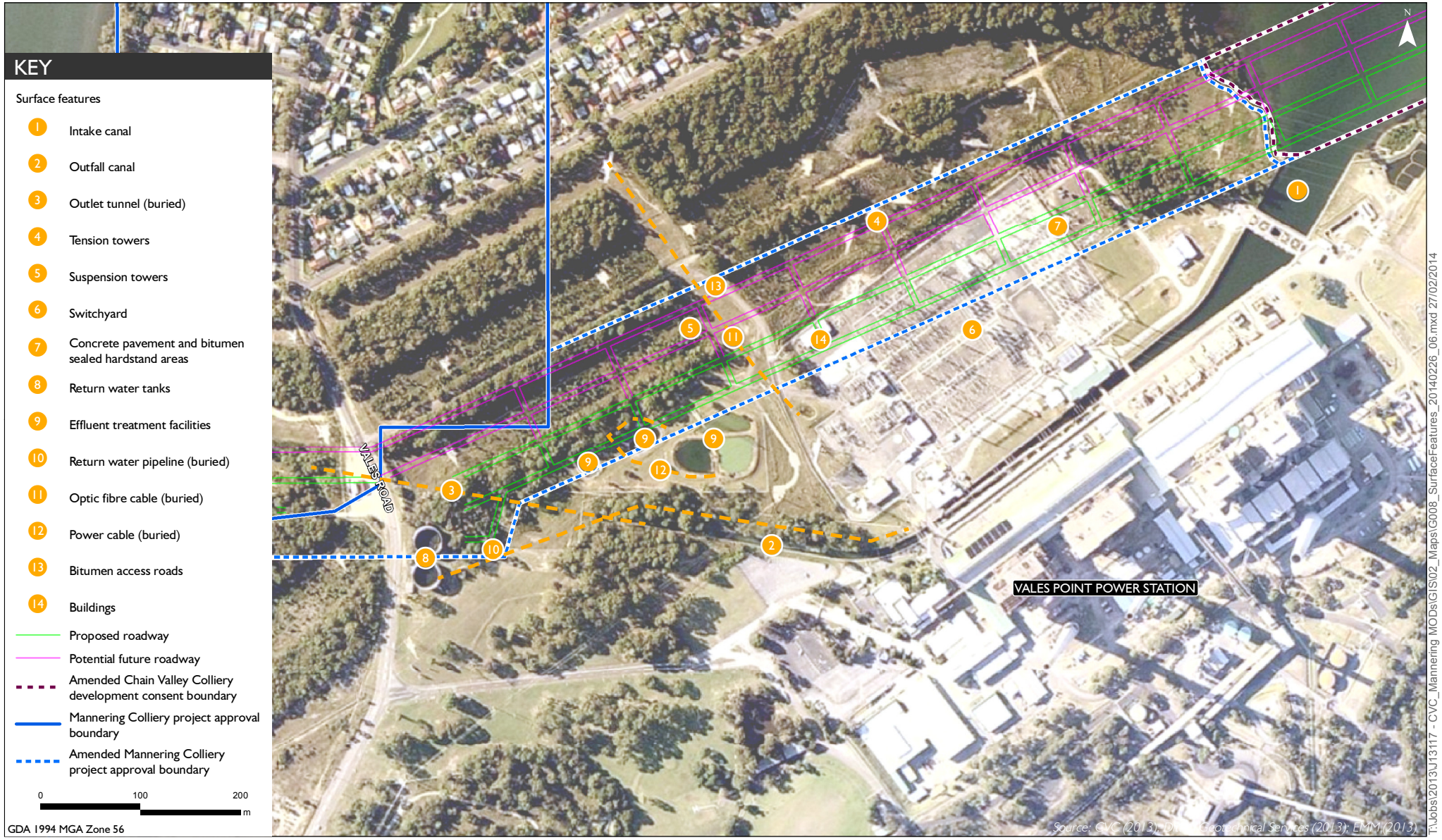
It is noted that in 2009, first workings were completed beneath a section of the Summerland Point foreshore, with subsidence monitoring being undertaken before and subsequent to the mining occurring. Results to date have shown approximately 15 mm of movement above the first workings. Importantly, these first workings were below first workings in the Great Northern Seam and secondary extraction in the Wallarah Seam. These results support the minor impacts modelled for the proposed modification (see Section 5.2.3), especially as there is only a single seam of overlying workings above the proposed linkage.

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.



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Existing surface features

Chain Valley Colliery – Modification 1

Figure 5.1

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 reparable.

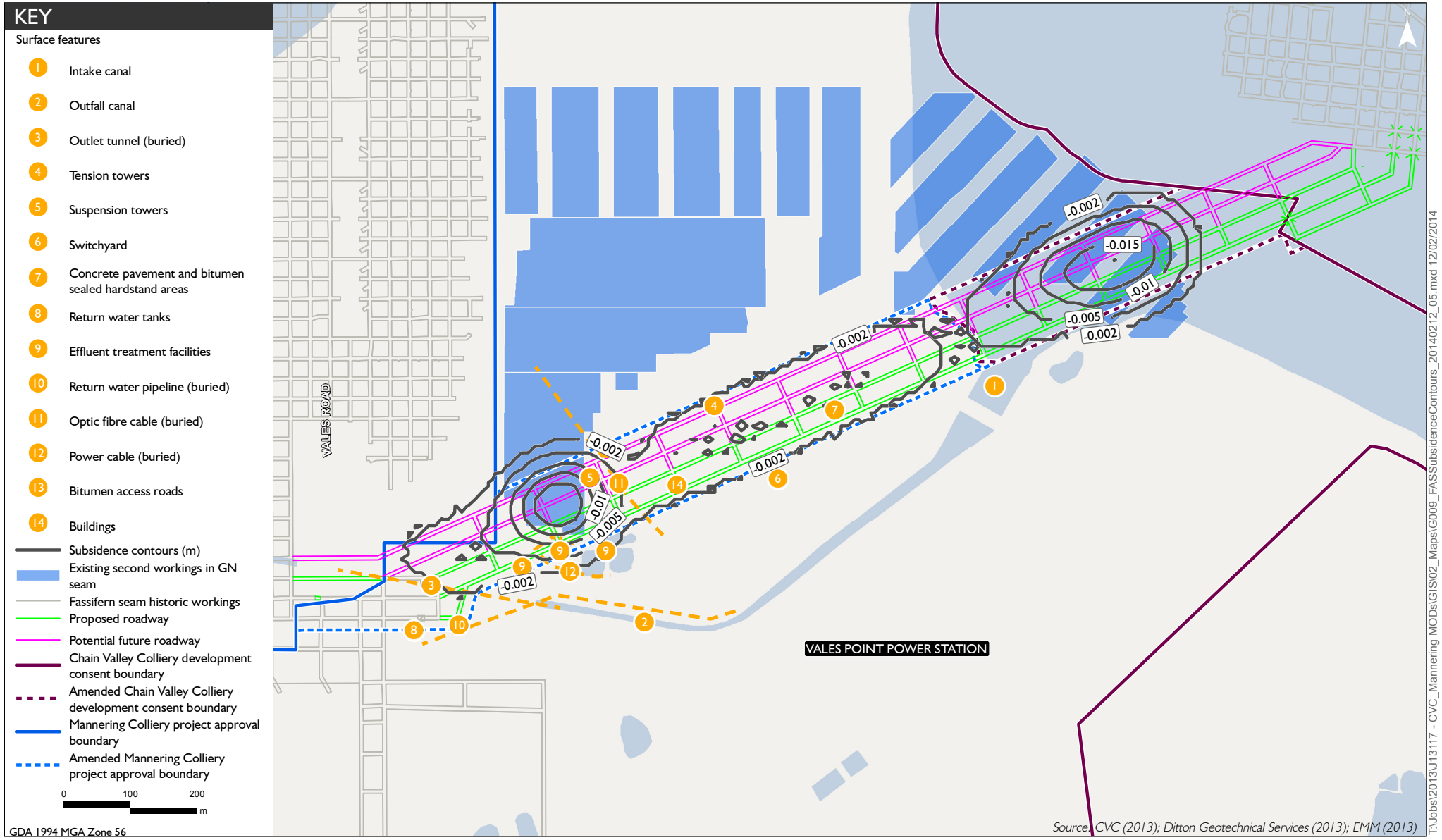
As described in Table 5.2 the change in subsidence levels from the proposed first workings is not predicted to adversely impact seagrasses, dry sclerophyll woodland or lake foreshore vegetation.

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 in 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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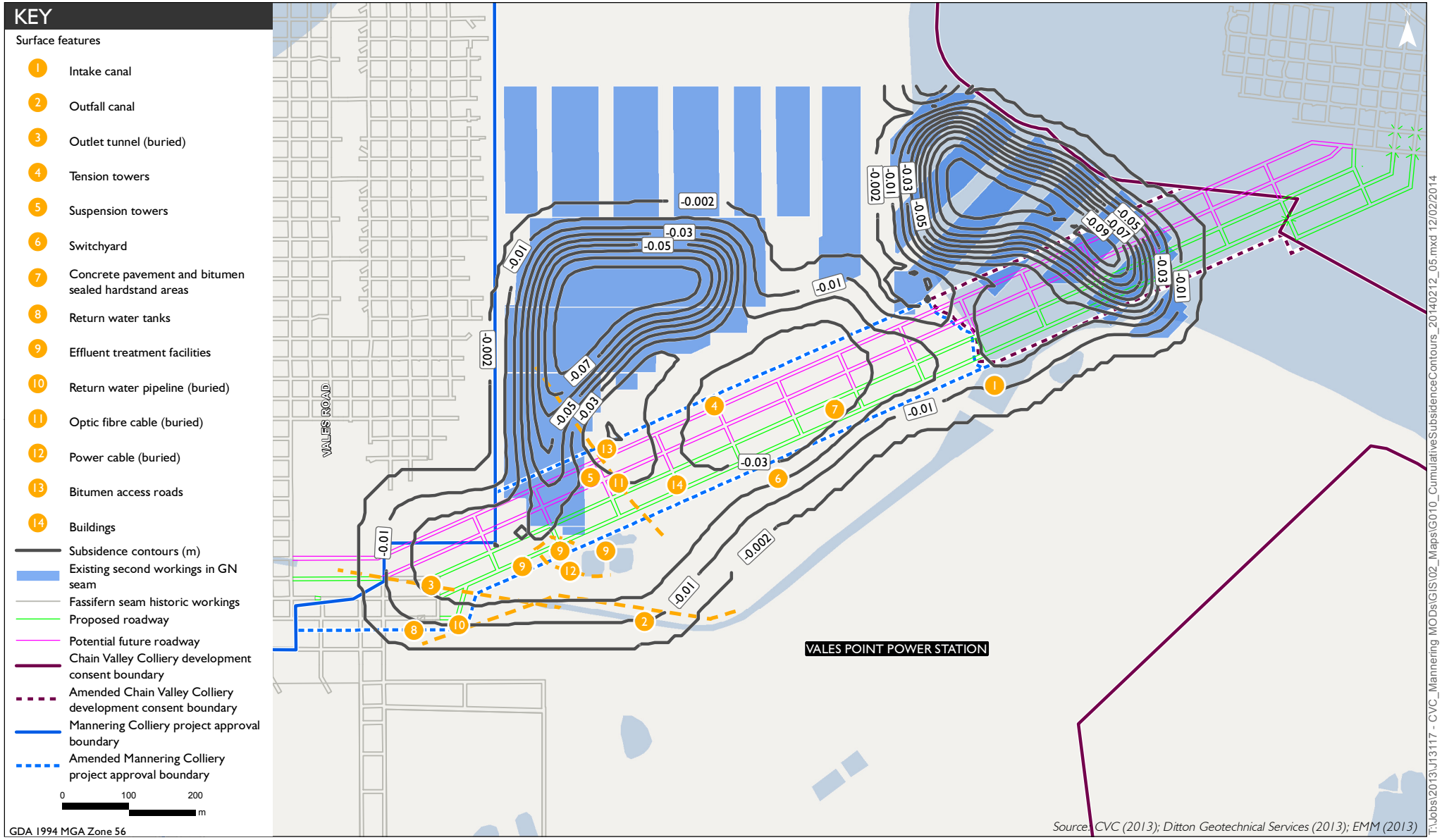
Predicted incremental subsidence contours

Chain Valley Colliery – Modification 1

Figure 5.2



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Predicted cumulative subsidence contours

Chain Valley Colliery – Modification 1

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 (refer to Section 3.1.2). 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 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 Introduction

This groundwater section was prepared by EMM's groundwater service manager, Liz Webb, and reviewed by Geoterra's Managing Geoscientist, Andrew Dawkins.

5.3.2 Existing environment

i Geology

The CVC 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 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	Moon Island Beach Formation	Vales Point Seam
			Karignan Conglomerate
			Wallarah Seam
			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 CVC and MC 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.

5.3.3 Impact assessment

Groundwater modelling was previously undertaken by Geoterra (2013) for the CVC. The groundwater assessment included a fully calibrated numerical groundwater model to predict the extent of groundwater drawdown resulting from the Mining Extension 1 Project.

The groundwater modelling assumed that the fracture height above the areas of secondary extraction (for miniwall widths between 72 and 97 m) ranged between 66 and 89 m above the Fassifern Seam. The median annual groundwater inflow to the Fassifern workings at the CVC is currently 2,773 ML and is predicted to ultimately increase to 3,832 ML once miniwall mining is approaching its fullest lateral extent. The modelling indicates that the approved CVC operations will not produce a significant increase in groundwater inflow (Geoterra 2013).

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 (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.

In the vicinity of the activity are 14 bores, of which seven are potentially used for groundwater extraction, six are test bores and one is a waste disposal bore (Geoterra 2013). Of the bores that are potentially used, one is a converted deep coal exploration bore while the other six are shallow (less than 18.3 m below ground) and only likely to intersect shallow alluvial aquifers.

Impacts on users from the approved CVC operations were assessed as negligible by Geoterra (2013). Based on the outcomes of the subsidence assessment, the construction of the underground linkage is anticipated to have negligible additional impacts.

The Geoterra (2013) groundwater modelling and assessment concluded that there will be negligible, if any, impacts on alluvial groundwater systems. Therefore, it is concluded that groundwater levels and quality within the alluvial aquifer will not be impacted from the construction of the underground linkage.

Groundwater dependent ecosystems (GDEs) were also assessed by Geoterra (2013), with no marine based ecosystems noted to occur.

Negligible impacts on terrestrial ecosystems are anticipated from the approved CVC operations due to the very limited lateral drawdown impacts. For the reasons identified previously, construction of the underground linkage is similarly anticipated to have negligible impact on terrestrial GDEs.

5.3.4 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 CVC lease 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 CVC, LakeCoal applied for a licence under the Water Act. The licence was issued on the 12 March 2013. The licence, 20BL173107, is valid until 11 March 2018 for the purposes of mine dewatering and industrial use, with a volumetric limit of 4,443 ML in any 12 month period.

Given that the volume licensed exceeds the predicted inflow of 3,832 ML/yr associated with the approved CVC operations, the negligible groundwater inflow associated with the underground linkage is to be managed under CVC's existing Water Act licence.

To determine if the proposed modification would 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). Based on the results of the Geoterra (2013) groundwater assessment for the Mining Extension 1 Project, it was considered that the approved operations would not be classified as being likely to, or having a significant impact. Similarly, no impacts on 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.

5.3.5 Mitigation and management

Groundwater impacts associated with the CVC are managed under LakeCoal's Water Management Plan, developed in consultation with NOW, OEH and DRE.

The Water Management Plan includes a commitment that all groundwater extracted will be metered and accounted for within its licensed entitlement and requires annual reporting of groundwater inflow volumes against model predictions and licensed volumetric limits.

No additional management or monitoring measures are warranted as a result of the proposed modification.

5.3.6 Conclusion

Based on the outcomes of the groundwater modelling undertaken for the approved CVC 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 environmental, social and economic aspects

An assessment of the environmental, social and economic aspects covered in the Mining Extension 1 Project EIS (other than for subsidence and groundwater addressed above) as a consequence of the proposed modification is given in Table 5.2. This method of assessment is commensurate with the outcomes of the risk assessment undertaken and 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 of these aspects will continue in accordance with the processes and procedures outlined in Section 3.1.4.

Table 5.2 Other environmental, social and economic aspects

Environmental aspect	Assessment
Surface water	The surface water management system for the CVC was most recently assessed as part of the Mining Extension 1 Project (GSS Environmental 2013). A Water Management Plan has been prepared for the CVC which contains a site water balance, an Erosion and Sediment Control Plan, Surface Water Management Plan, Groundwater Monitoring Program and a Surface and Groundwater Response Plan. Water entering the mine is pumped to the pit top area. Mine water and surface runoff is managed through a series of 13 interconnected sediment ponds. Water is discharged at a licensed discharge point (EPL 1770-LDP) on Swindles Creek, a tributary of Lake Macquarie. The proposed modification will not alter this arrangement and the volume of mine water generated is not projected to materially change and be within the bounds of historic variations. Additionally, no above ground surface disturbance or alterations to surface infrastructure are proposed which could lead to changes in surface water flows.
Geology and soils	Erosion and sedimentation, surface cracking, contamination and acid sulphate soils associated with the surface facilities and activities have been assessed as part of the Mining Extension 1 Project EIS (EMM 2013a). 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 above, the existing Water Management Plan includes an Erosion and Sediment Control Plan for management of soils. The proposed modification does not involve any above ground surface disturbance and, therefore, geology and soil impacts are unlikely.
Biodiversity (terrestrial)	The discharge of water from the final sediment pond passes through a vegetated area adjacent to the sedimentation ponds before draining into Swindles Creek via the licensed discharge point. This vegetated area was identified by EMM (2013a) as Swamp Oak Floodplain Forest which is an EEC listed under the TSC Act. The assessment of ecological impacts undertaken for the Mining Extension Project 1 (EMM 2013a) determined that the discharge of water was unlikely to have a significant impact on this EEC. However, changes in the condition and composition of the community are being monitored in accordance with the CVC's Biodiversity Management Plan. The quality and volumes of mine water discharged under the proposed modification will not be significantly changed and will be within the bounds of historic variations. Therefore, no significant impacts on the Swamp Oak Floodplain Forest EEC are anticipated. As noted in the Section 5.2, the proposed workings will also occur beneath an area of dry sclerophyll woodland and lake foreshore vegetation. Given the proposed modification will result in imperceptible or 'zero' subsidence and no surface disturbance is proposed, no direct or indirect impact on these areas of vegetation are anticipated.
Biodiversity (aquatic)	Benthic communities have previously been surveyed above areas of secondary extraction to determine the potential impacts of subsidence. As reported in JSA Environmental (2013) these surveys determined that abundance and community assemblage were not strongly linked to site type (including depth). Additionally, further analysis of the data identified that complex environmental variables including interactions between depth, dissolved oxygen levels, turbidity and sediment composition were influencing community assemblage. The imperceptible levels of subsidence predicted under the proposed modification are, therefore, unlikely to impact benthic organisms. The CVC's Benthic Communities Management Plan will continue to be implemented under the proposed modification and updated in accordance with Schedule 3 Condition 7 of SSD-5465. As described in Section 3.1.2, seagrasses are actively protected at the CVC through the implementation of the SPB. Extensive mapping of seagrass communities was undertaken for the Mining Extension 1 Project (JSA Environmental 2013) building on mapping undertaken for existing mining areas which was used to determine the SPB. LakeCoal also implements a seagrass management plan, with annual seagrass surveys monitoring seagrass diversity and density. 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 would be highly unlikely to adversely impact any seagrasses present. However, surveys conducted for this area showed an absence of seagrasses.

Table 5.2 Other environmental, social and economic aspects

Environmental aspect	Assessment
	There is moderate potential for three endangered marine species to occur above areas of predicted subsidence within Lake Macquarie including the Loggerhead and Green turtles and the seagrass *Posidonia australis*. 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. As noted in the 'surface water' section above, the volume of mine water generated is not projected to materially change and will be within the bounds of historic variations. 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	The CVC currently transports coal via private road to VPPS or via public roads to other domestic users and to Port Waratah Coal Services in the Port of Newcastle. Consistent with its commitment to pursue alternative transport options to reduce or eliminate the transport of coal from the CVC on public roads, LakeCoal is currently investigating options to haul coal via rail. Other traffic generation from the CVC includes employee movements, waste collection and deliveries. There will not be any increase in coal transport truck movements, or employee numbers at CVC due to the proposed modification. Existing coal transport is subject to a road maintenance agreement with Wyong Shire Council which will not be affected by the proposed modification. Truck deliveries of plant and equipment for the underground linkage are expected to be minor and within current daily truck numbers. Therefore, there will not be any impacts additional to those currently approved for the CVC.
Noise	Noise emissions from the CVC's operations are currently managed in accordance with a Noise Management Plan which includes implementation of a real-time noise monitoring system. Potentially sensitive receivers are located in Mannering Park, Kingfisher Shores and Chain Valley Bay. The noise assessment for the Mining Extension 1 Project (EMM 2013b) predicted that worst case operational noise would comply with relevant noise criteria at the majority of sensitive receivers. Existing traffic noise levels for roads along the CVC's coal transport route to PWCS currently exceed relevant day and night noise criteria even in the absence of any CVC related traffic. 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 Mannering approval, noise emissions at the CVC will be reduced when using 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 noise.
Air quality and greenhouse gasses	Air quality and greenhouse gas emissions from the CVC are managed in accordance with an Air Quality and Greenhouse Gas Management Plan. An air quality monitoring network comprising five dust deposition gauges and one real-time PM_{10} monitor, and greenhouse gas monitoring through measurement of ventilation shaft emissions and reporting against the National Greenhouse and Energy Reporting Scheme requirements, are currently undertaken. Similarly to noise emissions, potential sensitive receivers are located in Mannering Park, Kingfisher Shores and Chain Valley Bay. The air quality and greenhouse gas impact assessment for the Mining Extension 1 Project (Pacific Environment Limited 2013) found that emissions from the CVC are below relevant impact assessment criteria at all assessment locations. 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 the CVC will likely be reduced when using 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 air quality. GHG emissions associated with the construction of the underground linkage will be minimal and will be managed in accordance with the Air Quality and Greenhouse Gas Management Plan.
Heritage	The Mining Extension 1 Project EIS (EMM 2013a) assessed potential impacts of the CVC on heritage. No items of historic heritage were identified in the vicinity of the CVC and no impact on Aboriginal

Table 5.2 Other environmental, social and economic aspects

Environmental aspect	Assessment
	sites was predicted as all identified sites were located outside areas of subsidence greater than 20 mm or areas of proposed disturbance. Potential heritage impacts are managed through the CVC's Heritage Management Plan. There will be no impacts on heritage associated with the proposed modification as no above ground surface disturbance is proposed and predicted subsidence will be less than 20 mm, commonly referred to as zero subsidence.
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 22 of SSD-5465.
Social and economic	The Mining Extension 1 Project EIS (EMM 2013a) assessed potential social and economic impacts from continued operation of the CVC and found that there would be positive impacts associated with continued employment, revenue contributions and community support. In accordance with Schedule 2, Condition 12 of SSD-5465, LakeCoal will continue to make contributions annually for the purposes of both improving public infrastructure and community projects. LakeCoal is currently in the process of establishing an agreement with Wyong Shire Council to facilitate payments as required under SSD-5465. Approval of the proposed modification will enhance the economic viability of the CVC, thereby reinforcing the previously identified positive socio-economic outcomes. 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 and provide for additional employment at the MC above the current care and maintenance level. This would more than compensate for the loss of up to nine full time contractor positions at CVC.
Waste management	The CVC's waste streams and management procedures were described in the Mining Extension 1 Project EIS (EMM 2013a). Waste is managed according to OEH guidelines and Schedule 3, Condition 23 of SSD-5465. Consistent with this condition and continual improvement in waste management, LakeCoal has implemented a total waste management system at the CVC. The proposed modification will not generate any additional waste streams or increase existing waste volumes.
Hazards/risks	The CVC's surface facilities are on land mapped by Wyong Shire Council as bushfire prone. Bushfire risk at the CVC is managed in accordance with Schedule 3, Condition 24 of SSD-5465 and the management principles in NSW Rural Fire Service 2006 *Planning for bushfire protection.* Existing bushfire management measures, such as the provision of asset protection zones and access, were described in the Mining Extension 1 Project EIS (EMM 2013a). The proposed modification will not increase bushfire risk as there will not be any additional above ground surface disturbance or intensification of activities. 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. 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

Table 5.2 Other environmental, social and economic aspects

Environmental aspect	Assessment
	a set distance apart (for example 20 m from either lease boundary or 40 m apart) and then pumping the void between the seals with a foaming cement or similar product.
Rehabilitation	The mine closure and rehabilitation measures for the CVC are described in the Mining Extension 1 Project EIS (EMM 2013a) and the CVC's MOP and Rehabilitation Management Plan. Mine closure and rehabilitation will be in accordance with Condition 25 of Schedule 3 of SSD-5465 with the surface facilities to be rehabilitated to the satisfaction of the Executive Director Mineral Resources. 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.

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 3.1.4. Table 6.1 provides commitments specific to aspects of the proposed modification relevant to CVC and are additional to those identified in SSD-5465. Additional commitments relating to subsidence, identified in Section 5.2.4, are relevant only to MC and are included in the application to modify MP06_0311.

Table 6.1 Commitments

Aspect	Commitment
Subsidence	Install a new foreshore survey line above the first and second workings panels where the underground linkage passes beneath them and possibly extending from the foreshore to the point of connection with the MC workings.
	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 Substantially the same development

The proposed modification constitutes a minor change to an existing underground mine that has been operating successfully for over 50 years. The proposed modification does not seek approval to extend the area of second workings, modify surface infrastructure, increase production volumes, employee numbers beyond approved levels, water demand, project life or hours of operation. Predicted levels of subsidence will be less than 20 mm which will not have significant impacts on surface features or aquatic ecology.

The proposed modification is, therefore, considered substantially the same as the approved development.

7.3 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 CVC with MC, thereby providing an opportunity to improve the operational efficiency and economic viability of the CVC.

The minimal/negligible potential environmental impacts associated with the proposed modification will be managed in accordance with the CVC's contemporary approval issued on 23 December 2013 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 CVC.

(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 stated in the EIS for SSD-5465 and the associated development consent.

(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 SEE 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 SEE. 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 the CVC to the VPPS will provide for an improved amenity outcome.

Continued operation of the CVC in accordance with SSD-5465 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 SEE 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 SEE through existing LakeCoal engagement tools and will continue to be involved and consulted through the CVC's CCC and other mechanisms. The community will also have chance to comment on the application during the public exhibition process.

7.4 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 CVC, as approved under SSD-5465, 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 CVC operations which will result in improved amenity outcomes, operational cost savings, increased employment at MC and increased security of employment at CVC, all of which can be achieved with little to no adverse environmental impact and, as substantiated in this chapter, is aligned with the principles of ESD.

References

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

EMGA Mitchell McLennan Pty Limited (EMM) 2013a, *Chain Valley Colliery Mining Extension 1 Project – Environmental Impact Statement*. Report prepared for LakeCoal Pty Limited May 2013.

EMM 2013b, *Chain Valley Colliery Mining Extension 1 Project – Noise Impact Statement*. Report prepared for LakeCoal Pty Limited March 2013.

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

GSS Environmental 2013, *Chain Valley Colliery Mining Extension 1 Project – Surface Water Assessment.* Report prepared for LakeCoal Pty Limited March 2013.

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

Pacific Environment Limited 2013, *Chain Valley Colliery Mining Extension 1 Project – Air Quality and Greenhouse Gas Impact Assessment.* Report prepared for LakeCoal Pty Limited February 2013.

Abbreviations

Centennial Coal Company	Centennial
Chain Valley Colliery	CVC
community consultative committee	CCC
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 community	EEC
Environment Protection and Biodiversity Conservation Act 1999	EPBC Act
Environment Protection Authority	EPA
Environment Protection Licence	EPL
Environmental Impact Statement	EIS
Environmental Planning and Assessment Act 1979	EP&A Act
Fisheries Management Act 1994	FM Act
Groundwater dependent ecosystems	GDEs
hectares	ha
high water mark subsidence barrier	HWMSB
kilometre	km
LakeCoal Pty Ltd	LakeCoal
local government areas	LGAs
Mannering Colliery	MC
megalitre	ML
metre	m
million tonnes per annum	mtpa
Mining Act 1992	Mining Act
Mining Operations Plan	MOP
miniwall	MW
national environmental significance	NES
NSW Office of Water	NOW
NSW Planning & Infrastructure	P&I
Office of Environment and Heritage	OEH
Port Waratah Coal Services	PWCS
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 (State and Regional Development) 2011	State and Regional Development SEPP

Abbreviations (cont.)

State significant development	SSD
Statement of Environmental Effects	SEE
Threatened Species Conservation Act 1995	TSC Act
Vales Point Power Station	VPPS
Water Act 1912	Water Act
Water Management Act 2000	WM Act

Appendix A

Development Consent SSD-5465

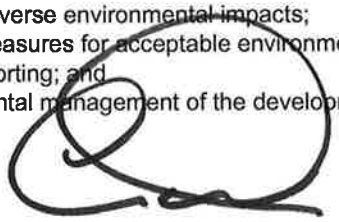
Development Consent

Section 89E of the *Environmental Planning & Assessment Act 1979*

As delegate of the Minister for Planning and Infrastructure, I approve the development application referred to in Schedule 1, subject to the conditions in Schedules 2 to 6.

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 development.



Chris Wilson
Executive Director
Development Assessment Systems and Approvals

Sydney 23. DECEMBER 2013

SCHEDULE 1

Application Number:	SSD-5465
Applicant:	LakeCoal Pty Limited
Consent Authority:	Minister for Planning and Infrastructure
Land:	See Appendix 1
Development:	Chain Valley Extension Project

TABLE OF CONTENTS

DEFINITIONS

Adaptive management	Adaptive management includes monitoring subsidence impacts and subsidence effects and, based on the results, modifying the mining plan as mining proceeds to ensure that the effects, impacts and/or associated environmental consequences remain within predicted and designated ranges and in compliance with the conditions of this consent
Annual Review	The review required by Condition 4 of Schedule 6
Applicant	LakeCoal Pty Limited, or any other person or persons who rely on this consent to carry out the development that is subject to this consent
Approved mine plan	The mine plan show in Appendix 3, as varied by any Extraction Plan approved under this consent
BCA	Building Code of Australia
Built features	Any building or work erected or constructed on land or water, and includes dwellings and infrastructure such as any formed road, street, path, walk, marina or driveway; any pipeline, water, sewer, telephone, gas or other service main
CCC	Community Consultative Committee
Coal haulage route	The route proposed in the EIS for haulage of coal by trucks between the site and Port Waratah Coal Services (as shown in Appendix 5).
Conditions of this consent	Conditions contained in Schedules 2 to 6 inclusive
Construction	The demolition of buildings or works, carrying out of works and erection of buildings covered by this consent
Day	The period from 7am to 6pm on Monday to Saturday, and 8am to 6pm on Sundays and Public Holidays
Delta Electricity	Delta Electricity, or future owners of the Vales Point Power Station
Department	Department of Planning and Infrastructure
Development	The development described in the EIS
Director-General	Director-General of the Department, or delegate
DPI Fisheries	Fisheries Division of the Department of Primary Industries
DRE	Division of Resources and Energy, within the Department of Trade & Investment, Regional Infrastructure & Services
EA	Environmental Assessment titled '*Environmental Assessment – Chain Valley Colliery Domains 1 and 2 Continuation Project*' dated July 2010 and associated response to submissions titled '*Submissions Report – Chain Valley Colliery Domains 1 and 2 Continuation Project',* dated 14 November 2011
EIS	Environmental Impact Statement titled '*Chain Valley Colliery Mining Extension 1 Project*' dated 28 May 2013, as modified by the response to submissions, titled '*Chain Valley Colliery Mining Extension 1 Project* Response to Submissions', dated August 2013, and the letter by EMM to the Applicant, dated 29 October 2013
Endangered population	As defined under the *Fisheries Management Act 1994*
Environmental consequences	The environmental consequences of subsidence impacts, including: damage to built features; loss of surface water flows to the subsurface; loss of standing pools; slope changes to streams; adverse water quality impacts; development of iron bacterial mats; landslides; damage to Aboriginal heritage sites; impacts on aquatic ecology; and ponding.
EPA	Environment Protection Authority
EP&A Act	*Environmental Planning and Assessment Act 1979*
EP&A Regulation	*Environmental Planning and Assessment Regulation 2000*
EPL	Environment Protection Licence issued under the POEO Act
	Executive Director Mineral Resources within DRE, or the equivalent role
Evening	The period from 6pm to 10pm
Feasible	Feasible relates to engineering considerations and what is practical to build or carry out
First workings	Development of the main headings and gateroads in the underground mining area
Ha	Hectare
Heritage item	An item as defined under the *Heritage Act 1977* and/or an Aboriginal object or Aboriginal place as defined under the *National Parks and Wildlife Act 1974*
High Water Mark Subsidence Barrier	The area of land defined: a) on the surface by the highwater level of Lake Macquarie and a point 2.44 metres in elevation above that highwater level; and b) in the seam, where it is intersected by lines: • drawn landwards from all points 2.44 metres elevation above the highwater level of Lake Macquarie; and

	• drawn lakewards from the highwater level of Lake Macquarie, at an angle of 35 degrees from the vertical.
Incident	A set of circumstances that: • causes or threatens to cause material harm to the environment; and/or • breaches or exceeds the limits or performance measures/criteria in this consent
Land	As defined in the EP&A Act, except for where the term is used in the noise and air quality conditions in Schedule 3 of this consent 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 consent
LMCC	Lake Macquarie City Council
Material harm to the environment	Actual or potential harm to the health or safety of human beings or to ecosystems that is not trivial
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
Mitigation	Activities associated with reducing the impacts of the development
MSB	Mine Subsidence Board
NCC	Newcastle City Council
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
OEH	Office of Environment and Heritage
Peak hour periods	7 am to 9 am and 4:30 pm to 6 pm weekdays
POEO Act	*Protection of the Environment Operations Act 1997*
Privately-owned land	Land that is not owned by a public agency, Delta Electricity or a mining company (or its subsidiary)
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
Reasonable costs	The costs agreed between the Department and the Applicant for obtaining independent experts to review the adequacy of any aspects of the Extraction Plan, or where such costs cannot be agreed, the costs determined by a dispute resolution process
Rehabilitation	The treatment or management of land disturbed by the development for the purpose of establishing a safe, stable and non-polluting environment
Remediation	Activities associated with partially or fully repairing or rehabilitating the impacts of the development or controlling the environmental consequences of this impact
Road Maintenance Agreement	The document prepared by McCullough Robertson Lawyers and titled '*Road Maintenance Agreement*', signed by WSC on 1 July 2013 and by LakeCoal on 5 July 2013
ROM coal	Run-of-mine coal
RMS	Roads and Maritime Services
Safe, serviceable & repairable	Safe means no danger to users who are present; serviceable means available for its intended use; and repairable means damaged components can be repaired economically
Second workings	Extraction of coal by miniwall or pillar extraction methods
Site	All land within the Development Area (see Appendices 1, 2 and 3)
Statement of commitments	The Applicant's commitments in Appendix 9
Subsidence	The totality of subsidence effects, subsidence impacts and environmental consequences of subsidence impacts
Subsidence effects	Deformation of the ground mass due to mining, including all mining-induced ground movements, such as vertical and horizontal displacement, tilt, strain and curvature
Subsidence impacts	Physical changes to the ground and its surface caused by subsidence effects, including tensile and shear cracking of the rock mass, localised buckling of strata caused by valley closure and upsidence and surface depressions or troughs
Surface facilities sites	The Chain Valley Colliery surface facilities site; the Summerland Point ventilation shaft site; and any other site subject to existing or proposed surface disturbance associated with the development
Threatened Species	As defined under the *Threatened Species Conservation Act 1995* and the *Environment Protection and Biodiversity Conservation Act 1999*
WSC	Wyong Shire Council

SCHEDULE 2
ADMINISTRATIVE CONDITIONS

OBLIGATION TO MINIMISE HARM TO THE ENVIRONMENT

1. In addition to meeting the specific performance criteria established under this consent, the Applicant shall implement all reasonable and feasible measures to prevent and/or minimise any harm to the environment that may result from the construction, operation, or rehabilitation of the development.

TERMS OF CONSENT

2. The Applicant shall carry out the development generally in accordance with the:
   (a) EA;
   (b) EIS;
   (c) statement of commitments; and
   (d) conditions of this consent.

   Note: The general layout of the development is shown in Appendices 2 to 4

3. If there is any inconsistency between the above documents, the more recent document shall prevail to the extent of the inconsistency. However, the conditions of this consent shall prevail to the extent of any inconsistency.

4. The Applicant shall comply with any reasonable requirement/s of the Director-General arising from the Department's assessment of:
   (a) any strategies, plans, programs, reviews, audits, reports or correspondence that are submitted by the Applicant in accordance with this consent; and
   (b) the implementation of any actions or measures contained in these documents.

LIMITS ON CONSENT

Mining Operations

5. The Applicant may carry out mining operations on the site until 31 December 2027.

   Note: Under this consent, the Applicant is required to rehabilitate the site and perform additional undertakings to the satisfaction of either the Director-General or the Executive Director Mineral Resources. Consequently this consent will continue to apply in all other respects other than the right to conduct mining operations until the rehabilitation of the site and these additional undertakings have been carried out satisfactorily.

Coal Extraction

6. The Applicant shall not extract more than 1.5 million tonnes of ROM coal from the site in any calendar year.

Coal Transport – Public Roads

7. The Applicant shall ensure that no laden coal trucks are dispatched from the site to public roads outside of the hours of 5:30 am to 5:30 pm, Monday to Friday, and not at all on Saturdays, Sundays or public holidays.

8. The Applicant shall not dispatch from the site more than:
   (a) 660,000 tonnes of product coal in any calendar year to Port Waratah Coal Services for export;
   (b) 180,000 tonnes of product coal in any calendar year to domestic customers other than Vales Point Power Station;
   (c) a total of 270 laden coal trucks per day by public roads;
   (d) a total of 32 laden coal trucks per hour; and
   (e) an average of 16 laden coal trucks per hour by public roads during peak hour periods, calculated monthly, until the intersection of M1 Motorway and Sparks Road Interchange (East Side - unsignalised with stop sign) is upgraded to a signalised intersection.

Coal Transport – Vales Point Power Station

9. The Applicant shall ensure that only private roads are used for the transport of coal by truck to Vales Point Power Station, except in an emergency. In an emergency, product coal may be transported by public roads, with the prior written approval of the Director-General, and subject to any restrictions that the Director-General may impose.

10. The Applicant shall restrict the transport of coal by truck to the Vales Point Power Station between 10 pm and 5:30 am to:

(a) 16 laden trucks per hour for the Spring and Autumn months; and
(b) zero during Winter months.

PLANNING AGREEMENT

11. Within 12 months of the date of this consent, unless otherwise agreed by the Director-General, the Applicant shall enter into a planning agreement with the WSC in accordance with Division 6 of Part 4 of the EP&A Act that provides for payment to the WSC for community enhancement purposes.

The agreement must include provision for those matters set out in condition 12 below.

If there is any dispute between the Applicant and WSC relating to the preparation or implementation of the planning agreement, then either party may refer the matter to the Director-General for resolution.

COMMUNITY ENHANCEMENT

12. The Applicant shall pay WSC $0.035 for each tonne of product coal dispatched from the site for the purposes of improving public infrastructure and providing community projects for the communities of Summerland Point, Gwandalan, Chain Valley Bay and Mannering Park. Payments from the date of approval of project approval 10_0161 must be:
(a) based on weighbridge records of the quantity of product coal transported from the site;
(b) paid by the date required by the invoice issued by Council; and
(c) increased over the life of the project in accordance with the Australian Bureau of Statistics Consumer Price Index.

SURRENDER OF EXISTING PROJECT APPROVAL

13. Within 12 months of the date of this development consent, unless the Director-General agrees otherwise, the Applicant shall surrender its project approval for the Chain Valley Colliery Domains 1 & 2 Continuation Project (10_0161) to the satisfaction of the Director-General, in accordance with section 75YA of the EP&A Act.

Note: This requirement does not extend to the surrender of construction and occupation certificates for existing and proposed building works under Part 4A of the EP&A Act. Surrender of a consent or approval should not be understood as implying that works legally constructed under a valid consent or approval can no longer be legally maintained or used.

14. Prior to the surrender of the existing project approval, the conditions of this consent (including any notes) shall prevail to the extent of any inconsistency with the conditions of the existing project approval (10_0161).

STRUCTURAL ADEQUACY

15. The Applicant shall ensure that all new buildings and structures, and any alterations or additions to existing buildings and structure, that are part of the development are constructed in accordance with:
(a) the relevant requirements of the BCA; and
(b) any additional requirements of the MSB where the building or structure is located on land within declared Mine Subsidence Districts.

Notes:
- *Under Part 4A of the EP&A Act, the Applicant 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 development; and*
- *Under Section 15 of the Mine Subsidence Compensation Act 1961, the Applicant is required to obtain the MSB's approval before constructing any improvements in a Mine Subsidence District.*

DEMOLITION

16. The Applicant 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

17. The Applicant shall ensure that all plant and equipment used at the site is:
(a) maintained in a proper and efficient condition; and
(b) operated in a proper and efficient manner.

STAGED SUBMISSION OF STRATEGIES, PLANS OR PROGRAMS

18. With the approval of the Director-General, the Applicant may submit any strategies, plans or programs required by this consent on a progressive basis. Strategies, plans or programs approved under the project

approval for the Chain Valley Colliery Domains 1 & 2 Continuation Project (10_0161) continue to apply to the development, until revised strategies, plans or programs required under the terms of this development consent are approved by the Director-General.

Notes:

- *While any strategy, plan or program may be submitted on a progressive basis, the Applicant will need to ensure that the existing operations on site are covered by suitable strategies, plans or programs at all times.*
- *If the submission of any strategy, plan or program is to be staged, then the relevant strategy, plan or program must clearly describe the specific stage to which the strategy, plan or program applies, the relationship of this stage to any future stages, and the trigger for updating the strategy, plan or program.*

ROAD MAINTENANCE CONTRIBUTION

19. The Applicant must pay Road Maintenance Fees to WSC in accordance with its Road Maintenance Agreement with WSC.

SCHEDULE 3
ENVIRONMENTAL CONDITIONS – GENERAL

TRANSPORT

Monitoring of Coal Transport

1. The Applicant shall:
   (a) keep accurate records of the amount of coal transported from the site (on a weekly basis); and
   (b) make these records publicly available on its website at the end of each calendar quarter.

Road Works

2. The Proponent shall upgrade the Ruttleys Road and Construction Road intersection within 6 months of the date of this consent, unless the Director-General directs otherwise, by:
   (a) installing additional signage on and adjacent to Construction Road prior to the intersection;
   (b) repairing the surface of Construction Road as required and ensuring the edge seal of the left turn lane is of sufficient width to accommodate coal trucks;
   (c) installing or replacing "Stop" signs in accordance with Austroads guidelines;
   (d) repainting road line markings and raised pavements associated with this intersection; and
   (e) installing barriers to prevent trucks parking on the gravel area adjacent to the intersection and the electricity substation located in the vicinity of this intersection.

   The design and construction of these works must be undertaken in consultation with, and to the relevant satisfaction of, WSC, RMS and Delta Electricity and to the satisfaction of the Director-General.

Road Transport Protocol

3. The Applicant shall prepare and implement a Road Transport Protocol to the satisfaction of the Director-General. This protocol shall:
   (a) be prepared in consultation with RMS, NCC, WSC, DRE and CCC and submitted to the Director-General for approval within 6 months of the date of this consent;
   (b) describe the designated haulage routes to be used (as shown in Appendix 5); the maximum number of road movements proposed and the haulage hours permitted under this consent;
   (c) include a Traffic Management Plan, which includes:
      - procedures to ensure that drivers adhere to the designated haulage routes;
      - measures to maximise the use of a low frequency (regular) trucking schedule rather than an intermittently-high frequency (campaign) trucking schedule, especially during the morning peak hour;
      - contingency plans to apply when (for example) the designated haulage route is disrupted, including procedures for notifying relevant agencies and affected communities of the need to implement such contingency plans;
      - procedures to ensure that all haulage vehicles associated with the development are clearly distinguishable as Chain Valley Colliery coal haulage trucks;
      - details of procedures for receiving and addressing complaints from the community concerning traffic issues associated with truck movements to and from the site;
      - measures to ensure that the provisions of the Traffic Management Plan are implemented, eg driver training in the heavy vehicle driver's Code of Conduct and contractual agreements with heavy vehicle operators; and
      - procedures for ensuring compliance with and enforcement of the heavy vehicle driver's Code of Conduct;
   (d) include a Code of Conduct for heavy vehicle drivers that addresses:
      - travelling speeds;
      - instructions to avoid grouping or convoying of trucks;
      - instructions to drivers not to overtake each other on the haulage route, as far as practicable, and to maintain appropriate distances between vehicles;
      - instruction to drivers to adhere to the designated haulage routes;
      - instruction to drivers to be properly safety conscious and to strictly obey all traffic regulations; and
      - appropriate penalties for infringements of the Code.

Independent Traffic Audit

4. Prior to 31 March 2014, and every 12 months thereafter, unless the Director-General directs otherwise, the Applicant shall commission a suitably qualified person, whose appointment has been approved by the Director-General, to conduct an Independent Traffic Audit of the development. This audit must:
   (a) be undertaken without prior notice to the Applicant, and in consultation with RMS, NCC, WSC and the CCC;

(b) assess the impact of the development on the performance and safety of the road network, including a review of:
- haulage records;
- accident records on the haulage route, infringements relating to the code of conduct and any incidents involving haulage vehicles;
- community complaints register; and

(c) assess the effectiveness of the Road Transport Protocol; and, if necessary, recommend measures to reduce or mitigate any adverse (or potentially adverse) impacts.

5. Within 1 month of receiving the audit report, or as otherwise agreed by the Director-General, the Applicant shall submit a copy of the report to the Director-General, with a detailed response to any of the recommendations contained in the audit report, including a timetable for the implementation of any measures proposed to address the recommendations in the audit report.

A summary of the audit report must be included in the Annual Review.

Alternative Coal Transport Options

6. Prior to 31 December 2014, and every three years thereafter, the Proponent shall prepare and submit to the Director-General for approval, a study of the reasonable and feasible options to reduce or eliminate the use of public roads to transport coal from the development. The assessment must include:
(a) an analysis of the capital, construction and operating costs of the alternative transport options; and
(b) quantified social and environmental impacts associated with road and rail transport.

NOISE

Noise Impact Assessment Criteria

7. The Applicant shall ensure that the noise generated by the development at any residence on privately-owned land does not exceed the criteria for the location in Table 1 nearest to that residence.

Table 1: Noise Criteria dB(A)

Location	***Day***	***Evening***	***Night***	
	$L_{Aeq(15\ min)}$	$L_{Aeq(15\ min)}$	$L_{Aeq(15\ min)}$	$L_{A1(1\ min)}$
R8	38	38	38	45
R11	49	49	49	54
R12	49	49	49	53
R13	43	43	43	49
R15	36	36	36	45
R19	37	37	37	45
R22	46	46	46	46
all other privately-owned land	35	35	35	45

Notes:
- *To interpret the locations referred to in Table 1, see Appendix 6 and the EIS; and*
- *Noise generated by the development is to be measured in accordance with the relevant requirements, and exemptions (including certain meteorological conditions), of the NSW Industrial Noise Policy. Appendix 8 sets out the meteorological conditions under which these criteria apply, and the requirements for evaluating compliance with these criteria.*

However, these criteria do not apply if the Applicant has a written agreement with the relevant landowner to exceed the noise criteria, and the Applicant has advised the Department in writing of the terms of this agreement.

Operating Conditions

8. The Applicant shall:
(a) implement best management practice, including all reasonable and feasible noise mitigation measures, to minimise the construction, operational and transport noise generated by the development;
(b) regularly assess the noise monitoring and meteorological data and relocate, modify, and/or stop operations on site to ensure compliance with the relevant conditions of this consent;
(c) minimise the noise impacts of the development during meteorological conditions under which the noise limits in this consent do not apply (see Appendix 8);
(d) use its best endeavours to achieve the long-term noise goals in Table 2, where reasonable and feasible, and report on progress towards achieving these goals in each Annual Review;

(e) carry out a comprehensive noise audit of the development in conjunction with each independent environmental audit; and
(f) prepare an action plan to implement any additional reasonable and feasible onsite noise mitigation measures identified by each audit;
to the satisfaction of the Director-General.

Table 2: Long-term Noise Goals dB(A)

Location	***Day***	***Evening***	***Night***
	$L_{Aeq(15\ min)}$	$L_{Aeq(15\ min)}$	$L_{Aeq(15\ min)}$
R11 – R13	41	41	41
R22	40	40	40

Notes:
- *To interpret the locations referred to in Table 2, see Appendix 6 and the EIS; and*
- *Noise generated by the development is to be measured in accordance with the relevant requirements, and exemptions (including certain meteorological conditions), of the NSW Industrial Noise Policy. Appendix 8 sets out the meteorological conditions under which these criteria apply, and the requirements for evaluating compliance with these criteria.*

Noise Management Plan

9. The Applicant shall prepare and implement a Noise Management Plan for the development to the satisfaction of the Director-General. This plan must:
(a) be prepared in consultation with the EPA and submitted to the Director-General for approval within 4 months of the date of this consent, unless otherwise agreed by the Director-General;
(b) describe the measures that would be implemented to ensure compliance with the noise criteria and operating conditions in this consent;
(c) describe the proposed noise management system in detail including the mitigation measures that would be implemented to minimise noise during construction and operations, including on and off site road noise generated by vehicles associated with the development; and
(d) include a monitoring program that:
- uses attended monitoring to evaluate the compliance of the development against the noise criteria in this consent;
- evaluates and reports on:
  - the effectiveness of the on-site noise management system; and
  - compliance against the noise operating conditions; and
- defines what constitutes a noise incident, and includes a protocol for identifying and notifying the Department and relevant stakeholders of any noise incidents.

AIR QUALITY

Odour

10. The Applicant shall ensure that no offensive odours are emitted from the site, as defined under the POEO Act.

Air Quality Criteria

11. The Applicant shall implement all reasonable and feasible mitigation measures to ensure that the particulate emissions generated by the development do not exceed the criteria listed in Tables 3, 4 and 5 at any residence on privately-owned land.

Table 3: Long-term criteria for particulate matter

Pollutant	***Averaging period***	***[d] Criterion***
Total suspended particulate (TSP) matter	Annual	[a] 90 µg/m^3
Particulate matter < 10 µm (PM_{10})	Annual	[a] 30 µg/m^3

Table 4: Short-term criterion for particulate matter

Pollutant	***Averaging period***	***[d] Criterion***
Particulate matter < 10 µm (PM_{10})	24 hour	[a] 50 µg/m^3

Table 5: Long-term criteria for deposited dust

Pollutant	*Averaging period*	*Maximum increase in deposited dust level*	*Maximum total deposited dust level*
[c] Deposited dust	Annual	[b] 2 g/m^2/month	[a] 4 g/m^2/month

Notes for Tables 3 to 5:

- *[a] Total impact (i.e. incremental increase in concentrations due to the development plus background concentrations due to other sources);*
- *[b] Incremental impact (i.e. incremental increase in concentrations due to the development on its own);*
- *[c] Deposited dust is to be assessed as insoluble solids as defined by Standards Australia, AS/NZS 3580.10.1:2003: Methods for Sampling and Analysis of Ambient Air - Determination of Particulate Matter - Deposited Matter - Gravimetric Method; and*
- *[d] Excludes extraordinary events such as bushfires, prescribed burning, dust storms, sea fog, fire incidents, illegal activities or any other activity agreed to by the Director-General.*

Operating Conditions

12. The Applicant shall:
    (a) implement best practice air quality management at the site, including all reasonable and feasible measures to minimise the off-site odour, fume and dust emissions generated by the development;
    (b) implement best practice management to minimise the risk of spontaneous combustion and related emissions;
    (c) implement all reasonable and feasible measures to minimise the release of greenhouse gas emissions from the site;
    (d) operate an air quality management system on site to ensure compliance with the relevant conditions of this consent;
    (e) minimise the air quality impacts of the development during adverse meteorological conditions and extraordinary events (see note d to Tables 3-5 above);
    (f) regularly assess the air quality monitoring data, and modify operations on site to ensure compliance with the relevant conditions of this consent,

    to the satisfaction of the Director-General.

Air Quality Management Plan

13. The Applicant shall prepare and implement an Air Quality Management Plan for the development to the satisfaction of the Director-General. This plan must:
    (a) be prepared in consultation with the EPA, and submitted to the Director-General for approval within 6 months of the date of this consent;
    (b) describe the measures that would be implemented to ensure compliance with the relevant air quality criteria and operating conditions of this consent;
    (c) describe the measures that would be implemented to minimise the release of greenhouse gas emissions from the site;
    (d) describe the proposed on-site air quality management system; and
    (e) include an air quality monitoring program that:
        - is capable of evaluating the operating conditions of this consent;
        - evaluates and reports on:
            - the effectiveness of the air quality management system; and
            - compliance against the air quality operating conditions;
        - defines what constitutes an air quality incident, and includes a protocol for identifying and notifying the Department and relevant stakeholders of any air quality incidents.

METEOROLOGICAL MONITORING

14. During the life of the development, the Applicant shall ensure that there is a suitable meteorological station operating in the vicinity of the site that:
    (a) complies with the requirements in the *Approved Methods for Sampling of Air Pollutants in New South* Wales guideline; and
    (b) is capable of continuous real-time measurement of temperature lapse rate in accordance with the NSW Industrial Noise Policy, unless a suitable alternative is approved by the Director-General following consultation with the EPA.

SOIL & WATER

Note: Under the Water Act 1912 and/or the Water Management Act 2000, the Applicant is required to obtain the necessary water licences for the development.

Water Supply

15. The Applicant shall ensure that it has sufficient water for all stages of the development, and if necessary, adjust the scale of mining operations to match its available water supply, to the satisfaction of the Director-General.

Water Pollution

16. Unless an EPL authorises otherwise, the Applicant shall comply with Section 120 of the POEO Act.

Sewage Management

17. The Proponent shall manage on-site sewage in accordance with *NSW Environmental Guidelines: Use of Effluent by Irrigation* (DEC 2004) and the *National Guidelines for Sewerage Systems - Effluent Management (ANZECC 1997)* or its latest version, to the satisfaction of EPA.

Water Management Plan

18. The Proponent shall prepare and implement a Water Management Plan for the surface facilities sites to the satisfaction of the Director-General. This plan must be prepared in consultation with NOW and EPA, by suitably qualified and experienced persons whose appointment has been endorsed by the Director-General, and submitted to the Director-General for approval within 6 months of the date of this consent. This plan must include:
    (a) a comprehensive water balance for the development that includes details of:
        - sources and security of water supply;
        - water make in the underground workings;
        - water transfers from the underground operations to the surface;
        - water use; and
        - any water discharges;
    (b) management plans for the surface facilities sites, that include:
        - a detailed description of water management systems for each site, including:
            - clean water diversion systems;
            - erosion and sediment controls; and
            - any water storages;
        - measures to minimise potable water use and to reuse and recycle water;
        - measures to manage acid sulfate soils, if encountered;
        - activities that would involve ground disturbance at the site; and
        - monitoring and reporting procedures.
    (c) a Surface Water Management Plan which:
        - includes baseline data on surface water flows and quality of Swindles Creek;
        - details surface water impact assessment criteria, including trigger levels for investigating any potentially adverse impacts on surface water resources or surface water quality;
        - provides a program to monitor:
            - surface water discharges;
            - surface water flows and quality; and
            - channel stability;
    (d) a Ground Water Monitoring Program which includes a program to:
        - monitor and report groundwater inflows to underground workings;
        - predict, manage and monitor impacts to nearby groundwater bores on privately-owned land that may be impacted by the development; and
    (e) a detailed review of surface water management at the site, with particular reference to the water storages within the dirty water management system, to:
        - determine whether the capacity, integrity, retention time and management of the dirty water storages (particularly the final Pollution Control Dam) are sufficient to ensure that water discharged from the site meets the EPL limits and surface water impact assessment criteria within the Surface Water Management Plan; and
        - propose any appropriate changes to the surface water management system.

    Note: The Director-General may require the Applicant to implement upgrades and other changes identified under paragraph (e), in accordance with condition 4 of schedule 2.

BIODIVERSITY

Biodiversity Enhancement Strategy

19. The Applicant shall implement a Biodiversity Enhancement Strategy as described in the EIS and summarised in Table 6, in consultation with OEH, and to the satisfaction of the Director-General.

Table 6: Summary of the Biodiversity Enhancement Strategy

Area	*Offset Type*	*Minimum Size/Amount*
Biodiversity Enhancement Area	Enhancement and restoration measures, including weed and rubbish removal, return of natural hydrological regime and regeneration with native endemic species.	3 ha (in total) of Swamp Sclerophyll Floodplain Forest and Swamp Oak Floodplain Forest endangered ecological communities within the surface facilities sites

Note: To identify the Biodiversity Enhancement Area referred to in Table 6 see the applicable figures in Appendix 7.

Biodiversity Management Plan

20. The Applicant shall prepare and implement a Biodiversity Management Plan for the surface facilities sites, for all areas that are not, or will not, be subject to condition 7 of schedule 4, to the satisfaction of the Director-General. This plan must:
    (a) be prepared by a suitably qualified person approved by the Director-General; in consultation with OEH, and submitted to the Director-General within 6 months of the date of this consent;
    (b) establish baseline data for the existing habitat in the Biodiversity Enhancement Area and elsewhere on the site;
    (c) describe the short, medium, and long term measures that would be implemented to:
        - manage the impacts of clearing vegetation;
        - manage the remnant vegetation and habitat in the Biodiversity Enhancement Area and elsewhere on the site; and
        - implement the Biodiversity Enhancement Strategy, including detailed performance and completion criteria;
    (d) include a program to monitor and report on the effectiveness of these measures, and progress against the detailed performance and completion criteria;
    (e) identify the potential risks to the successful implementation of the Biodiversity Enhancement Strategy, and the contingency measures that would be implemented to mitigate these risks; and
    (f) include details of who would be responsible for monitoring, reviewing, and implementing the plan.

HERITAGE

Heritage Management Plan

21. The Proponent shall prepare and implement a Heritage Management Plan for the development to the satisfaction of the Director-General. This Plan must:
    (a) be prepared in consultation with any relevant Aboriginal stakeholders;
    (b) be submitted to the Director-General for approval within 6 months of the date of this consent;
    (c) include consideration of the Aboriginal and non-Aboriginal cultural context and significance of the site;
    (d) detail the responsibilities of all stakeholders; and
    (e) include programs/procedures and management measures for:
        - the ongoing monitoring of site 45-7-0189 at Summerland Point;
        - managing the discovery of any human remains or previously unidentified Aboriginal objects on site, including (in the case of human remains) stop work provisions and notification protocols;
        - ongoing consultation and involvement of the Aboriginal community in the conservation and management of Aboriginal heritage within the site; (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
        - ensuring relevant workers on site receive suitable heritage inductions prior to carrying out any activities which may disturb Aboriginal sites, and that suitable records are kept of these inductions.

VISUAL

Visual Amenity and Lighting

22. The Applicant shall:
    (a) minimise visual impacts, and particularly the off-site lighting impacts, of the Surface facilities sites;
    (b) take all reasonable and feasible measures to further mitigate off-site lighting impacts from the development; and
    (c) ensure that all external lighting associated on site complies with *Australian Standard AS4282 (INT) 1995 – Control of Obtrusive Effects of Outdoor Lighting,*

    to the satisfaction of the Director-General.

WASTE

23. The Applicant shall:
    (a) minimise and monitor the waste generated by the development;
    (b) ensure that the waste generated by the development is appropriately stored, handled and disposed of; and
    (c) report on waste management and minimisation in the Annual Review,

    to the satisfaction of the Director-General.

BUSHFIRE MANAGEMENT

24. The Applicant shall:
    (a) ensure that the development is suitably equipped to respond to any fires on site; and
    (b) assist the Rural Fire Service and emergency services as much as possible if there is a fire in the vicinity of the Surface facilities sites.

REHABILITATION

Rehabilitation Objectives

25. The Applicant shall rehabilitate the site to the satisfaction of the Executive Director Mineral Resources. This rehabilitation must be generally consistent with the proposed rehabilitation strategy described in the EIS, and comply with the objectives in Table 7.

Table 7: Rehabilitation Objectives

Feature	***Objective***
Mine site (as a whole)	• Safe, stable and non-polluting. • Final land use compatible with surrounding land uses.
Surface infrastructure	• To be decommissioned and removed, unless the Executive Director Mineral Resources agrees otherwise.
Portals and ventilation shafts	• To be decommissioned and made safe and stable. • Retain habitat for threatened species (eg bats), where practicable.
Other land affected by the development	• Restore ecosystem function, including maintaining or establishing self-sustaining ecosystems comprised of: - local native plant species (unless the Executive Director Mineral Resources agrees otherwise); and - a landform consistent with the surrounding environment.
Built features damaged by mining operations	• Repair to pre-mining condition or equivalent unless: - the owner agrees otherwise; or - the damage is fully restored, repaired or compensated under the *Mine Subsidence Compensation Act 1961.*
Community	• Ensure public safety. • Minimise the adverse socio-economic effects associated with mine closure.

Notes:

- *These rehabilitation objectives apply to all subsidence impacts and environmental consequences caused by underground mining taking place after the granting of project approval MP 10_0161, and to all development surface infrastructure that is part of the development, whether constructed prior to or following the date of this consent.*
- *Rehabilitation of subsidence impacts and environmental consequences caused by mining which took place prior to the date of project approval (MP 10_0161) may be subject to the requirements of other approvals (eg under a mining lease or a Subsidence Management Plan approval).*

Progressive Rehabilitation

26. The Applicant shall carry out the rehabilitation of the site progressively, that is, as soon as reasonably practicable following disturbance.

Rehabilitation Management Plan

27. The Applicant shall prepare and implement a Rehabilitation Management Plan for the development, in consultation with OEH, NOW, WSC, LMCC, and the CCC, and to the satisfaction of the Executive Director Mineral Resources. This plan must:
    (a) be submitted to the Director-General and the Executive Director Mineral Resources for approval within 12 months of the date of approval of this development consent;
    (b) be prepared in accordance with any relevant DRE guideline and be consistent with the rehabilitation objectives in the EIS and in Table 7;
    (c) describe how the performance of the rehabilitation would be monitored and assessed against the objectives in Table 7;
    (d) describe the process whereby additional measures would be identified and implemented to ensure the rehabilitation objectives are achieved;
    (e) provide for detailed mine closure planning, including measures to minimise socio-economic effects due to mine closure, to be conducted prior to the site being placed on care and maintenance; and
    (f) be integrated with the other management plans required under this consent.

    Note: The Rehabilitation Management Plan should address all land impacted by the development whether prior to, or following, the date of this consent.

SCHEDULE 4
ENVIRONMENTAL CONDITIONS – UNDERGROUND MINING

SUBSIDENCE

1. The Proponent shall ensure that vertical subsidence within the High Water Mark Subsidence Barrier and within seagrass beds is limited to a maximum of 20 millimetres (mm).

Performance Measures – Natural Environment

2. The Applicant shall ensure that the development does not cause any exceedance of the performance measures in Table 8 to the satisfaction of the Director-General.

Table 8: Subsidence Impact Performance Measures – Natural and Heritage Features

Biodiversity	
Threatened species or endangered populations	Negligible environmental consequences
Seagrass beds	Negligible environmental consequences including: • *negligible* change in the size and distribution of seagrass beds; • *negligible* change in the functioning of seagrass beds; and • *negligible* change to the composition or distribution of seagrass species within seagrass beds.
Benthic communities	Minor environmental consequences, including minor changes to species composition and/or distribution.
Mine workings	
First workings under an approved Extraction Plan beneath any feature where performance measures in this table require negligible environmental consequences	To remain long-term stable and non-subsiding.
Second workings	To be carried out only in accordance with an approved Extraction Plan.

Notes:

- *The Applicant will be required to define more detailed performance indicators (including impact assessment criteria) for each of these performance measures in the various management plans that are required under this consent (see Condition 7 below).*
- *Measurement and/or monitoring of compliance with performance measures and performance indicators is to be undertaken using generally accepted methods that are appropriate to the environment and circumstances in which the feature or characteristic is located. These methods are to be fully described in the relevant management plans. In the event of a dispute over the appropriateness of proposed methods, the Director-General will be the final arbiter.*
- *The requirements of this condition only apply to the impacts and consequences of mining operations, construction or demolition undertaken following the date of approval of this consent.*

Offsets

3. If the Applicant exceeds the performance measures in Table 8 and the Director-General determines that:
   (a) it is not reasonable or feasible to remediate the impact or environmental consequence; or
   (b) the remediation measures implemented by the Proponent have failed to satisfactorily remediate the impact or environmental consequence;

   then the Proponent shall provide a suitable offset to compensate for the impact or environmental consequence to the satisfaction of the Director-General.

   Note: Any offset required under this condition must be proportionate with the significance of the impact or environmental consequence.

Performance Measures – Built Features

4. The Applicant shall ensure that the development does not cause any exceedances of the performance measures in Table 9, to the satisfaction of the Director-General.

Table 9: Subsidence Impact Performance Measures – Built Features

Built Features	***Performance Measure***
Trinity Point Marina Development Other built features	• Always safe. • Serviceability should be maintained wherever practicable. Loss of serviceability must be fully

	compensated. • Damage must be fully repaired, replaced or fully compensated.
Public Safety	
Public Safety.	Negligible additional risk.

Notes:

- *The Applicant will be required to define more detailed performance indicators for each of these performance measures in Built Features Management Plans or a Public Safety Management Plan (see Condition 7 below).*
- *Measurement and/or monitoring of compliance with performance measures and performance indicators is to be undertaken using generally accepted methods that are appropriate to the environment and circumstances in which the feature or characteristic is located. These methods are to be fully described in the relevant management plans. In the event of a dispute over the appropriateness of proposed methods, the Director-General will be the final arbiter.*
- *The requirements of this condition only apply to the impacts and consequences of mining operations undertaken following the date of this development consent.*
- *Requirements regarding safety or serviceability do not preclude preventative actions or mitigation being taken prior to or during mining in order to achieve or maintain these outcomes.*
- *Requirements under this condition may be met by measures undertaken in accordance with the Mine Subsidence Compensation Act 1961.*

5. Any dispute between the Applicant and the owner of any built feature over the interpretation, application or implementation of the subsidence performance measures in Table 9 is to be settled by the Director-General, following consultation with the MSB and the Executive Director Mineral Resources. Any decision by the Director-General shall be final and not subject to further dispute resolution under this consent.

Multi-Seam Mining Feasibility Investigation

6. Prior to the submission of an Extraction Plan for Miniwalls 41 to 45 in Chain Valley Bay, the Applicant must prepare a detailed Multi-Seam Mining Feasibility Investigation to the satisfaction of the Director-General. This plan must:
   (a) be prepared in consultation with DRE by suitably qualified and experienced persons whose appointment has been endorsed by the Director-General;
   (b) assess the extent of the soft claystone floor/roof conditions within former workings in the Great Northern and Wallarah Seams;
   (c) assess the stability of remnant coal pillars within former workings in the Great Northern and Wallarah Seams;
   (d) give particular consideration to the risks of irregular subsidence, pillar run and long-term subsidence leading to subsidence outside of the predicted angle of draw;
   (e) include revised multi-seam subsidence predictions for the proposed second workings; and
   (f) recommend final design of the second workings and any necessary adaptive management measures.

Extraction Plan

7. The Applicant shall prepare and implement an Extraction Plan for all second workings on site, to the satisfaction of the Director-General. Each Extraction Plan must:
   (a) be prepared by suitably qualified and experienced persons whose appointment has been endorsed by the Director-General;
   (b) be approved by the Director-General before the Applicant carries out any second workings covered by the plan;
   (c) include detailed plans of existing and proposed first and second workings and any associated surface development, including any applicable adaptive management measures;
   (d) include detailed performance indicators for each of the performance measures in Tables 8 and 9;
   (e) provide revised predictions of the potential subsidence effects, subsidence impacts and environmental consequences of the proposed second workings, incorporating any relevant information obtained since this consent;
   (f) describe the measures that would be implemented to ensure compliance with the performance measures in Tables 8 and 9, and manage or remediate any impacts and/or environmental consequences;
   (g) include a Built Features Management Plan, which has been prepared in consultation with DRE and the owners of affected public infrastructure, to manage the potential subsidence impacts and/or environmental consequences of the proposed second workings, and which
      - addresses in appropriate detail all items of public infrastructure and other public infrastructure and all classes of other built features;
      - has been prepared following appropriate consultation with the owner/s of potentially affected feature/s;

- recommends appropriate remedial measures and includes commitments to mitigate, repair, replace or compensate all predicted impacts on potentially affected built features in a timely manner; and;

(h) include a Benthic Communities Management Plan, which has been prepared in consultation with OEH, LMCC, and DPI Fisheries, which provides for the management of the potential impacts and/or environmental consequences of the proposed second workings on benthic communities, and which includes:
- surveys of the lake bed to enable contours to be produced and changes in depth following subsidence to be accurately measured;
- benthic species surveys within the area subject to second workings, as well as control sites outside the area subject to second workings (at similar depths) to establish baseline data on species number and composition within the communities;
- a program of ongoing seasonal monitoring of benthic species in both control and impact sites;
- development of a model to predict likely impact of increased depth and associated subsidence impacts and effects, including but not limited to light reduction and sediment disturbance, on benthic species number and benthic communities composition, incorporating the monitoring and survey data collected; and
- updating the model every 2 years using the most recent monitoring and survey data;

(i) include a Seagrass Management Plan, which has been prepared in consultation with OEH, LMCC, and DPI Fisheries, which provides for the management of the potential impacts and/or environmental consequences of the proposed second workings on seagrass beds, and which includes:
- a program of ongoing monitoring of seagrasses in both control and impact sites; and
- a program to predict and manage subsidence impacts and environmental consequences to seagrass beds to ensure the performance measures in Table 8 are met;

(j) include a Public Safety Management Plan, which has been prepared in consultation with DRE, to ensure public safety;

(k) include a Subsidence Monitoring Program which has been prepared in consultation with DRE, to:
- provide data to assist with the management of the risks associated with subsidence;
- validates the subsidence predictions;
- analyses the relationship between the predicted and resulting subsidence effects and predicted and resulting impacts under the plan and any ensuing environmental consequences; and
- informs the contingency plan and adaptive management process;

(l) include a contingency plan that expressly provides for adaptive management where monitoring indicates that there has been an exceedance of any performance measure in Tables 8 and 9, or where any such exceedance appears likely;

(m) include appropriate revisions to the Rehabilitation Management Plan required under Condition 28 of Schedule 3; and

(n) include a program to collect sufficient baseline data for future Extraction Plans.

Notes:
- *To identify the underground mining areas approved under this consent referred to in this condition, see Appendix 3.*
- *This condition does not limit secondary extraction under a Subsidence Management Plan approved as at the date of this consent.*

8. The Applicant shall ensure that the management plans required under conditions 7(g)-(j) above include:
   (a) an assessment of the potential environmental consequences of the Extraction Plan, incorporating any relevant information that has been obtained since this consent; and
   (b) a detailed description of the measures that would be implemented to remediate predicted impacts.

First Workings

9. The Applicant shall not carry out first workings on site that are not generally in accordance with the approved mine plan without written approval of the Director-General.

Payment of Reasonable Costs

10. The Applicant shall pay all reasonable costs incurred by the Department to engage suitably qualified, experienced and independent experts to review the adequacy of any aspect of an Extraction Plan.

SCHEDULE 5
ADDITIONAL PROCEDURES

NOTIFICATION OF LANDOWNERS

1. As soon as practicable after obtaining monitoring results showing:
   (a) an exceedance of any relevant criteria in Schedule 3, the Applicant shall notify affected landowners in writing of the exceedance, and provide regular monitoring results to each affected landowner until the development is again complying with the relevant criteria; and
   (b) an exceedance of any relevant air quality criteria in Schedule 3, the Applicant shall send a copy of the NSW Health fact sheet entitled "Mine Dust and You" (as may be updated from time to time) to the affected landowners and/or existing tenants of the land (including the tenants of any mine-owned land).

INDEPENDENT REVIEW

2. If an owner of privately-owned land considers the development to be exceeding the relevant criteria in Schedule 3, then he/she may ask the Director-General in writing for an independent review of the impacts of the development on his/her land.

   If the Director-General is satisfied that an independent review is warranted, then within 2 months of the Director-General's decision the Applicant shall:
   (a) commission a suitably qualified, experienced and independent person, whose appointment has been approved by the Director-General, to:
      - consult with the landowner to determine his/her concerns;
      - conduct monitoring to determine whether the development is complying with the relevant criteria in Schedule 3; and
      - if the development is not complying with these criteria then identify the measures that could be implemented to ensure compliance with the relevant criteria; and
   (b) give the Director-General and landowner a copy of the independent review.

SCHEDULE 6
ENVIRONMENTAL MANAGEMENT, REPORTING AND AUDITING

ENVIRONMENTAL MANAGEMENT

Environmental Management Strategy

1. The Applicant shall prepare and implement an Environmental Management Strategy for the development to the satisfaction of the Director-General. This strategy must:
   (a) be submitted to the Director-General for approval within 7 months of the date of this consent;
   (b) provide the strategic framework for environmental management of the development;
   (c) identify the statutory approvals that apply to the development;
   (d) describe the role, responsibility, authority and accountability of all key personnel involved in the environmental management of the development;
   (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 development;
      - receive, handle, respond to, and record complaints;
      - resolve any disputes that may arise during the course of the development;
      - respond to any non-compliance;
      - respond to emergencies; and
   (f) include:
      - copies of any strategies, plans and programs approved under the conditions of this consent; and
      - a clear plan depicting all the monitoring required to be carried out under the conditions of this consent.

Adaptive Management

2. The Applicant must assess and manage development-related risks to ensure that there are no exceedances of the criteria and/or performance measures in Schedules 3 and 4. Any exceedance of these criteria and/or performance measures constitutes a breach of this consent and may be subject to penalty or offence provisions under the EP&A Act or EP&A Regulation.

   Where any exceedance of these criteria and/or performance measures has occurred, the Applicant must, at the earliest opportunity:
   (a) take all reasonable and feasible steps to ensure that the exceedance ceases and does not recur;
   (b) consider all reasonable and feasible options for remediation (where relevant) and submit a report to the Department describing those options and any preferred remediation measures or other course of action; and
   (c) implement remediation measures as directed by the Director-General,
   to the satisfaction of the Director-General.

Management Plan Requirements

3. The Applicant shall ensure that the management plans required under this consent 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 development 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 development;
      - 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 program to investigate and implement ways to improve the environmental performance of the development over time;
   (g) 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

(h) a protocol for periodic review of the plan.

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

Annual Review

4. By the end of March each year, or other timing as may be agreed by the Director-General, the Applicant shall review the environmental performance of the development 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 calendar year;
   (b) include a comprehensive review of the monitoring results and complaints records of the development over the past calendar year, which includes a comparison of these results against the:
      - relevant statutory requirements, limits or performance measures/criteria;
      - requirements of any plan or program required under this consent;
      - monitoring results of previous years; and
      - relevant predictions in the EIS;
   (c) identify any non-compliance over the past calendar 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 development;
   (e) identify any discrepancies between the predicted and actual impacts of the development, 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 development.

Revision of Strategies, Plans and Programs

5. Within 3 months of:
   (a) the submission of an annual review under Condition 4 above;
   (b) the submission of an incident report under Condition 7 below;
   (c) the submission of an audit report under Condition 9 below; or
   (d) any modification to the conditions of this consent, (unless the conditions require otherwise),

   the Applicant shall review, and if necessary revise, the strategies, plans, and programs required under this consent, to the satisfaction of the Director-General. Where this review leads to revisions in any such document, then within 4 weeks of the review the revised document must be submitted for the approval 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 development.

Community Consultative Committee

6. The Applicant shall continue to operate a Community Consultative Committee (CCC) for the development to the satisfaction of the Director-General. This CCC must be operated in general accordance with the *Guidelines for Establishing and Operating Community Consultative Committees for Mining Developments* (Department of Planning, 2007, or its latest version).

   Notes:
   - *The CCC is an advisory committee. The Department and other relevant agencies are responsible for ensuring that the Applicant complies with this consent.*
   - *In accordance with the guideline, the Committee should be comprised of an independent chair and appropriate representation from the Applicant, Council, recognised environmental groups and the local community.*
   - *In operating the CCC, the Department will accept the continued representation from existing CCC members.*

REPORTING

Incident Reporting

7. The Applicant shall immediately notify 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 incident associated with the development, the Applicant shall notify the Director-General and any other relevant agencies as soon as practicable after the Applicant becomes aware of the incident. Within 7 days of the date of the incident, the Applicant 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

8. The Applicant shall provide regular reporting on the environmental performance of the development on its website, in accordance with the reporting arrangements in any plans or programs approved under the conditions of this consent.

INDEPENDENT ENVIRONMENTAL AUDIT

9. By the end of February 2016 (or other such timing as agreed by the Director-General), and every 3 years thereafter, unless the Director-General directs otherwise, the Applicant shall commission and pay the full cost of an Independent Environmental Audit of the development. 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 development and assess whether it is complying with the requirements in this consent and any relevant EPL or Mining Lease (including any assessment, plan or program required under these approvals);
   (d) review the adequacy of strategies, plans or programs required under the abovementioned approvals; and
   (e) recommend appropriate measures or actions to improve the environmental performance of the development, 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.

10. Within 6 weeks of the completion of this audit, or as otherwise agreed by the Director-General, the Applicant 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

11. The Applicant shall:
   (a) make copies of the following publicly available on its website:
      - the EIS;
      - all current statutory approvals for the development;
      - all approved strategies, plans and programs required under the conditions of this consent;
      - a comprehensive summary of the monitoring results of the development, which have been reported in accordance with the various plans and programs approved under the conditions of this consent;
      - a complaints register (updated monthly);
      - minutes of CCC meetings;
      - the Annual Reviews of the development;
      - any Independent Environmental Audit, and any other audit, and the Applicant's response to the recommendations in these audits;
      - 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
SCHEDULE OF LAND

Notes:	
1.	All proposed secondary extraction for the Project (Mining Extension 1) is to occur under Lake Macquarie.
2.	The surface facilities for the Colliery are limited to “pit top area” adjacent to Vales Point Power Station, and the “ventilation shaft site” at Summerland Point.
3.	Refer to Figure 1.2 of the Environmental Impact Statement for the Site.

Project Related Surface Facilities				
Pit Top Area			Ventilation shaft site	
Lot	Deposited Plan		Lot	Deposited Plan
A	379918		1	226133
B	379918			
C	349733			
A	187570			
1B	339441			

All other areas within the Site			
Lot	Deposited Plan	Lot	Deposited Plan
7339	1167067	20	708344
7330	1148105	19	708344
593	727722	18	708344
594	727722	17	708344
D	349733	34	714879
1	410653	33	714879
23	708344	32	714879
21	708344	31	714879
2	1043151	64	31306
426	755266	65	31306
427	755266	66	31306
136	755266	67	31306
2	515214	68	31306
1	515214	69	31306
1	214300	70	31306
2	214300	71	31306
167	755266	72	31306
1	388154	73	31306
144	661695	74	31306
19	25593	75	31306
20	25593	76	31306
21	25593	77	31306
22	25593	78	31306
23	25593	79	31306
24	25593	139	31306
25	25593	140	31306
26	25593	141	31306
27	25593	142	31306
58	31306	143	31306
59	31306	144	31306
60	31306	145	31306
61	31306	146	31306
62	31306	147	31306
63	31306	148	31306
149	31306	175	31306
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3	981104
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APPENDIX 2
DEVELOPMENT AREA

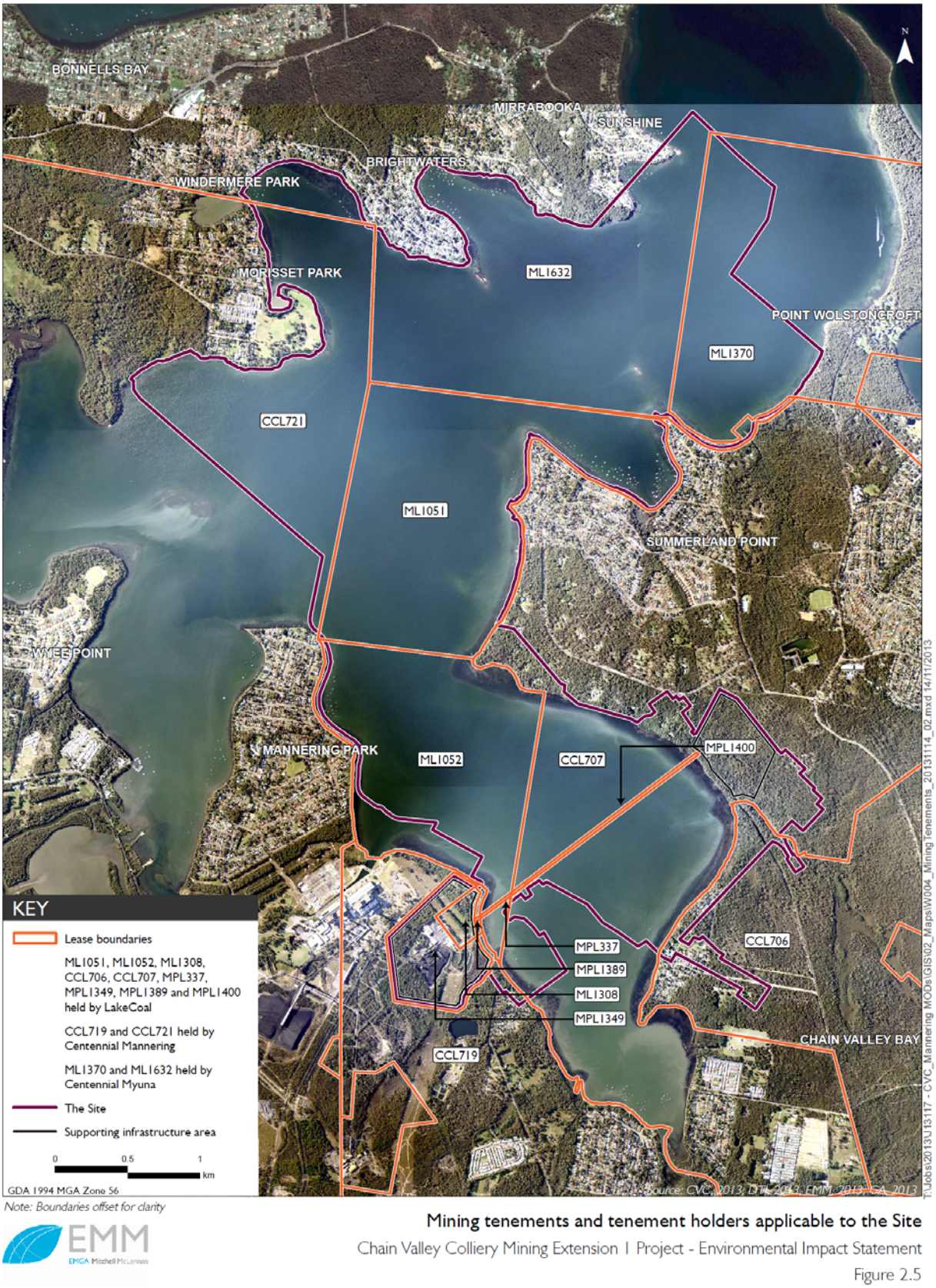

Figure 1: *Chain Valley Extension Project – Development Application Area (The Site)*

APPENDIX 3
DEVELOPMENT LAYOUT

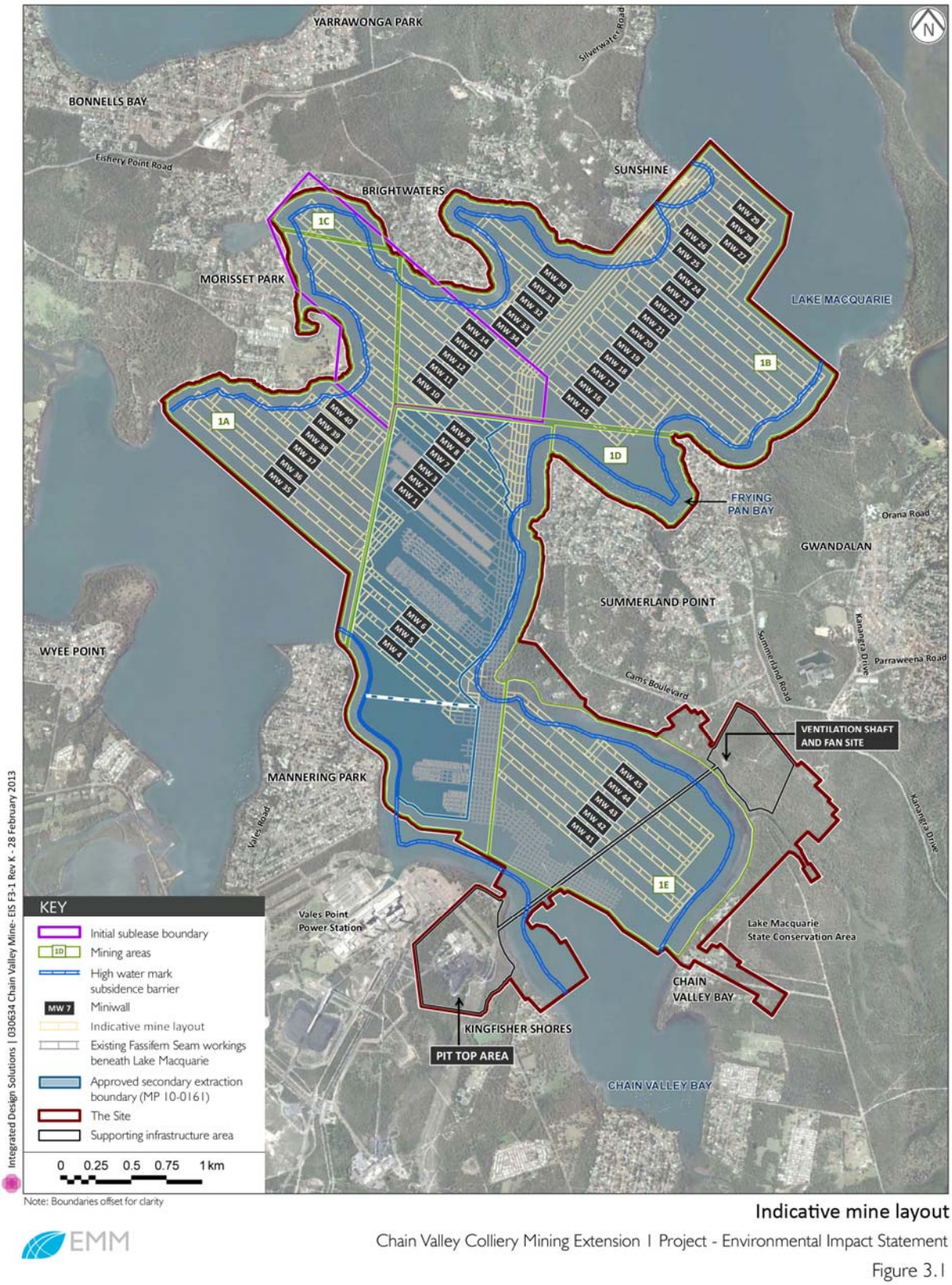

Figure 1: *General Layout of the Chain Valley Extension Project*

APPENDIX 4
SURFACE FACILITIES SITES

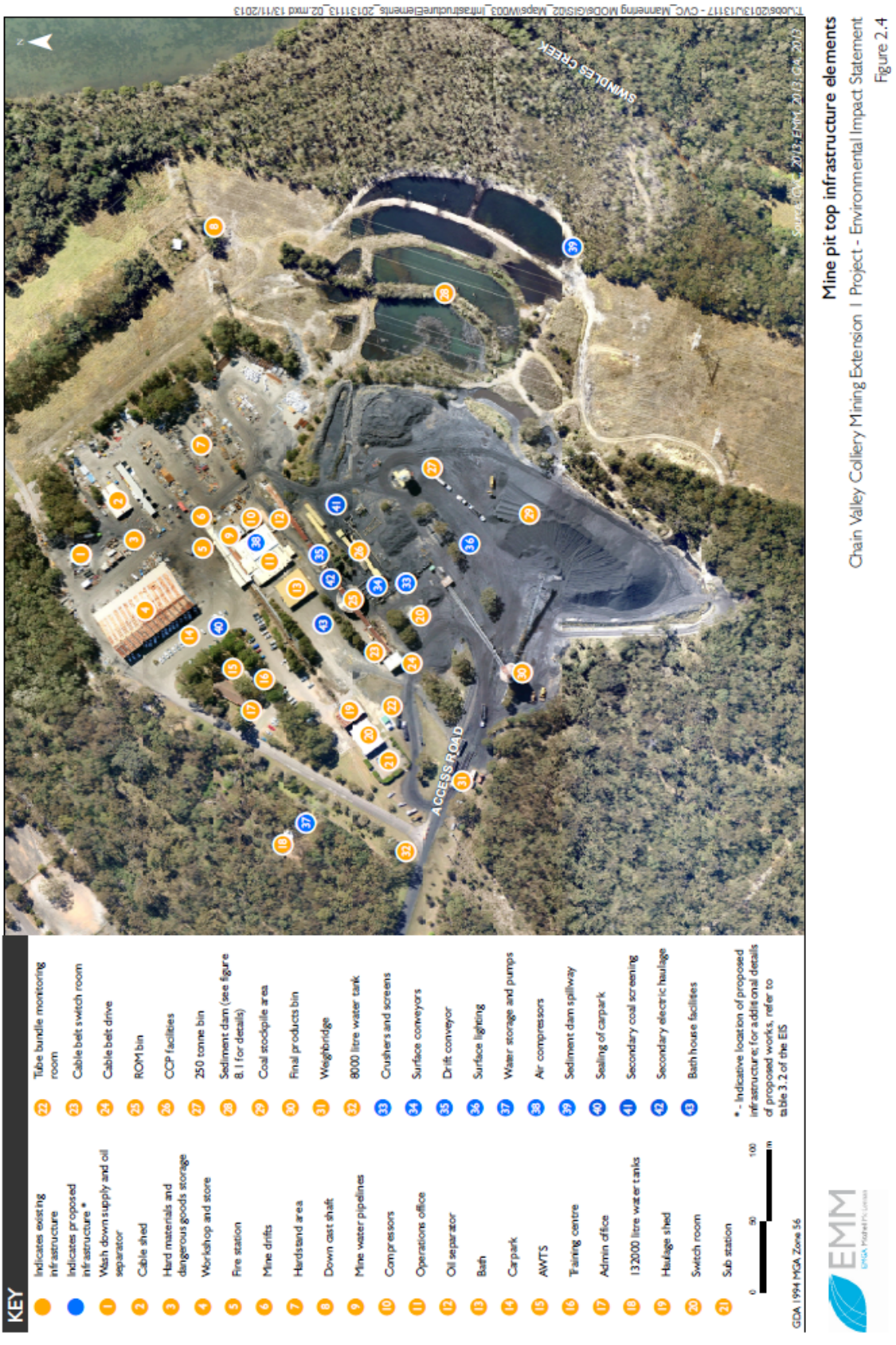

Figure 1: *General Arrangement of the Chain Valley Colliery surface facilities site*

APPENDIX 5
COAL HAULAGE ROUTE – PUBLIC ROADS

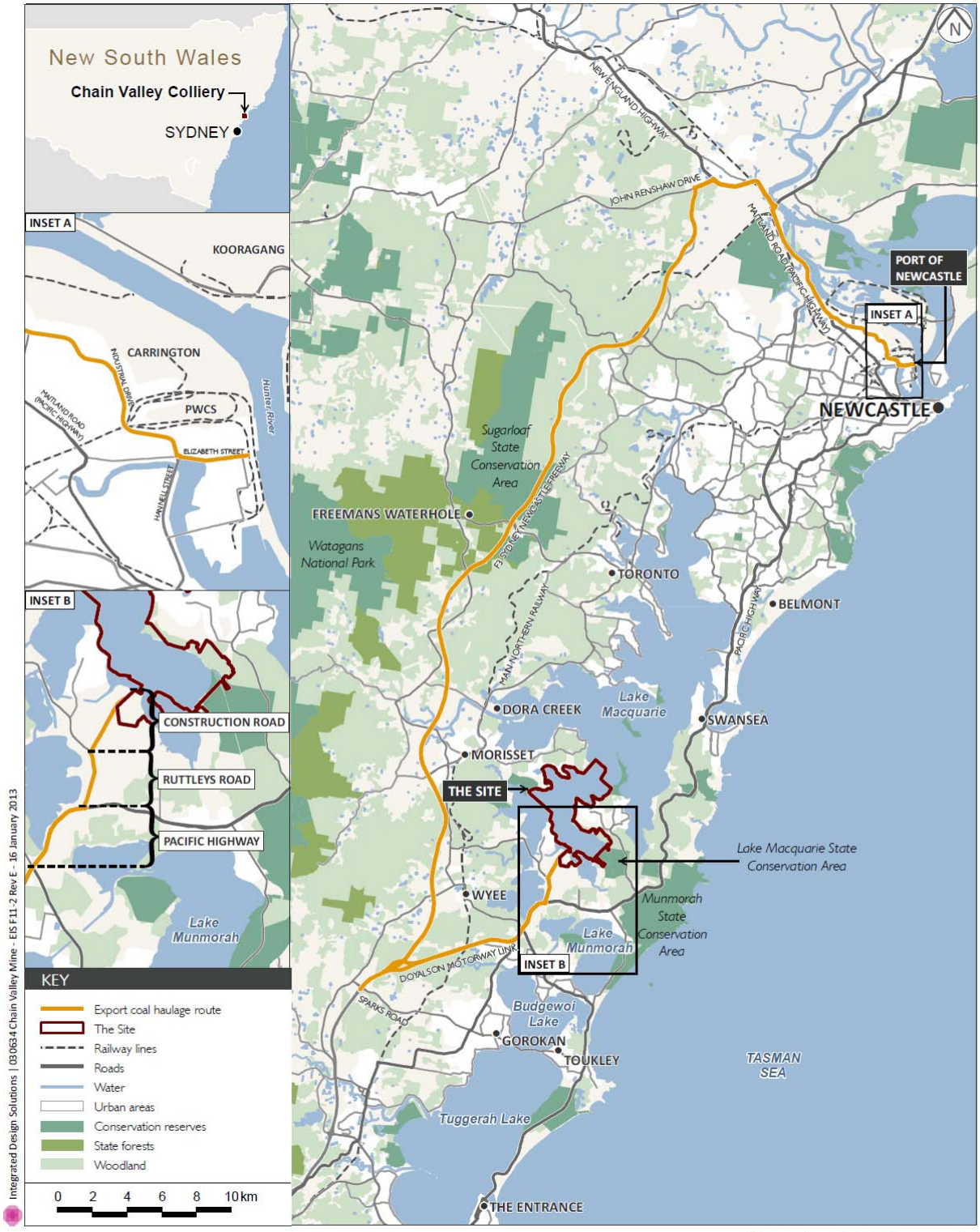

Figure 1: *Export Coal Haulage Route*

APPENDIX 6
NOISE RECEIVER LOCATIONS

Figure 1: *Noise Receiver Locations*

APPENDIX 7
BIODIVERSITY ENHANCEMENT AREA

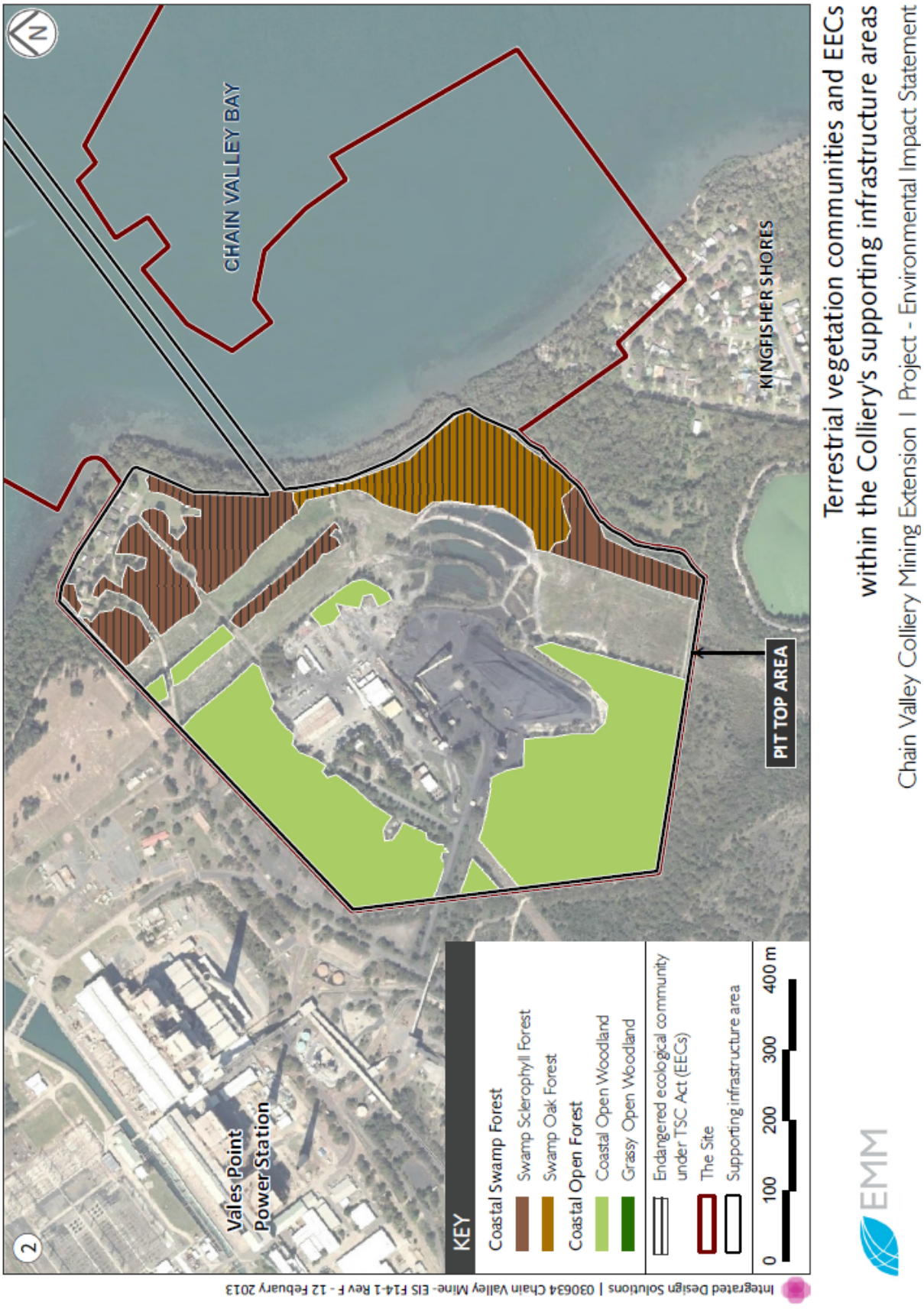

Figure 1: *Location of the Biodiversity Enhancement Area, shown in red and orange hatching*

APPENDIX 8
NOISE COMPLIANCE ASSESSMENT

Applicable Meteorological Conditions

1. The noise criteria in Table 1 of the conditions are to apply under all meteorological conditions except the following:
   (a) during periods of rain or hail;
   (b) average wind speed at microphone height exceeds 5 m/s;
   (c) wind speeds greater than 3 m/s measured at 10 m above ground level; or
   (d) temperature inversion conditions greater than 3°C/100 m.

Determination of Meteorological Conditions

2. Except for wind speed at microphone height, the data to be used for determining meteorological conditions shall be that recorded by the meteorological station described in condition 15 of schedule 3.

Compliance Monitoring

3. Attended monitoring is to be used to evaluate compliance with the relevant conditions of this consent.

4. This monitoring must be carried out at least 4 times in each calendar year (ie at least once every 3 months), unless the Director-General directs otherwise.

5. Unless otherwise agreed with the Director-General, this monitoring is to be carried out in accordance with the relevant requirements for reviewing performance set out in the *NSW Industrial Noise Policy* (as amended from time to time), in particular the requirements relating to:
   (a) monitoring locations for the collection of representative noise data;
   (b) meteorological conditions during which collection of noise data is not appropriate;
   (c) equipment used to collect noise data, and conformity with Australian Standards relevant to such equipment; and
   (d) modifications to noise data collected, including for the exclusion of extraneous noise and/or penalties for modifying factors apart from adjustments for duration.

APPENDIX 9
STATEMENT OF COMMITMENTS

Item	Commitment
Groundwater	In addition to the management and mitigation measures undertaken at the Colliery for groundwater as described in the WMP, the following commitments specific to the Proposal will be undertaken. Some commitments are already undertaken under the WMP. LakeCoal will: • assess whether abnormal or significant groundwater inflow changes occur in the active panels; • maintain the water flow monitoring appliances used to measure pumped water volumes to and from the Colliery in good working order; • maintain and plot records of daily total Colliery water pumping and annually communicate an interpretation of the findings within the Annual Review. A copy of the Annual Review will be supplied to NOW; • measure water levels and quality within private bores, where access is possible, in relevant areas to assess if any adverse effects occur due to subsidence from the Proposal; and • develop groundwater assessment criteria and triggers, response protocols and contingency measures. Although it is not anticipated that private bore yields would be impacted due to subsidence, should such a situation arise, LakeCoal would provide an alternative water supply until the impacted bore recovers. Any monitored or reported adverse impacts on the yield, saturated thickness or quality of a private registered bore will be investigated by LakeCoal. In the event of a groundwater level drop of over 2 m for a period of two months or more, a notable increase in iron hydroxide, or an adverse change in salinity as a consequence of subsidence, LakeCoal will enter into negotiations with the affected landowners and the Mine Subsidence Board with the intent of formulating an agreement which provides for one, or a combination of: • re-establishment of saturated thickness in the affected bore(s) through bore deepening; • establishment of additional bores to provide a yield at least equivalent to the affected bore prior to mining; • provision of access to alternative sources of water; and/or • compensation to reflect increased water extraction costs (e.g., due to lowering pumps or installation of additional or alternative pumping equipment).

Item	Commitment
Surface water	Management and monitoring of surface water will continue to be undertaken in accordance with the Colliery's WMP, which will be reviewed and updated as required to include the commitments made below. LakeCoal will: • limit the main underground pumps to a maximum pump out rate of 10.5 ML/day within 12 months of approval; • request an amendment of EPL 1770 to include a condition on the daily discharge volume limit stating that "Exceedence of the volume limit for Point 1 is permitted only if the discharge from Point 1 occurs solely as a result of rainfall at the premises exceeding 10 mm during the 24 hours immediately prior to commencement of the discharge"; • undertake daily measurements of discharge volumes and report publically on a monthly basis via LakeCoal's website; • continue collection of baseline water quality data to aid in the development of appropriate discharge water quality trigger values; • engage a suitably qualified expert to conduct an assessment of the metals contained within discharge water in accordance with the ANZECC water quality guidelines and provide this assessment to the EPA by 31 December 2013; • investigate water saving measures to minimise the amount of potable water required from WSC for Colliery operations; • quantify the groundwater storage capacity in the Great Northern and Wallarah Seams; • continue effluent monitoring regime of receiving soils from the AWTS in accordance with the parameters and testing frequencies identified in the Colliery's WMP. The results of this monitoring program will be reviewed by a suitably qualified expert and used to determine the appropriateness of the existing irrigation area to receive this effluent; • develop a program to monitor creek line channel stability and the health of riparian vegetation within Swindles Creek. Monitoring will be undertaken in accordance with Section 8.5.2 of the Surface Water Impact Assessment (EIS Appendix E) and incorporated into the Colliery's WMP or Biodiversity Management Plan; and • record monitoring data in accordance with the Colliery's WMP and EPL 1770. Monitoring data will be interpreted as it is received to ensure appropriate operational guidance on monitoring water quality within desired parameters. Results of water quality monitoring will be reported in the Annual Review and made available to the CCC, as well as Wyong and Lake Macquarie Councils.

Item	Commitment
Noise	Management and monitoring of noise will continue to be undertaken in accordance with the Colliery's NMP, which will be reviewed and updated as required to include the commitments made below. LakeCoal will: • continue attended compliance monitoring on site which will be used to identify potential hot spots and primary noise sources; • continue real-time noise monitoring alerts to site personnel to enable implementation of any required rapid noise management initiatives; • manage potential non-compliance through a noise complaint handling and response system, including the identification of responsible sources to enable targeted remedial action; • assess if further noise mitigation options for the ventilation fans are reasonable and feasible following the receipt of attenuation proposals; and • discuss potential management measures or agreement options with the landowner at 275 Cams Boulevard, following receipt of proposals from acoustics specialists. In addition to the above, LakeCoal is committed to the progressive implementation of feasible measures to target long term noise goals which are designed to reduce noise emissions from the Colliery. Long term options for investigation include: • modification to belt/movement alarms; • investigation of surface conveyor and coal preparation equipment, to determine if noise reductions are possible; • identifying sound attenuation options for the surface bulldozer and front end loader; • strategic placement of acoustic barriers; • attenuation for the surface screener/shaker; • installation of quiet rollers for surface conveyor belts; • acoustic treatments around compressors; and • the use of a conveyor stacker for product coal stockpiling.

Item	Commitment
Air quality and greenhouse gases	Management and monitoring of air quality and greenhouse gases will continue to be undertaken in accordance with the Colliery's AQGHGMP, which will be reviewed and updated as required to include the commitments made below. LakeCoal will: • investigate the use of a stacker to replace hauling between current conveyor system and stockpiles; • undertake GHG monitoring comprising measurement of carbon dioxide and methane at the ventilation shaft and fans site; and • record and report annual diesel, oil, grease, acetylene and electricity use to fulfil National Greenhouse and Energy Reporting Scheme requirements.
Traffic and transport	Management and monitoring of traffic and transport will continue to be undertaken in accordance with the Colliery's RTP. In addition, LakeCoal will continue to investigate alternative options for transporting export coal to the PWCS, specifically the preferred rail transport option, requiring the construction of a private haul road to the VPPS coal unloading facility and associated infrastructure upgrades. In addition, LakeCoal will: • provide a detailed feasibility report of rail transport options to DP&I as part of the next coal transport options report to be submitted, by 31 December 2014. Should the report identify that coal transport via rail is feasible, and subject to obtaining necessary agreements, LakeCoal will prepare and lodge an application to modify the relevant approval so as to permit the installation and operation of facilities necessary to undertake rail transport of coal to PWCS; • discuss the potential to utilise proposed rail loading facilities associated with the Wallarah 2 Coal Project, following this project receiving approval; and • investigate options to reduce peak hour traffic would be investigated including potentially limiting the peak hourly volumes of the Colliery truck traffic which would be permitted to travel via this intersection should the Colliery not be using rail transport for export coal by five years from the granting of development consent. Alternatively, a pro rata financial contribution to the cost of installing traffic signals at the southbound intersection of the F3 and Sparks Road interchange could be made commensurate with the percentage of Colliery generated traffic using the intersection.
Subsidence	Management and monitoring of subsidence will continue to be undertaken in accordance with the Colliery's SMP, which will be reviewed and updated as required to include the commitments made below. LakeCoal will: • undertake annual bathymetric surveys of the lake bed to determine actual subsidence and undertake a comparison with predicted levels. Should measured subsidence significantly exceed predicted levels, LakeCoal will review future panel designs to limit future impacts to acceptable levels; and • complete an annual subsidence report and make this report publically available on the Colliery's website.

Item	Commitment
Marine ecology	Management and monitoring of marine ecology will continue to be undertaken in accordance with the Colliery's BCMP and SGMP, which will be reviewed and updated as required to include the commitments made below. LakeCoal will: • revise the BCMP to include the sampling locations in the assessment of the Proposal; • revise the BCMP to incorporate monitoring sites within the creek; • undertake seasonal surveys (spring and autumn) for the Site as required under the BCMP; • commission additional independent sampling and analysis to validate results obtained during monitoring, and review future panel design if impacts due to subsidence are determined to be moderate or greater; • revise the SGMP to include the transect locations utilised in the assessment of the Proposal; • continue annual seagrass surveys/monitoring; • continue annual subsidence surveys (bathymetric surveys) and land based surveys; • include results from the BCMP and SGMP within the Colliery's Annual Review; • make the Annual Review and annual subsidence surveys available on the Colliery's website; and • have a suitably qualified marine scientist update the BCMP to incorporate monitoring sites within Swindles Creek (inclusive of sediment and macro-invertebrate monitoring).
Terrestrial ecology	In addition to the management and mitigation measures undertaken at the Colliery for terrestrial ecology as described in the BMP, the following commitments specific to the Proposal will be undertaken. Some commitments are already undertaken under the BMP. LakeCoal will: • undertake the design of the dam embankment and spillway works in consultation with an ecologist to minimise potential impacts on the Swamp Oak Floodplain Forest EEC; • ensure pre-clearing surveys are undertaken by an ecologist to minimise the potential impact to fauna and significant vegetation prior to clearing works being undertaken within the embankment and spillway area;

Item	Commitment
	• clearly delineate the clearing footprint and cordon off surrounding vegetation as a 'no go' zone during works to the dam embankment and spillway; • minimise disturbance areas where possible by ensuring all stockpiling of materials, parking of machinery etc, is undertaken in previously cleared areas; • ensure that, wherever possible, dead standing timber and fallen timber will be avoided by any clearing works, or if required to be removed, be relocated into suitable habitat areas nearby; • ensure all equipment used for the earthworks associated with the dam embankment and spillway will be cleaned of excess soil potentially containing pathogens and weed seeds prior to entering the Site; • install sediment fencing surrounding the proposed earthwork areas, in accordance with a site-specific erosion and sediment control plan for the works; • ensure that in the event that sedimentation dam water is released from Dam 10 prior to the works being undertaken, it will be undertaken in a controlled manner over a number of days to ensure that the release does not result in significant erosion and sedimentation to the Swamp Oak Floodplain Forest; • remove and continually control noxious weeds from the pit top area, allowing for natural regeneration of vegetation; • monitor weed invasion as part of the Colliery's BMP; • monitor the condition of the EEC areas in accordance with the Colliery's BMP; • engage a suitable qualified ecologist to undertake targeted surveys for the Wallum Froglet in line with the DECC (2009) survey guidelines during the next planned annual BMP monitoring effort in suitable weather. If the Wallum Froglet is identified, it will be included in the Colliery's annual monitoring program; and
	• continue the management and monitoring of flora and fauna in accordance with the BMP for the life of the mine, including: - the condition and composition of the Swamp Oak Floodplain Forest area; - the condition of vegetation adjacent to the ventilation shaft and fans; - the location and distribution of weed infestations; and - the abundance and distribution of feral animal use.

Item	Commitment
	• The improvement and enhancement of the Swamp Oak Forest and Swamp Sclerophyll Forest will be included in an update of the BMP for the existing operations which will be undertaken within 12 months of approval. This will form the basis for the compensatory habitat package to offset potential impacts on endangered ecological communities Rehabilitation methods will be devised in accordance with the Saltwater Wetlands Rehabilitation Manual (DECC 2008) as required, in accordance with the condition monitoring under the BMP. Rehabilitation methods may include:
	• restoration of natural flow regimes;
	• rubbish and litter removal;
	• control and removal of competitive introduced species to allow for regeneration of native species; and
	• revegetation where natural regeneration processes are interrupted.
Heritage	Management and monitoring of heritage will continue to be undertaken in accordance with the Colliery's HMP, which will be reviewed and updated in consultation with the RAPs, as required, to include the commitments made below. LakeCoal will: • update the HMP following approval of the Proposal to include the extended area to which it relates, including baseline monitoring for registered Aboriginal sites 45-7-0154 and 45-7-0157 identified above Area 1 at least three months prior to mining near the sites, and follow-up inspections at intervals consistent with the current monitoring or at a period determined in the updated HMP; • complete a due diligence site inspection of the area to be disturbed by the sediment dam embankment and spillway upgrade prior to commencement of works in these areas;

Item	Commitment
	• ensure that should unanticipated Aboriginal or historic heritage artefacts be found during dam embankment and diversion works, work will cease and the site assessed by an archaeologist; and • ensure that in the unlikely event that skeletal remains are found during dam embankment and diversion works, work will cease immediately in the area and the NSW Police Coroner called to determine if the material is of Aboriginal origin. OEH and relevant Aboriginal community stakeholders will be notified if the remains are positively identified as being of Aboriginal origin to determine their appropriate management prior to works recommencing.
Wastes	Management and monitoring of waste will continue to be undertaken in accordance with the Colliery's Waste Management Standard. In addition, LakeCoal will continue to try and improve its waste volumes and waste management practices in line with its objective for 60% of all wastes generated at the Colliery (excluding wastewater) to be recyclable or reusable.
Hazards	Management and monitoring of hazards will continue in accordance with the Colliery's existing hazard management measures. Periodic review of the effectiveness of existing measures will occur in accordance with the Colliery's safety management system and additional measures implemented as warranted.
Visual	Management and monitoring of visual impacts will continue to be undertaken in accordance with the Colliery's existing commitment. In addition, LakeCoal will ensure additional surface lighting at the Colliery complies with *AS4282 (INT) 1995 – Control of Obtrusive Effects of Outdoor Lighting.*
Soil	Management and monitoring of soils will continue to be undertaken in accordance with the Colliery's WMP, which will be reviewed and updated as required to include the commitments made below. LakeCoal will: • prevent disturbance of ASS where practicable during any construction activities; • prepare an ASSMP where there is potential that ASS will be disturbed; • test and handle any ASS disturbed in accordance with the ASSMP and treat or dispose of to an appropriately licensed facility; • limit the area of any disturbance at the surface infrastructure sites and period of exposure; • implement site management procedures such as watering of disturbed areas and unsecured stockpiles; • ensure relevant licences and management plans are in place for the correct storage and handling of hydrocarbons; • maintain suitable bunding around all hazardous liquid storage areas;

Item	Commitment
	• maintain oil separation facilities on the wash down sump for the treatment of oily water; and • remove all waste oil from site and dispose via a licensed external waste collection company.
Rehabilitation and mine closure	Rehabilitation will be undertaken in accordance with the Colliery's RMP and the MOP in force at the time. Detailed management and monitoring Proposals for final rehabilitation will be included within a Mine Closure Plan to be prepared at least two years prior to cessation of mining activities.
Economic	LakeCoal will contribute $0.035/t of coal from the Colliery into a dedicated community fund to improve public infrastructure and for the provision of community projects in the surrounding communities of Chain Valley Bay, Mannering Park, Summerland Point and Gwandalan.
Social	LakeCoal will continue to implement management measures and monitoring programs to prevent or minimise negative impacts and enhance positive impacts in accordance with its Environment and Community Policy. LakeCoal will: • maintain open and constructive communication with affected individuals and groups; • participate in the CCC; • provide environmental monitoring data and other relevant information in a timely manner via the LakeCoal website; • be responsive to community issues and actual and/or perceived impacts from the Colliery's activities; • work in partnership with stakeholders to address community needs;

Item	Commitment
	• ensure effective management of LakeCoal's social impacts; • liaise regularly with relevant government agencies and councils; • provide regular Colliery updates with landowners and local residents through the CCC; • continue payments, throughout the life of the Proposal, to the community fund established; and • consider individual sponsorship opportunities throughout the life of the Proposal.
Other	LakeCoal will commit to only carrying out mining operations in the extension areas consistent with the development consent granted pursuant to this Proposal.

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 the Mining Extension 1 Project EIS – EMM 2013a).

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

Likelihood of Impact	*Consequence*					
	1 Minor	2 Medium	3 Serious	4 Major	5 Catastrophic
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	Risk rating
Subsidence			
Subsidence impacts to aquatic ecology	1 (Rare)	1 (Minor)	2 (Low)
Subsidence impacts to 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 to terrestrial ecology	1 (Rare)	1 (Minor)	2 (Low)
Subsidence impacts to aquatic ecology	1 (Rare)	1 (Minor)	2 (Low)
Aboriginal/historic heritage			
Subsidence impacts to 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 to beneficial aquifers	1 (Rare)	1 (Minor)	2 (Low)
Volumes of mine water inflows	2 (Unlikely)	1 (Minor)	3 (Low)
Impacts to 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)
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
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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^{o} 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

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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-levelling 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^o to 83^o). *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^{o} to 20^{o} 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^{o}.
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
Wallarah 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, $E_{laboratory}$ = 300 x 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**:

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

Undrained, jointed rock mass Youngs Modulii (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:

$E_{rockmass}$ = 0.4 $E_{laboratory}$ for Claystone/Mudstone
= 0.5 $E_{laboratory}$ for Shale/Coal/Siltstone
= 0.9 $E_{laboratory}$ for Conglomerate

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:

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

Drained Modulii 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:

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

$$q_u = N'_{square} \times UCS_1/2 = [5.14 + 0.33(w/t)]\ UCS_1/2$$

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:

$$q_u = N'_{strip} \times UCS_1/2 = [4.14 + 0.5(w/t)]\ UCS_1/2$$

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 Cooronbong 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:

$s_{max} = s_{pillar} + s_{roof} + s_{floor}$

where

s_{pillar} = σ_{net} h/E_{coal} = compression of pillar

s_{roof} = σ_{net} w I(1-v^2)/E_{roof} = compression roof strata units

s_{floor} = σ_{net} w I(1-v^2)/E_{floor} = compression of floor strata units

$\sigma_{net1,2}$ = 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

v = 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 (H1 and H2), rock mass density γ, pillar extraction ratios in each seam (e1 and e2) 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:

$$\sigma_{net1} = \gamma H_1 \, e_{1/(}1\text{-}e_{1)}$$

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

$$\sigma_{net2} = [\gamma(H_2\text{-}H_1) + a.\sigma_{net1}]e_{2/(}1\text{-}e_{2)}$$

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:

$$\sigma_{net12} = \sigma_{net2} \, e_{1/(}1\text{-}e_{1)}$$

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 x 2.65 = 0.50 (see **Figure 7**)

C_s = swell index = 0.0463 (LL/100)G_s = 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:

$OCR = \sigma_{vo}/\sigma_v = 5.2/0.6 = 8.7$ 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:

$= \sigma_{vo\ (H=24m)} + \gamma(H - 24)$

$= 5.2 + 0.025(170 - 24) = 8.9$ MPa (GN Seam)

$= 5.2 + 0.025(195 - 24) = 9.5$ MPa (FAS Seam)

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:

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

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 m^2/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:

$$U = S_t/S_{max} = 1 - (2/M^2)\, e^{-M2Tv}$$

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 m^2/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													
A (I)	*SW (FW)*	*170*	*26.5 x 27.5 x 2.5*	*15.18*	*4.25*	*0.17*	*8.9*	11	15	80	106	19	125
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)

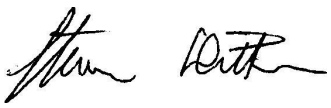
- Fibre Optic Cable (FoC)
- Steel Lattice Conductor Support Frames in Switchyard (Lattice Frames)
- Rigid Pavement (Pavement)
- Inlet Canal Wall (Inlet Canal Wall)

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



Steven Ditton
Principal Engineer

Attachments:

Figures 1 - 22

References:

ACARP, 1998a. **Establishing the Strength of Irregular and Rectangular Pillars**. J.M. Galvin, B.K. Hebblewhite, M.D.G. Salamon, B.B. Lin. ACARP Report No. C5024, UNSWUMRC Research Report RR3/98. (December).

ACARP, 1998b. **Chain Pillar Design (Calibration of ALPS)**. Colwell, M., Mark, C.ACARP Report No. C6036 (October).

Brown & Meyerhof, 1969. **Experimental Study of Bearing Capacity in Layered Clays**. Proceedings of 7th International Conference on Soil Mechanics and Foundation Engineering, Mexico.

Das, 1998. **Principles of Geotechnical Engineering**. PWS.

DgS, 2012. **Review of the Subsidence Predictions for the Proposed Partial Pillar Extraction of 3-West Panel (Panel 13) at the Tasman Mine, George Booth Drive, Seahampton**. DgS Report No. TAS-004/10 (April).

DgS, 2013a. **Subsidence Predictions and General Impact Assessment for the Chain Valley Colliery – Mining Extension 1 Project**. DGS Report No. CHV-002/1 (25/04/13).

DgS, 2013b. **Additional Subsidence Data Review for the Proposed MWs 41 to 45 at Chain Valley Colliery**. Report No. CHV-002/2 (25/11/13).

EMGA Mitchell McLennan 2013, **Environmental Impact Statement Chain Valley Colliery Mining Extension 1 Project**, prepared on behalf of LakeCoal Pty Ltd.

EMGA Mitchell McLennan, 2014, **Chain Valley Colliery Modification 1 Statement of Environmental Effects**, prepared on behalf of LakeCoal Pty Ltd.
Hoek and Brown, 1999. **Practical Estimates of Rock Mass Strength**. International Journal of Rock Mechanics, 34 (8).

Holla, 1998. **Geological Factors Affecting Mine Subsidence Assessment**. L. Holla, Department of Mineral Resources. Published in Australian Geomechanics Society (AGS) Conference Proceedings, Engineering Geology in the Hunter Valley, University of Newcastle (July).

Ives, 1995. **Stratigraphy and Engineering Properties of the Newcastle and Tomago Coal Measures**. Ives, M.J. Published in Australian Geomechanics Society (AGS) Conference Proceedings (February), Engineering Geology of Newcastle – Gosford Region, University of Newcastle.

Li and Smith, 1998. **Planning for Time-Dependant Subsidence**. Published Proceedings of 4th Triennial MSTS Conference, University of Newcastle, July.

Li *et al*, 2001. **Investigation of Long Term Stability of Mine Workings on Claystone Floor and Associated Subsidence Issues**. MSTS Conference 2001, Maitland.

Lohe & Dean Jones, 1995. **Structural Geology of the Newcastle-Gosford Region**. Published in Australian Geomechanics Society (AGS) Conference Proceedings (February), Engineering Geology of Newcastle – Gosford Region, University of Newcastle.

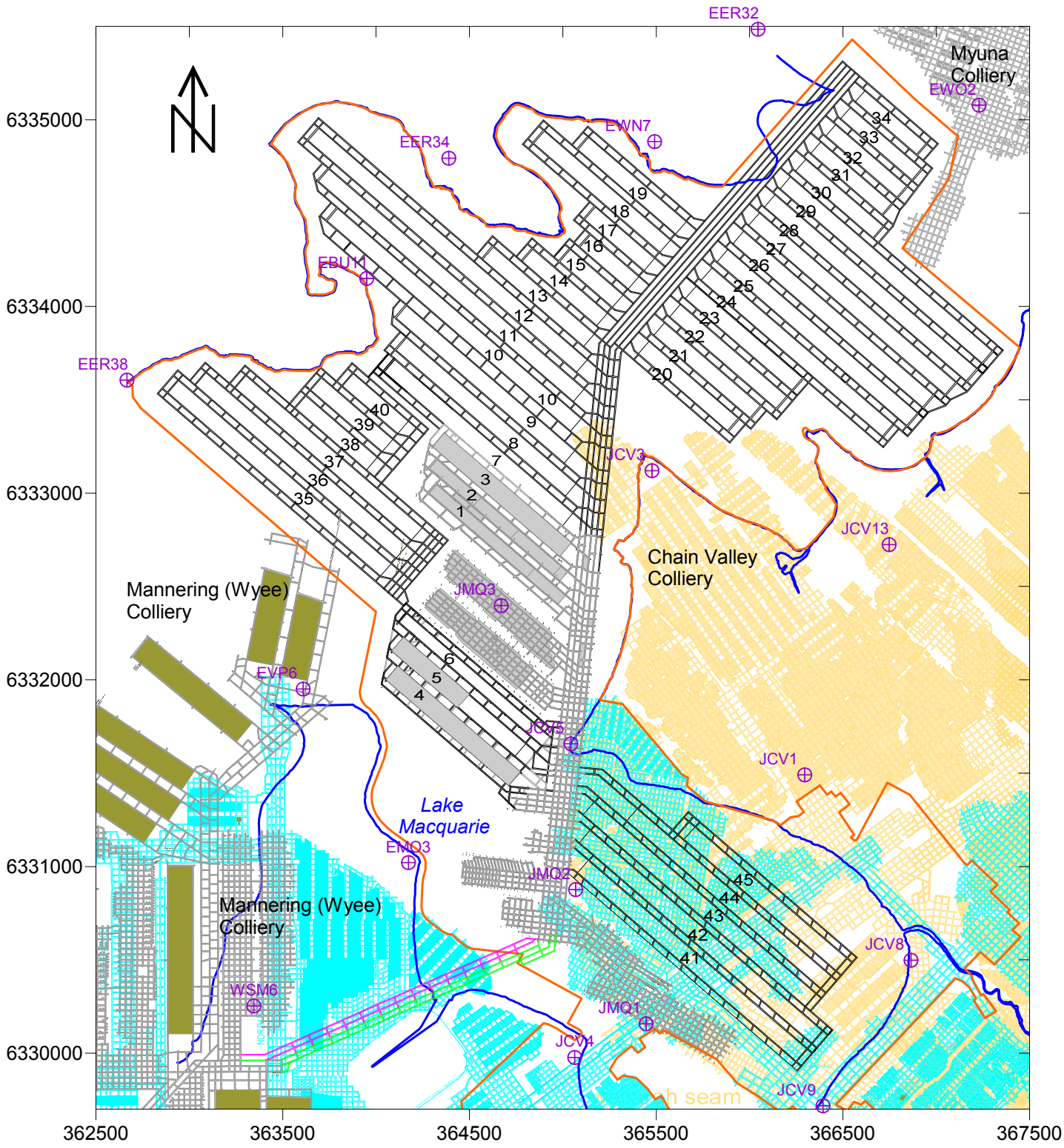
Marino and Choi, 1999. **Softening Effects on Bearing Capacity of Mine Floors**. G.G. Marino & S. Choi. Journal of Geotechnical and Geoenvironmental Engineering (Dec 1999).

Nagaraj and Murty, 1985. **Prediction of Pre-consolidation Pressure and Recompression Index of Soils**. Geotechnical Testing Journal Vol 8 No. 4.

Pells *et al*, 1998. **Foundations on Sandstone and Shale in the Sydney Region**, Pells, P.J.N., Mostyn, G. and Walker, B.F..Australian Geomechanics Journal.

Seedsman & Gordon, 1992. **Weak Claystone Floors and their Implications to Pillar Design and Settlement**. 11th International Conference on Ground Control In Mining, University of Wollongong, NSW (July).

Yee *et al*, 1991. **Lloyd Avenue, Chain Valley Bay - Mine Subsidence Restoration, Stage 1: A Case Study**. D.M. Yee, A.J. Geddes, C.G. Simpson. Proceedings of 2nd Triennial Conference on Buildings and Structures Subject to Mine Subsidence, Maitland (August).



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

DgS

Ditton Geotechnical Services Pty Ltd

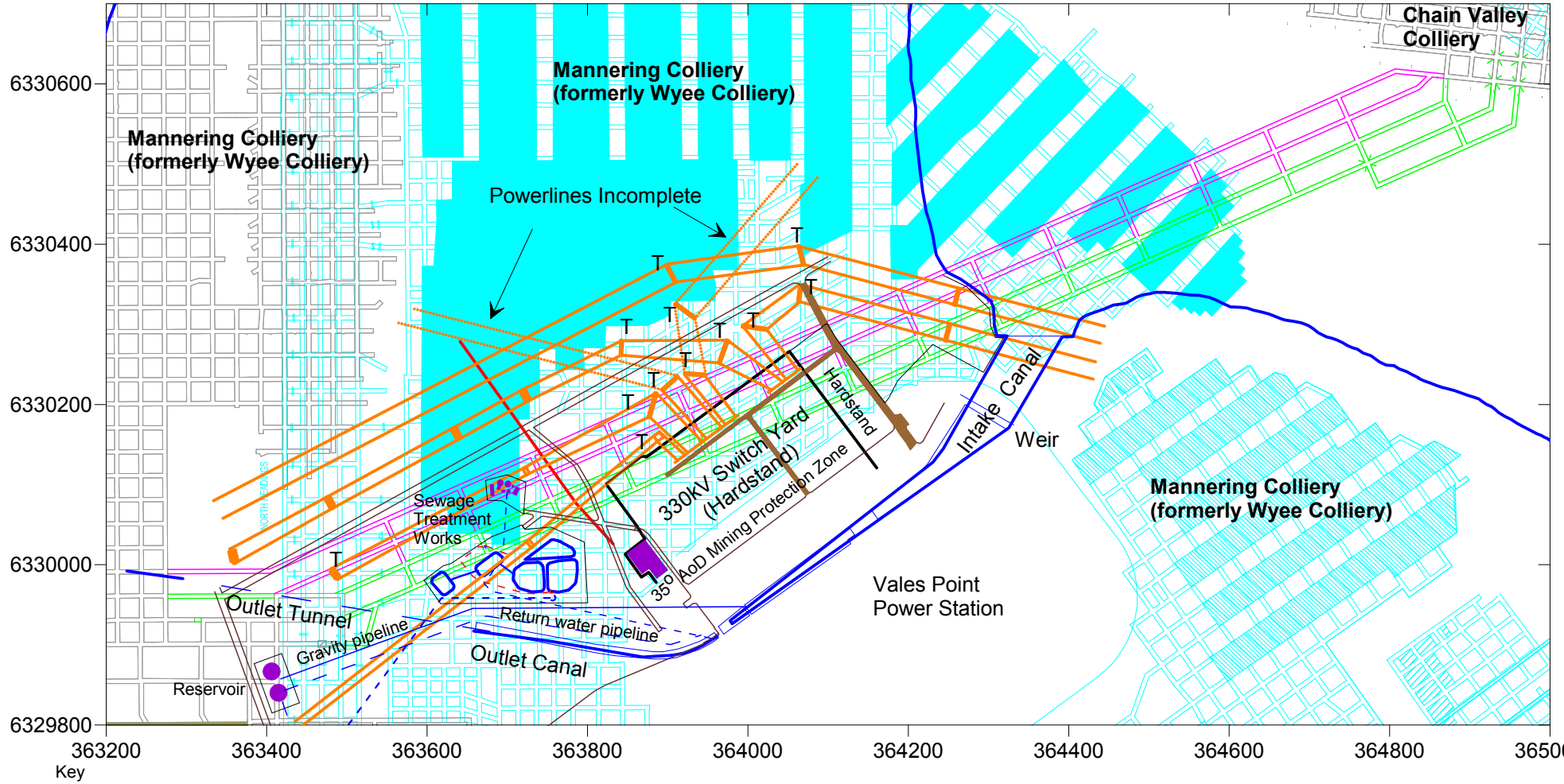
Engineer:	S.Ditton
Drawn:	S.Ditton
Date:	05.12.12

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

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

Scale: 1:12,000 (A4)

Figure No: 1a



Key

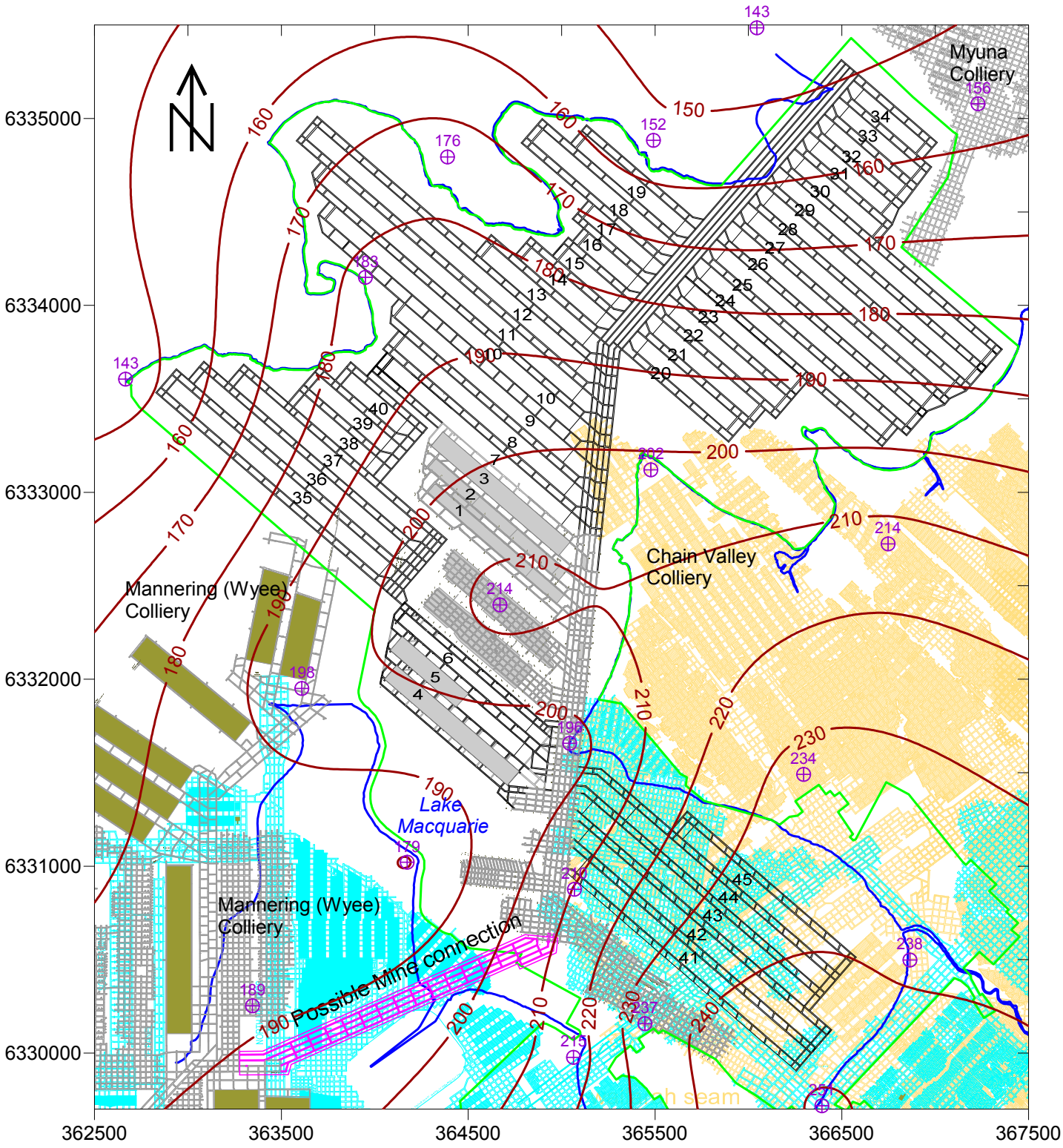
- Existing First Workings in GN Seam
- Existing Second Workings in GN Seam
- Existing First Workings in FAS Seam
- Proposed Mine Connection Headings in FAS Seam (Green - Stage 1; Magenta - Stage 2)
- Optic Fibre Cable (buried)
- Power Cable (buried)
- Security Fence Lines
- Rising Main (buried)
- 330kv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

DgS

Ditton Geotechnical Services Pty Ltd

Engineer:	S.Ditton
Drawn:	S.Ditton
Date:	25.01.14

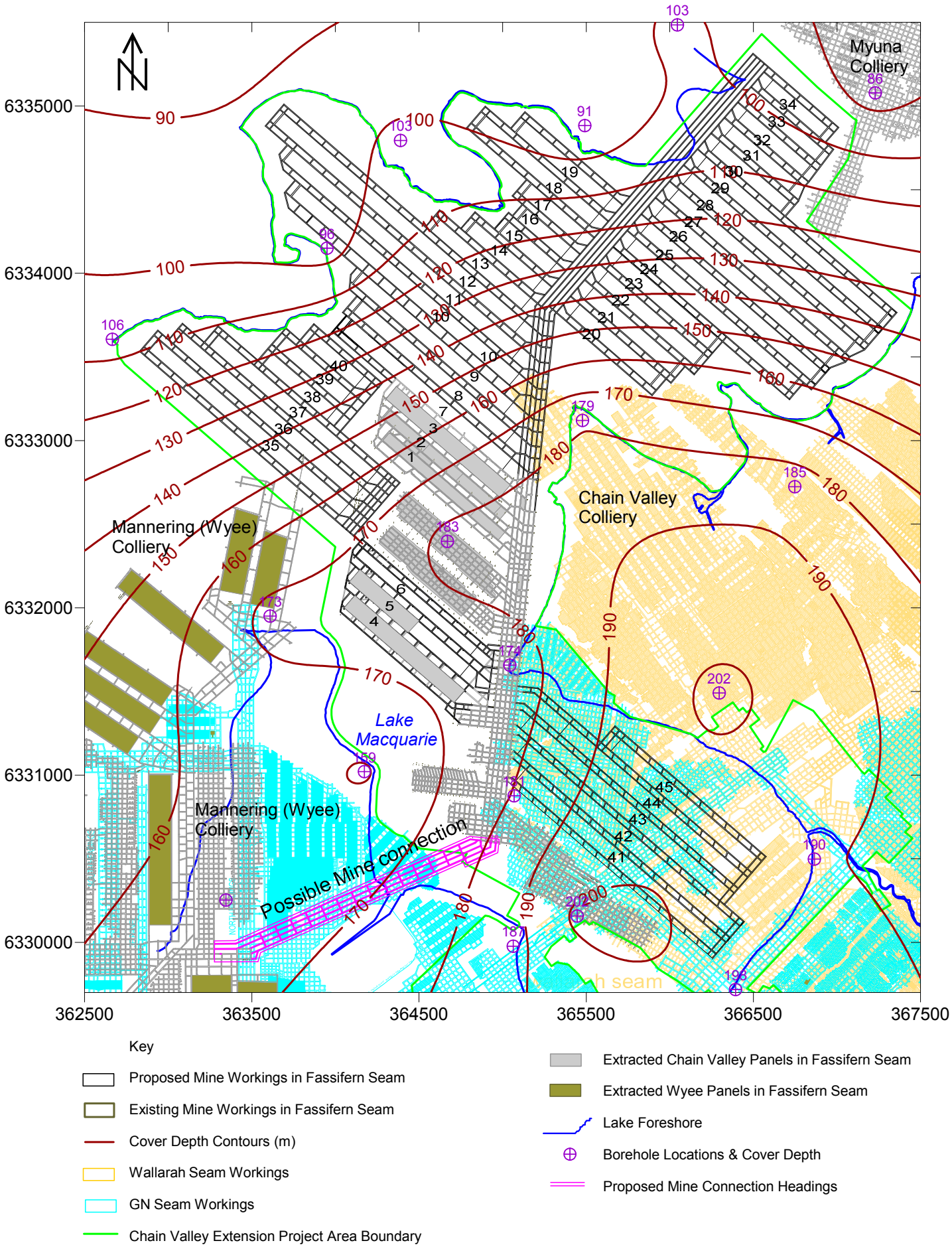
Client:	LakeCoal - Chain Valley Colliery CHV-002/3
Title:	Existing Surface Features above Proposed Mine Connection Headings to Mannering Mine in the Fassifern Seam plus Overlying Great Northern Seam Mine Workings
Scale:	1:7,500 (A4)
Figure No:	1b



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 Wyee Panels in Fassifern Seam
- Lake Foreshore
- Borehole Locations & No.
- Proposed Mine Connection Headings

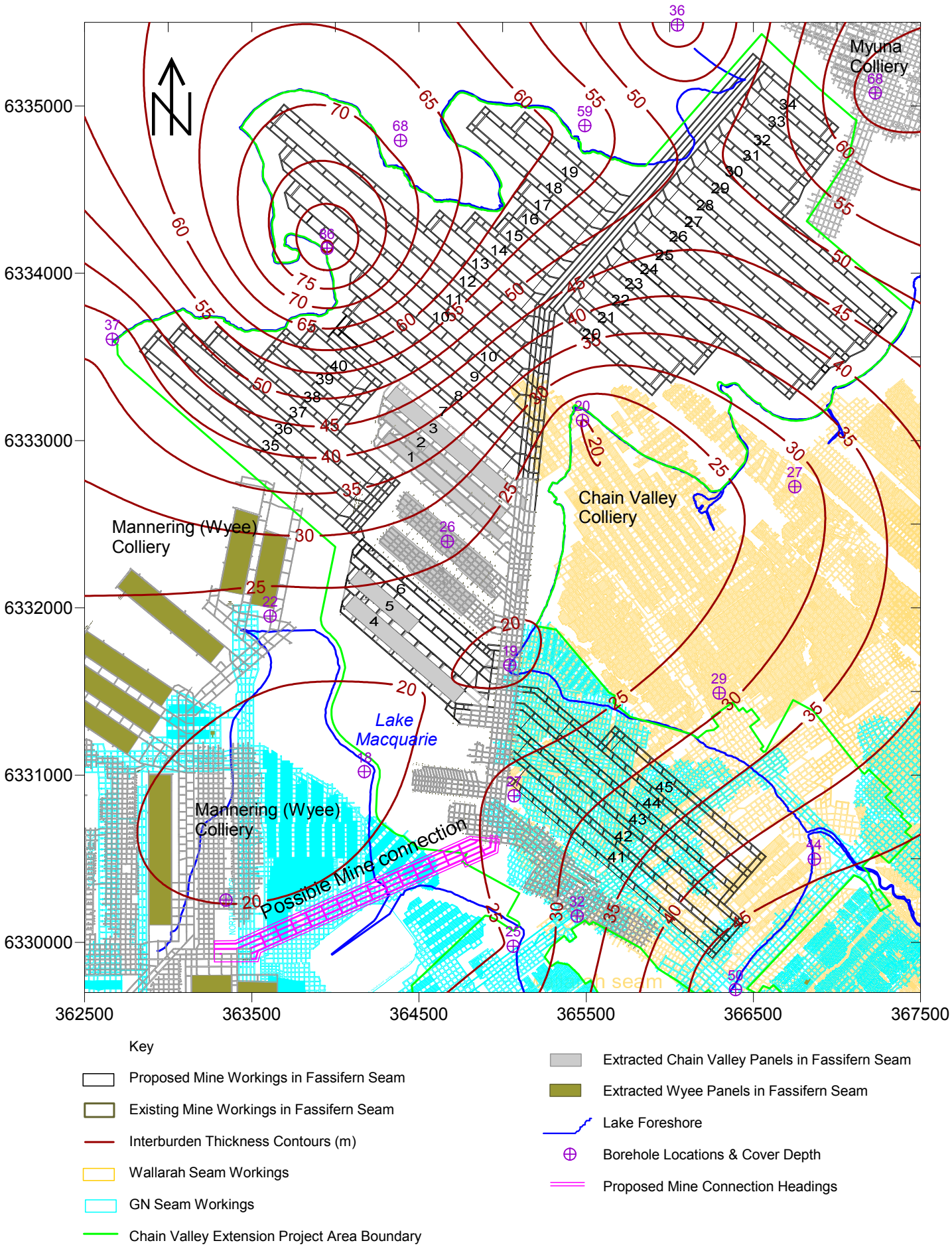
DgS	Engineer:	S.Ditton	Client:	LakeCoal - Chain Valley Colliery CHV-002/3	
	Drawn:	S.Ditton			
	Date:	05.12.12	Title:	Proposed Mine Connection Headings to Mannering Mine in the Fassifern Seam	
Ditton Geotechnical Services Pty Ltd			Scale:	1:12,000 (A4)	Figure No: 2



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 Wyee Panels in Fassifern Seam
- Lake Foreshore
- Borehole Locations & Cover Depth
- Proposed Mine Connection Headings

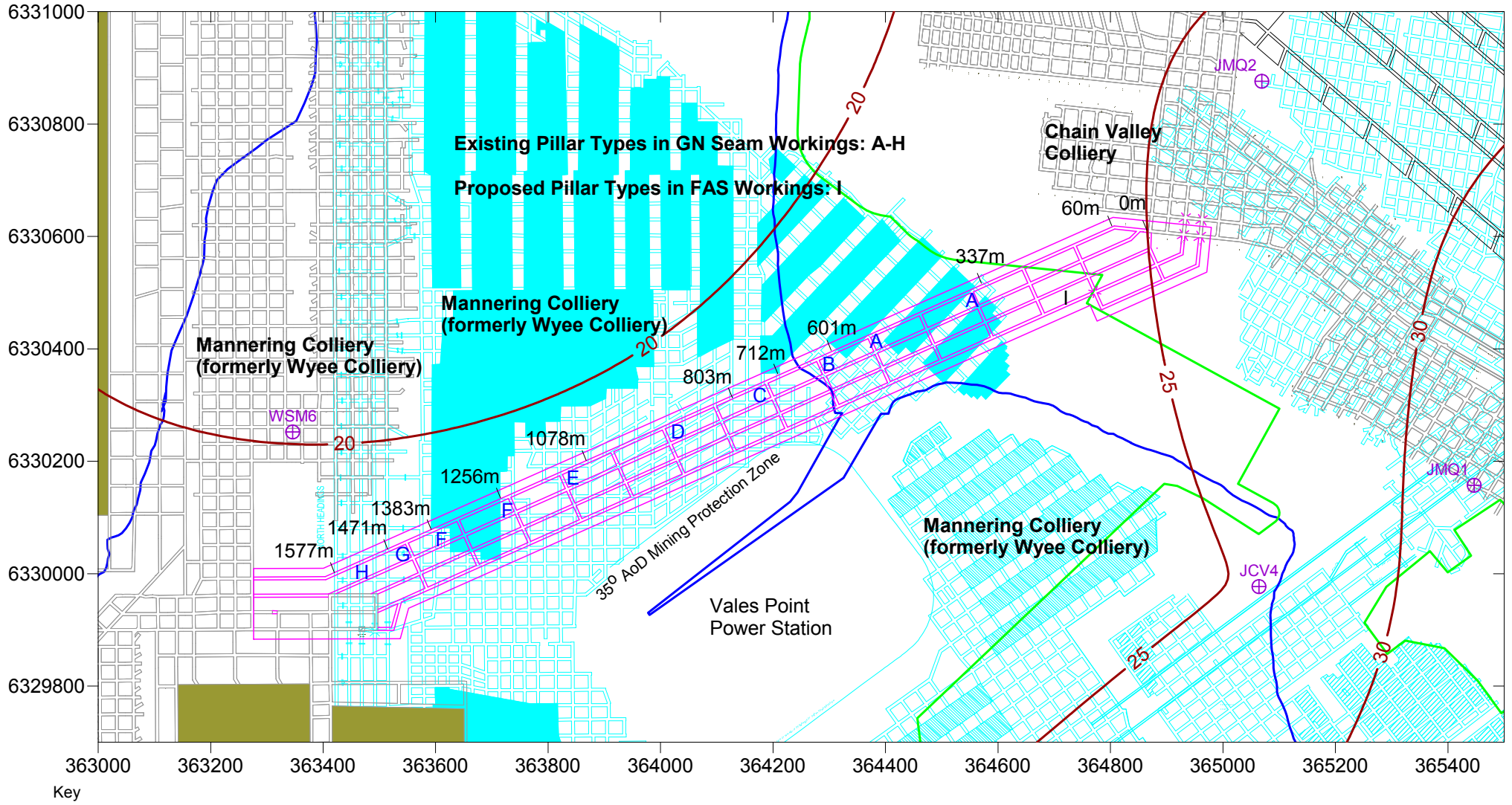
DgS	Engineer:	S.Ditton	Client:	LakeCoal - Chain Valley Colliery CHV-002/3	
	Drawn:	S.Ditton			
	Date:	05.12.12	Title:	Proposed Mine Connection Headings to Mannering Mine in the Fassifern Seam with Cover Depth Contours to the Great Northern Seam Mine Workings	
Ditton Geotechnical Services Pty Ltd			Scale:	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 Wyee Panels in Fassifern Seam
- Lake Foreshore
- Borehole Locations & Cover Depth
- Proposed Mine Connection Headings

DgS	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

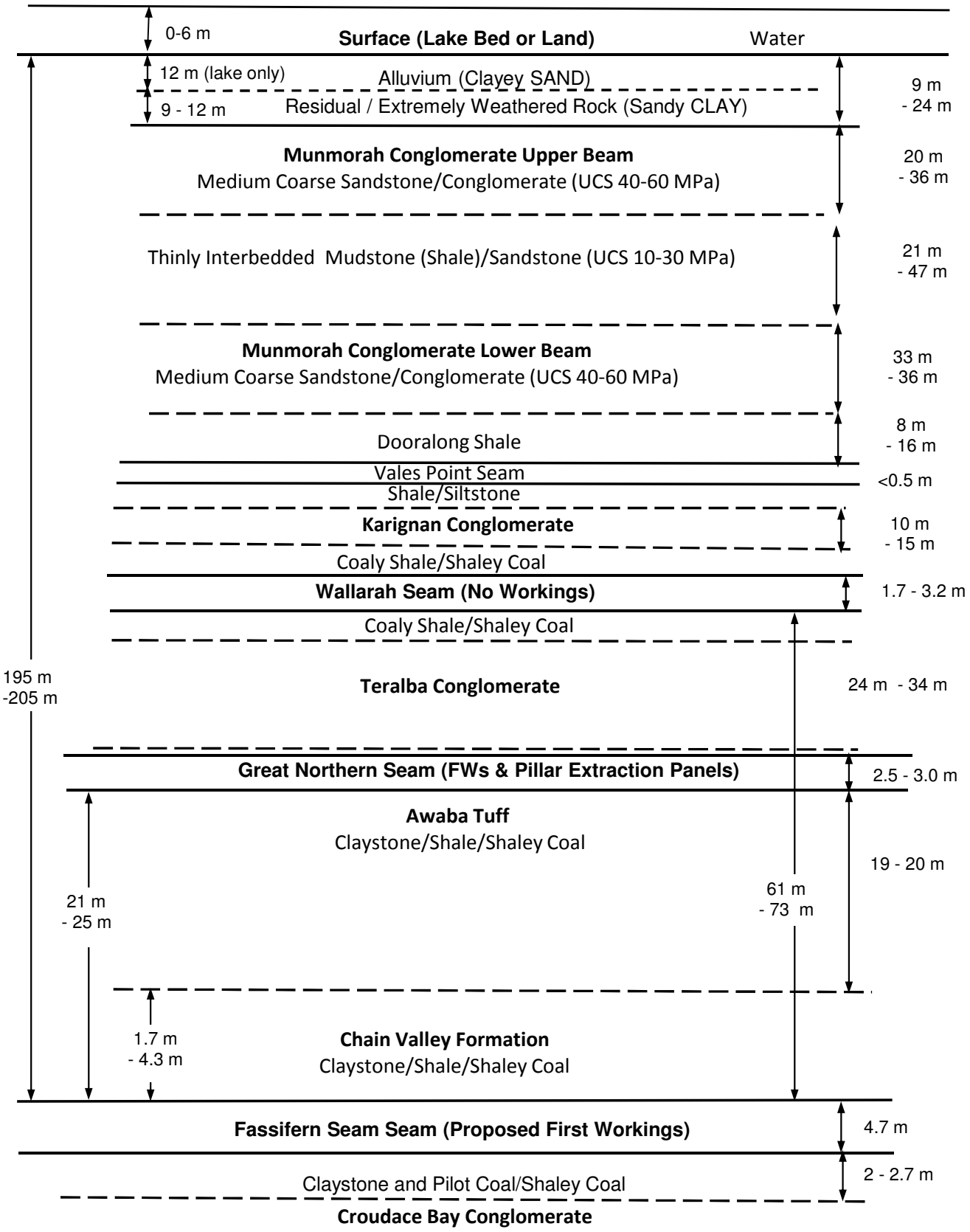
- Existing First Workings in GN Seam
- Existing Second Workings in GN Seam
- Existing First Workings in FAS Seam
- Interburden Thickness Contours (m)
- Chain Valley Extension Project Area Boundary
- Proposed Mine Connection Headings in FAS Seam
- Extracted Wyee LWs in Fassifern Seam
- Lake Foreshore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

DgS

Ditton Geotechnical Services Pty Ltd

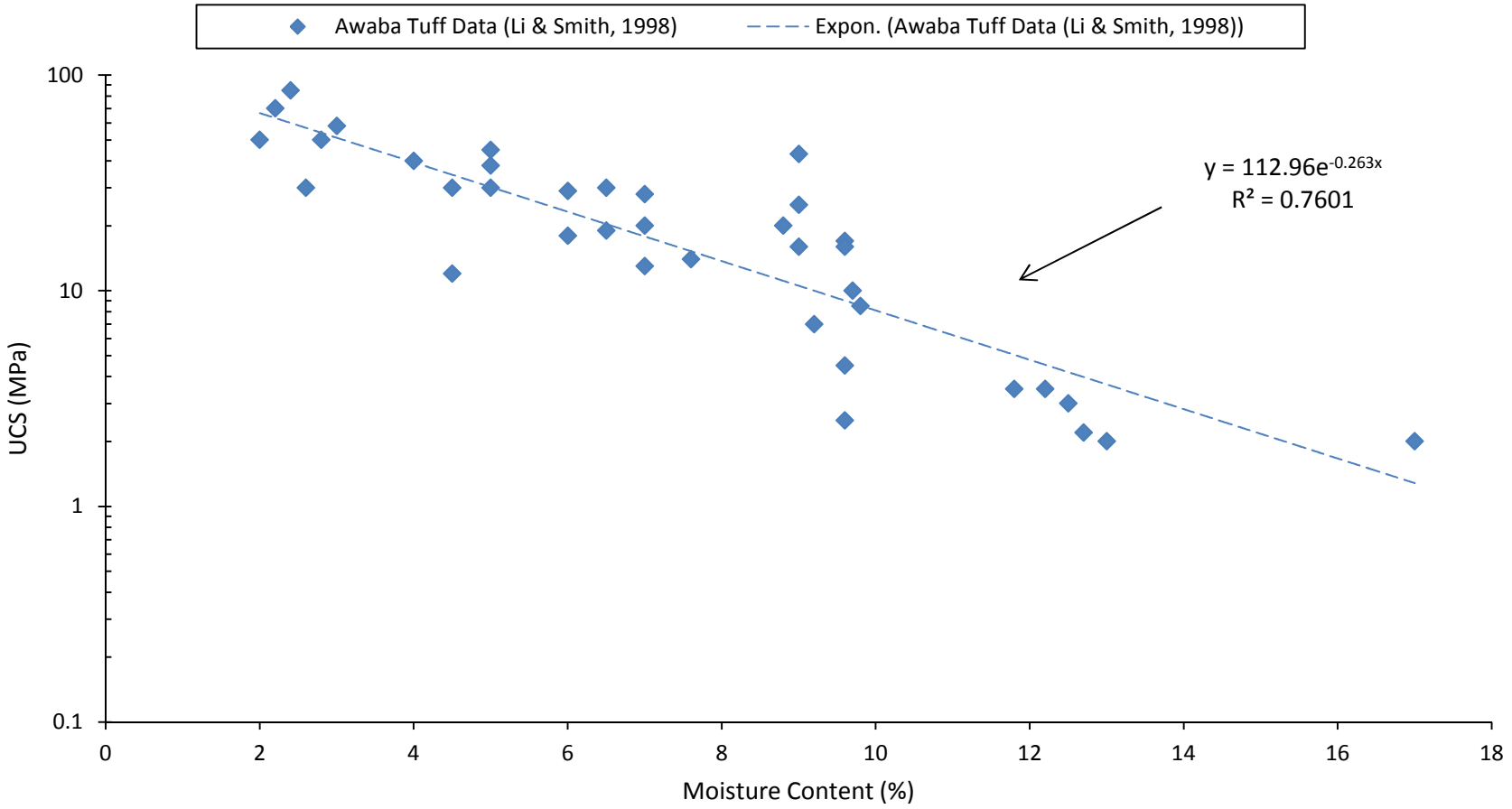
Engineer:	S.Ditton
Drawn:	S.Ditton
Date:	25.11.13

Client:	LakeCoal - Chain Valley Colliery CHV-002/3
Title:	Proposed Mine Connection Headings to Mannering Mine in the Fassifern Seam with Interburden Thickness Contours to the Great Northern Seam Mine Workings
Scale:	1:10,000 (A4)
Figure No:	5

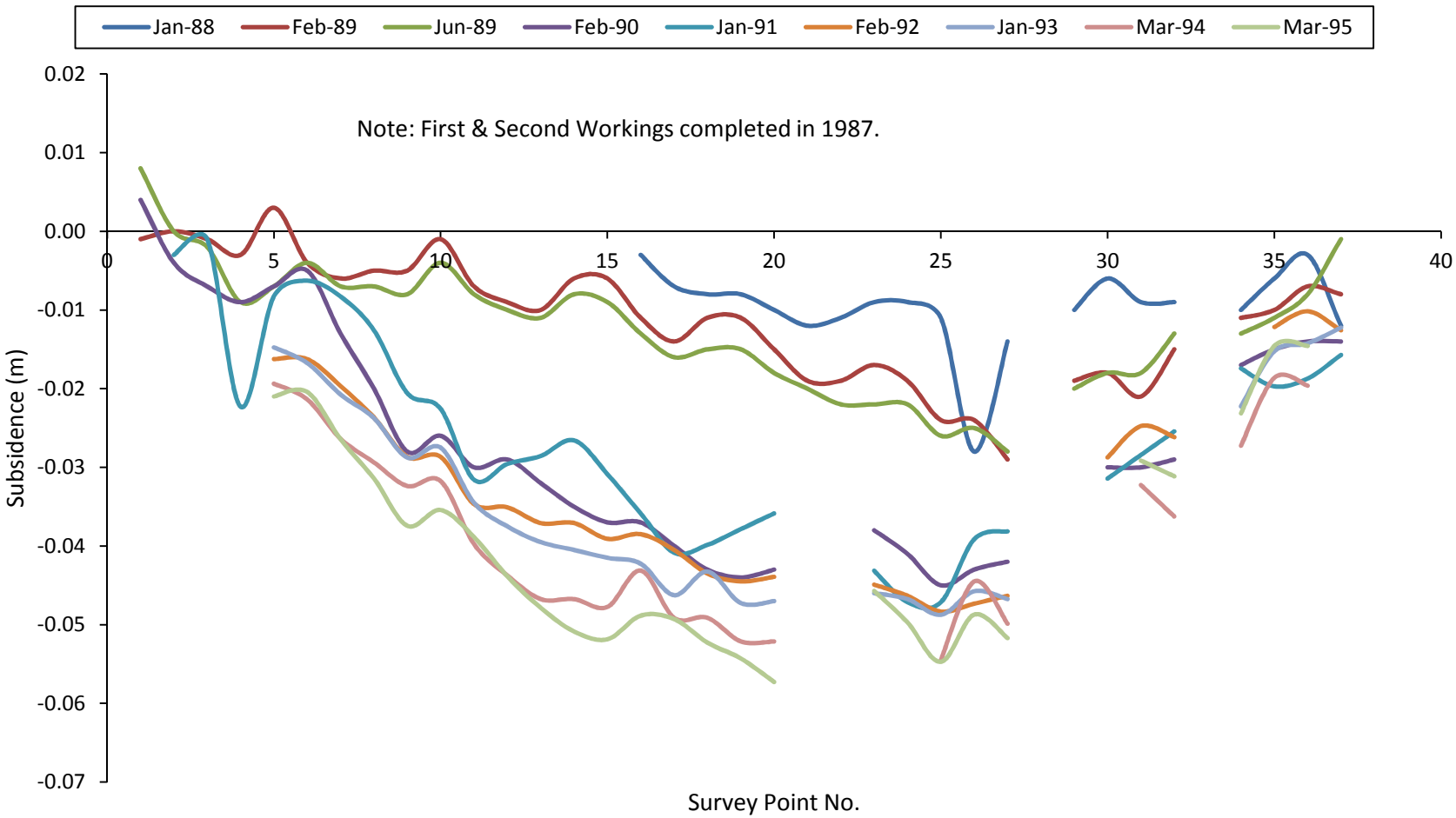


DgS	Engineer: S.Ditton	Client:	LakeCoal - Chain Valley Colliery		
	Drawn: S.Ditton		CHV-002/3		
	Date: 29.11.13	Title:	Geotechnical Model of the Strata Within the Mine		
	Ditton Geotechnical Services Pty Ltd		Connection Area		
		Scale:	NTS	Figure No:	6

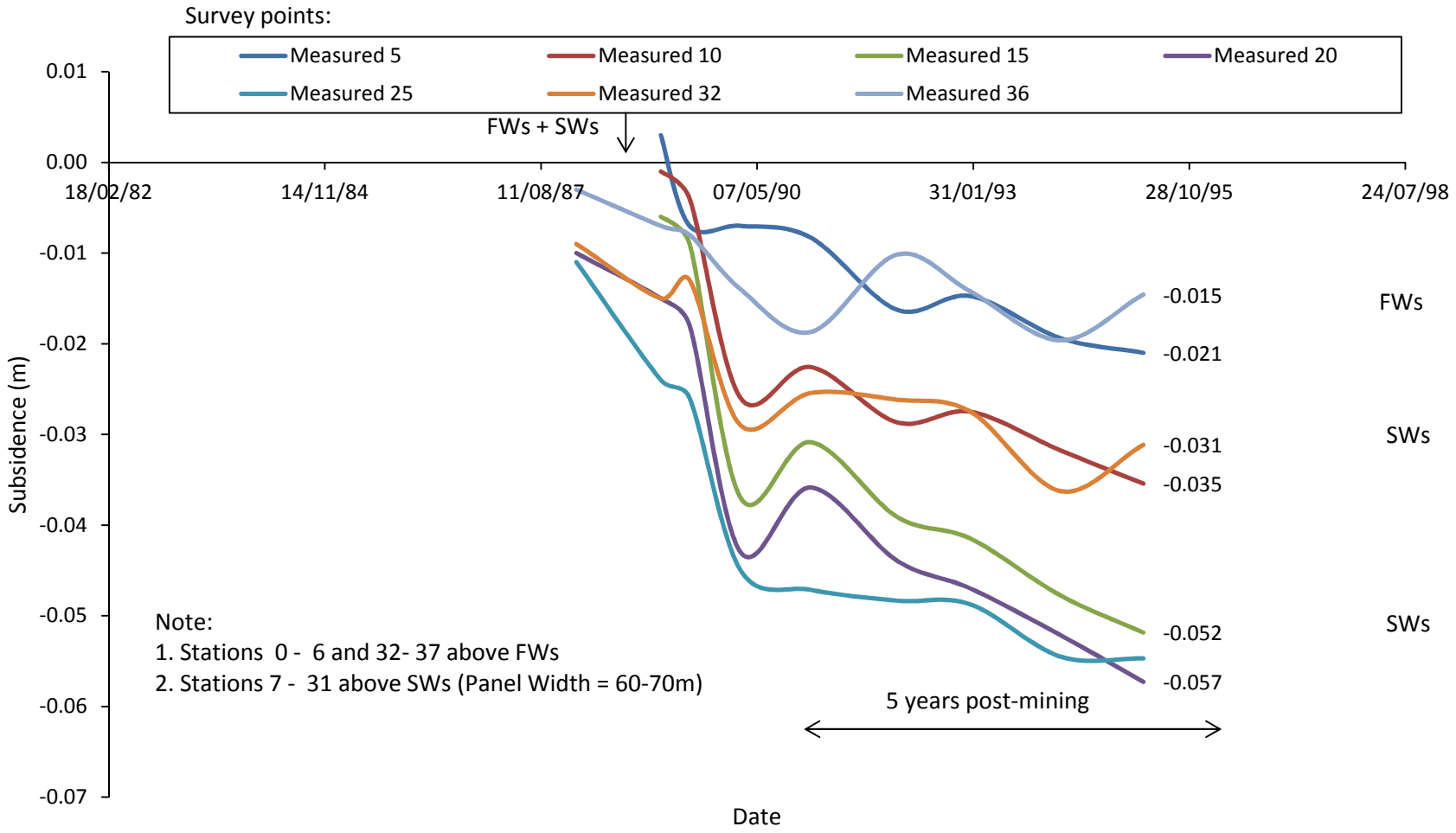
Awaba Tuff Data (Li & Smith, 1998)



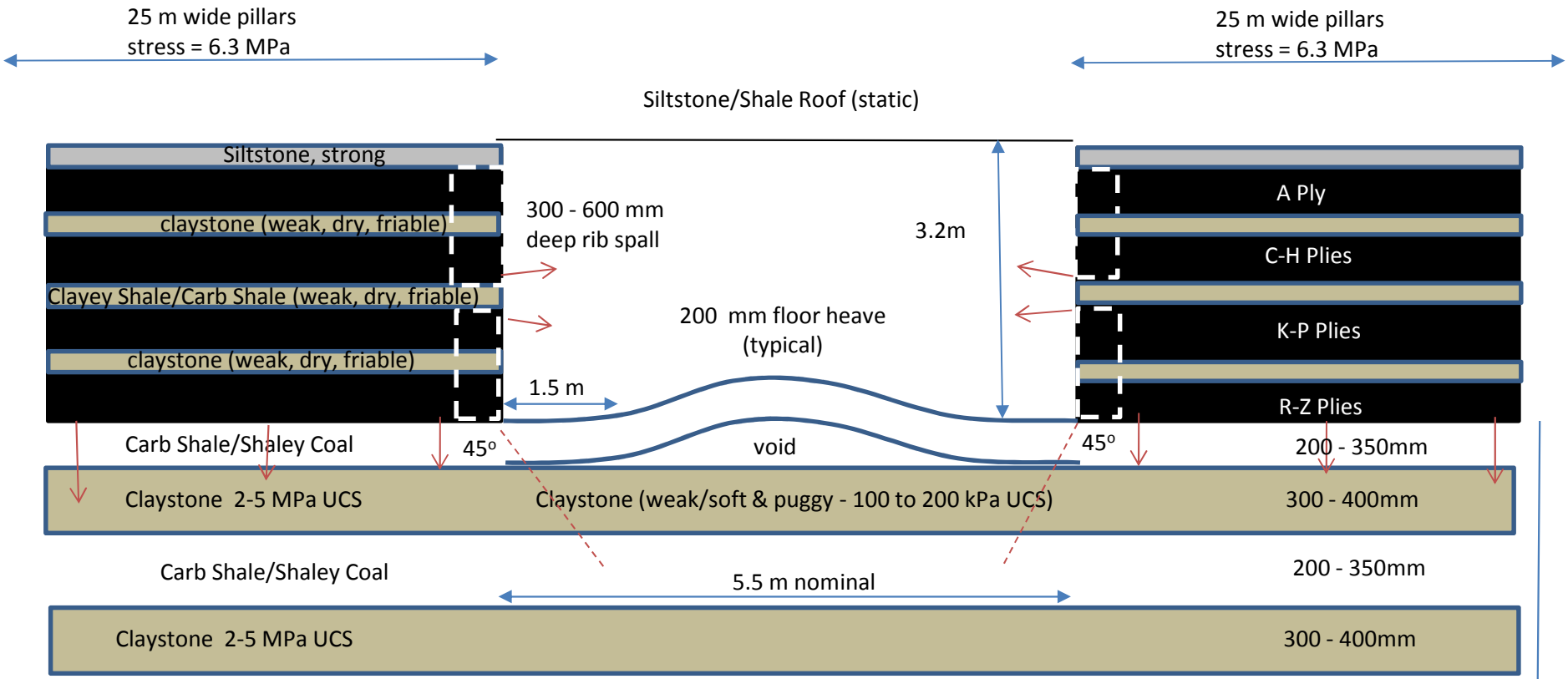
DgS	Engineer:	S.Ditton	Client:	LakeCoal - Chain Valley Colliery CHV-002/3	
	Drawn:	S.Ditton			
	Date:	20.11.13	Title:	Awaba Tuff Claystone UCS Tests v. Moisture Content	
	Ditton Geotechnical Services Pty Ltd		Scale:	NTS	Figure No: 7



DgS	Engineer:	S.Ditton	Client:	LakeCoal - Chain Valley Colliery CHV-002/3	
	Drawn:	S.Ditton			
	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



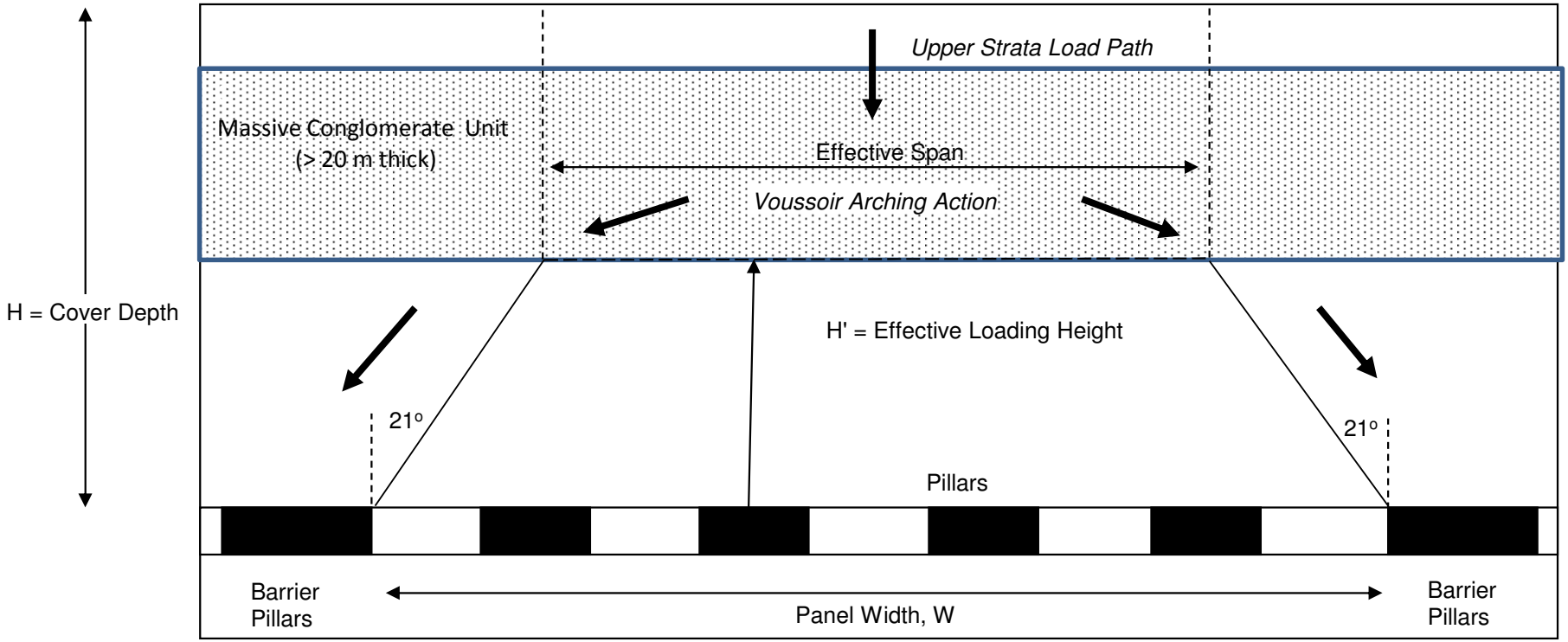
DgS	Engineer: S.Ditton	Client:	LakeCoal - Chain Valley Colliery CHV-002/3
	Drawn: S.Ditton		
	Date: 20.11.13	Title:	Measured Subsidence Data Along Chain Valley Bay Foreshore (Line 24) Above First and Second Workings Panels in GN Seam, 1km to south of Proposed Connection Workings
	Ditton Geotechnical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



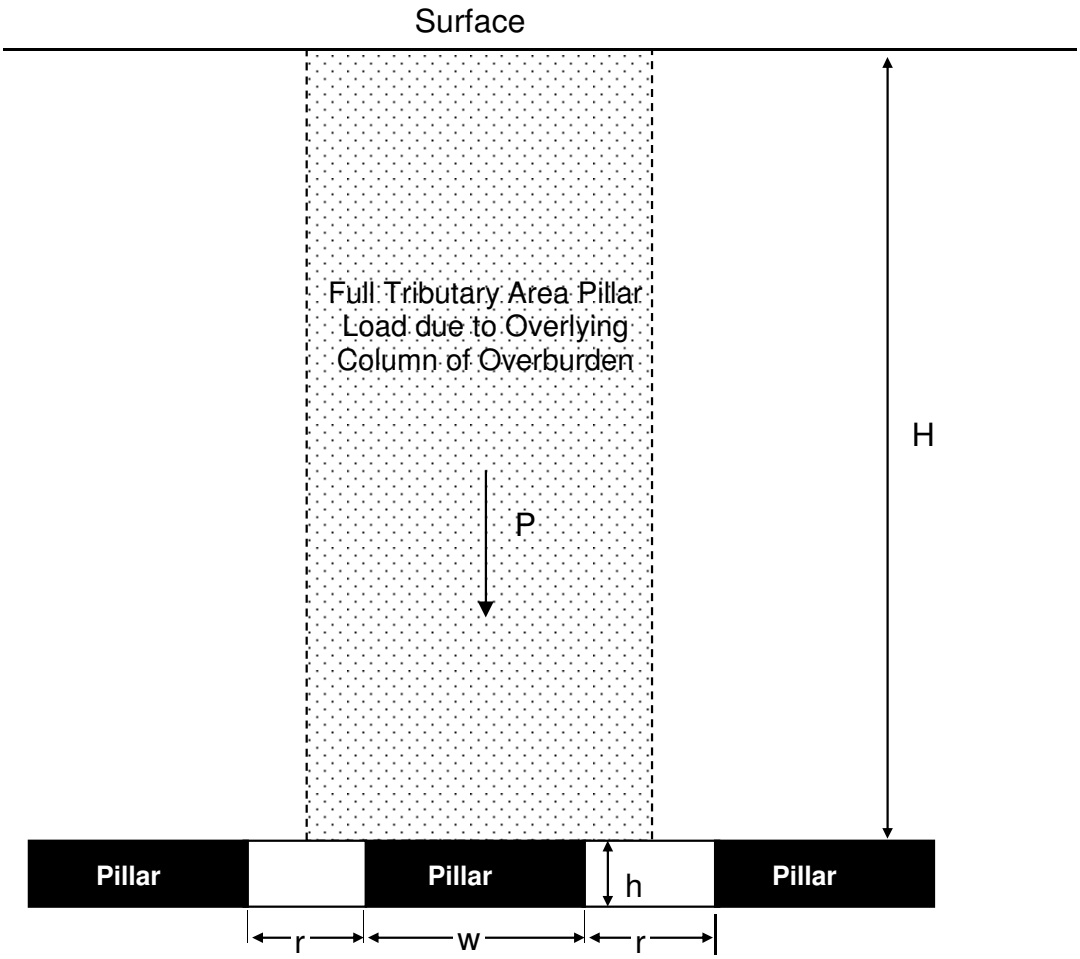
Notes:

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 subsequantly been driven upwards and buckled/sheared outwards along mid-height pillar claystone unit.

DgS	Engineer:	S.Ditton	Client:	LakeCoal - Chain Valley Colliery CHV-002/3	
	Drawn:	S.Ditton			
	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: 9

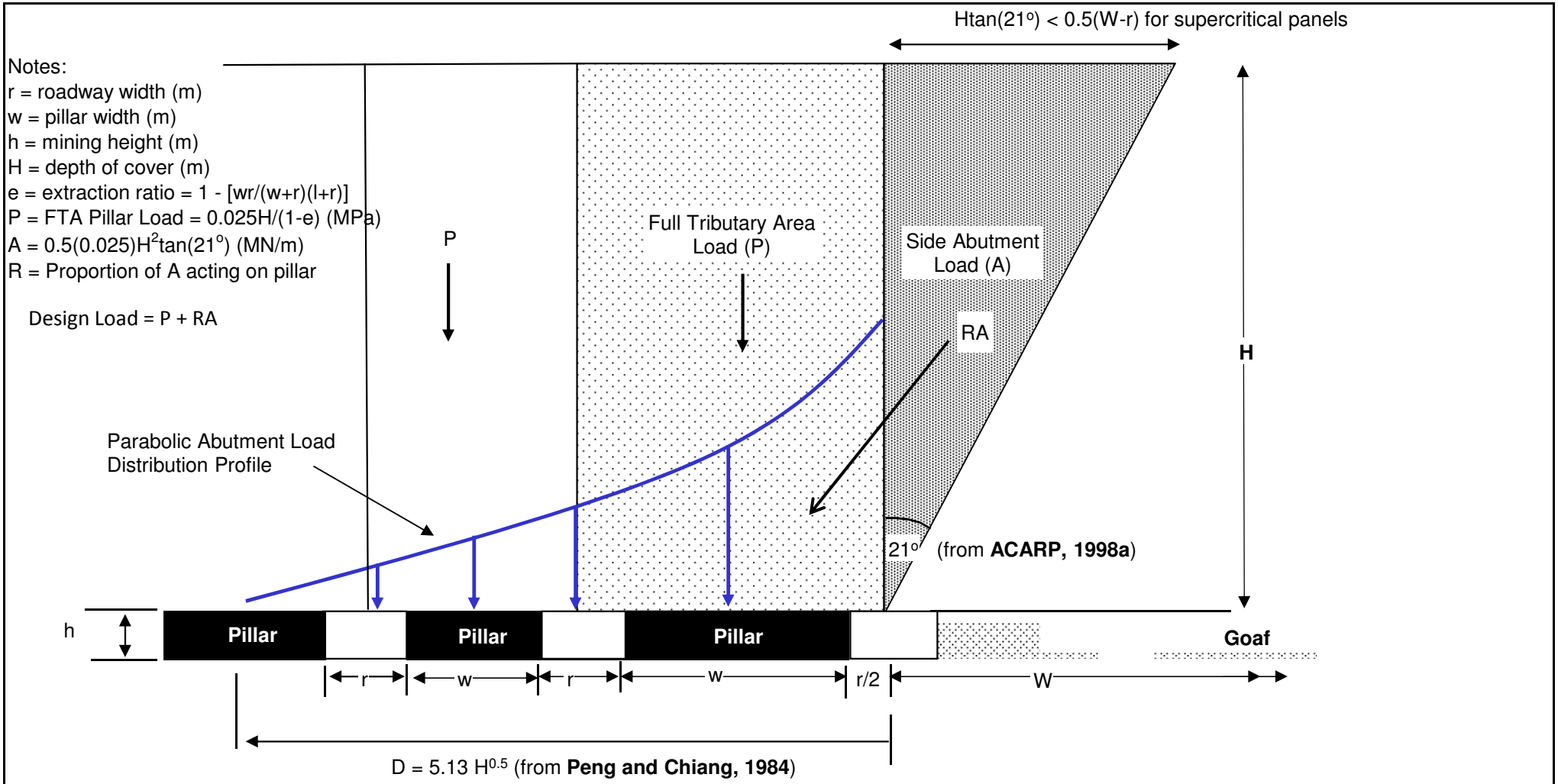


DgS	Engineer:	S.Ditton	Client:	LakeCoal - Chain Valley Colliery CHV-002/3	
	Drawn:	S.Ditton			
	Date:	29.11.13	Title:	Conceptual Strata Spanning Model for Panels with Spanning Conglomerate	
	Ditton Geotechnical Services Pty Ltd		Scale:	NTS	Figure No: 10



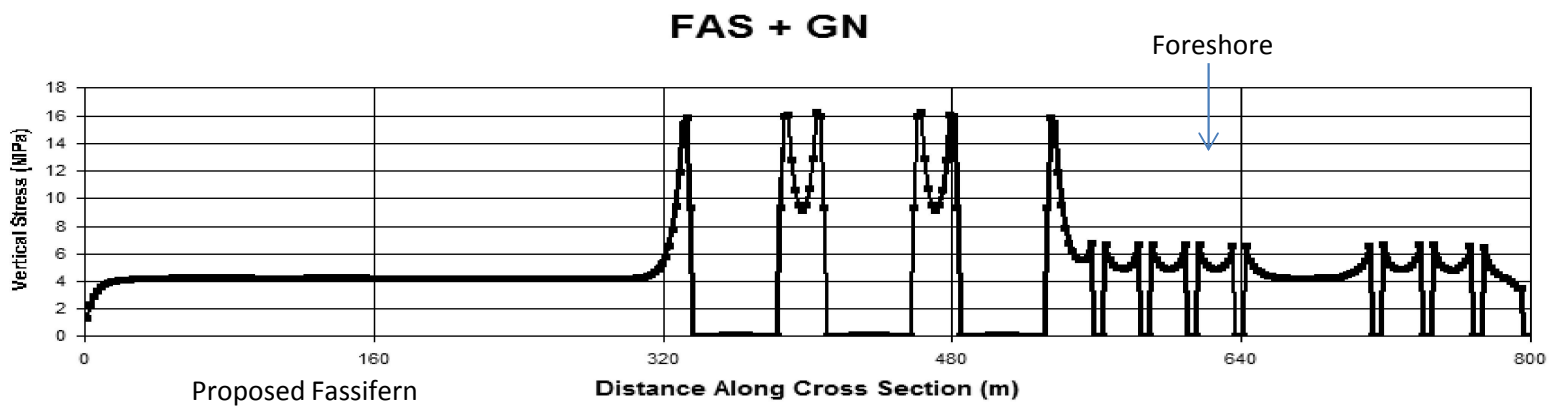
Notes:
r = roadway width (m)
w = pillar width (m)
l = pillar length (m)
h = mining height (m)
H = depth of cover (m)
e = extraction ratio = 1 - [wr/(w+r)(l+r)]
P = Pillar Load = 0.025H/(1-e) (MPa)

DgS	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

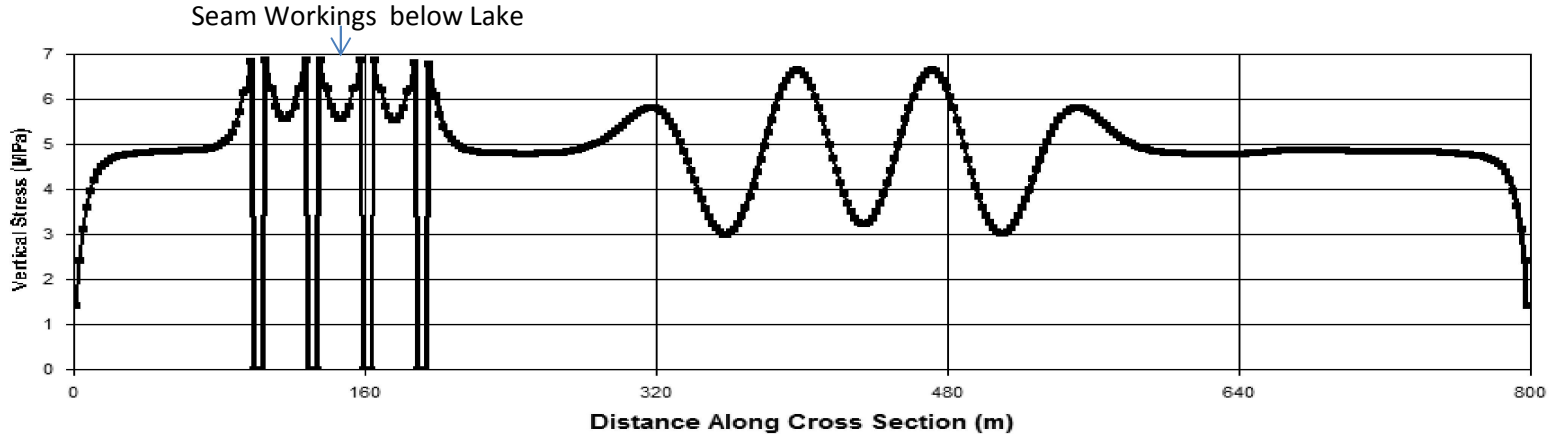


DgS	Engineer:	S.Ditton	Client:	LakeCoal - Chain Valley Colliery CHV-002/3	
	Drawn:	S.Ditton			
	Date:	23.11.13	Title:	Analytical Model for Calculating Worst-Case Abutment Load Acting on Pillars Pillars adjacent to Pillar Extraction Goaf	
	Ditton Geotechnical Services Pty Ltd		Scale:	NTS	Figure No: 11b

GN Seam

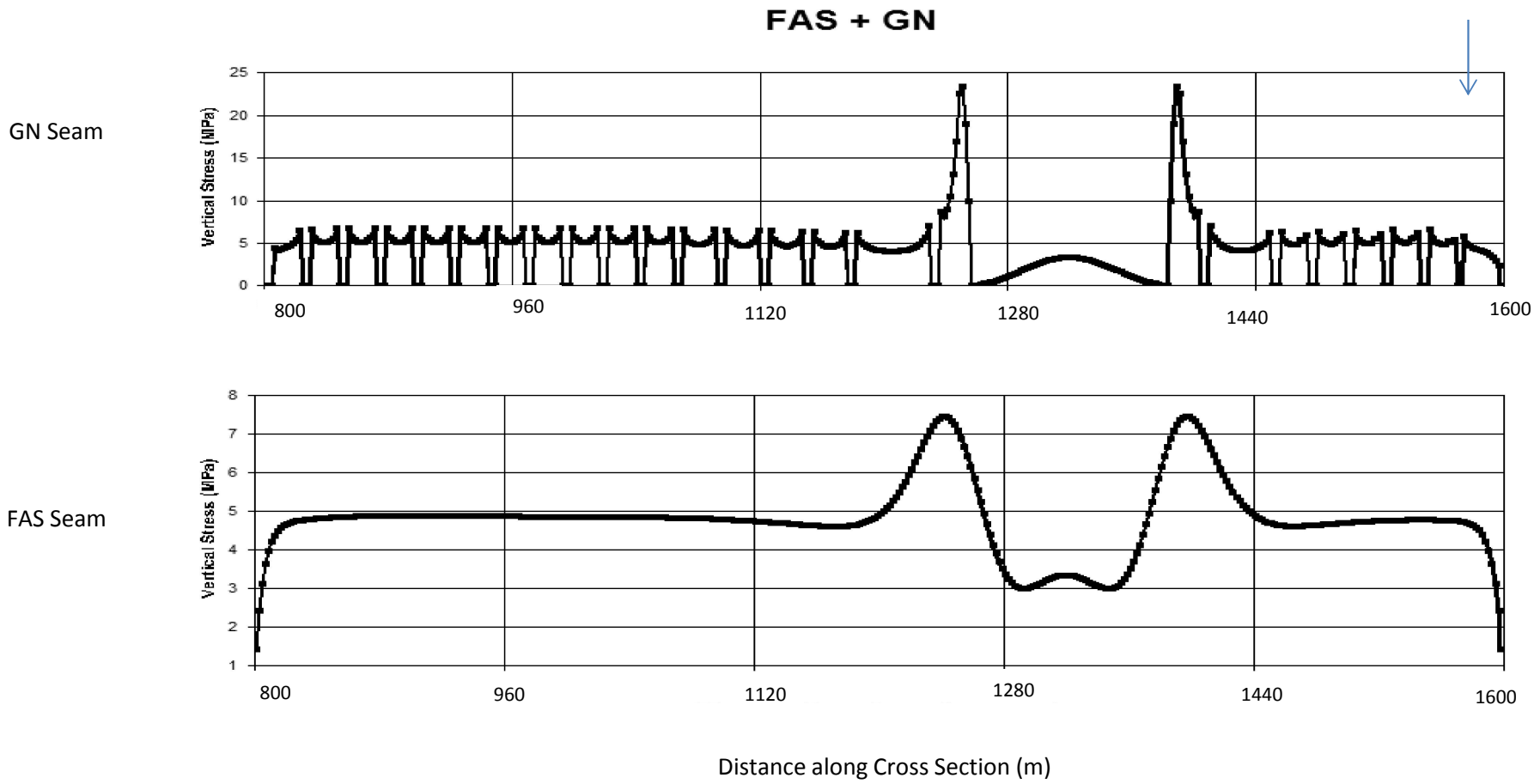


FAS Seam



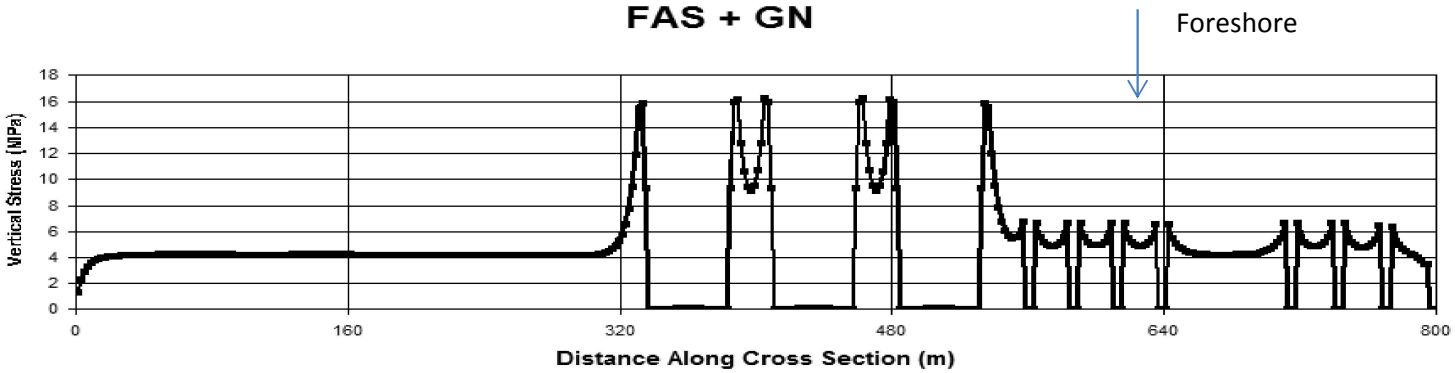
DgS	Engineer:	S.Ditton	Client:	LakeCoal - Chain Valley Colliery CHV-002/3	
	Drawn:	S.Ditton			
	Date:	30.11.13	Title:	Vertical Stress Profiles due to Great Northern Seam Workings on Fassifern Seam below (Ch 0 - 800 m from Existing Chain Valley Workings)	
	Ditton Geotechnical Services Pty Ltd		Scale:	NTS	Figure No: 12a

Existing Mannering Workings in GN and Fassifern Seam below Vales Point



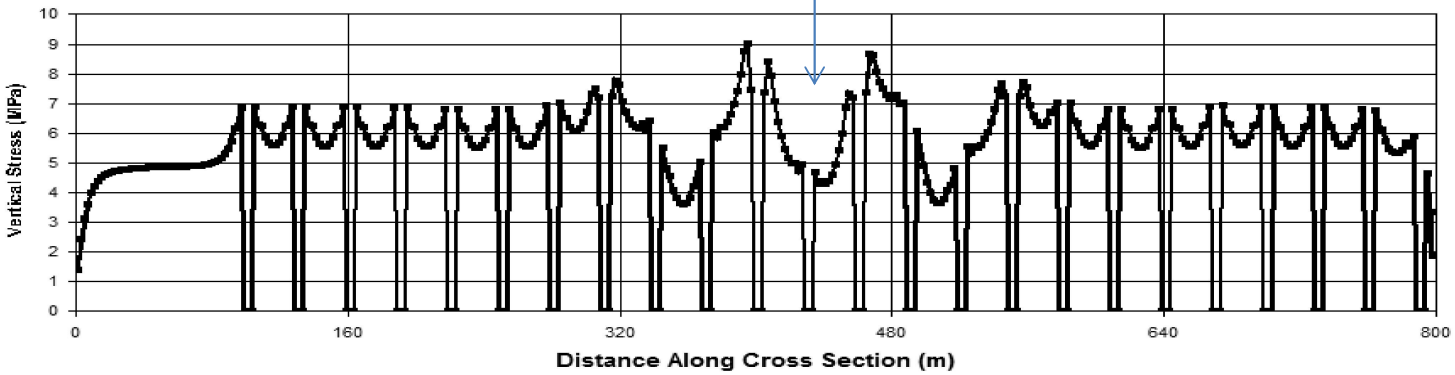
DgS	Engineer:	S.Ditton	Client:	LakeCoal - Chain Valley Colliery CHV-002/3	
	Drawn:	S.Ditton			
	Date:	30.11.13	Title:	Vertical Stress Profiles due to Great Northern Seam Workings on Fassifern Seam below (Ch 800 - 1600 m from Existing Chain Valley Workings)	
	Ditton Geotechnical Services Pty Ltd		Scale: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

GN Seam



Proposed Fassifern Seam Workings below Vales Point

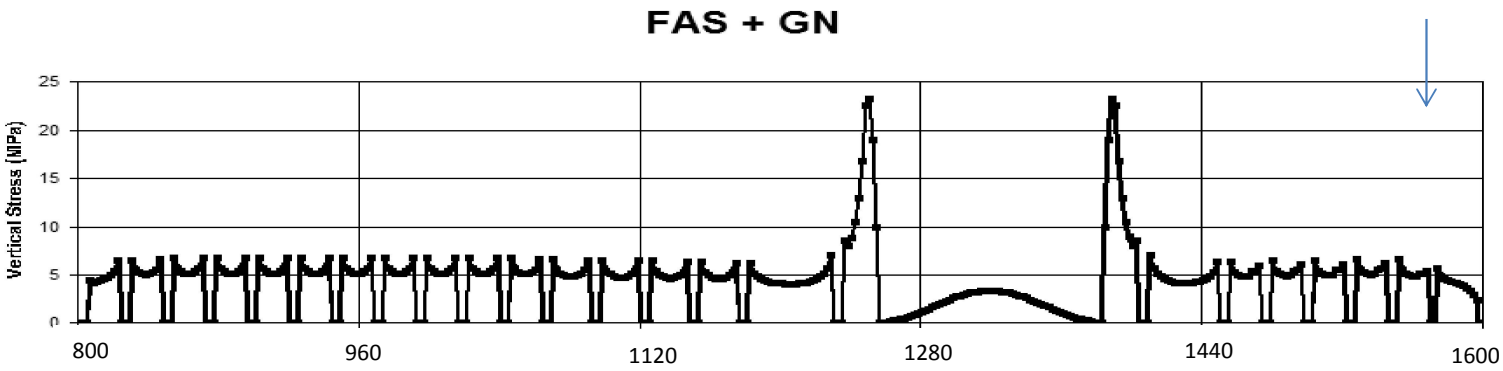
FAS Seam



DgS	Engineer:	S.Ditton	Client:	LakeCoal - Chain Valley Colliery CHV-002/3	
	Drawn:	S.Ditton			
	Date:	30.11.13	Title:	Vertical Stress Profiles due to Great Northern Seam Workings on Proposed Fassifern Seam Workings (Ch 0 - 800 m from Existing Chain Valley Workings)	
	Ditton Geotechnical Services Pty Ltd		Scale:	NTS	Figure No: 13a

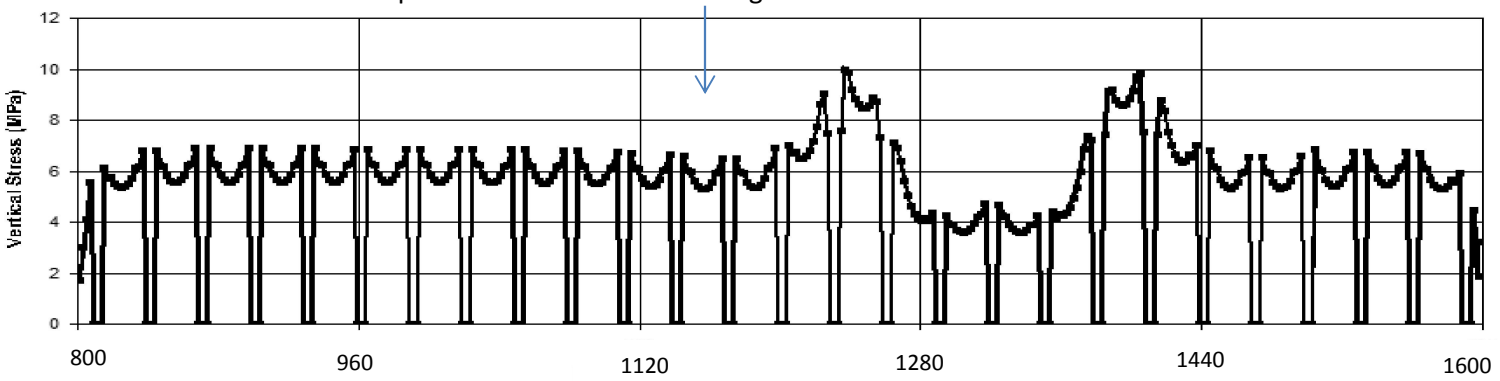
Existing Mannering Workings in GN and Fassifern Seam below Vales Point

GN Seam



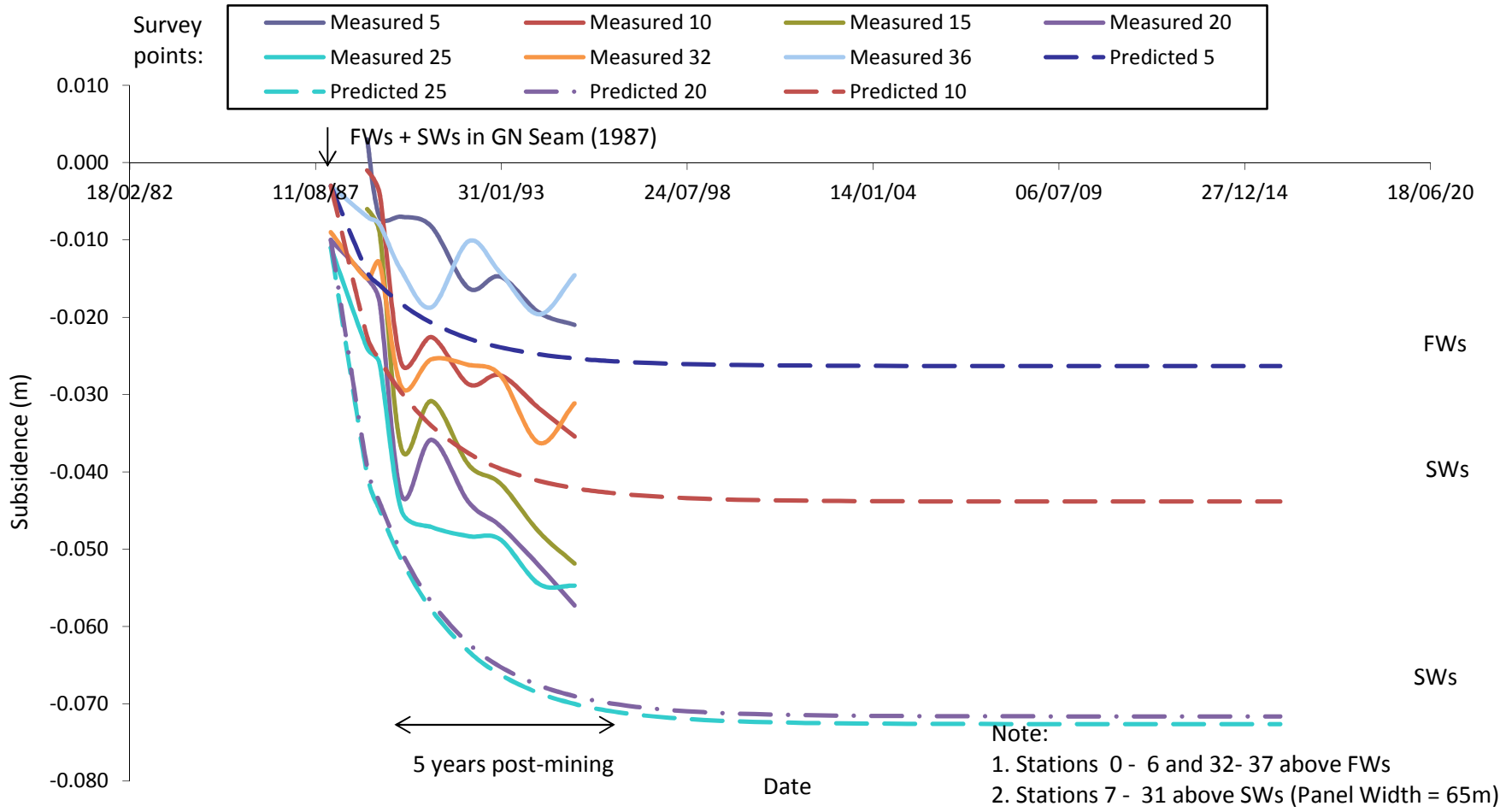
Proposed Fassifern Seam Workings below Vales Point

FAS Seam

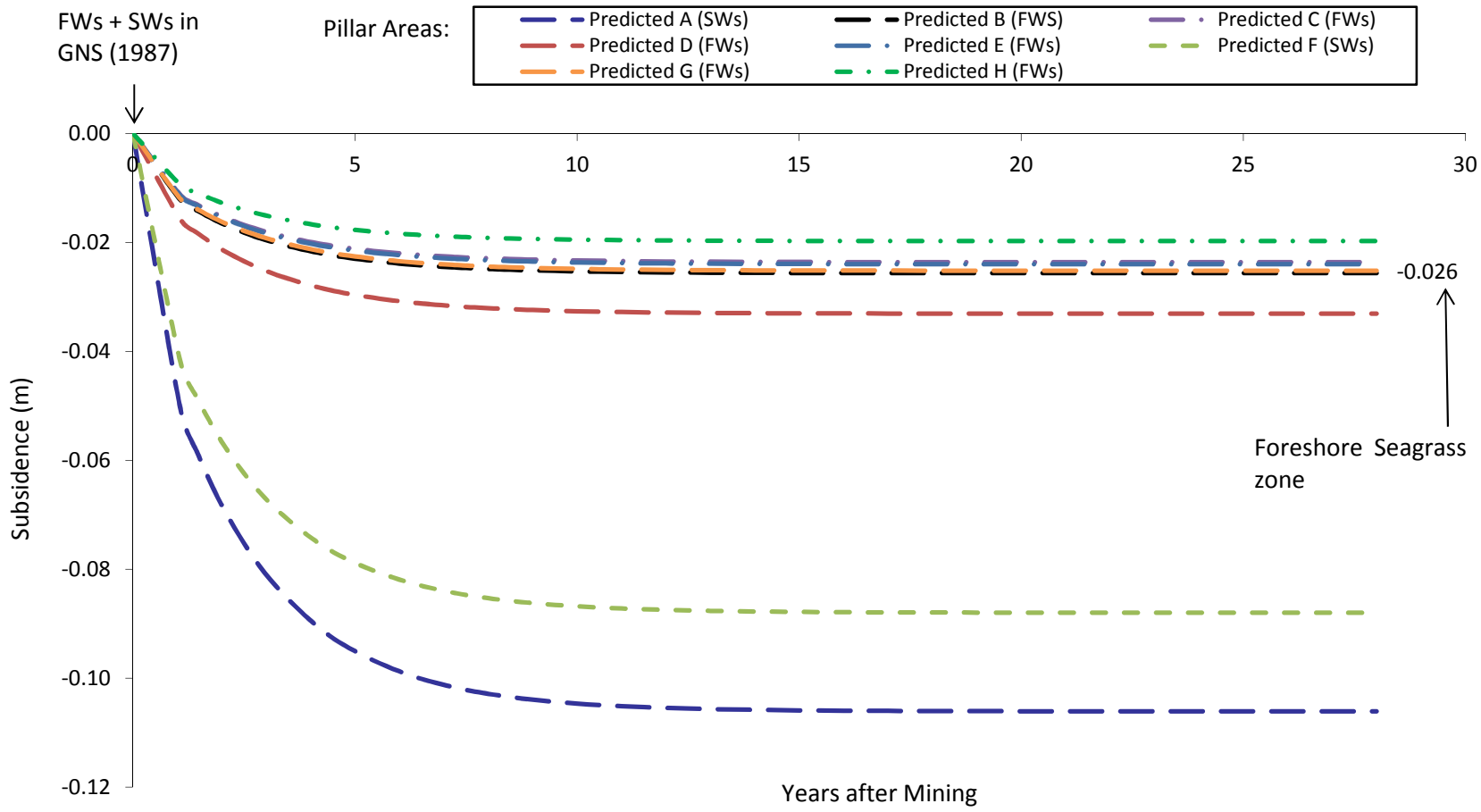


Distance along Cross Section (m)

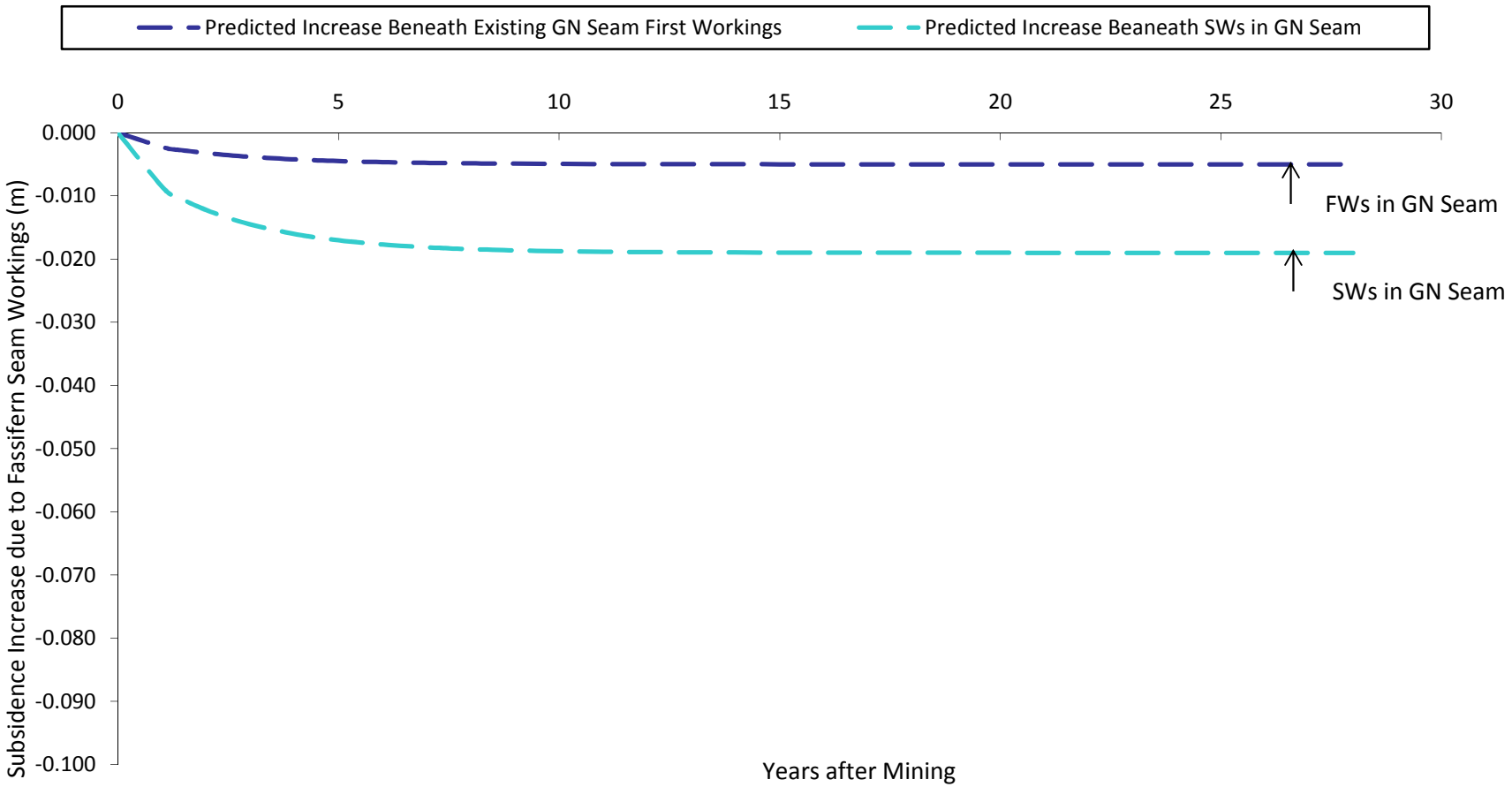
DgS	Engineer:	S.Ditton	Client:	LakeCoal - Chain Valley Colliery CHV-002/3	
	Drawn:	S.Ditton			
	Date:	30.11.13	Title:	Vertical Stress Profiles due to Great Northern Seam Workings on Proposed Fassifern Seam Workings (Ch 800 - 1600 m from Existing Chain Valley Workings)	
	Ditton Geotechnical Services Pty Ltd		Scale:	NTS	Figure No: 13b



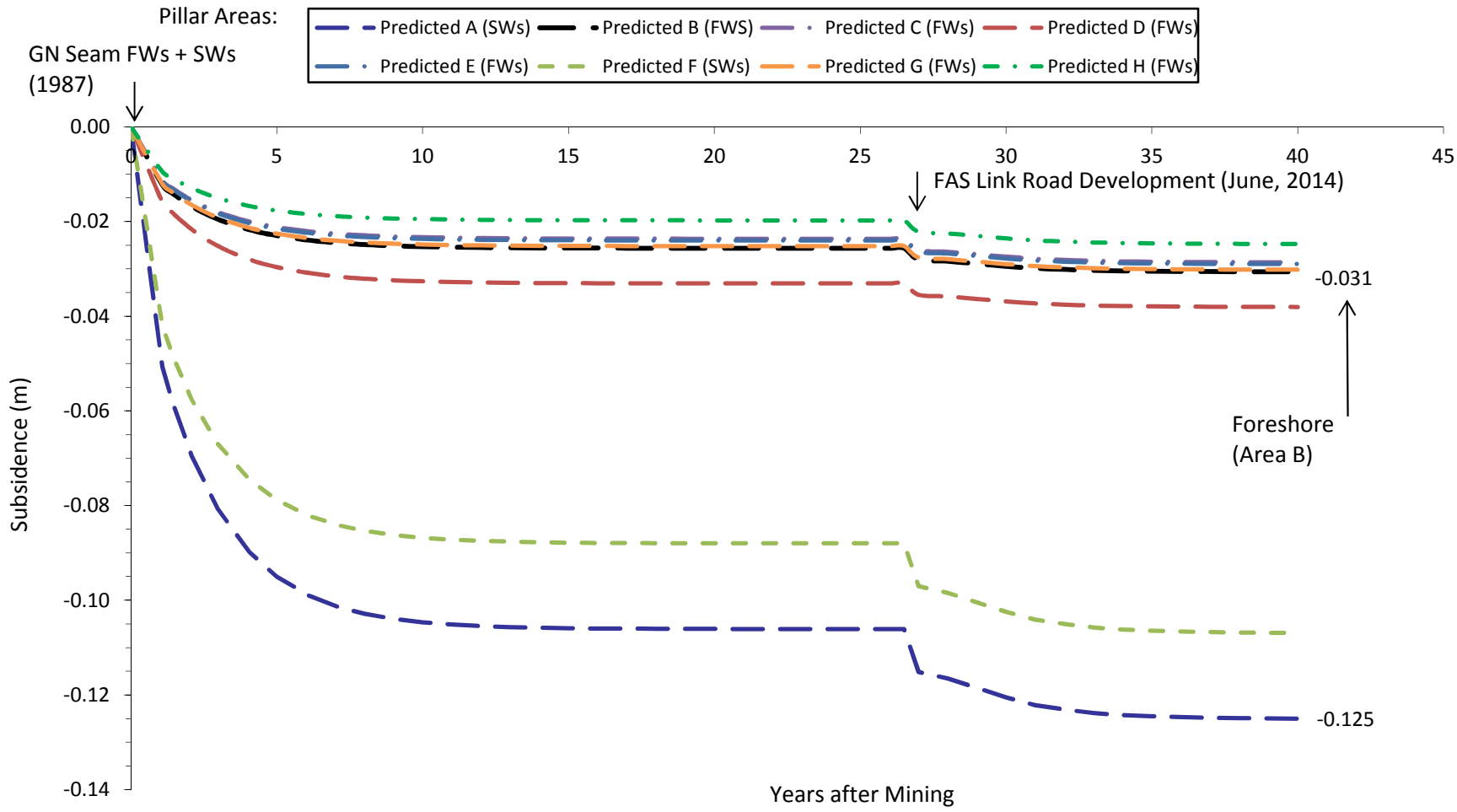
DgS	Engineer:	S.Ditton	Client:	LakeCoal - Chain Valley Colliery CHV-002/3	
	Drawn:	S.Ditton			
	Date:	20.11.13	Title:	Predicted Subsidence Along Chain Valley Bay Foreshore (Line 24) Above First and Second Workings Panels in GN Seam, 1km to south of Proposed Connection Workings	
	Ditton Geotechnical Services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



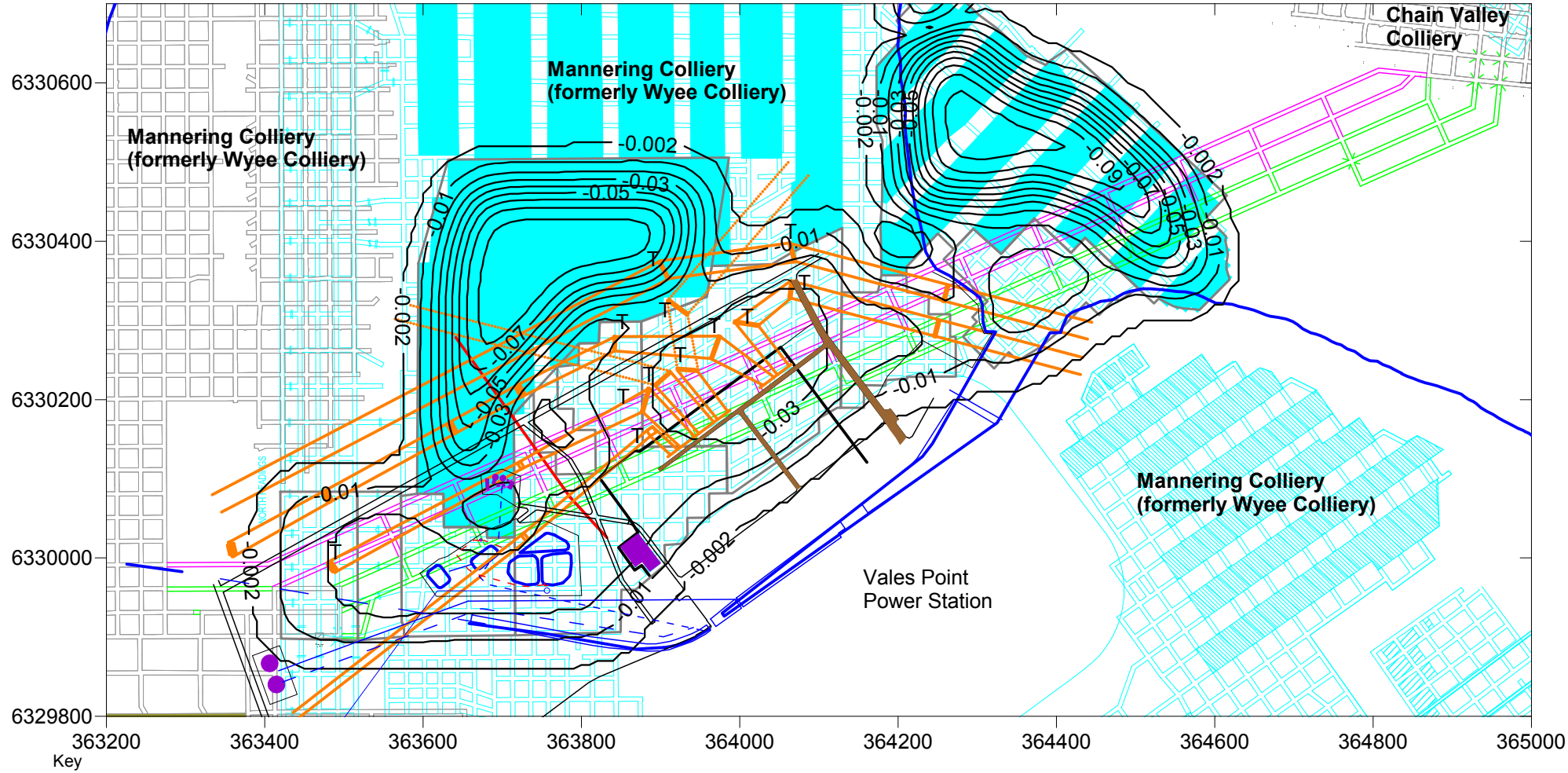
DgS	Engineer:	S.Ditton	Client:	LakeCoal - Chain Valley Colliery CHV-002/3	
	Drawn:	S.Ditton			
	Date:	20.11.13	Title:	Predicted Subsidence Above Link Road Route after First and Second Workings in the GN Seam	
	Ditton Geotechnical Services Pty Ltd		Scale:	NTS	Figure No: 15



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



DgS	Engineer:	S.Ditton	Client:	LakeCoal - Chain Valley Colliery CHV-002/3	
	Drawn:	S.Ditton			
	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



Key

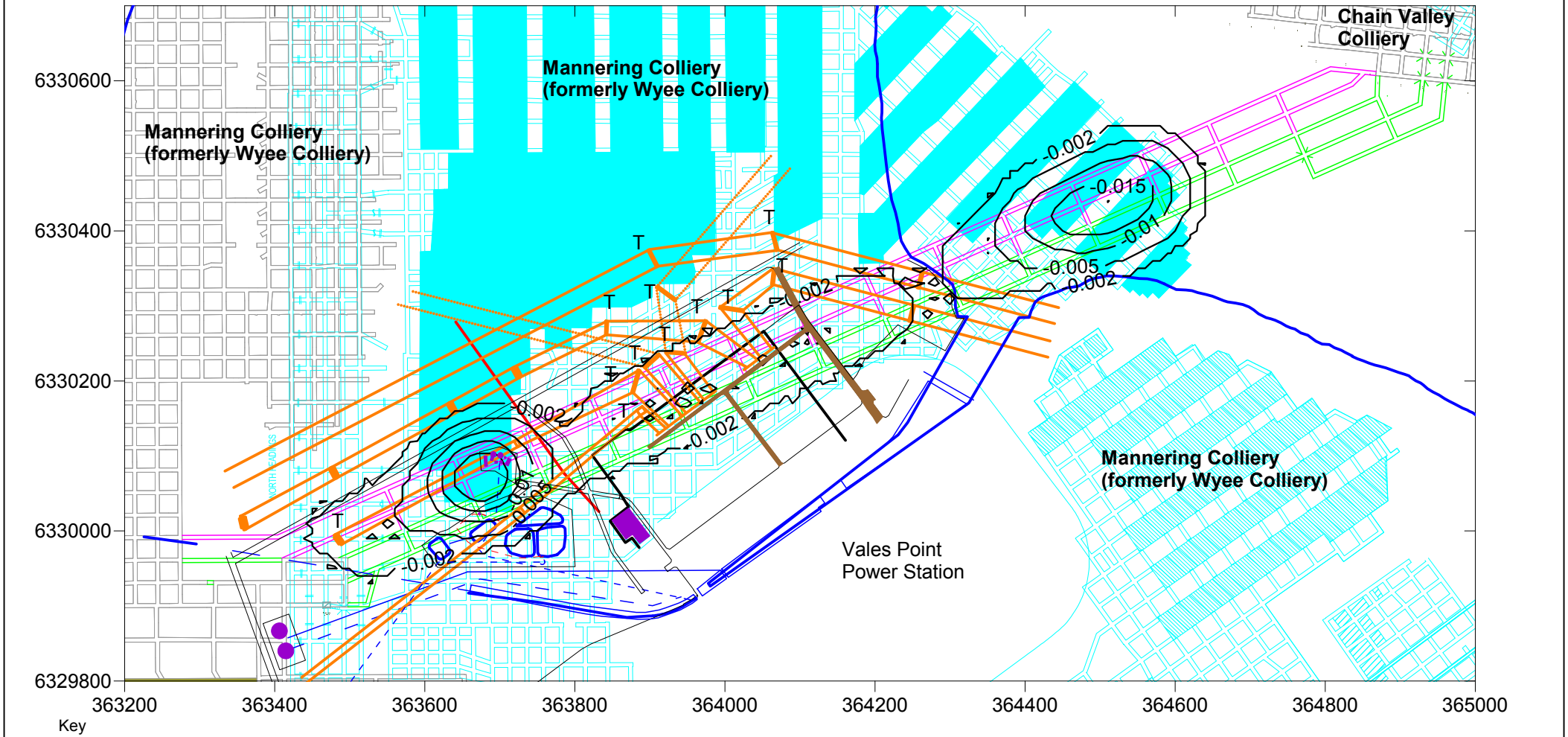
- Existing First Workings in GN Seam
- Existing Second Workings in GN Seam
- Existing First Workings in FAS Seam
- Proposed Mine Connection Headings in FAS Seam (Green - Stage 1; Magenta - Stage 2)
- Optic Fibre Cable (buried)
- Power Cable (buried)
- Security Fence Lines
- Rising Main (buried)
- 330kv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

DgS

Ditton Geotechnical Services Pty Ltd

Engineer:	S.Ditton
Drawn:	S.Ditton
Date:	27.01.14

Client:	LakeCoal - Chain Valley Colliery CHV-002/3
Title:	Predicted Subsidence Contours due to Mine Workings in the GN Seam Only
Scale:	1:7,500 (A4)
Figure No:	18a



Key

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- Existing First Workings in FAS Seam
- Proposed Mine Connection Headings in FAS Seam (Green - Stage 1; Magenta - Stage 2)
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- Jointed Reinforced Concrete Pavement
- Bitumen Sealed Access Road
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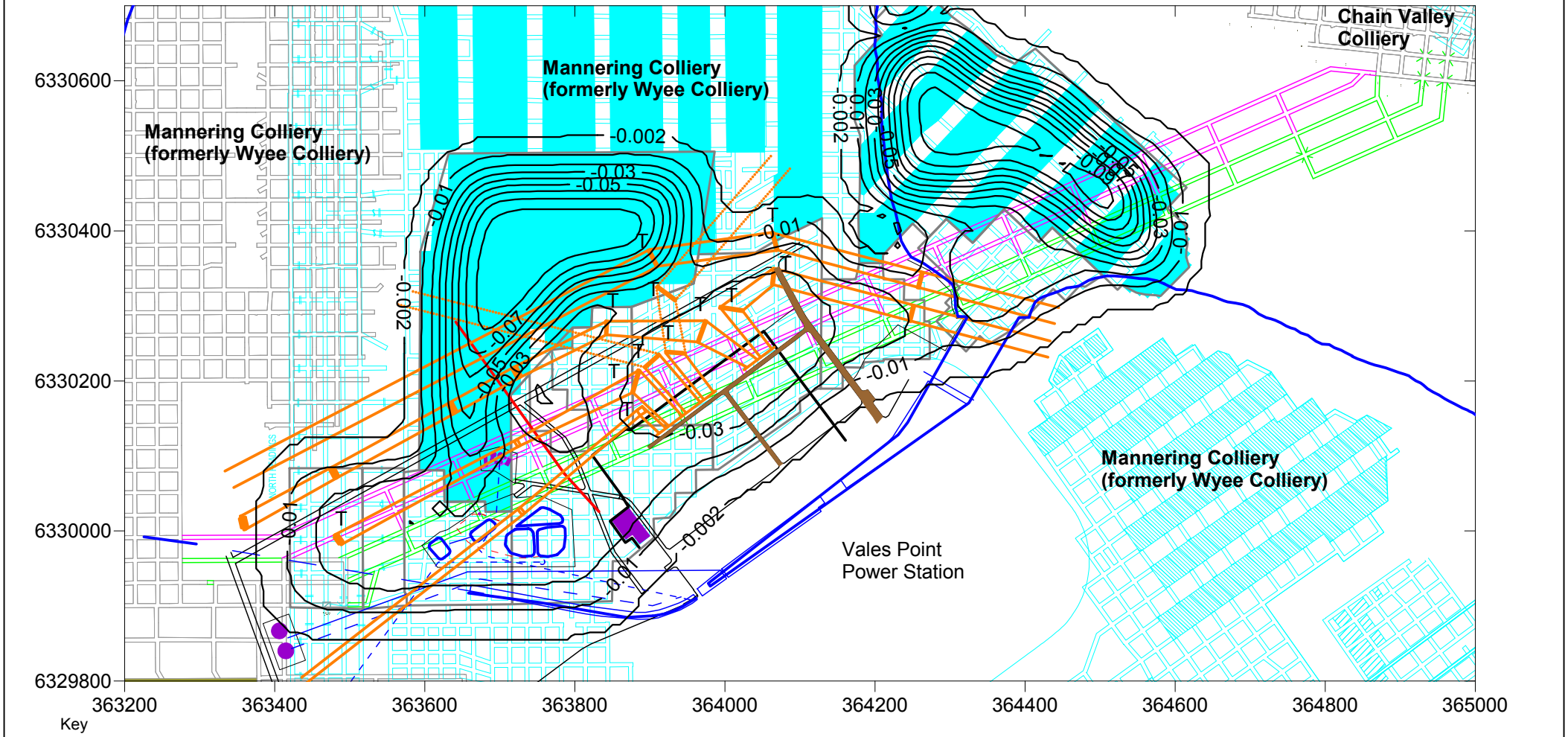
- Buildings & Tanks

DgS

Ditton Geotechnical Services Pty Ltd

Engineer:	S.Ditton
Drawn:	S.Ditton
Date:	19.12.13

Client:	LakeCoal - Chain Valley Colliery CHV-002/3
Title:	Predicted Subsidence Contours due to Mine Workings in the FAS Seam Only
Scale:	1:7,500 (A4)
Figure No:	18b



Key

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- Proposed Mine Connection Headings in FAS Seam (Green - Stage 1; Magenta - Stage 2)
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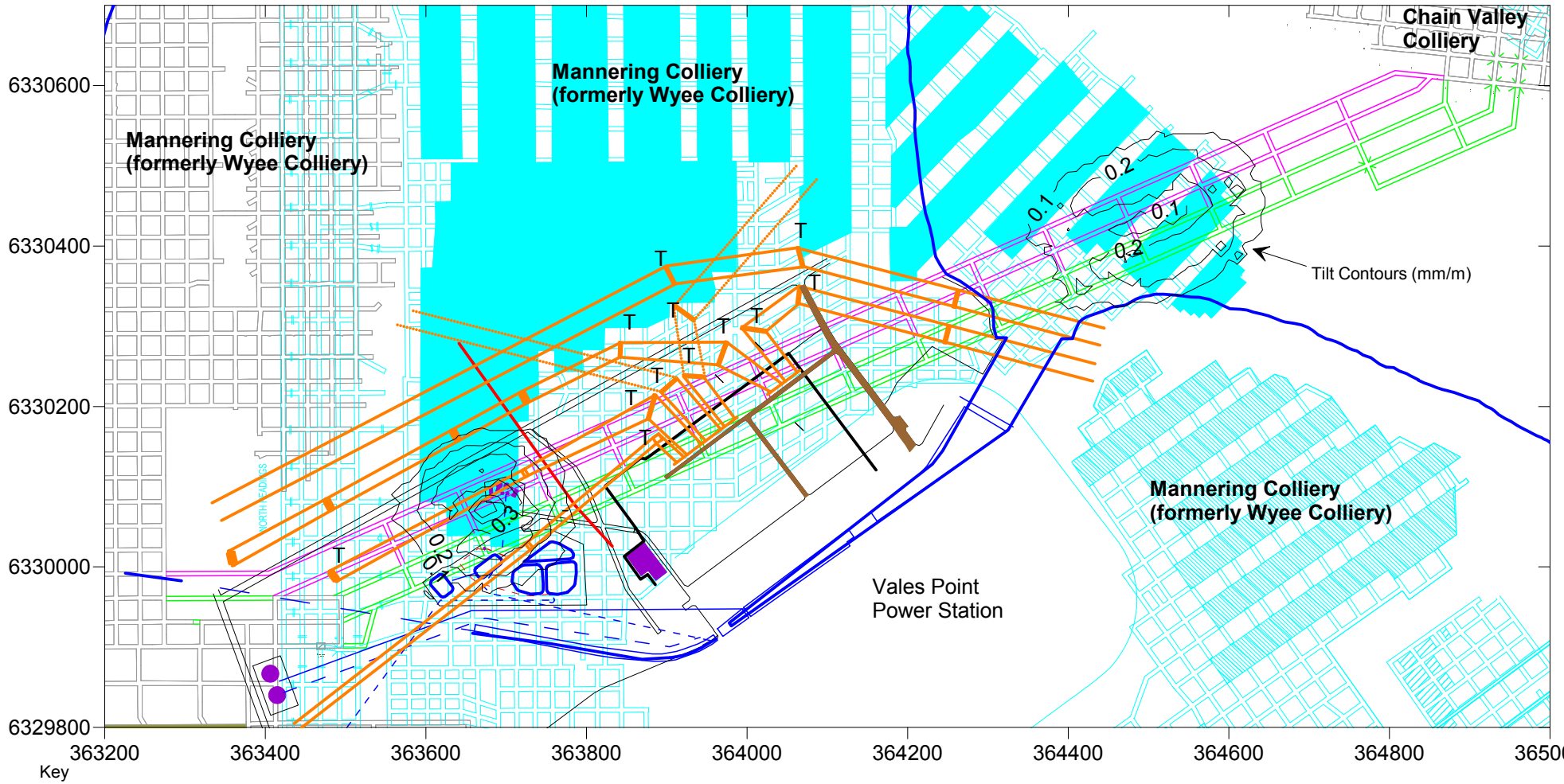
- Subsidence Contours (m)
- Jointed Reinforced Concrete Pavement
- Bitumen Sealed Access Road
- T Tension Tower (Transgrid)
- Buildings & Tanks

DgS

Ditton Geotechnical Services Pty Ltd

Engineer:	S.Ditton
Drawn:	S.Ditton
Date:	25.11.13

Client:	LakeCoal - Chain Valley Colliery CHV-002/3
Title:	Predicted Cumulative Subsidence Contours due to Mine Workings in the GN & FAS Seams
Scale:	1:7,500 (A4)
Figure No:	18c



Key

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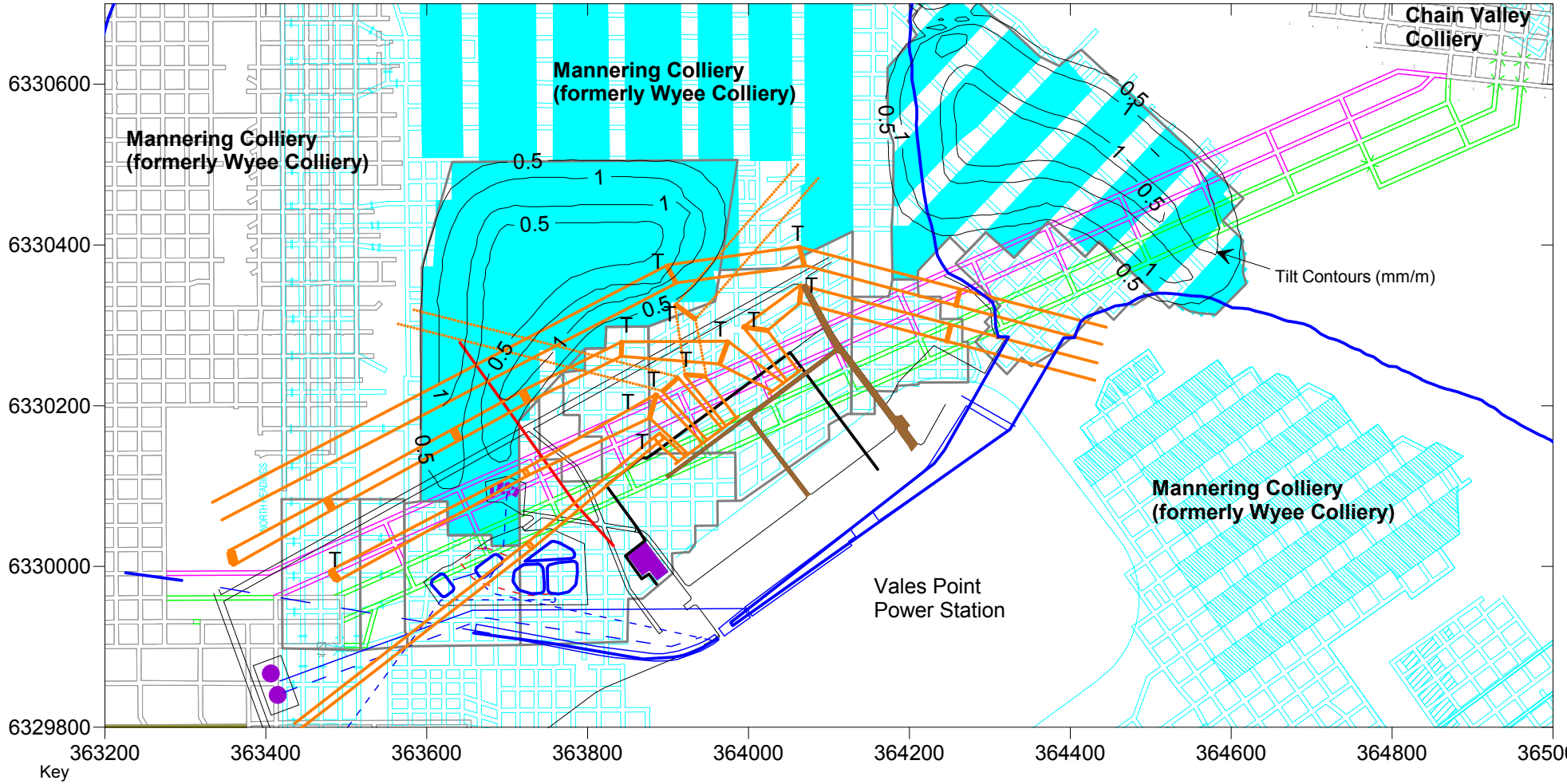
- Buildings & Tanks

DgS

Ditton Geotechnical Services Pty Ltd

Engineer:	S.Ditton
Drawn:	S.Ditton
Date:	19.12.13

Client:	LakeCoal - Chain Valley Colliery CHV-002/3
Title:	Predicted Tilt Contours due to Mine Workings in the FAS Seam Only
Scale:	1:7,500 (A4)
Figure No:	19a



Key

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- Proposed Mine Connection Headings in FAS Seam (Green - Stage 1; Magenta - Stage 2)
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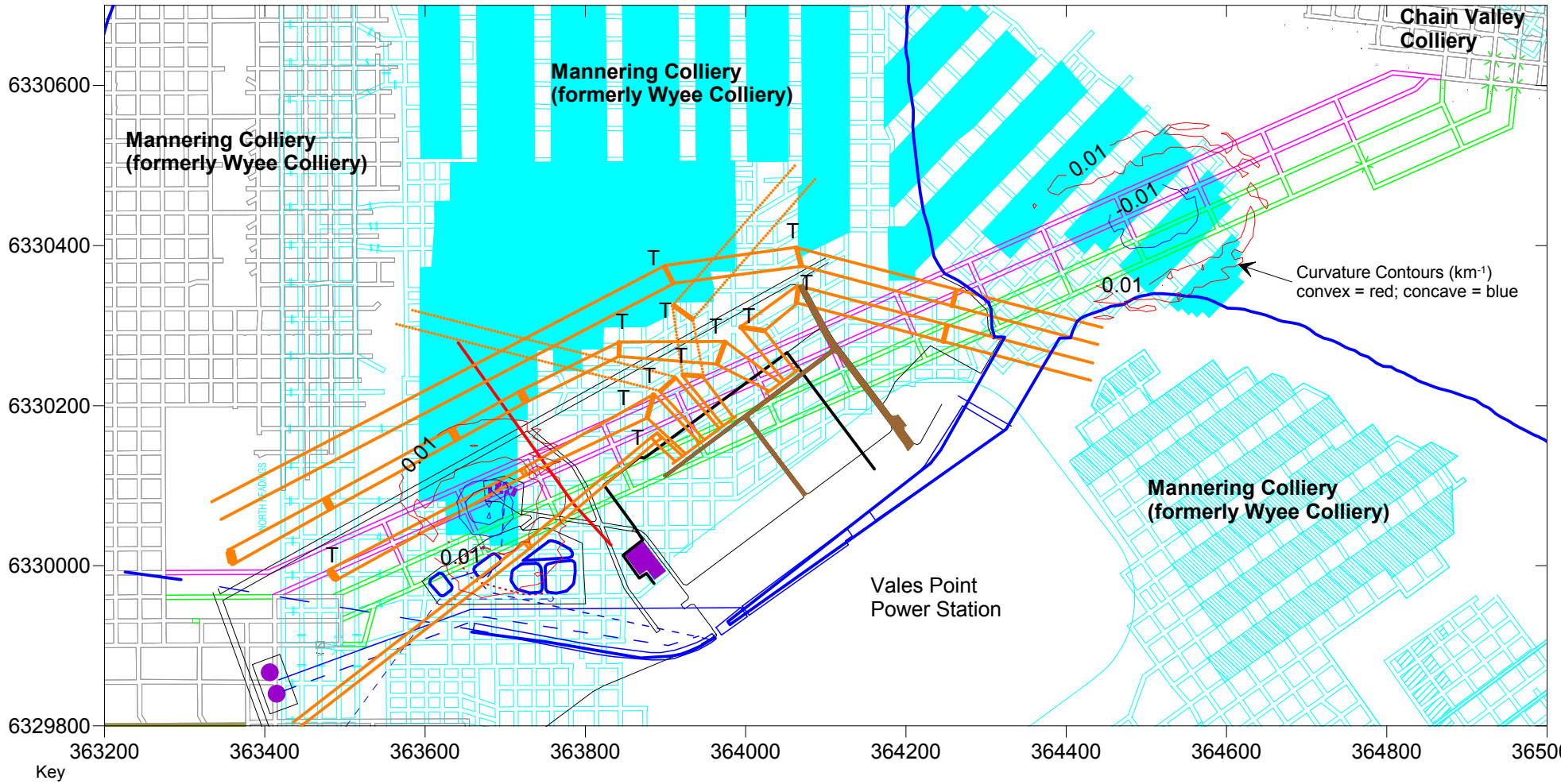
- Buildings & Tanks

DgS

Ditton Geotechnical Services Pty Ltd

Engineer:	S.Ditton
Drawn:	S.Ditton
Date:	25.11.13

Client:	LakeCoal - Chain Valley Colliery CHV-002/3
Title:	Predicted Cumulative Tilt Contours due to Mine Workings in the GN & FAS Seams
Scale:	1:7,500 (A4)
Figure No:	19b



Key

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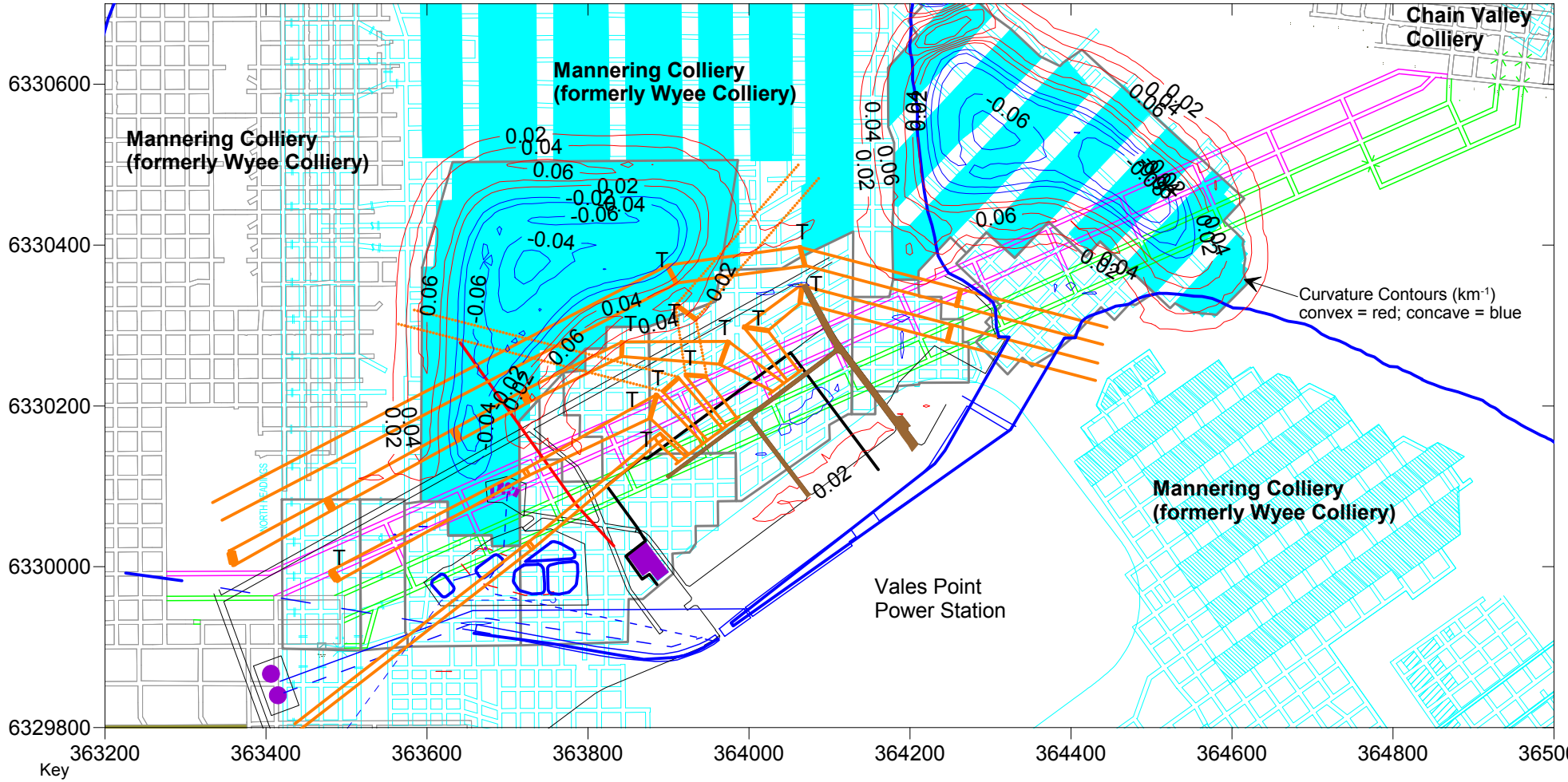
Ditton Geotechnical Services Pty Ltd

Engineer:	S.Ditton
Drawn:	S.Ditton
Date:	19.12.13

Client:	LakeCoal - Chain Valley Colliery CHV-002/3
Title:	Predicted Curvature Contours due to Mine Workings in the FAS Seam Only
Scale:	1:7,500 (A4)
Figure No:	20a



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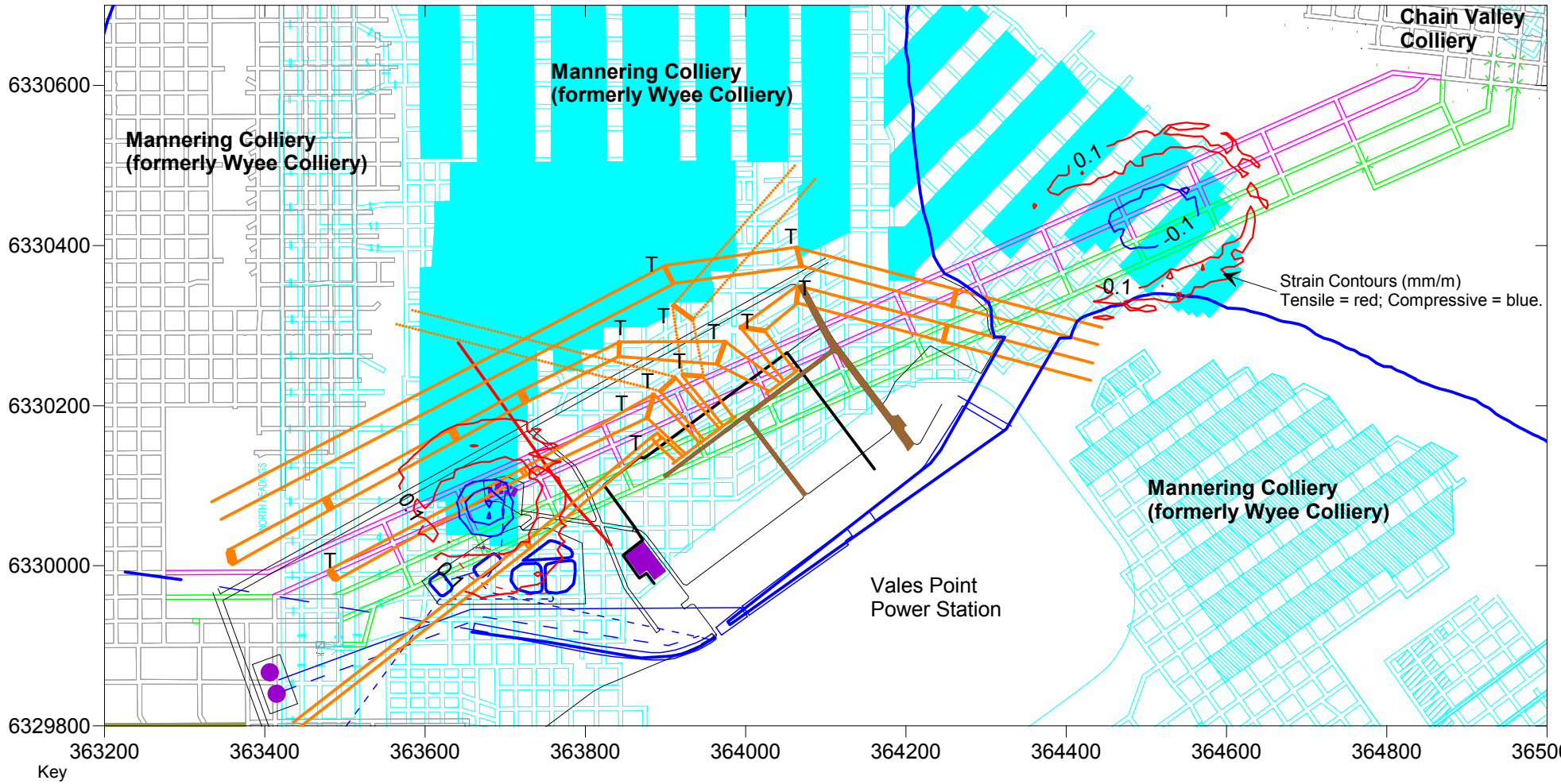
Engineer:	S.Ditton
Drawn:	S.Ditton
Date:	25.11.13

Client:	LakeCoal - Chain Valley Colliery CHV-002/3		
Title:	Predicted Cumulative Curvature Contours due to Mine Workings in the GN & FAS Seams		
Scale:	1:7,500 (A4)	Figure No:	20b



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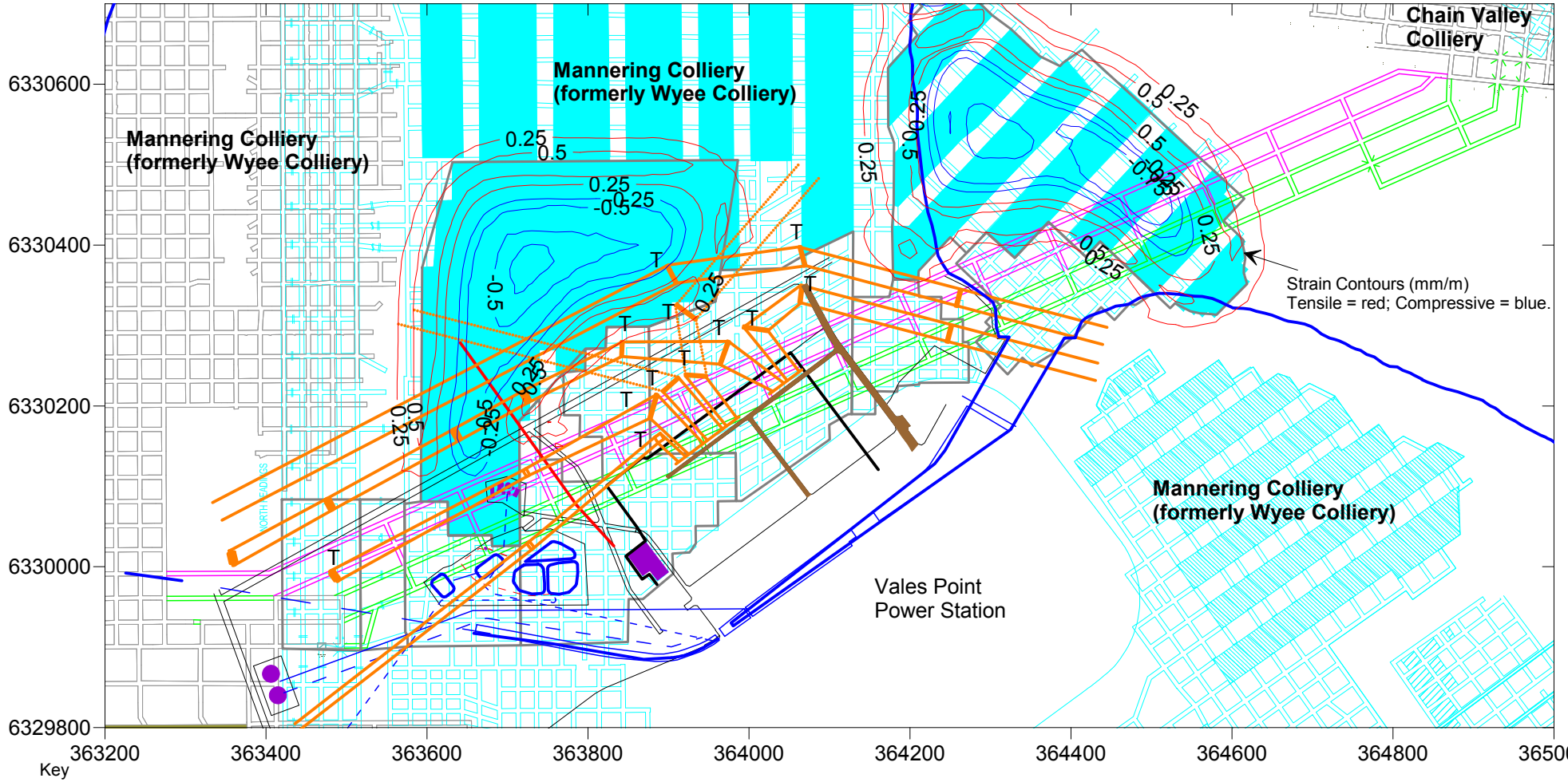
Engineer:	S.Ditton
Drawn:	S.Ditton
Date:	19.12.13

Client:	LakeCoal - Chain Valley Colliery CHV-002/3
Title:	Predicted Strain Contours due to Mine Workings in the FAS Seam Only
Scale:	1:7,500 (A4)
Figure No:	21a



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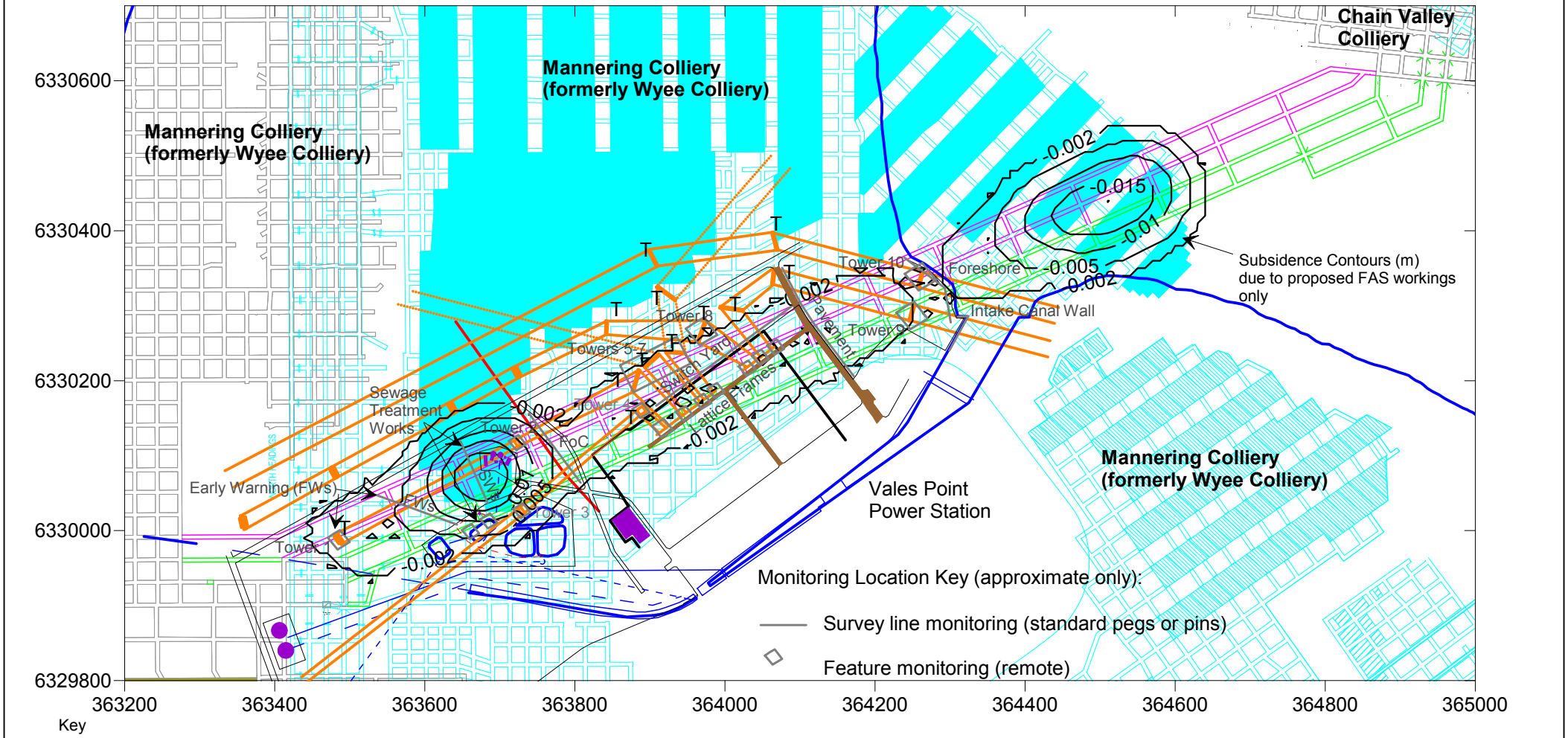
Ditton Geotechnical Services Pty Ltd

Engineer:	S.Ditton
Drawn:	S.Ditton
Date:	25.11.13

Client:	LakeCoal - Chain Valley Colliery CHV-002/3		
Title:	Predicted Cumulative Strain Contours due to Mine Workings in the GN & FAS Seams		
Scale:	1:7,500 (A4)	Figure No:	21b



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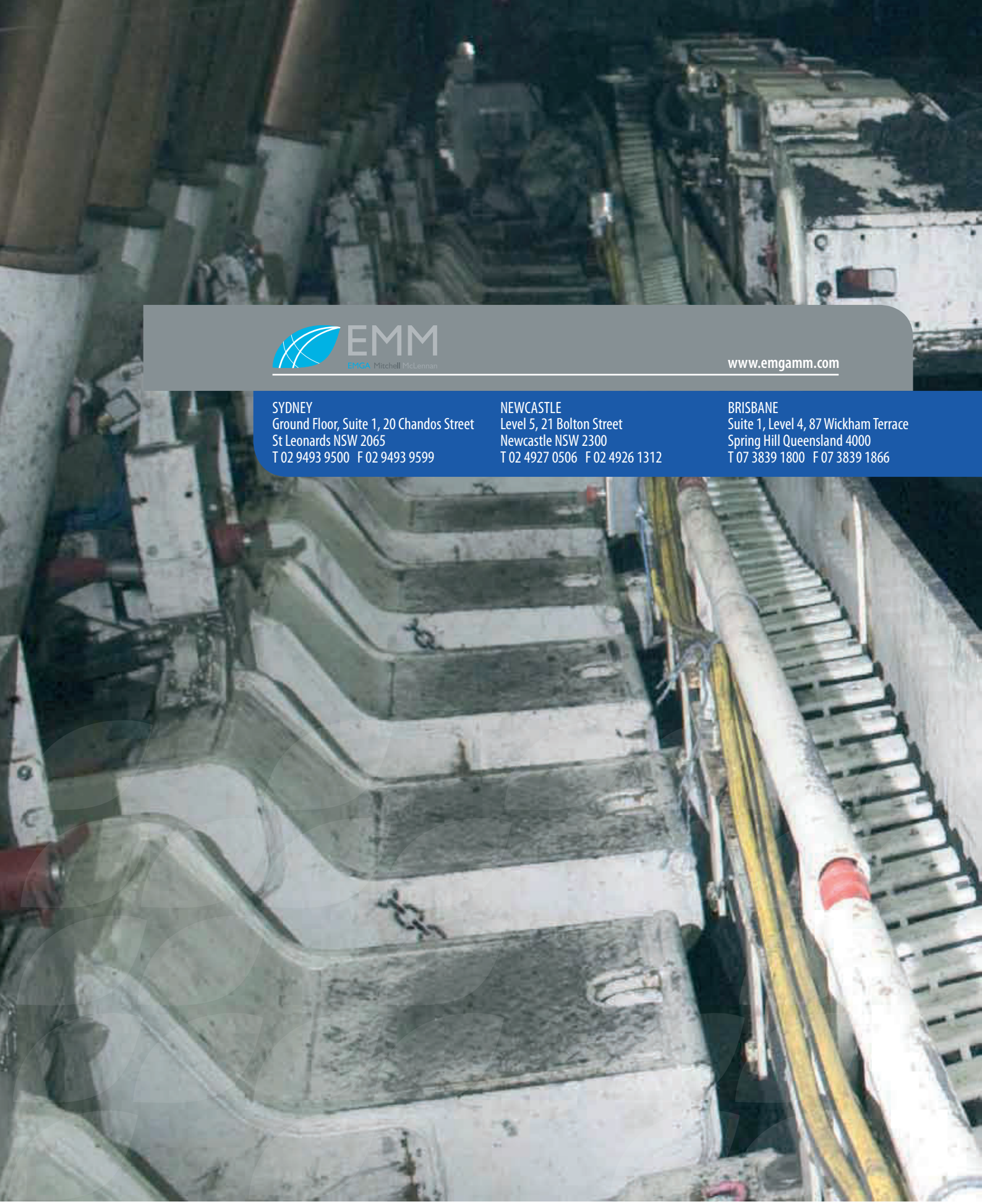
Ditton Geotechnical Services Pty Ltd

Engineer:	S.Ditton
Drawn:	S.Ditton
Date:	25.01.14

Client:	LakeCoal - Chain Valley Colliery CHV-002/3
Title:	Suggested Surface Monitoring Locations for Surface Features above the Proposed Mine Linkage Headings
Scale:	1:7,500 (A4)
Figure No:	22



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