CHAIN VALLEY COLLIERY – MODIFICATION 2
Statement of Environmental Effects

2

Section 96 Modification to SSD-5465

Prepared for LakeCoal Pty Limited
June 2015

VOLUME 3 of 3 – Appendices E to K

LakeCoal

EMM
EMGA Mitchell McLennan

VOLUME 3 – Appendices E to K

Appendix E Groundwater assessment
Appendix F Marine ecology assessment
Appendix G Mine subsidence impacts on wave climate
Appendix H Assessment of significance
Appendix I Aboriginal cultural heritage assessment
Appendix J Traffic and transport assessment
Appendix K Greenhouse gas assessment

Appendix E

Groundwater assessment

Appendix E — Groundwater assessment

E

GeoTerra

LAKECOAL PTY LTD

CHAIN VALLEY COLLIERY
GROUNDWATER ASSESSMENT
Panel Re-Orientation Project
Lake Macquarie, New South Wales

LDO4-R1C
25 MAY, 2015

GeoTerra PTY LTD **ABN 82 117 674 941**

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LDO4 – R1C (25 May, 2015)

LakeCoal Pty Ltd – Chain Valley Coal Mine
Off Construction Rd
Mannering ParkNSW 2259

Attention: Chris Ellis

Chris,

RE: Chain Valley Colliery – Modification 2 Groundwater Assessment

Please find enclosed a copy of the above mentioned report.

Yours faithfully

GeoTerra Pty Ltd

Andrew Dawkins (AuSIMM CP-Env)

Distribution:	Original	GeoTerra Pty Ltd
	1 electronic copy	EMGA Mitchell McLennan Pty Ltd
	1 electronic copy	Chain Valley Colliery

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Name:	Andrew Dawkins
Signature:	
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Date	Rev	Comments
17.04.2015		Draft
01.05.2015	A	Incorporate reviewer comments
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EXECUTIVE SUMMARY

Chain Valley Colliery (CVC) is an underground mine located at the southern end of, and underneath, Lake Macquarie, and is approximately 60km south of Newcastle.

CVC is operated by LakeCoal Pty Limited (LakeCoal).

LakeCoal Pty Ltd is seeking approval to modify the consent for CVC (SSD-5465) under Section 96(2) of the EP&A Act, to permit:

- an increase in the maximum rate of ROM coal extraction at CVC from 1.5 Mtpa to 2.1 Mtpa;
- mine design changes, primarily the re-orientation of miniwall panels in CVC's northern mining area and minor amendments to the development consent boundary;
- an increase in full time personnel from approximately 160 to approximately 220; and
- minor vegetation clearing adjacent to some infrastructure at CVC's pit top and at the ventilation fan site at Summerland Point to enable the establishment and/or extension of asset protection zones (APZs) for bushfire management purposes.

The proposed panel re-orientation will result in a minor change to the spatial extent of the proposed mining activities, with all secondary extraction confined to areas beneath Lake Macquarie, and with the existing protection barriers for the foreshore and seagrass continuing to apply.

The predicted subsidence for single seam extraction is up to 0.78 m and up to 1.2 m for triple seam extraction areas (DGS, 2015).

It is anticipated that due to the approximately 3.8% reduction in underground mine area arising as a consequence of the proposed modification, there will be no perceptible change to the effects predicted in GeoTerra (2013) regarding;

- hydraulic connection to Lake Macquarie
- aquifer / aquitard Interconnection
- regional groundwater depressurisation
- private bore yields and serviceability
- groundwater dependent ecosystems
- groundwater quality
- groundwater seepage to or from terrestrial streams

The minimal reduction in aerial extent of the originally modelled, as opposed to the proposed re-oriented and modified, underground mine workings area is within the error constraints of the MODFLOW Surfact groundwater model. As a consequence, no apparent observable differences from those previously predicted are anticipated in;

- loss of lake water or loss of connate groundwater within the overburden to the underlying workings;
- vertical hydraulic connection to the workings. This will still be restricted by the Dooralong Shale and the Mannering Park Tuff aquitards which are still not anticipated to be breached by subsidence over the modified workings asthe shale and tuff are both below the surficial and above the goaf, vertically connected,

dilation zones;

- horizontal permeability. Horizontal permeability above and between the aquitards will not be observably different as a result of the proposed modification and will still be enhanced after subsidence. However, there will be no additional vertical connectivity through or below them to the underlying workings;
- the original modelled maximum mine groundwater inflow of 10.5ML/day is not anticipated to be observably different due to the proposed modification.

1. INTRODUCTION

Chain Valley Colliery (CVC) is an underground mine located at the southern end of, and underneath, Lake Macquarie, and is approximately 60km south of Newcastle.

CVC is operated by LakeCoal Pty Limited (LakeCoal).

Underground mining at CVC commenced in 1962 and, since that time, the Colliery has extracted coal from three seams, namely the Wallarah Seam, the Great Northern Seam and the Fassifern Seam using a combination of bord and pillar and miniwall mining methods.

Current mining activities are limited to the Fassifern Seam.

CVC currently 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). SSD-5465 superseded MP10_0161which was approved under Part 3A of the EP&A Act on 23 January 2012.

Current features at CVC which are related to, or have potential to impact on groundwater, include the:

- historic Great Northern and Wallarah seams bord and pillar workings;
- current Fassifern Seam development and miniwall workings as well as historic bord and pillar operations; and
- water storage and management facilities owned and operated by the colliery.

LakeCoal is seeking approval to modify SSD-5465 under Section 96(2) of the EP&A Act, to permit:

- an increase in the maximum rate of ROM coal extraction at CVC from 1.5 Mtpa to 2.1 Mtpa;
- mine design changes, primarily the re-orientation of miniwall panels in CVC's northern mining area and minor amendments to the development consent boundary;
- an increase in full time personnel from approximately 160 to approximately 220; and
- minor vegetation clearing adjacent to some infrastructure at CVC's pit top and at the ventilation fan site at Summerland Point to enable the establishment and/or extension of asset protection zones (APZs) for bushfire management purposes.

The proposed panel reorientation will result in a minor change to spatial extent of the proposed mining activities, with all secondary extraction remainingconfined to areas beneath Lake Macquarie and with the existing protection barriers for the foreshore and seagrass continuing to apply.

The predicted subsidence for single seam extraction is up to 0.78 m and up to 1.2 m for triple seam extraction areas (DGS, 2015).

There will be no change to CVC surface infrastructure,nor to the maximum road coal haulage with all production beyond the existing limit of 1.5 Mtpa to be sent viaMannering Colliery (MC) to Vales Point Power Station (VPPS) via the existing overland conveyor. Once the already-approved linkage between Mannering and Chain Valley is completed, all CVC coal destined for VPPS will preferentially be sent via Mannering Colliery, to a maximum of 1.3 mtpa, consistent with the proposed limits associated with the Mannering Colliery.

The approved mine layout is shown in **Figure 1**. **Figure 2** shows the proposed re-orientation of the northern extraction panels and their modified extents.

As part of the groundwater investigations undertaken for SSD-5465, a groundwater model was set up using approximately 867ha of decommissioned, existing and then proposed CVC workings within the Study Area as shown in **Figure 3**.

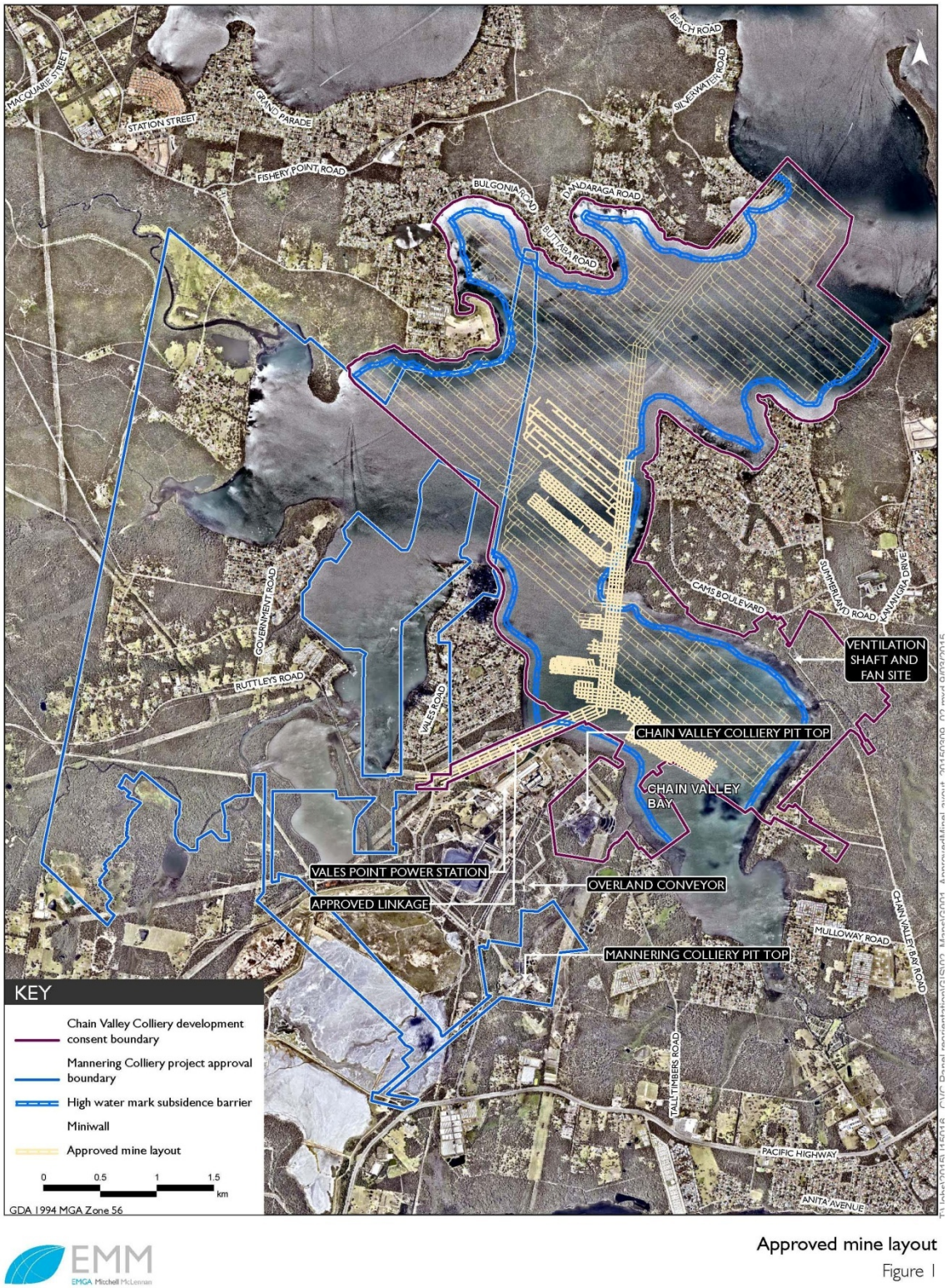

Figure 1 Approved Mine Layout

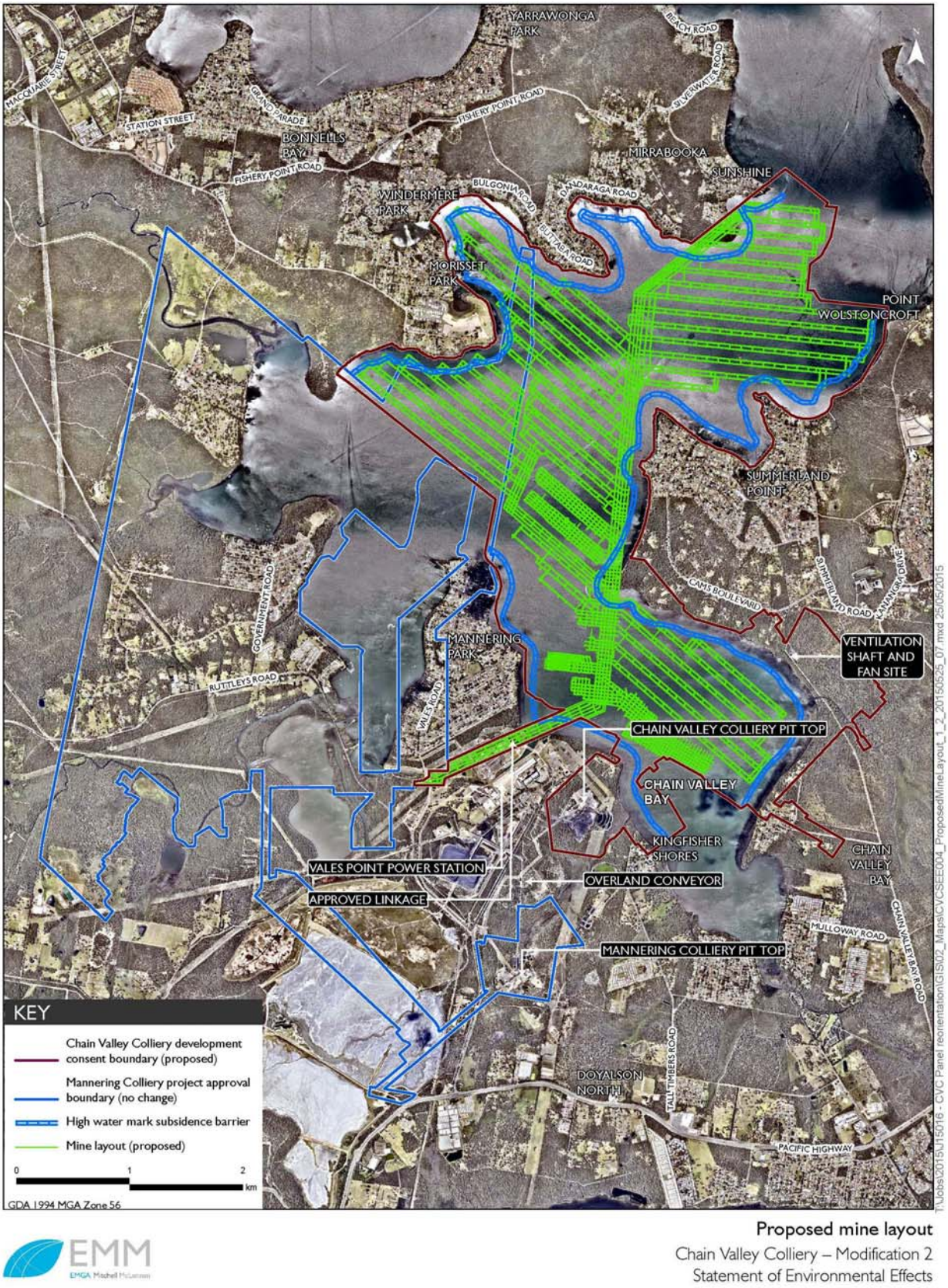

Figure 2 Proposed Mine Layout

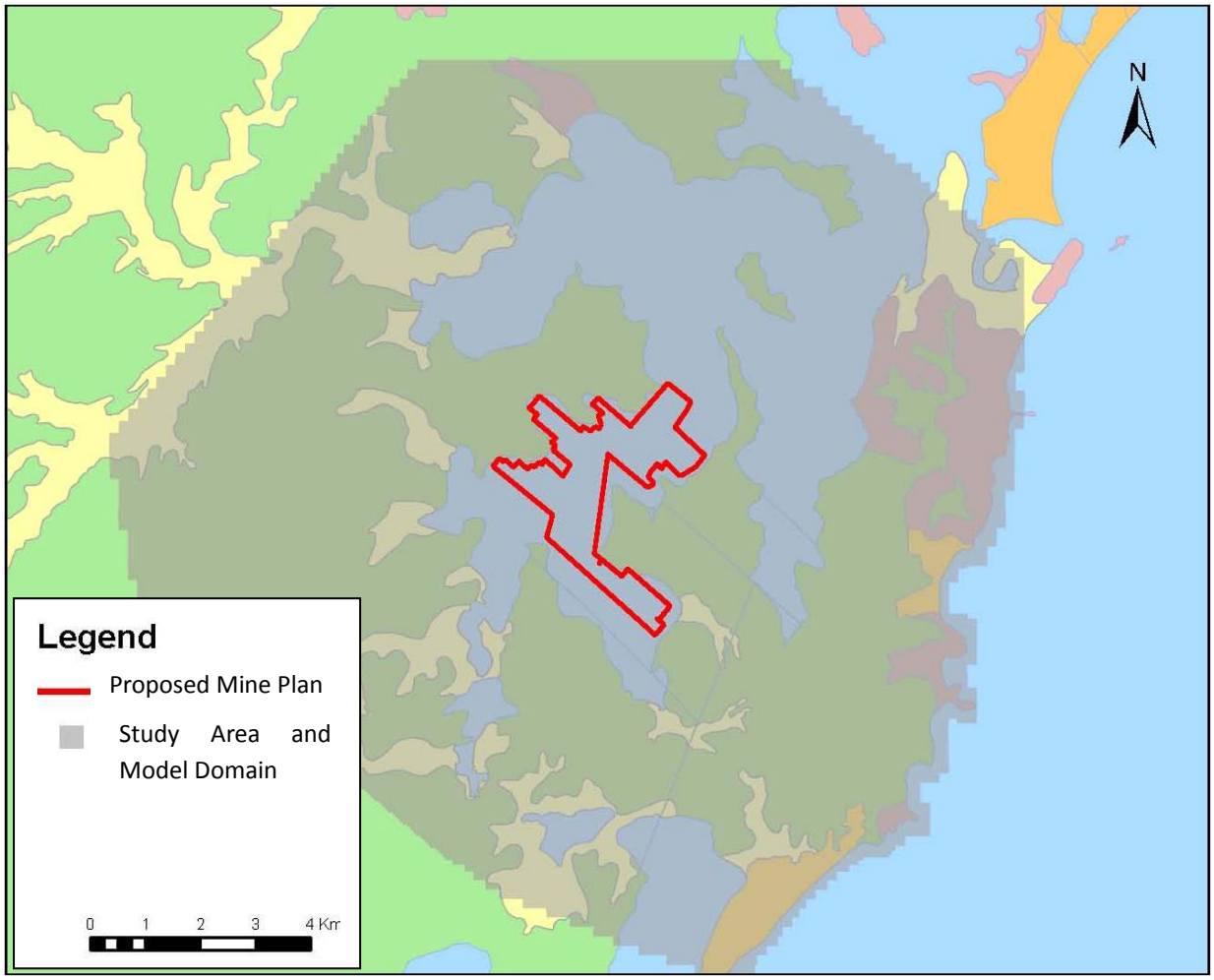

Figure 3 Groundwater Model Domain and Associated Study Area

The currently proposed re-orientation and modified extent of the workings constitutes a reduction of approximately 33ha of underground mine workings, or 3.8% of the originally modelled mine area.

It is possible that minor changes to the mine layout may be required in the futureas discussed within the Statement of Environmental Effects for the proposed modification (EMM, 2015).

However, the proponent commits to ensuring the mining area will not exceed the original footprint size or adversely affect other factors such as any predicted subsidence maximums associated with the current proposal.

2. SCOPE OF WORK

GeoTerra was commissioned to provide an assessment of the potential groundwater impacts arising from the proposed modification compared to those currently approved.

In order to complete the above, GeoTerra has also:

- summarised the key findings of the Chain Valley Colliery Mining Extension 1 Groundwater Assessment (GeoTerra, 2013) and Groundwater Monitoring Plan (GeoTerra, 2015); and
- summarised the available groundwater monitoring data and compared it to the 2013 EIS predictions.

The Study Area for the proposed modification is unchanged from that adopted in the GeoTerra (2013) groundwater model.

3. PREVIOUS STUDIES

A Groundwater Assessment was prepared for the Chain Valley Colliery Mining Extension 1 Project Environmental Impact Statement (EIS) in March 2013. This assessment (GeoTerra 2013):

- concluded there were no terrestrial alluvial Quaternary aquifers of significance within the then proposed subsidence area, which was dominated by marine lacustrine sediments in Lake Macquarie which are hydraulically separated from the underlying sedimentary basement aquifer;
- concluded there were no terrestrial streams that would be adversely affected within the subsidence area;
- concluded that the modelling indicates that no observable adverse effects are anticipated on stream flow in the surrounding terrestrial streams; and
- concluded that the majority of recharge to the local groundwater system would be from the marine waters of Lake Macquarie, with lesser fresh water recharge from the surrounding land mass;
- concluded that no groundwater dependent ecosystems are located within the predicted subsidence area;
- determined that the salinity of seepage water collected from within the existing workings in the Great Northern Seam, under Lake Macquarie, ranges up to 28,200mg/L. This indicates a significant proportion of recharge and overburden seepage is sourced from Lake Macquarie;
- determined that the salinity of seepage water collected from within the current workings in the Fassifern Seam under Lake Macquarie, ranges up to 2,390mg/L, which indicates minimal saline recharge into the Fassifern Seam from Lake Macquarie;
- concluded that the regional overburden groundwater systems have historically been, and will continue to be, significantly depressurised by multi seam underground workings in adjacent mines and the existing Colliery multi seam workings;
- assessed that the 11 layer MODFLOW SURFACT groundwater model developed to represent the Study Area indicated the main groundwater depressurisation was predicted to occur in the extracted seams, as well as the overlying goaf and highly fractured overburden, and that the groundwater head depressurisation results from

subsidence fracture development and the associated increased horizontal and vertical permeability in the overburden;

- determined from modelling that depressurisation of the proposed Colliery workings, when combined with depressurisation from the adjacent mines, may extend up to 2km out from the proposed CVC workings;
- concluded that a groundwater level reduction of up to 160m in the deeper overburden (Fassifern Seam) may occur following the proposed extraction. However, drawdown in the shallower layers is predicted to not generally exceed 20m, except in very isolated areas, with the majority affected by approximately 0.1m drawdown;
- concluded that the predicted drawdowns are significantly affected by cumulative effects from surrounding existing and proposed underground workings;
- identified fifteen NSW Office of Water registered bores located within the predicted 0.1m drawdown area, with bore yields of up to 1.5L/sec and standing water levels ranging up to 6 metres below ground level (mbgl);
- concluded that the model indicates up to six private bores within the subsidence zone may be affected by up to 1.0m of drawdown following extraction of the Fassifern Seam workings;
- through modelling, determined that the total mean underground inflow of 2,396ML/yr (6.56ML/day) observed at the time of modelling was predicted to increase to 10.5ML/day (3,832ML/yr) at the end of mining in the Study Area.

A Water Management Plan (including a Groundwater Monitoring Program (GwMP) was prepared in consultation with the Environment Protection Authority (EPA) and NOW as a condition of MP10_0161 and was approved on 6th November 2012. A revised GwMP was subsequently prepared in January 2015,as part of the Groundwater Management Plan required by Schedule 3 (Condition 18(d)) of SSD-5465 and is in the process of being approved by the regulators.

The GwMP comprises:

- a groundwater water quality and quantity monitoring program;
- trigger levels for mining impacts on groundwater systems;
- procedures to be followed in the event that monitoring of groundwater indicates an exceedance of trigger levels;
- measures to mitigate, remediate and/or compensate for identified impacts;
- a protocol for the notification of trigger level exceedances; and
- a contingency plan where, in the event of adverse effects on groundwater quality and/or quantity due to mining impacts, the Colliery would provide an equivalent supply until the affected supply is restored, or as agreed with the landowner and the NSW Office of Water (NOW).

4. SUMMARY OF GEOTERRA (2013) ASSESSMENT

A summary of the GeoTerra (2013) assessment,including a description of the existing environment, is presented below.

4.1 Location and Local Features

CVC is located in the Newcastle Coalfields, at the southern end of Lake Macquarie in NSW and within the Swansea-North Entrance Mine Subsidence District.

The Study Area incorporated the relatively flat pit top area, existing ventilation fan site on Summerland Point, as well as Lake Macquarie and its foreshore areas. The terrestrial land within the Study Area was reported as gently undulating and draining to Lake Macquarie.

CVC commenced operation in the 1962 and, since that time, has extracted coal from the Wallarah Seam and the Great Northern Seam using bord and pillar methods, and the Fassifern seam using both bord and pillar and miniwall methods. Miniwall mining is currently employed, and proposed for all future secondary extraction, within that seam. Further mining in the Wallarah and Great Northern Seams is not currently approved or proposed.

No approved or proposed secondary extraction underlies any terrestrial based surface water catchments, with all approved and proposed secondary extraction to be undertaken underneath the saline, tidal region of Lake Macquarie within a boundary set by the application of a High Water Mark Subsidence Barrier and Seagrass Protection Barrier**.**

The maximum water depth within the then proposed mining areaswas approximately 9m andthe maximum depth to rock head was 20m. Sediment on the bottom of Lake Macquarie varies inthickness up to about 10m.The overburden above the Fassifern Seam, determined by subtracting the rock head from the seam level depth, ranged from 130 - 214m.

The miniwall panels were approved to be a maximum 97m wide (rib to rib) with 30.6m wide inter-panel pillars. These panel widths are significantly less than those previously completed for adjacent mines – for example, Wyee State Mine (now Mannering Colliery) Longwalls 17 to 21 were up to 150m wide, and were extracted between 150m and 180m below surface.

4.2 Adjacent Workings

CVC is entirely surrounded by the existing Mannering and Myuna Collieries as well as by the historic Newvale, Wallarah and Moonee Collieries.

Mannering Colliery (formerly the Wyee State Mine), has conducted mining in the Great Northern and Fassifern Seams since the 1960s, using both bord and pillar and longwall methods. Extraction continued until 2002, when mining became uneconomic. The mine was temporarily shut down until 2004 when it was reopened by Centennial Coal. From 2004 until the end of 2012 when Mannering Colliery was placed under care and maintenance, mining progressed in the Fassifern Seam using bord and pillar methods.

The Myuna Colliery commenced operation in 1981 and is currently mining the Wallarah and Fassifern Seams via bord and pillar techniques.

Wallarah Colliery operated from 1979 until 2002, when it was placed under care and maintenance and subsequently closed.

The former Munmorah, Cooranbong and Endeavour Collieries and the operating Mandalong Colliery are also nearby, but are not immediately adjacent to the Chain Valley Colliery holding boundary.

4.3 Mine Hydrogeology

Groundwater flows from the “terrestrial” recharge areas outside Lake Macquarie, as well as from the saline waters of Lake Macquarie, into the overburden under a regional hydraulic gradient, with dominantly horizontal confined flow along discrete discontinuities and fractures within bedding planes, and / or above fine grained, relatively impermeable strata within the overburden sequence.

The overburden generally contains low yielding aquifers with low hydraulic conductivities.

A schematic of the stratigraphic sequence is shown in **Figure 4.**

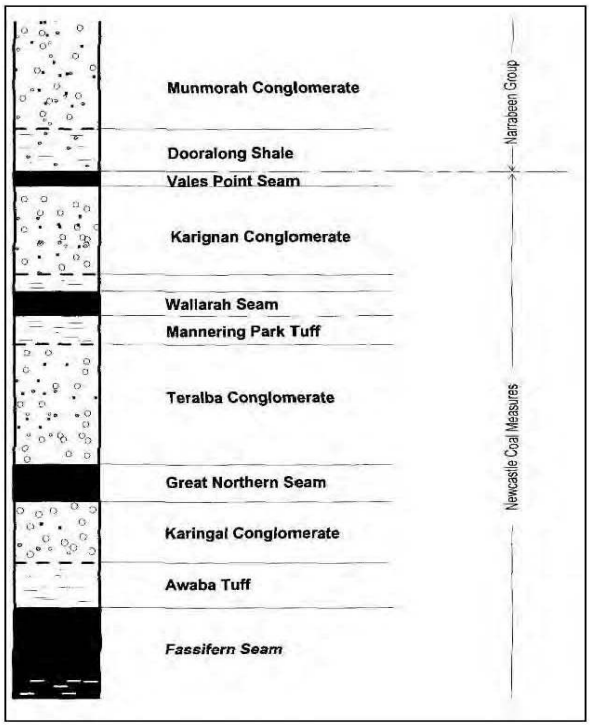

Figure 4 Local Area Stratigraphy

The following sections outline the characteristics of the hydrogeological divisions within the CVC overburden and surrounding areas.

4.3.1 Alluvial Aquifers

Quaternary to recent alluvial terrestrial sediments comprising sand, gravel, clay and silt are associated with creeks and drainage channels in the local area, to the east, west and south the shores of Lake Macquarie, with any alluvium present in the vicinity of the Study Area likely to be associated with the drainage lines which discharge to Lake Macquarie.

No data is available for the thickness or lithology of alluvium within the Study Area. However, if present, it is anticipated that it would be thin, with limited aerial extent, and no significant water storage or transmitting capacity.

Alluvial sediments within the "terrestrial" areas outside of the Study Area are generally too shallow and limited in extent to be used for groundwater supply.

4.3.2 Lake Macquarie Sediments

Sediments within Lake Macquarie comprise unconsolidated sands, clays, silts and gravels from 6 – 10m thick, with a maximum depth to bedrock from the surface of Lake Macquarie being approximately 20m.

4.3.3 Shallow Bedrock

The shallow bedrock comprises a weathered layer of rock which potentially contains discontinuous perched aquifers developed at the interface between the soil and deep bedrock and along zones of locally increased permeability caused by weathering of bedrock and faulting.

The depth and permeability of any aquifers is likely to be dependent on the depth of weathering and the extent and frequency of any permeable fracture systems.

Recharge to the shallow bedrock aquifer is primarily through rainfall infiltration in terrestrial areas and from the saline water body of the lake, with infiltration into to the underlying basement through fractures, joints and faults.

4.3.4 Deep Bedrock

The Newcastle Coal Measures are overlain by the Munmorah Conglomerate and the Dooralong Shale of the Triassic Narrabeen Group which comprise the majority of the overburden.

The total overburden above the Fassifern Seam, determined by subtracting the rock head from the seam level depth, ranged from 130 - 214m. Within the overburden, the Munmorah Conglomerate extendsto a depth of approximately 120m in the vicinity of the Study Area and comprises mostly quartz-lithic sandstone interbedded with pebble conglomerate.

The Dooralong Shale is up 20m thick and comprises cross-bedded sandstone intercalated with siltstone and claystone (Forster and Enever, 1992).

Fractured bedrock aquifers would be present within the Narrabeen Group and the Newcastle Coal Measures with discrete water yielding horizons associated with zones of increased permeability i.e. faults and the coal seams.

The overburden and interburden is a low yielding sequence of essentially dry conglomerates and shales.

Joints and fractures associated with fractured bedrock systems tend to be laterally and vertically discontinuous, resulting in poor hydraulic connection and low groundwater yields.

Forster and Enever (1992) state that "*neither the Narrabeen Group nor the Newcastle Coal Measures contain any significant quantities of groundwater and their permeabilities are known to be generally low (<10^{-7} m/s).*

Any permeable zones which do occur are usually due to jointing, faulting and shearing on bedding planes.

Because of the extremely low permeability of the rock substance, groundwater flow through the overburden strata is almost exclusively by interconnecting defects such as joints and bedding.

For this reason, coal seams with their interconnecting cleat and joint patterns are often found to be 'aquifers' relative to the surrounding strata. Despite this, most underground coal mines on the Central Coast are quite dry, and rarely have any major groundwater problems."

Groundwater in the deep bedrock aquifer is of poor quality with salinity levels ranging from 3000 - 7000 µS/cm.

Recharge to the deep bedrock aquifer is generally from infiltration of rainfall from overlying aquifers and the flow direction is expected to reflect the local topography and the lake water surface.

4.3.5 Coal Seams

The coal deposits historically or currently mined in the area include 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.

The up to 8m thick Fassifern seam underlies the Wallarah and Great Northern seams within the Study Area, and lies between 150 - 230m below surface. The mining height ranges up to 3.5m.

4.3.6 Structure and Intrusions

The overburden dips at approximatelytwo degrees to the south-west.

Superimposed on the regional dip is the Macquarie Syncline, with an axis that runs through the CVC holding, along with associated faulting and igneous intrusions. Mapped and inferred geological structures in the Study Area include a number of faults and dykes. The current Fassifern Seam workings have intersected some of these geological structures, however, no significant inflows have been observed to date when installing the main headings or undertaking gateroad development.

4.3.7 Private Bores Within or Adjacent to the Mining Area

The NOW database indicates 15 registered bores lie within the predicted 0.1m drawdown boundary for the Extension 1 Project as shown in **Figure 5**.

From the available data shown in **Table 1**, the majority of bores are completed in shallow (<18.3mbgl) sandy alluvium, with one 277.5 m deep coal exploration bore (GW31646) which was converted for use as a domestic water supply but no longer functions and is now capped. Six private bores were confirmed as either no longer being present. One bore (GW80489) was reported as being in use for domestic garden water supply (mixing the groundwater with rainwater captured). One test bore (GW80830) is capped and covered and is not used. No response was received from the three landowners on whose land four bores exist and no data was available for two bores.

Data available from the NOW records shows that the groundwater has been obtained from the shallow sandy alluvial / colluvial aquifers with low to moderate yields at around 1.50L/sec.

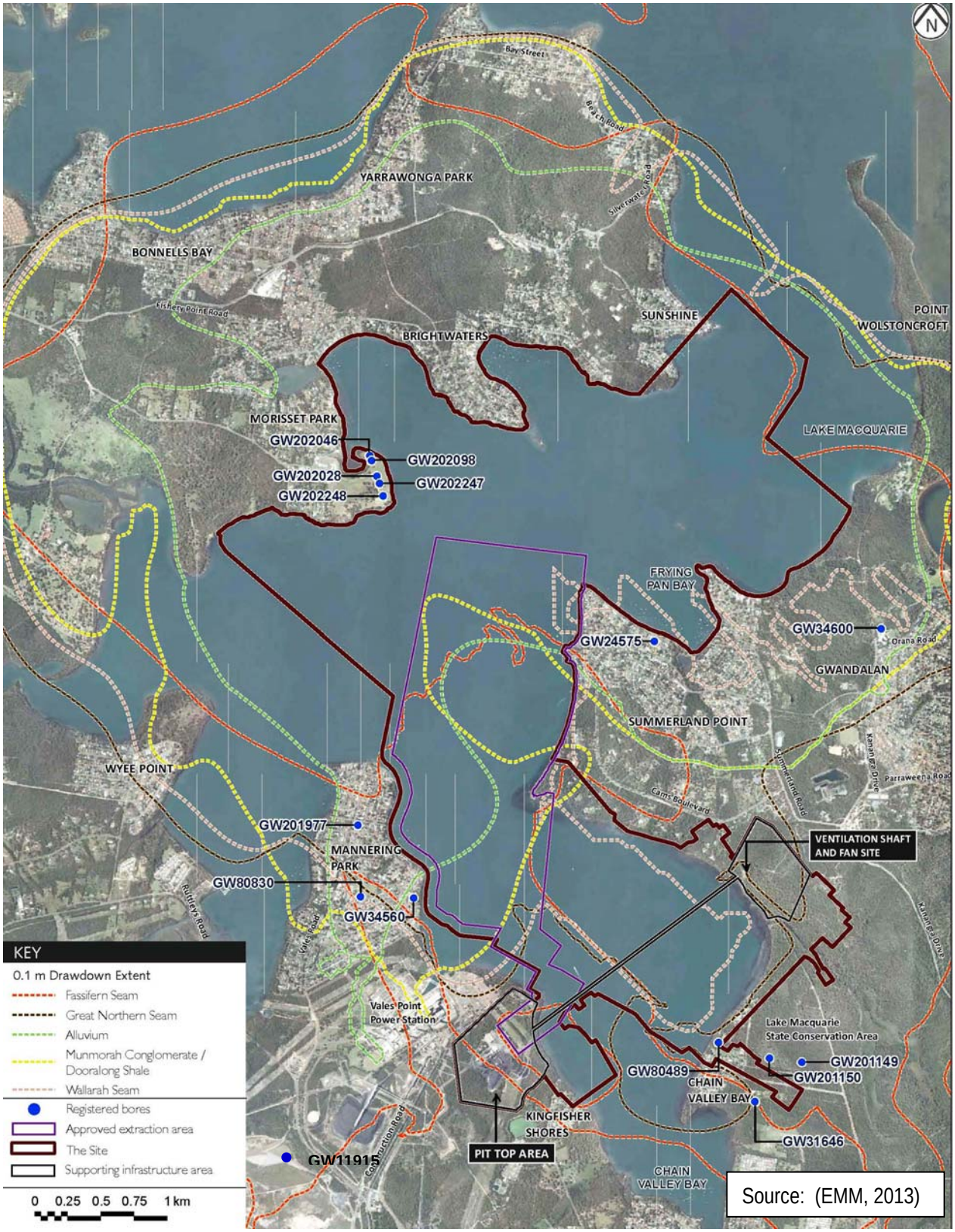

Figure 5 Local Groundwater Bores

Table 1 Registered Local Private Bores

GW	E	N	Drilled	Depth (m)	SWL (m)	Aquifer (mbgl)	YIELD (L/s)	Purpose	Bore Currency
11915	363007	6329604	-	5.4	-	-	-	Poultry	no response
24575	365969	6332788	1965	15.2	-	-	-	Domestic	no response
31646	366742	6329317	1960	277.5	3.0	3.0 – 10.6	0.13	Dom. / Coal Explore	capped / covered
34560	364130	6330883	1970	18.3	5.5	5.5	-	Domestic	not present
34600	367678	6332873	1971	61.0	5.7	18.2	0.06	Waste disposal	-
80489	366441	6329674	2003	-	-	-	-	Domestic	no internal access
80830	363757	6330850	2004	-	-	-	-	Test bore	capped / covered
201149	367104	6329608	2006	4.0	1.0	1.0 – 4.0	1.50	Irrigation spear	no response
201150	366840	6329640	2006	4.0	1.0	1.0 – 4.0	1.50	Irrigation spear	no response
201977	363730	6331388	2008	7.1	6.0	6.0 – 7.0	-	Monitoring	-
202028	363872	6334034	2007	5.5	1.6	-	-	Test bore	not present
202098	363829	6334141	2007	4.0	0.8	-	-	Test bore	not present
202246	363834	6334174	2007	3.5	1.2	0.6 – 3.5	-	Test bore	not present
202247	363899	6333964	2007	5.0	3.6	2.0 – 5.1	-	Test bore	not present
202248	363918	6333881	2007	5.0	-	2.0 – 5.0	-	Test bore	not present

Note: - no data available

Registered bores in the vicinity of the Study Area are generally installed in the shallow alluvium, with the majority of bores installed to less than 18.5m.

Groundwater yields are generally less than 1.5 L/s, with the authorised use of the bores including:

- test and monitoring bores;
- irrigation spears;
- domestic, poultry and waste disposal.

While it is recognised that not all existing bores are likely to be registered, the database gives an indication ofgroundwater usage in the area.

Overall, it is concluded that theimportance and reliance on groundwater by local landowners and residents is limited.

5. CURRENT GROUNDWATER MONITORING

5.1 Mine Inflow

Monitoring activities currently conducted principally involve recording the mine groundwater make (via the difference between water pumped in and out of the workings) and liaison with local bore owners when, or if, adverse effects are observed in the limited number of active bores in CVC's drawdown area.

The limited bore monitoring is principally due to CVC's drawdown area being almost entirely covered by the surface of Lake Macquarie and that when landowners with registered bores were contacted as part of developing the GwMP, only one responded indicating that the bore (GW80489) was present and in use. Other responses identified that bores were either not present or had no supply.

Data for the period between March 2013 and December 2014 indicates that an average of 118KL/day, or 43.07ML/year of potable water was pumped into the underground, whilst over the 2009 to 2014 period, **Figure 6** shows that between 2,305 ML/year and 2,536ML/year of groundwater was extracted from the mine.

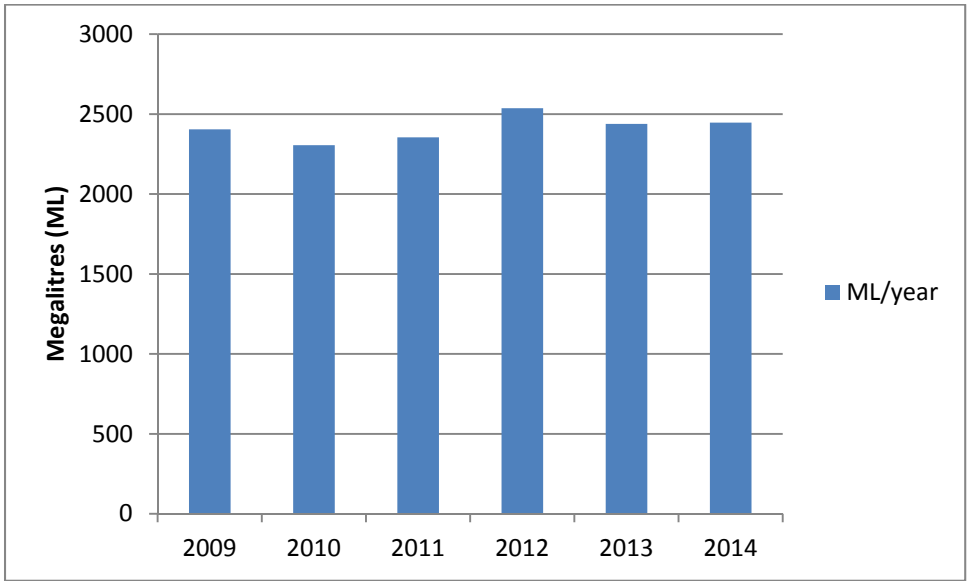

Figure 6 Annual Average CVC Dewatering Volumes

The net groundwater seepage into the workings has been estimated from the difference between the annual potable water intake and the annual water volume extracted from the underground workings. Using this method, the annual groundwater make for the current CVC workings is estimated at approximately 2440ML/yr, or 6.7ML/day (C Ellis, pers comm.).

Temporary increases in groundwater inflows to CVC have been reported in the vicinity of faults and associated fractures. However, the increases in inflow are usually short lived as the structures associated withfractured bedrock systems tend to be laterally and vertically discontinuous (resulting in poor hydraulic connection) and have low groundwater yields (GeoTerra, 2013). These groundwater inflows encountered during the development process have only been considered as nuisance inflows as a result of changes to the work environment

and roof conditions during mining. In general, the Fassifern Seam has been the driest of the seams mined at CVC to-date. Notably, mining of the overlying Wallarah Seam, the shallowest seam mined, has previously been conducted without major adverse impacts onthe overlying aquifers or inflow of water from Lake Macquarie (GeoTerra, 2013).

5.2 Groundwater Quality

Groundwater monitored within the current and historic underground mining areas at CVC indicates the inflow water is brackish to relatively saline in subsided areas over the Great Northern Seam workings (11,800 – 28,200mg/L) with a circum-neutral to mildly alkaline pH (7.30 – 7.76). However, groundwater seepage from a dyke over the mains adjacent to Miniwall 6 within the Fassifern Seam workings, had a brackish salinity of 2,390mg/L and an alkaline pH of 8.63 as outlined in GeoTerra (2013), indicating there is not a significant component of sea water seeping into the Fassifern Seam workings.

Water quality sampling and analysis outlined in GeoTerra (2013) indicates that groundwater within sections of the underground workings is significantly above the ANZECC 2000 criteria (default trigger values for physical & chemical stressors in SE Aust lowland rivers and 95% protection of freshwater species) for:

- pH;
- electrolytical conductivity;
- total nitrogen;
- total phosphorous: and
- filterable copper and zinc

GeoTerra (2013) identified that groundwater seepage into the underground workings is not generally suitable for potable, livestock or irrigation use where it is discharged at surface from the mine, but is suitable for discharge under the EPA licence to Lake Macquarie.

No adverse changes to groundwater quality in subsided private bores over the historic mining areas have been reported to date by landowners.

6. SUMMARY OF GEOTERRA (2013) PREDICTED IMPACTS

GeoTerra (2013) assessed that subsidence over the then proposed 185 - 220m deep miniwall workings may affect the overlying groundwater system through the following mechanisms, assuming an exponential decrease in overburden permeability with height above the workings:

- surface cracking from the lake floor to a depth of approximately 20m;
- goaf fracturing to less than 115m above the seam, with partial loss of groundwater if fracturing extended into an overlying aquifer resulting in minor groundwater inflow from the goaf to the workings
- connectivity between the mine workings and overlying aquifers within the fractured goaf, which can result in depressurisation of the aquifers;
- dewatering and depressurisation of the Great Northern and Fassifern Seams as mining progresses;
- increased aquifer permeability; and potentially
- reduced groundwater quality in the overlying aquifers.

The predicted impacts presented in GeoTerra 2013 aresummarised in the following sub-sections.

6.1 Hydraulic Connection to Lake Macquarie

Hydraulic connection between CVC and Lake Macquarie over the proposed workings was not predicted to develop due to the depth of cover, and mine design limiting the height of fracture above the workings.

6.2 Aquifer / Aquitard Interconnection

No adverse interconnection of aquifers and aquitards was anticipated within 20m of the lake bed as there were no recorded aquifers in this interval. However, it was assessed that there may be an increased rate of recharge into the upper overburden from the lake waters due to the increased secondary porosity and permeability of the subsided, fractured overburden.

6.3 Regional Groundwater Depressurisation

Potential for a temporary lowering of the regional piezometric surface over the subsidence area of up to 1.0m due to horizontal dilation of strata, and an increase in secondary porosity and permeability was identified, with that effect being more notable directly over the area of greatest subsidence and dilation, dissipating laterally out to the edge of the subsidence zone.

Based on similar observations in NSW with similar mining layouts, it is generally the case that surficial and mid depth strata groundwater levels may reduce by up to 15m, and may stay at that reduced level until maximum subsidence develops at a specific location. It is also generally observed that the duration of the reduction depends on the time required to develop maximum subsidence, the time for subsidence effects to migrate away from a location as mining advances to subsequent panels and the length of time required to recharge the secondary voids.

It was also assessed that the degree of groundwater level decline under the lake due to subsidence is predominantly determined by the proximity to a mined panel, although it can also be significantly affected by the rate of lake water infiltration and terrestrial rainfall recharge

to an aquifer, as well as changes in the rate or duration of groundwater extraction in any adjacent groundwater bores.

On the basis that the pre-mining circumstances of lake water and rainfall recharge as well as any local bore pumping remain the same, it was anticipated that groundwater levels would recover over a few months as the secondary void space is recharged by lake water and rainfall infiltration.

GeoTerra (2013) also noted that there is generally no permanent post-mining reduction in groundwater levels under the lake, as no new hydraulically connected outflow paths from within the overburden develop.

6.4 Private Bore Yields and Serviceability

Although ten registered bore sites were located within the predicted 0.1m Layer 1 (Alluvium) depressurisation area **(Figure 7)**, no private bore yields or serviceability were anticipated to be affected by subsidence or regional groundwater depressurisation associated with the then proposed workings, which were entirely located under Lake Macquarie. As previously noted in Section 4.3.7, only a single bore (GW80489) was determined to be currently in use. This bore is outside the 0.1m Layer 1 (Alluvium) drawdown extent.

Further, no beneficial users of the deep bedrock/coal measures aquifers were identified in the vicinity of the Study Area.

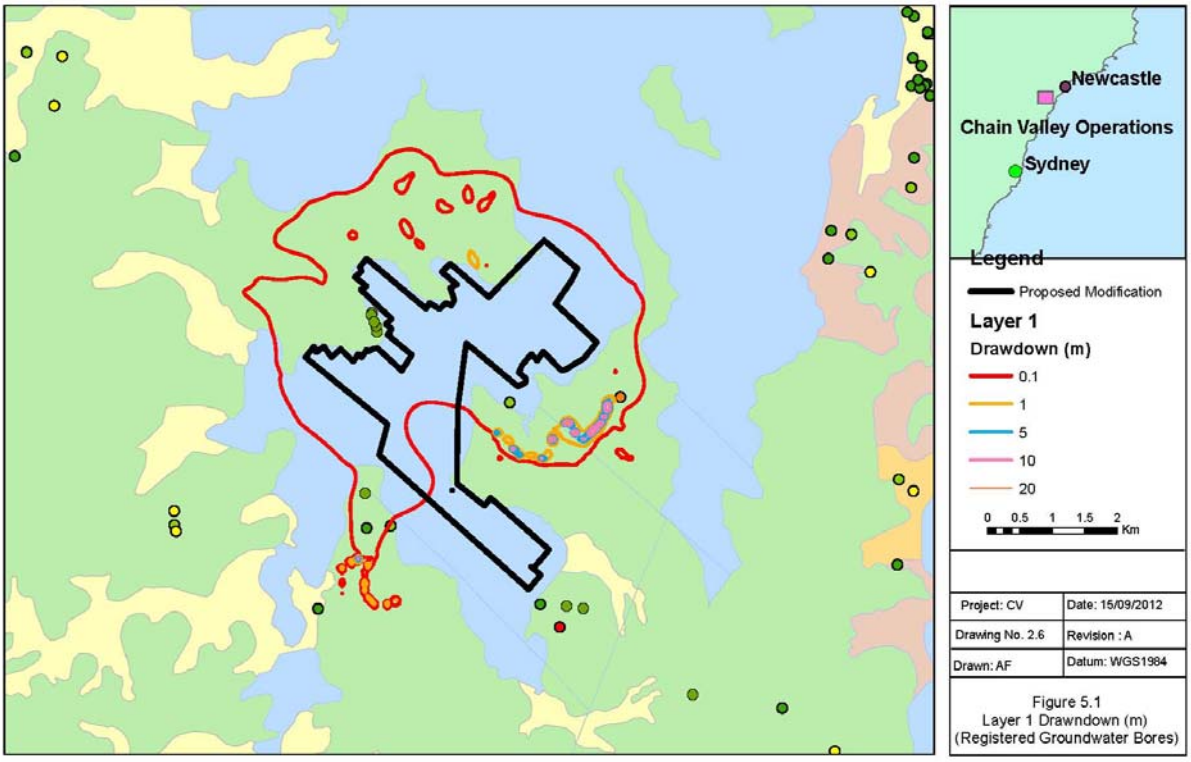

Figure 7 Local Groundwater Bores and Groundwater Drawdown Areas

6.5 Groundwater Dependent Ecosystems

Given that no groundwater dependent ecosystems had been identified within the area determined to be subject to subsidence effects within and adjacent to Lake Macquarie, cumulative impacts from the proposed mining were not anticipated to adversely impact on groundwater dependant ecosystems in the 20mm subsidence area.

6.6 Groundwater Quality

GeoTerra (2013) noted that the degree of iron hydroxide and pH change due to subsidence was difficult to predict, and could range from no observable effect to a distinct discolouration of water pumped out of bores. However, itwas also noted that many bores in the local area already potentially had significant iron hydroxide levels. With respect to pH, GeoTerra also noted that acidity (pH) changes of up to 1 order of magnitude could occur, but the change can be reduced if the bore has sufficient bicarbonate levels.

A pre-mining survey of the active bores within the Study Area to assess the baseline water quality prior to undermining identified only one active bore (GW80489), however access inside, and water sampling of the bore, was not possible.

6.7 Groundwater Seepage to or From Terrestrial Streams

No known springs or streams were present in the Study Area that would be affected by subsidence and associated regional groundwater depressurisation. Furthermore, it was determined that overall, the terrestrial streams within the Study Area would be subjected to no or very low tensile and compressive strains and not anticipated to be adversely affected by subsidence-related stream bed cracking. Consequently, no loss of overall stream flow or regional change in stream water quality within the local streams was anticipated to occur.

6.8 Groundwater Inflow to Mine Workings

Loss of lake water or any significant loss of connate groundwater within the overburden to the underlying workings has not been observed in mines in the local area at similar depths of cover to the formerly proposed, and now approved, workings, with vertical hydraulic connection to the workings restricted by the Dooralong Shale and the Mannering Park Tuff aquitards, which were not anticipated to be breached by subsidence over the Fassifern seam workings. Furthermore, both are located below the surficial, and above the goaf, vertically connected, dilation zones.

GeoTerra (2013) determined that the horizontal permeability above and between the aquitards may be enhanced after subsidence, although there would be no additional vertical connectivity through or below them to the underlying workings.

Based on available recordsat the time of the Chain Valley Colliery Extension 1 Project Groundwater Assessment, the groundwater seepage averaged 2,396ML/yr (6.56ML/day), with no distinctive relationship between expansion of the mine and increase in groundwater inflow to the workings evident.

However, based on the modelling undertaken for that assessment, GeoTerra (2013) determined that the average inflow of 6.56ML/day may increase up to 10.5ML/day as the underground workings expanded to their currently-approved extent.

7. POTENTIAL IMPACTS DUE TO THE PROPOSED MODIFICATION

7.1 General

The proposed extraction of the CVC workings is predicted to generate up to 0.78m of subsidence over single seam and up to 1.2m over triple seam extraction areas (DGS, 2015) in an area with up to at least 185m depth of cover under the extent of Lake Macquarie.

It is anticipated that due to the approximately 3.8% reduction in underground mine area arising as a consequence of the proposed modification, there will be no perceptible change to the effects predicted in GeoTerra (2013) regarding;

- hydraulic connection to Lake Macquarie
- aquifer / aquitard Interconnection
- regional groundwater depressurisation
- private bore yields and serviceability
- groundwater dependent ecosystems
- groundwater quality
- groundwater seepage to or from terrestrial streams

7.2 Groundwater Inflow to Mine Workings

The minimal reduction (3.8%) in aerial extent of the originally modelled, as opposed to the proposed re-oriented and modified, underground mine workings area is within the error constraints of the MODFLOW Surfact groundwater model. As a consequence, no apparent observable differences from those previously predicted are anticipated in;

- loss of lake water or loss of connate groundwater within the overburden to the underlying workings;
- vertical hydraulic connection to the workings. This will still be restricted by the Dooralong Shale and the Mannering Park Tuff aquitardswhich are still not anticipated to be breached by subsidence over the modified workings asthe shale and tuff are both below the surficial and above the goaf, vertically connected, dilation zones;
- horizontal permeability. Horizontal permeability above and between the aquitards will not be observably different as a result of the proposed modification and will still be enhanced after subsidence. However, there will be no additional vertical connectivity through or below them to the underlying workings;
- the original modelled maximum mine groundwater inflow of 10.5ML/day is not anticipated to be observably different due to the proposed modification.

7.3 Recommendations

It is recommended that the groundwater monitoring and management system outlined in GeoTerra (2015) should be adhered to including monitoring and reporting of:

- daily and annual mine water pumping volumes and calculated groundwater inflows to the workings;
- plotted groundwater levels and/or mine water trends; and
- mine water and discharge water chemistry.

Any observable changes in the groundwater system should be reported as required, with any required ameliorative actions conducted as outlined in the GwMP.

8. REFERENCES

Ditton Geotechnical Services, 2015 Subsidence Impact Assessment for the Chain Valley Colliery – Modification 2, prepared for LakeCoal Pty Ltd.

EMGA Mitchell McLennan, 2015 Chain Valley Colliery – Modification 2, Statement of Environmental Effects – Section 96 Modification to SSD-5465, prepared for LakeCoal Pty Ltd

GeoTerra, 2013 LakeCoal Pty Ltd Chain Valley Colliery Mining Extension 1 Groundwater Assessment

GeoTerra, 2015 LakeCoal Pty Ltd Chain Valley Colliery Groundwater Management Plan

LIMITATIONS

This report was prepared in accordance with the scope of services set out in the contract between GeoTerra Pty Ltd (GeoTerra) and the client, or where no contract has been finalised, the proposal agreed to by the client. To the best of our knowledge the report presented herein accurately reflects the clients requirements when it was printed. However, the application of conditions of approval or impacts of unanticipated future events could modify the outcomes described in this document.

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The findings contained in this report are the result of discrete / specific methodologies used in accordance with normal practices and standards. To the best of our knowledge, they represent a reasonable interpretation of the general condition of the site in question. Under no circumstances, however, can it be considered that these findings represent the actual state of the site at all points.

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Appendix F

Marine ecology assessment

Appendix F — Marine ecology assessment

F

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TO:
John Arnold
Project Manager
EMGA Mitchell McLennan
via email: jarnold@emgamm.com

Chain Valley Colliery Modification 2: Marine Ecology

Dear John,

JSA Environmental (JSA) provides this letter to EMGA Mitchell McLennan (EMM) to address potential impacts on marine ecology as a result of proposed modification to the Chain Valley Colliery (CVC) development consent, SSD-5465 (as modified).

1. Project Summary

CVC is an underground coal mine located at the southern end of Lake Macquarie, approximately 60 km south of Newcastle. CVC is operated by LakeCoal Pty Ltd (LakeCoal). Underground mining at CVC commenced in 1962, and since that time has extracted coal from three seams; namely, the Wallarah seam, the Great Northern Seam and the Fassifern Seam, using a combination of bord and pillar and miniwall mining methods. Current mining activities are limited to the Fassifern Seam.

CVC operates under Development Consent SSD-5465, 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). A subsequent modification permitting an underground linkage to Mannering Colliery was approved on the 27 November 2014 (Mod 1). At the time of the assessment CVC had completed Miniwalls (MWs) 1 to 8 and mining was yet to commence in MW 9.

LakeCoal seeks approval to modify SSD-5465 under Section 96(2) of the EP&A Act, to permit:

- an increase in the maximum rate of ROM coal extraction at the CVC from 1.5 Mtpa to 2.1 Mtpa;
- mine design changes, primarily the re-orientation of miniwall panels in CVC's northern mining area;
- minor vegetation clearing adjacent to some infrastructure at the CVC pit top and the ventilation fan site on Summerland Point to enable the establishment of fire management asset protection zones (APZs); and
- an increase of full time personnel from 160 to approximately 220.

The mine design changes necessitate minor amendments of CVC's development consent boundary.

Consistent with the existing mine layout, the proposed mine design changes would still ensure that all secondary extraction is located entirely beneath Lake Macquarie in areas where the depth of cover ranges from 148 m to 230 m. The primary mine design change, reoriented miniwalls, would also be located outside the previously-established High Water Mark Subsidence Barrier (HWMSB) and Seagrass Protection Barrier (SPB).

The only aspect of the modification that has the potential to impact on marine ecology is the mine design changes and associated change in subsidence predictions. The re-orientation will result in a minor change to spatial extent of the proposed mining activities, although all secondary extraction will remain limited to areas beneath Lake Macquarie with protection barriers for the foreshore and seagrass continuing to apply. Large scale surveys of marine ecology were undertaken in 2012 as part of marine ecology assessment for the CVC Extension Project, while annual seagrass monitoring has been undertaken since 2010 and benthic communities monitoring has been occurring 6-monthly since early 2012. The data from these reports has been used to support the analysis of the potential impacts arising from the proposed the mine design changes.

2. Seagrass Protection Barrier

LakeCoal has implemented a SPB to protect foreshore environments and seagrass communities within its mining areas in Lake Macquarie. Information on the development of the SPB is provided in the following.

The seagrass bed assessment completed for CVC by JH & ES Laxton – Environmental Consultants P/L (2011) found that two forms of the seagrass *Zostera capricorni* (the short-leaved and long-leaved forms) and some Paddle Weed (*Halophila* spp) were present adjacent to the mining operations proposed as part of the CVC Continuation Project. Their occurrence was observed to commence along the lake edge and terminate when water depths approached 2m.

Further mapping undertaken as part of the Chain Valley Colliery Mining Extension 1 Project (JSA 2013), enabled the maximum depths and locations of seagrass to be considered in the mine design for the project. This resulted in the generation of a SPB that covered the full extent of the now approved mining areas, which was then used to refine the mine design and ensure subsidence impacts on seagrass communities could be avoided. This study also found that the communities were dominated by *Zostera capricorni* and that in general, the areas were characterised by patchy individuals of that species. The seagrass beds were found to exist to a maximum depth of 1.9m. Details from both of these studies were combined to produce the mapping of seagrass over the entirety of the historic, current and future mining areas and enabled the SPB to be defined.

The surface expression of the SPB effectively extends seaward from a vertical projection of a line corresponding with the surveyed boundary of the seagrass. This boundary, in turn, generally lies approximately 2 m below the low tide mark. Subsidence within the SPB is to be less than 20 mm, i.e. a magnitude considered to be 'zero' subsidence. To achieve this, the extent of secondary extraction which would result in subsidence is limited by an angle of 26.5 degrees from the vertical, projected downwards to the coal seam to be mined. For example, at a depth of 200 m the secondary extraction

activities cannot come closer than 99.7 m from the seaward edge of the seagrass. The mapped seagrass beds and SPB are shown on Figure 1.

The SPB is supported by a Seagrass Management Plan (LakeCoal 2014) which outlines the seagrass protection limits, impact mitigation measures, monitoring, incident reporting and management, and audits and reviews.

As part of the protection of the lake foreshore, the various mining leases covering the Lake Macquarie area require a protection barrier around the foreshore, known as the HWMSB. The surface expression of the HWMSB extends around the shoreline from the high water mark to 2.44 mAHD. The width of the barrier at coal seam level is defined by an angle of 35^{o} from each of the high water mark and the 2.44 mAHD line. The barrier is approximately 130 m wide at the surface, but increases or decreases in width depending on the depth of cover of the coal seam. No secondary extraction occurs within this zone. Although similar in some locations, the HWMSB and the SPB are separate barriers, with the mine layout limited (among other factors) by either barrier at any specific location. The proposed mine layout as a result of the application of the HWMSB and SPB are depicted in Figure 1, with Figure 2 depicting the vertical representation of the barriers.

This concept of a SPB was introduced by LakeCoal to protect seagrass beds around Lake Macquarie within its areas of mining activity. However, the barrier also has the effect of minimising the potential for impacts on micro and macroalgae, saltmarsh and mangrove communities of the Lake shore environment and is important when assessing the potential impacts of the proposed modification.

Despite the SPB barrier definition, monitoring thresholds have been established based on observable change to seagrass beds or bed height, with the following triggers set in consultation with government agency stakeholders at the initiation of the monitoring program to allow for natural estuarine processes involving erosion and deposition to be accounted for:

- 20% decline in condition from the base year survey (i.e. earliest survey prior to mining occurring nearby).
- Mining induced subsidence of 150mm or greater being recorded at one of the monitoring sites.

In accordance with the Seagrass Management Plan, the Colliery Environment and Community Coordinator will notify DPI Fisheries and DTIRIS – Resources and Energy if either of the above impact thresholds are exceeded, if deemed necessary by any of the parties, a meeting will be convened to discuss the results and determine required future action.

If, through the monitoring program, subsidence is found to occur in areas known to contain seagrass beds and loss of seagrass habitat has been determined to have occurred as a direct result of this subsidence, then LakeCoal has committed to undertaking remediation strategies to replace an equal area of any loss of seagrass habitat that has occurred. While LakeCoal's approach to manage seagrass is aimed at protection, if an investigation were to identify that an exceedence / incident has occurred that was a direct result of the mining activities and associated subsidence, then LakeCoal would develop a response plan, which would be submitted to DPI Fisheries, identifying the proposed remediation strategy. The strategy would identify proposed remediation measures which could include:

- Transplanting existing communities with additional fast growing locally occurring seagrass

plants;

- Regrading: topographical restoration; and/or
- Fertilising: to stimulate lateral ingrowth of communities.

The exact method of remediation would be determined based on the existing integrity of the seagrass beds, existing species and specific impacts that have occurred, that is, the remediation strategy would be "site specific" to ensure the most appropriate remediation methodology is implemented in consultation with NSW Fisheries.

Should remediation on-site not be viable, mitigation would be undertaken at other sites within Lake Macquarie in consultation with DPI Fisheries and Lake Macquarie City Council. That is, work would be completed to offset the impact arising as a result of mining activities.

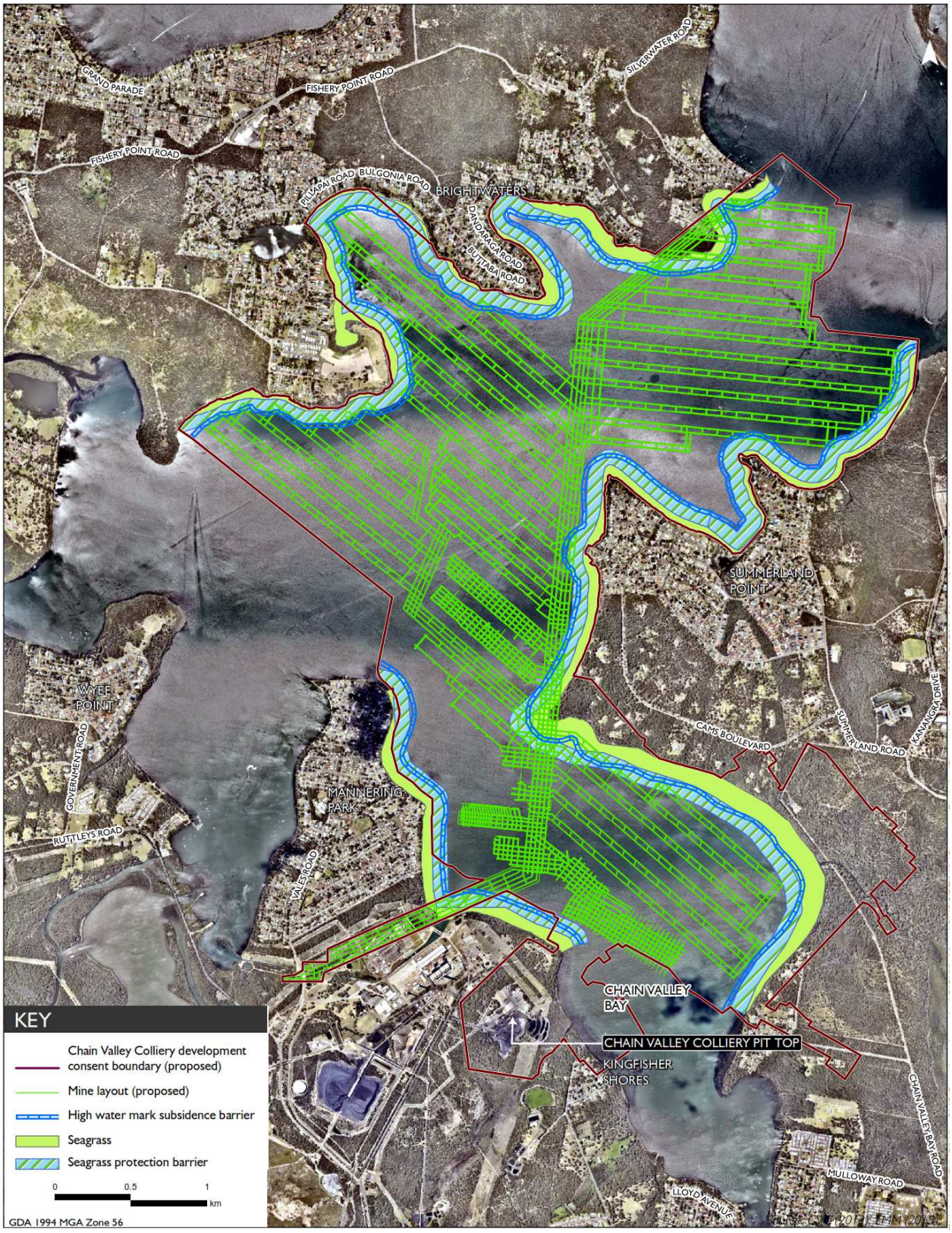


Figure 1: Seagrass Beds and Seagrass and High Water Mark Protection Barriers

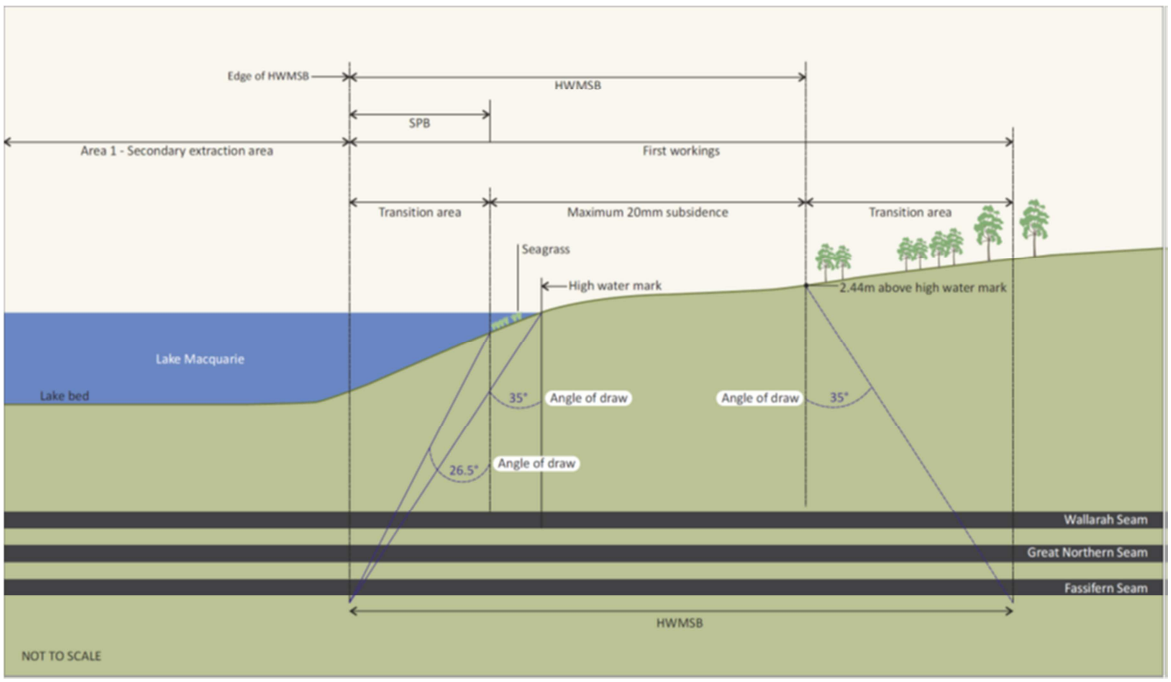


Figure 2: Protection Barrier Schematic

3. Subsidence

The principal surface impact of underground coal mining is subsidence (lowering of the surface above areas that are mined). The total subsidence of a surface point consists of two components, active and residual. Active subsidence, which forms 90 to 95% of the total subsidence in most cases, follows the advance of the working face and usually occurs immediately following extraction. Residual subsidence is time-dependent and is due to readjustment and compaction within the goaf among other factors. Trough-shaped subsidence profiles associated with miniwall mining develop tilt between adjacent points that have subsided different amounts. Maximum ground tilts are developed above the edges of the area of extraction and may be cumulative if more than one seam is worked up to a common boundary. The surface area affected by ground movement is greater than the area worked in the seam, with the lateral extent of that effect generally determined by the angle of draw from the edge of the secondary extraction activity.

The degree of subsidence resulting from a particular mining activity depends on a number of site specific factors. Factors that affect subsidence include the design of the mine, the thickness of the coal seam section being extracted, the width of the chain pillars, the ratio of the depth of overburden to the miniwall panel width and the nature of the overlying strata. Massive geological structures, such as the Munmorah Conglomorate, which overlie the mining area at CVC, act as large beams supporting the mined out areas. Subsidence is also dependent on topography (NSW Scientific Committee 2011).

Subsidence modelling of the mine layout changes assessed that the modification to the mine layout will result in an additional 160 mm of subsidence in the single seam mining areas and an increase of approximately 340 mm in the multi-seam mining area, assuming worst cast cumulative mining impacts.

The modified layout's MWs 9 to 36 are still located entirely beneath Lake Macquarie in areas where the depth of cover ranges from 148 m to 230 m. The miniwalls will still remain outside the High Water Mark Subsidence Barrier (HWMSB) and Seagrass Protection Barrier (SPB).

Within the single seam mining areas (MW 9 to MW 31) final maximum chain pillar subsidence ranges from 420 mm to 780 mm. Maximum panel tilt is estimated to range from 2 mm/m to 15 mm/m (average of 12 mm/m) with maximum compressive and tensile strains ranging from 1 to 6 mm/m (average of 3 mm/m). Maximum subsidence was previously predicted to be a maximum 620 mm in the single seam mining areas.

Within the areas of overlying workings (i.e. the multi-seam mining area which comprises MW 31 to MW 36), total cumulative subsidence is predicted to reach 1.23 m, or 340 mm greater than the original prediction of 0.89 m which was considered in the original marine ecology assessment (JSA 2013).

In all mining areas the secondary workings will be set back from the SPB to ensure that less than 20mm subsidence occurs within the seagrass communities. These secondary workings are restricted by the SPB with only first workings to be undertaken below the SPB.

Although the angle of draw routinely adopted is 26.5°, the angle of draw around the north-eastern limits of modified MWs 35 and 36 may exceed 26.5° slightly due to multi-seam effects. However, in areas where the angle of draw may exceed 26.5 degrees, LakeCoal will amend the mine design to ensure the greater angle of draw is applied, resulting in no impact to the seagrass communities.

4. Marine Ecology

As part of the Chain Valley Colliery Mining Extension 1 Project, surveys were undertaken at 26 sites throughout the study area for water quality, benthic substrate, benthic invertebrates and seagrasses. Qualitative habitat assessments for listed species were undertaken during the quantitative surveys. As described in Section 2, the results of the seagrass surveys were used to map the extent of the beds, define the SPB and guide mine planning for secondary workings (Figure 1).

The seagrass surveys and mapping identified two species of seagrass, *Zostera capricorni* and *Ruppia sp*. within the Site although, in general, the areas were characterised by patchy single individuals of *Z. capricorni*.

The first annual seagrass survey was undertaken in 2008 with ongoing annual surveys continuing from 2010. Six monthly benthic community surveys have been conducted since 2012 throughout the area of approved mining activity in accordance with the relevant management plans. The aim of these surveys is to ensure that negligible impacts to the seagrass communities are occurring as a result of mining activities and only minor impacts occur the benthic communities. Reporting identifies that all seagrass beds have been expanding since 2011 and it is considered that the overall improvements to seagrass cover may be linked to the cessation of commercial fishing within the Lake and that the 'landing' of nets in seagrass covered areas no longer occurs (Laxton and Laxton 2014).

Both species diversity and abundance have been recorded as part of the 6 monthly seasonal (autumn and spring) benthic communities monitoring which commenced in 2012. Results from monitoring to

date have shown variations over time in both diversity of taxa and total abundance at almost all monitoring locations. Polychaete worms and bivalve molluscs have been the most frequently collected animals and are responsible for a significant proportion of the total number of individuals recorded at the majority of the sites (abundance). It also appears that certain taxa seem to dominate specific monitoring sites (Laxton & Laxton, 2013).

5. Potential Marine Impacts of Mine Layout Changes

With the exception of the MW 35 and 36 area, the limits of impacts associated with secondary (miniwall) extraction within the revised mine layout has been determined by a 26.5 degrees angle of draw from the mapped seaward extent of the seagrass, with only first working to be undertaken within the SPB. In these areas, subsidence will be limited to less than 20mm. While the angle of draw around the north-eastern limits of Modified MWs 35 and 36 may exceed 26.5^{o} slightly due to multi-seam effects, in areas where this is predicted to occur, LakeCoal will amend the mine design to ensure the greater angle of draw is applied, resulting in no impact to the seagrass communities.

Within the secondary extraction areas, subsidence is expected to range up to 780 mm (although average subsidence would be lower) within the single seam mining areas. This is a maximum of 160 mm higher than previously considered in this area.

Within the areas of overlying workings (i.e. the multi-seam mining area), total cumulative subsidence is predicted to reach 1.23 m, or 340 mm higher than the original prediction of 0.89m.

5.1 Seagrass Communities

The proposed mine layout changes, including re-orientation of miniwall panels, will not include multi-seam or secondary workings in the SPB and as such have been designed not to impact on the seagrass communities or foreshore environments within this zone.

Nevertheless, the seagrass occurrence will continue to be surveyed annually to monitor the community assemblage and extent of seagrasses. Monitoring will be undertaken in accordance with the approved Seagrass Management Plan.

5.2 Benthic Communities

The primary potential impact on benthic communities arising from subsidence to the lake floor is increased depth and consequent decreased light penetration of the water column, which may affect light dependent biota such as algae and biofilms on which benthic organisms feed.

The benthic community results of all surveys and annual monitoring undertaken have identified that while communities at some sites were defined by dominant species, the abundance and diversity of the communities did not identify clear links to location or impact type. Rather the analysis identified that

natural environmental fluctuations in water quality, benthic substrate composition and natural depth intervals were influencing the communities (JSA 2013).

Monitoring of the sites over time has also established that water depth is not the primary determining feature of the benthic communities, and that physical variables such as salinity, conductivity, dissolved oxygen and turbidity had little influence on the species composition. While there were some differences in the relative abundance of organisms between the two monitoring events undertaken on the EIS (JSA 2013) and the seasonal monitoring since 2012 (Laxton and Laxton 2012-2015), further monitoring will be required to determine whether they represent seasonal fluctuations or overall patchiness of benthic communities. Importantly, recent monitoring of benthic fauna on the lake bed, both prior and subsequent to mine subsidence, has confirmed that no significant impacts to either diversity or abundance has occurred to date.

Subsidence of up to 570 mm has been recorded to date within the single seam mining areas in the vicinity of benthic monitoring sites R3 (IM5) and R4 (IM6). In the most recent benthic communities monitoring event (March 2015), the maximum species diversity (6 different species) was found at site R3 (IM5), with the second highest diversity (5 species) shared across sites C3, R1, IM1, IM2, IM4 and R3 (IM6). Since monitoring commenced in 2012 species diversity at the monitoring sites has ranged from 3 to 10 species. Table 1 presents the number of species found at monitoring sites over time.

Table 1: Benthic fauna monitoring - species diversity results 2012 - 2015

Station	C1	C2	C3	C4	R1	R2	R3	R4	R5	R6	IM1	IM2	IM3	IM4
Feb 2012	10	5	5	7	8	8	5	5			7	4	4	5
Sept 2012	3	6	4	4	6	3	4	5			4	4	3	5
March 2013	4	5	7	7	6	5	6	5			7	5	5	5
Sept 2013	6	6	3	7	5	6	5	4			4	3	4	5
March 2014	4	3	5	5	6	4	5	3	4	3	5	9	4	5
Sept. 2014	3	4	4	8	6	5	6	6	3	3	5	6	3	6
March 2015	3	3	5	3	5	3	6	5	3	3	5	4	4	5

Further, the monitoring has identified that substantial species abundance and diversity is still present at the deeper sites (6.0m), and given the maximum subsidence predictions are proposed to occur over Chain Valley Bay, where the current depth is typically between 4 and 5 m, it is not anticipated that a significant impact to benthic communities would occur as a result of maximum subsidence predicted.

In addition, as was the case in the original assessment, the maximum levels of subsidence are still predicted to occur toward the end of the mining sequence (when mining of the miniwalls with overlying workings (MW is planned to occur), which provides additional time for further monitoring and refinement of the mine design should this be required.

As specified in the approved Benthic Communities Management Plan (2014) which forms part of the Extraction Plan, ongoing sampling, analysis and modelling of the communities will be undertaken to ensure changes in community assemblage do not exceed a level of 5% significance.

6. Mitigation Measures

LakeCoal has previously made a number of commitments, and has processes in place to monitor and manage potential impacts on marine ecology, that will continue to be undertaken and are relevant to this modification. These measures include:

- Annual bathymetric surveys (both over the active mining areas and previously mined areas – bathymetric surveys) and land based subsidence monitoring near the foreshore areas and on the lake floor. This monitoring will be extended around the Site as required throughout the life of the Proposal.
- Continuation of the six monthly / seasonal monitoring as required by the existing BCMP.
- Additional sampling and analysis will be undertaken to validate the results obtained, including their assessment by an independent third party, if impacts due to subsidence are moderate or major as defined in the existing approved Benthic Communities Management Plans.
- If moderate or major impacts are positively verified, the mine plan will be modified for future panels in order to achieve a minor or lower impact.
- Continuation of annual seagrass surveys/monitoring.
- Provision of the annual subsidence survey report on the LakeCoal website or in the Annual Review.
- Inclusion of results from the BCMP / Seagrass Management Plan monitoring programs within the Annual Review and provision of the Annual Review on the LakeCoal website.

7. References

JSA Environmental 2013 Chain Valley Colliery Mining Extension 1 Project Marine Ecology Assessment LakeCoal

Laxton and Laxton (2015) Benthic Communities Survey of Chain Valley Bay, Summerland Point and Crangan Bay, Lake Macquarie, NSW

Laxton and Laxton (2011) Seagrass Survey of Chain Valley Bay, Summerland Point and Crangan Bay, Lake Macquarie, NSW (Results for 2008, 2010, 2011)

Laxton and Laxton (2014) Seagrass Survey of Chain Valley Bay, Summerland Point and Crangan Bay, Lake Macquarie, NSW (Results for 2008, 2010, 20112012, 2013, 2014)

NSW Scientific Committee - final determination (2011) Alteration of habitat following subsidence due to longwall mining key threatening process listing http://www.environment.nsw.gov.au/determinations/LongwallMiningKtp.htm

Regards,

Jemma Sargent
Director
JSA Environmental

Appendix G

Mine subsidence impacts on wave climate

Appendix G— Mine subsidence impacts on wave climate

G

26 May 2015

WRL Ref: WRL2015023 CDD JTC LR20150526

Mr John Arnold
Senior Environmental Planner
EMM
20 Chandos Street
St Leonards NSW 2065

Email: jarnold@emgamm.com

UNSW AUSTRALIA

Water Research Laboratory

Dear John,

Mine Subsidence Impacts on Wave Climate in Lake Macquarie

1. Introduction

The Water Research Laboratory (WRL) of the School of Civil and Environmental Engineering at UNSW Australia provided advice in relation to the Chain Valley Colliery Mine Extension Project environmental impact statement (EMM 2012) prepared for SSD_5465 regarding potential impacts of proposed mine subsidence on the wave climate and associated foreshore erosion and recession within Lake Macquarie. WRL is pleased to provide further updated advice in relation to the proposed modification.

Chain Valley Colliery (CVC) is an underground coal mine located at the southern end of Lake Macquarie. CVC is operated by LakeCoal Pty Limited (LakeCoal). EMM have advised WRL that underground mining has occurred at CVC since 1962, with coal extraction undertaken using a combination of bord and pillar and miniwall mining methods. CVC has extracted coal from three seams – the Wallarah Seam, the Great Northern Seam and the Fassifern Seam, with current activities restricted to the Fassifern Seam to extract up to 45 miniwalls under State Significant Development consent SSD_5465.

LakeCoal is seeking an approval under Section 96(2) of the *Environmental Planning and Assessment Act 1979* (EP&A Act) to modify the mining layout by reducing the number of previously proposed miniwalls from 45 to 36 through mine design changes, primarily the re-orientation of miniwall panels in CVC's northern mining area (the proposed modification). The revised miniwall layout and associated subsidence predictions are shown on Figure 2.

The following impacts of the latest future subsidence estimates on processes and features from the proposed modification have been assessed within the study site:

1. Wave climate and wave transformation;
2. The cross shore profile (closure depth, Bruun Rule); and
3. Changes to the tidal prism as a result of the expected subsidence.

The findings of this letter report are based on a desktop study with supporting calculations of the above processes.

2. Study Area

Lake Macquarie is a large coastal lake system located between Sydney and Newcastle on the NSW Central Coast and is connected to the ocean via Swansea Channel (Figure 1). The Lake covers 110 km^2, has an average water depth of 8 to 9 m and has a typical water level of 0.1m AHD (Australian Height Datum approximately equal to mean sea level). The typical tidal range of the ocean of ±0.5 m is reduced to a typical range of ±0.05 m within the lake system (WMA Water, 2012). Specifically, this letter report is focussed on the Chain Valley Bay area located in the south-western area of Lake Macquarie, with consideration of subsidence in the vicinity of Bardens Bay and Sugar Bay.

Predicted worst case subsidence in the vicinity of Bardens Bay and Sugar Bay is generally less than 0.7 m, while for Chain Valley Bay it is up to 1.2 m due to multiseam effects (Figure 2) (Ditton Geotechnical Services, 2015).

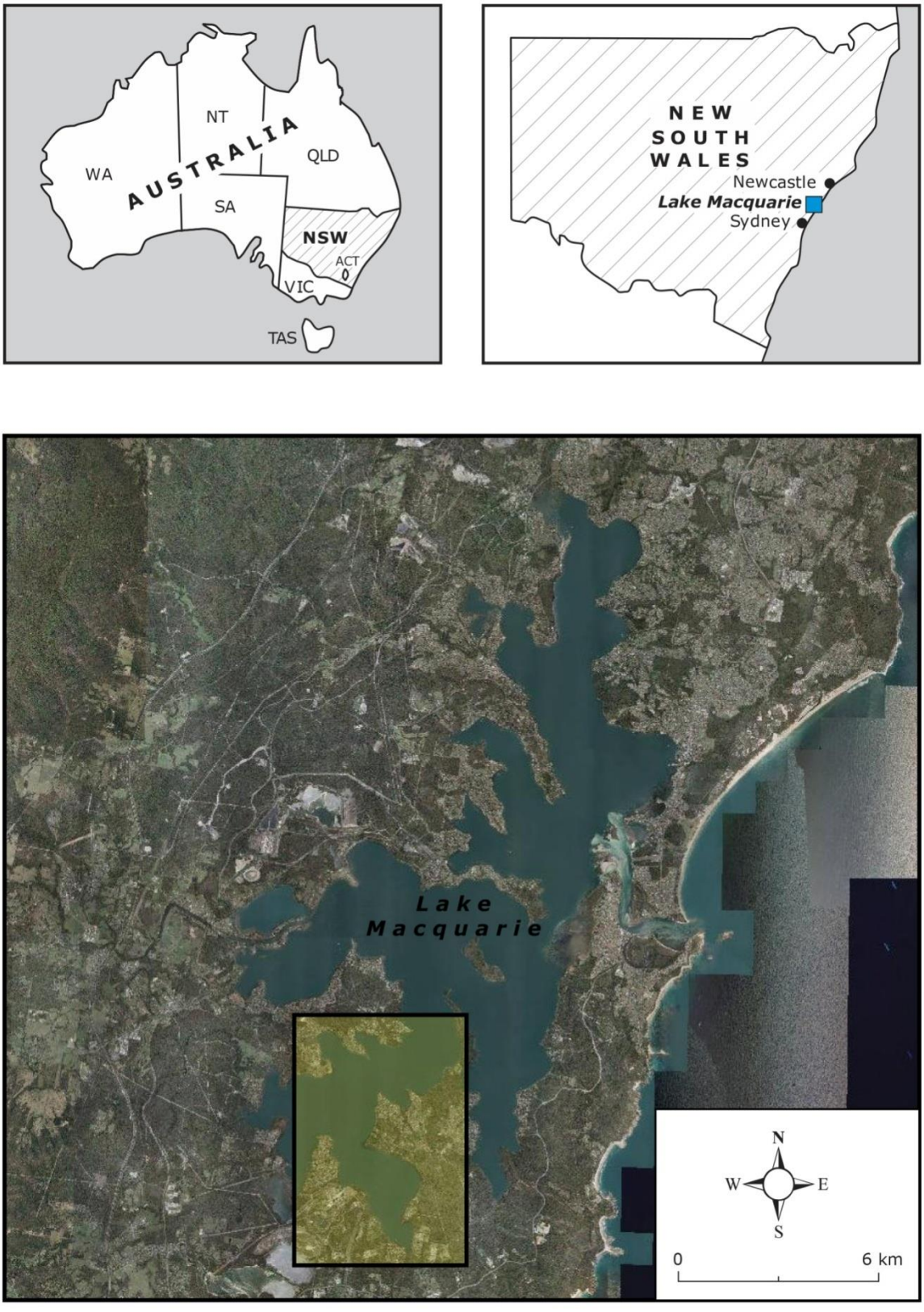


Figure 1: Study Location

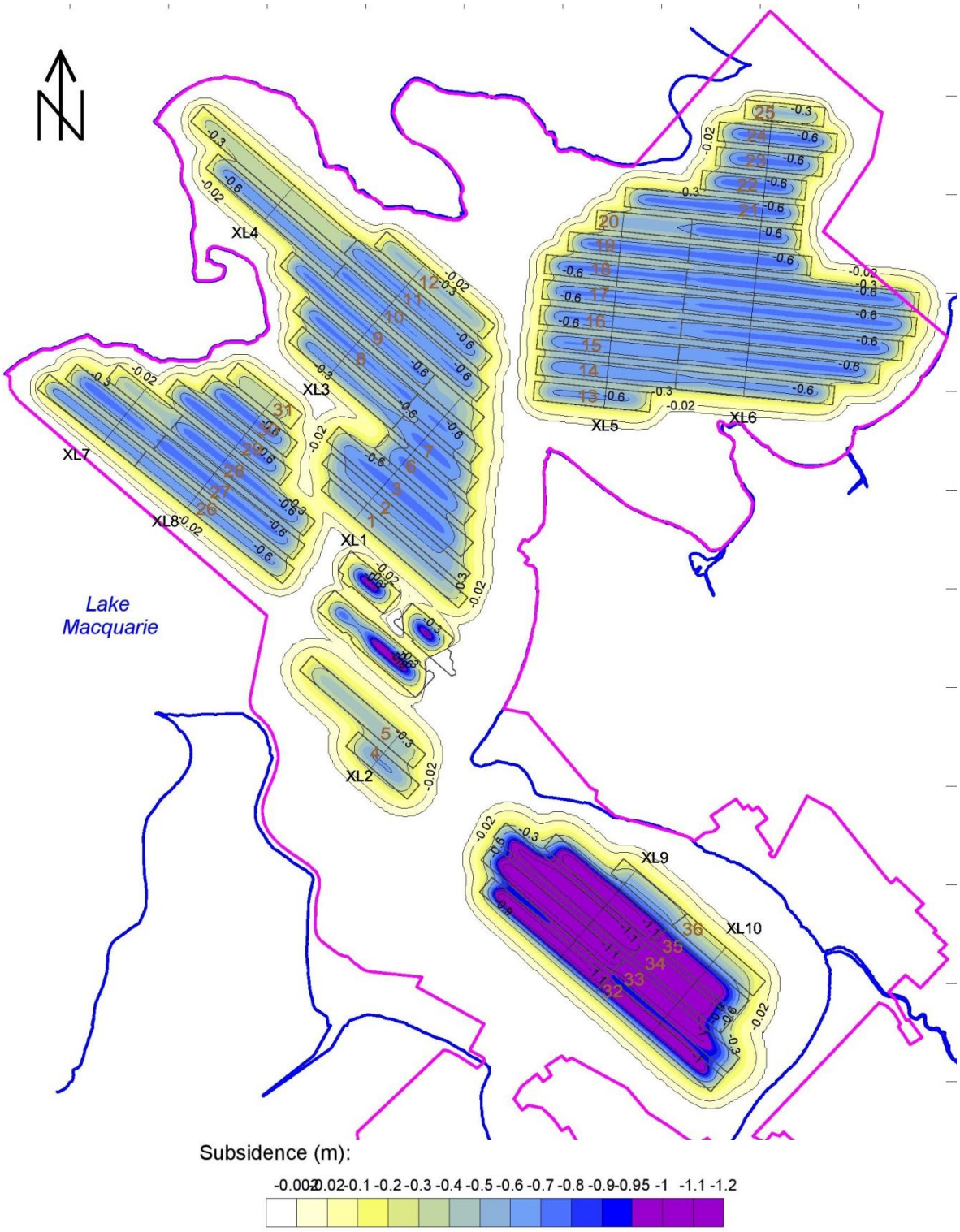


Figure 2: Predicted worst-case cumulative subsidence contours above proposed miniwall layout with multi-seam mining effects (Ditton Geotechnical Services, 2015)

3. Saltmarsh

Areas of saltmarsh have been identified in the foreshore area surrounding the predicted mining subsidence area (Figure 3). The wave climate analysis has focussed on the Chain Valley Bay area as this region has the most saltmarsh and has the largest expected future subsidence. Therefore, the assessment in this letter report regarding changes to wave climate is conservative. That is, actual impacts are likely to be less than those derived in this report due to the conservative assumptions adopted.

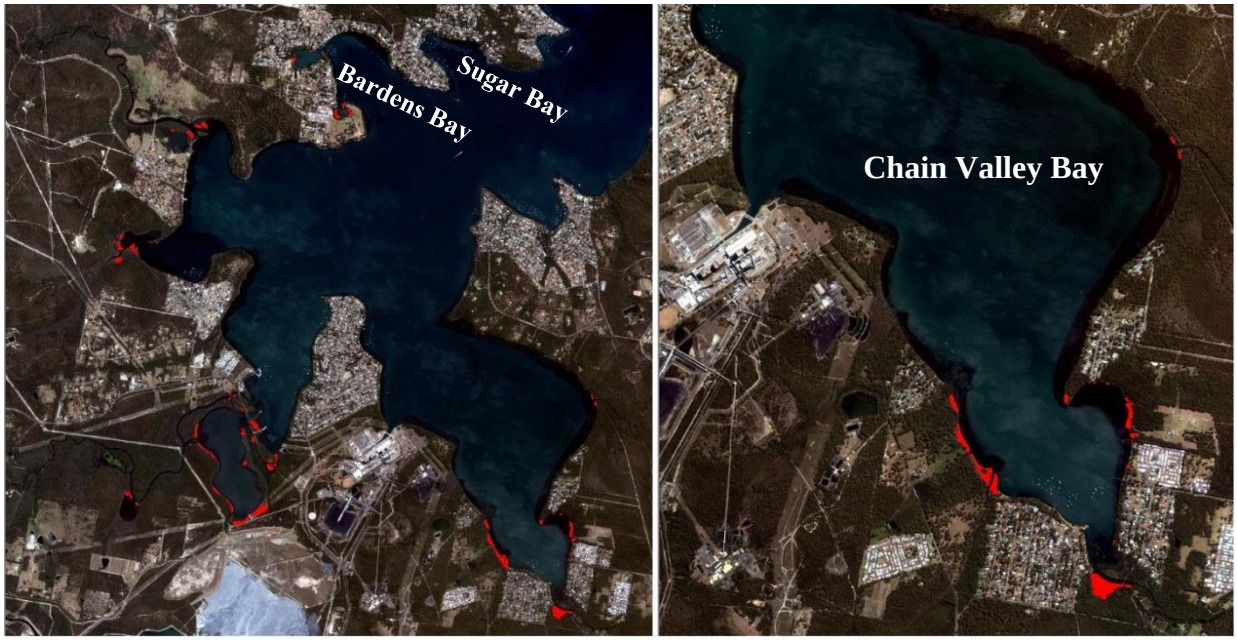


Figure 3: Saltmarsh Mapping (red) in Chain Valley Bay area (Source: Creese *et al*., 2009)

4. Wave Climate

4.1 Factors Affecting Wave Climate

Waves in the subject area of Lake Macquarie are generated by local winds only - ocean swells do not penetrate to the subject area. Wave conditions are determined by the wind speed, the wind duration and the *fetch*, which is the length of water over which the wind blows. The limited fetch lengths of Lake Macquarie mean that wave heights will be far smaller than those encountered on open coasts.

4.2 Fetch Lengths

Wind wave fetches were defined for two locations shown in Figure 4. As described in the Shore Protection Manual (SPM, 1984, p 3-42), due to the irregular shoreline, the fetch for each primary direction was defined by using nine separate radials spaced at 3 degrees (centred on the primary direction) which were then averaged to define the average fetch length shown in Table 1.

Table 1: Primary Fetch Lengths

Site	Average Fetch Length (km) *	Fetch Direction
A	3.2	NW
B	4.3	SW

*Averaged over nine separate 3 degree radials

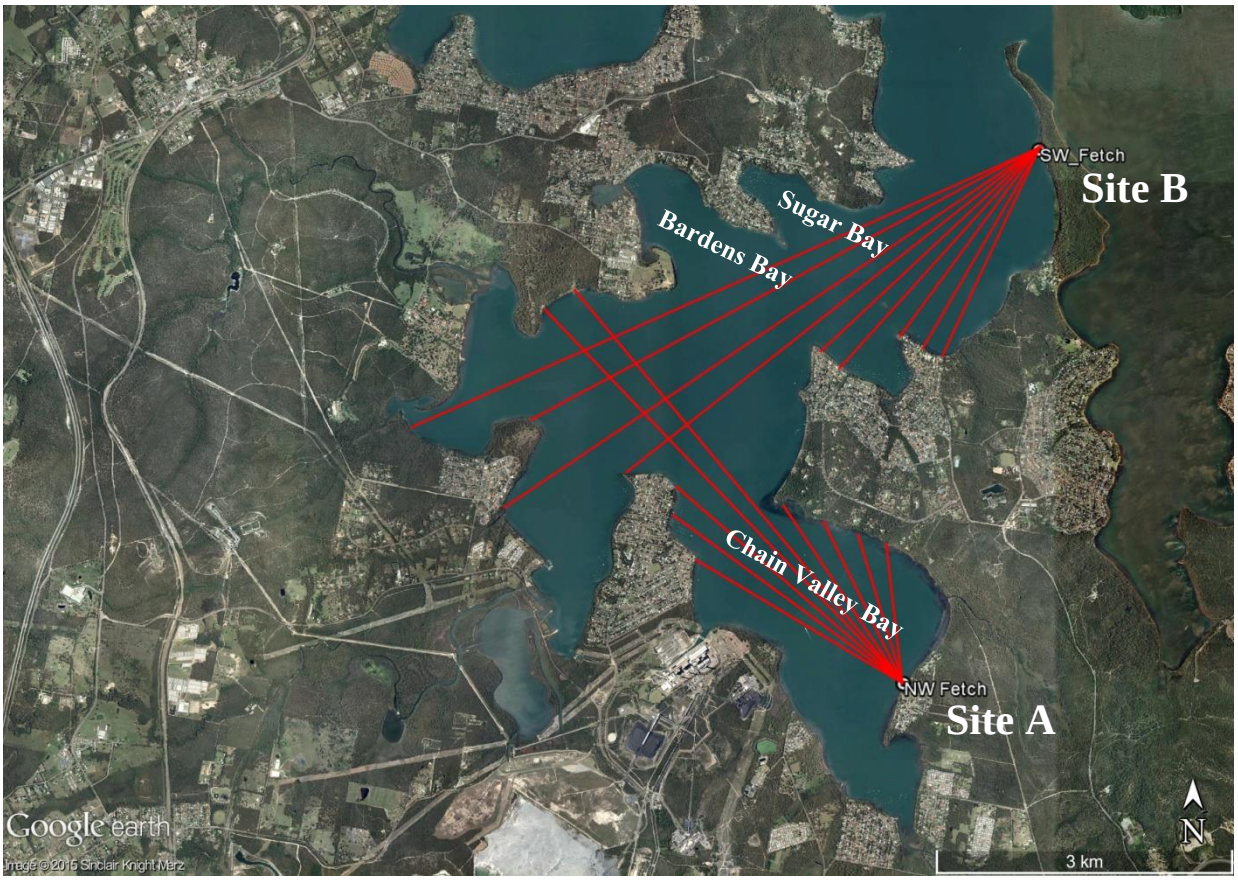


Figure 4: North West and South West Wind Wave Fetch Locations

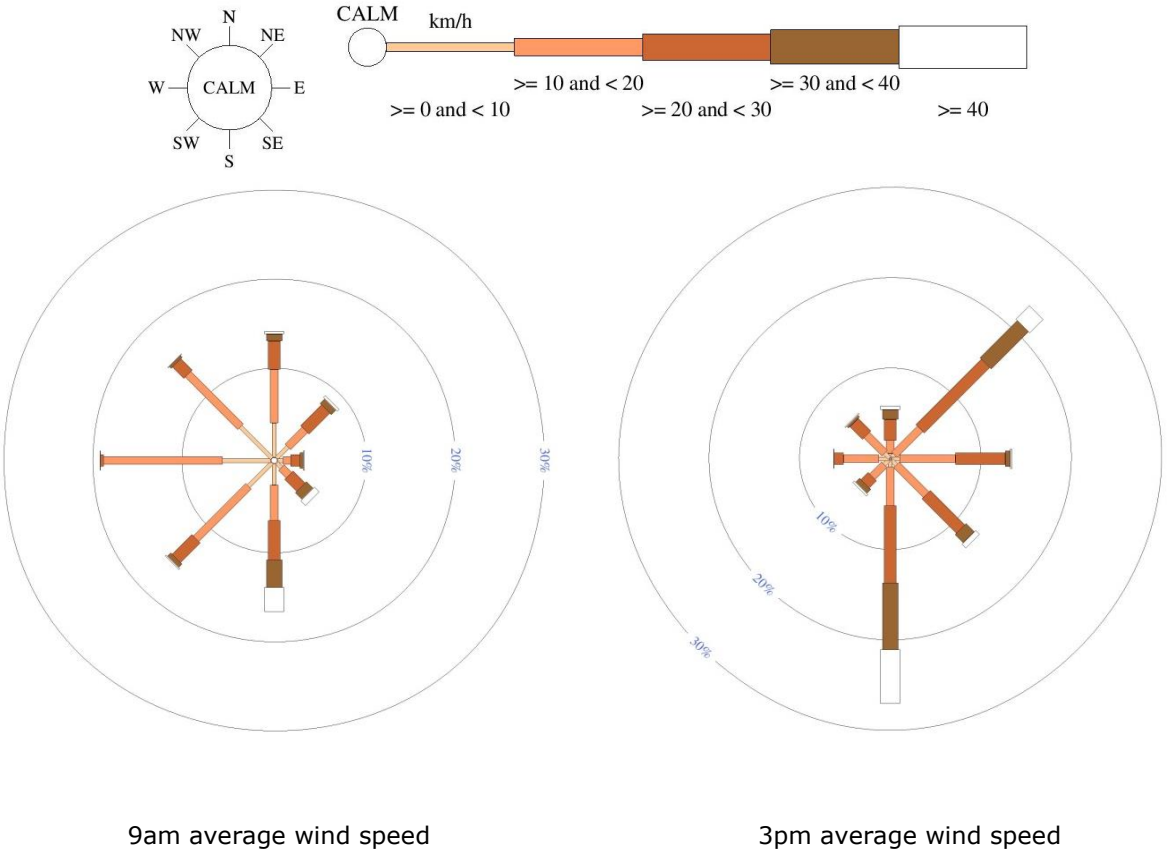
4.3 Design Wind Speeds

Regional design extreme wind speed information is available from Australian/New Zealand Standard AS/NZS 1170.2:2011 as well as recorded wind speed data from the nearby Norah Head weather station. Both these sources of data have been investigated to analyse design wind speeds. Norah Head Lighthouse is situated on the coastline approximately 15 km to the south of Chain Valley Bay

and has been operated by the Bureau of Meteorology as a weather station since 1995. Relevant wind data from this station is summarised in Table 2 and Figure 5. The location of the Norah Head Station exposes it to predominately NE to S winds while it is more sheltered in W winds.

Table 2: Norah Head Lighthouse Wind Data Summary (1995- present)

Parameter	Recorded at 9 am	Recorded at 3 pm
Mean wind speed (averaged over 10 mins)	17 km/hr; 9 knots	25 km/hr; 13 knots
Dominant wind directions	S, SW	S, NE
Maximum wind gust speed ever recorded (5th March 2007)	146 km/hr 79 knots	



9am average wind speed

3pm average wind speed

Figure 5: Wind rose data for Norah Head using data from 1 Feb 1995 to 30 Sep 2010 (BOM, 2014)

Extreme wind speed design presented in AS/NZS 1170.2:2011 provides a regional wind gust speed for the eastern fringe of NSW and is likely to calculate higher wind speeds than the Norah Head data as it uses conservative assumptions to cover a wide region. In this study, the Australian/New Zealand Standard has been used to provide an initial, conservative analysis. The extreme (0.2 second gust) wind speeds for the east coast of Australia from AS/NZS 1170.2:2011 are shown in Table 3. Directional information on wind speeds is given for the east coast of NSW in AS/NZS1170.2:2011, which indicates that the strongest design winds come from the west followed

by north-west, south-west and south-east. It should be noted that the wind direction data provided by the Norah Head station shows more exposure to easterly and southerly winds as well as being shielded from westerly winds due to its site location. This study has focused on two fetch orientations involving winds from the north-west and south west as these directions coincide with large fetch lengths over areas of maximum predicted mine subsidence. For terrain category 1.5 (AS/NZS 1170.2:2011) and a design local elevation of 10 m (used as input into wave equations), these wind speeds are adjusted by a factor of 1.06 in accordance with the standard for winds over water (Terrain Category 1.5). The equivalent average wind speed for other durations was calculated as per SPM (1984) Figure 3-13. An iterative process found that for the SW fetch and NW fetch, for the 1, 10 and 100 year ARI events, the duration limitation is approximately 30 to 40 minutes. Ambient wind speeds less than a 1 year ARI were also investigated (Table 4). Ambient and more extreme conditions were also assessed for 10 minute duration wind speeds of 5, 10, 20, 30 and 40 knots. The ambient wind speed analysis was also undertaken with a duration limitation of 30 minutes which is a more conservative assumption.

Table 3: Extreme Wind Velocities for Different Durations

ARI	U,0.2 s duration	U, 30 min duration
(years)	(m/s)	(m/s)
1	30.2	27.3
10	34.7	32.4
100	41.4 (80 knots)	40.4 (78 knots)

Table 4: Ambient Wind Velocities for Different Durations

ARI	Wind Speed, 10 min duration		U, 0.2 s duration	U, 30 min duration
(years)	(knots)	(m/s)	(m/s)	(m/s)
< 1	5	2.6	2.1	2.4
< 1	10	5.1	5.0	4.9
< 1	20	10.3	11.7	9.8
< 1	30	15.4	19.4	14.7
< 1	40	20.6	27.7	19.6

4.4 Wind Wave Conditions

The US Army Coastal Engineering Manual (CEM 1110-2-1100, 2002, p II-2-45) recommends that the deepwater wave forecasting equations be used even in relatively shallow water, provided that the wave period does not exceed a limiting value (7 s for 5 m water depths). The estimated design significant wave heights (H_S) and spectral peak wave periods (T_p) for the 3.2 km NW fetch for ambient and extreme conditions are shown in Table 6. The T_p values are less than the 7 s limit and therefore the deep water equations can be used.

Table 5: Calculated Wave Conditions for SW fetch (4.3 km)

Wind Condition	Wind Condition	U_A (m/s), 30 min duration	Hs (m)	Tp (s)
Ambient	5 knots (10 min duration)	2.1	0.1	1.3
	10 knots (10 min duration)	5.0	0.2	1.7
	20 knots (10 min duration)	11.7	0.4	2.3
Extreme	30 knots (10 min duration)	19.4	0.7	2.7
	40 knots (10 min duration)	27.7	0.9	3.1
	1 ARI	27.2	0.90	3.03
	10 ARI	32.3	1.07	3.21
	100 ARI	40.2	1.34	3.46

Table 6: Calculated Wave Conditions for NW fetch (3.2 km)

Wind Condition	Wind Condition	U_A (m/s), 30 min duration	Hs (m)	Tp (s)
Ambient	5 knots (10 min duration)	2.1	0.1	1.2
	10 knots (10 min duration)	5.0	0.1	1.6
	20 knots (10 min duration)	11.8	0.3	2.1
Extreme	30 knots (10 min duration)	19.5	0.6	2.5
	40 knots (10 min duration)	27.8	0.8	2.8
	1 ARI	27.3	0.8	2.8
	10 ARI	32.4	0.9	2.9
	100 ARI	40.4	1.2	3.2

4.5 Wave Classifications

A wave is classified as being a deep water wave if its water depth (d) is greater than half its wavelength (L) (i.e. d>$L/2$). A deep water wave does not "feel" the bottom of the lake or sea that it is travelling through (Figure 6) and therefore does not refract or shoal.

As deep water waves propagate into shallower water depths (d<L/2), the waves begin to interact with the lake bottom by slowing down and increasing wave heights in a process called shoaling. In these shallower water depths, waves can be defined as transitional water waves (L/20<d<L/2) and shallow water waves (d<L/20). Transitional water waves are affected by the bottom and will refract but to a lesser degree than shallow water waves.

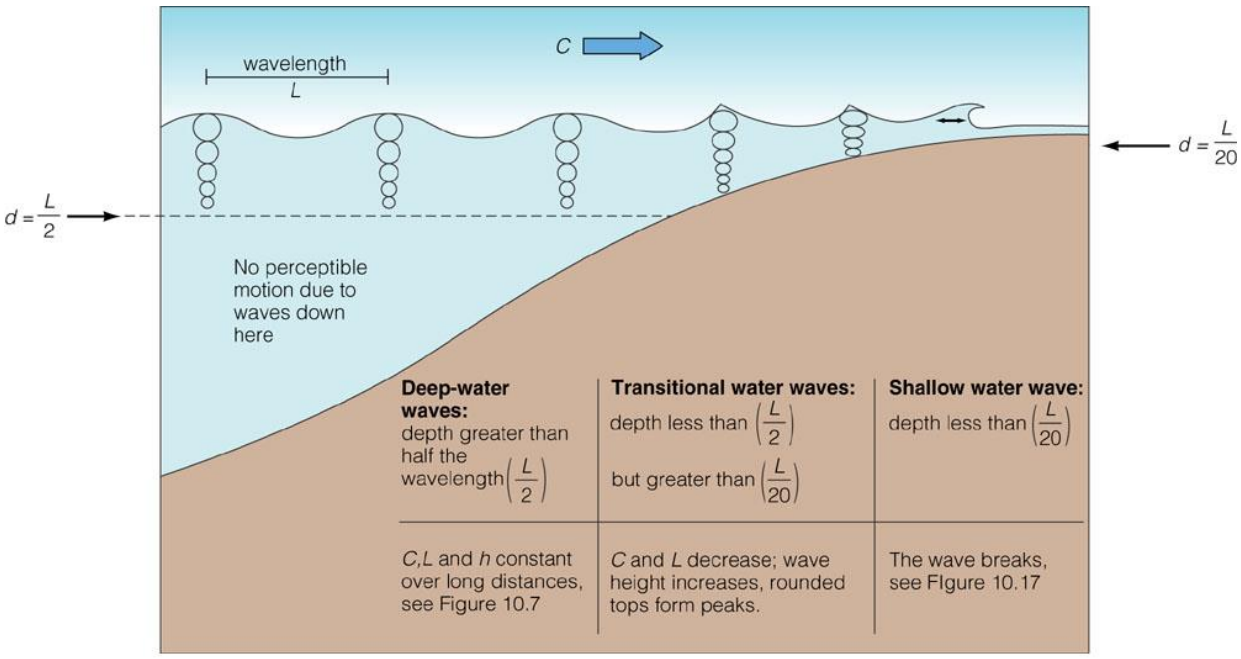


Figure 6: Wave types (Source: Brooks/Cole-Thomson, 2005)

4.6 Typical Section

North-west (NW) and south-west (SW) longitudinal bathymetric profiles of the site showing the original and subsided profile are presented in Figure 7 and Figure 8. These sections were derived from the following information:

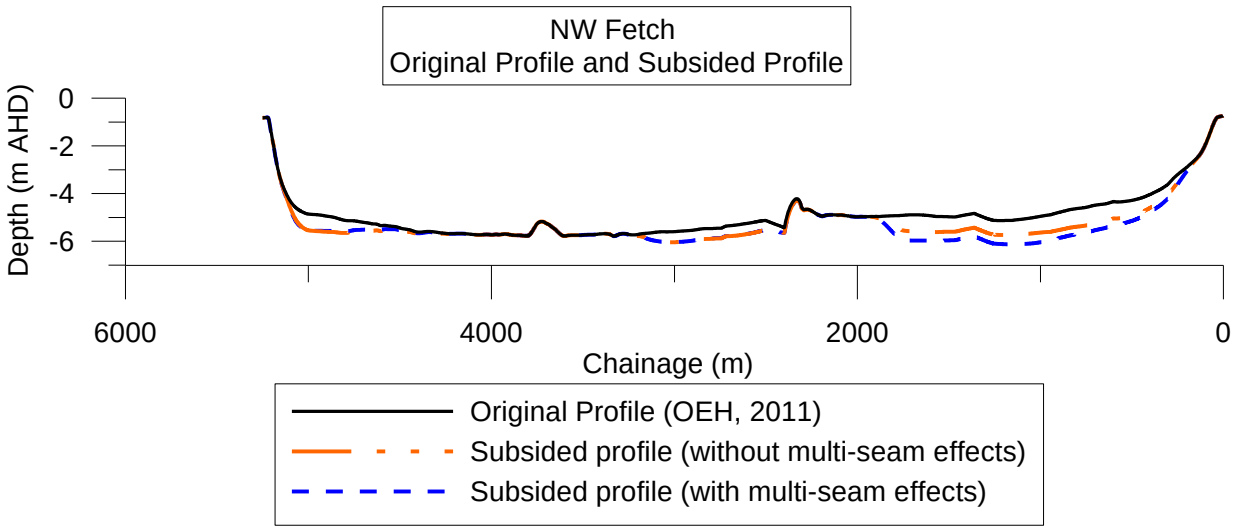
- OEH bathymetry data using DGPS and 200 kHz echosounder, dated 2011, accuracy 0.1 m;
- Ditton Geotechnical Services Figure No. 26.1, dated 15.05.15: Predicted incremental Subsidence contours above the Modified Mine Layout without multi-seam mining effects above MWs 32-36; and
- Ditton Geotechnical Services Figure No. 27.1, dated 15.05.15: Predicted worst-case cumulative subsidence contours above the Modified Mine Layout with multi-seam mining effects included above MWs 32-36 (reproduced in Figure 2).

4.7 Effect of Predicted Subsidence on Waves

The predicted subsidence will have no impact on the incident wind climate of the study area, and therefore no impact on the total energy input into the wind wave system. The analysis below considers whether the altered water depths would alter the dissipation of wind wave energy within the system. An analysis of the impact of subsidence on the wind wave climate calculated in Section 4.4 for Chain Valley Bay is shown in Table 7 and Table 8 for the NW fetch, and for the SW fetch in Table 9 and Table 10. Locations for the analysed points are shown in Figure 7 and Figure 8. Note that total water depth values have assumed a mean lake level of 0.1 m AHD. Waves have been characterised as being either deep, transitional or shallow water using a Padé approximation after Hunt (1979) to calculate the local wavelength.

4.7.1 North West Fetch

Latest worst case subsidence estimates along the NW fetch show typical subsidence of 0.4 m with extreme subsidence of 1.0 m in Chain Valley Bay (Figure 7) where original bed levels were -3 to -5 m AHD. The short wind fetches associated a NW orientation leads to short wind waves with spectral wave periods (Tp) of 1 to 3 s. For the NW fetch with the maximum worst case subsidence, the majority of waves are deepwater waves in subsided areas for ambient wind conditions up to 11.8 m/s (30 min duration). Deepwater waves by definition will not "feel" the bottom. Waves generated by wind speeds greater than 11.8 m/s winds (30 min duration) for the subject fetch are classed as transitional and will begin to interact with the lake bottom. These waves will also respond to changes of the lake bed due to subsidence by increasing slightly in velocity and decreasing in height, however, these wind conditions occur infrequently (less than once per year) and so will have minimal expected impact on the area. The percentage increase in velocity due to deepening is also shown in Table 7 and Table 8. Note that these increases would return to the existing values in shallow water. Note also that for 100 year ARI conditions, the maximum velocity increase is 2.7%. Detailed numerical wave modelling (such as SWAN) would be required to further quantify this process.



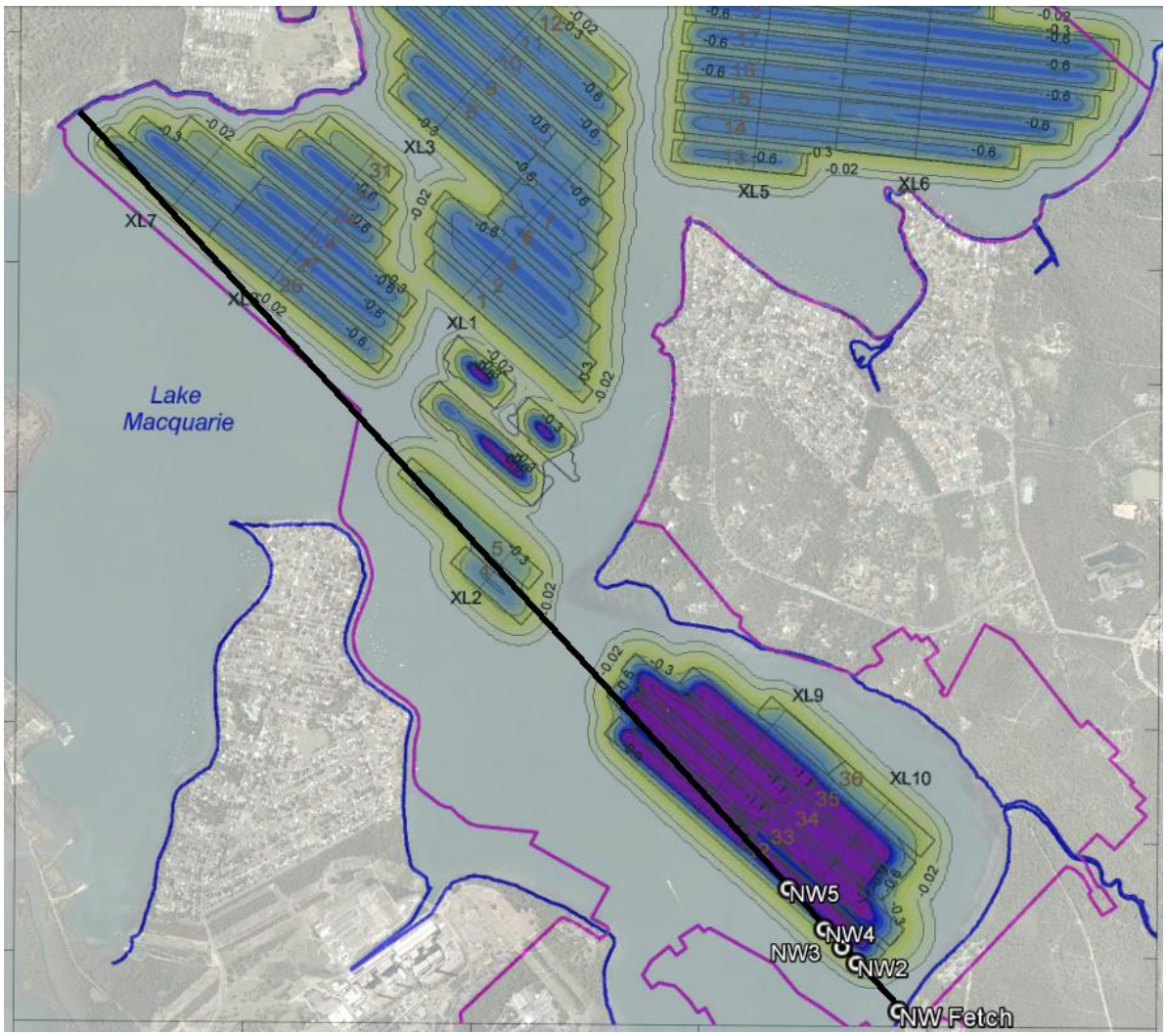


Figure 7 NW long section showing original and subsided profile overlayed on DGS Figure 27.1: Predicted worst-case cumulative subsidence contours including multi-seam effects.

Table 7: Wave Analysis for NW fetch with Ambient Conditions

Point	Original Bed Level	Subsidence	Water Depth	U, 30 min duration	Tp	Hso	Wave type	Change in velocity
	m AHD	m	m	m/s	s	m		%
NW-2	3.15	0	3.25	2.1	1.2	0.1	Deepwater	
		-0.3	3.55				Deepwater	0.0
		0	3.25	5.0	1.6	0.1	Deepwater	
		-0.3	3.55				Deepwater	0.0
		0	3.25	11.8	2.1	0.3	Transitional	
		-0.3	3.55				Deepwater	0.2
		0	3.25	19.5	2.5	0.6	Transitional	
		-0.3	3.55				Transitional	0.8
		0	3.25	27.8	2.8	0.8	Transitional	
		-0.3	3.55				Transitional	1.4
NW-3	4.02	0	3.75	2.1	1.2	0.1	Deepwater	
		-0.6	4.35				Deepwater	0.0
		0	3.75	5.0	1.6	0.1	Deepwater	
		-0.6	4.35				Deepwater	0.0
		0	3.75	11.8	2.1	0.3	Deepwater	
		-0.6	4.35				Deepwater	0.2
		0	3.75	19.5	2.5	0.6	Transitional	
		-0.6	4.35				Transitional	0.7
		0	3.75	27.8	2.8	0.8	Transitional	
		-0.6	4.35				Transitional	1.6
NW-4	4.3	0	4.29	2.1	1.2	0.1	Deepwater	
		-0.8	5.09				Deepwater	0.0
		0	4.29	5.0	1.6	0.1	Deepwater	
		-0.8	5.09				Deepwater	0.0
		0	4.29	11.8	2.1	0.3	Deepwater	
		-0.8	5.09				Deepwater	0.1
		0	4.29	19.5	2.5	0.6	Transitional	
		-0.8	5.09				Deepwater	0.4
		0	4.29	27.8	2.8	0.8	Transitional	
		-0.8	5.09				Transitional	1.1
NW-5	4.54	0	4.29	2.1	1.2	0.1	Deepwater	
		-1.0	5.29				Deepwater	0.0
		0	4.29	5.0	1.6	0.1	Deepwater	
		-1.0	5.29				Deepwater	0.0
		0	4.29	11.8	2.1	0.3	Deepwater	
		-1.0	5.29				Deepwater	0.1
		0	4.29	19.5	2.5	0.6	Transitional	
		-1.0	5.29				Deepwater	0.5
		0	4.29	27.8	2.8	0.8	Transitional	
		-1.0	5.29				Transitional	1.3

Table 8: Wave Analysis for NW fetch with Extreme Conditions

Point	Original Bed Level	Subsidence	Water Depth	ARI	U, 30 min duration	Tp	Hso	Wave type	Change in velocity
	m AHD	m	m	Years	m/s	s	m		%
NW-2	3.15	0	3.25	1	27.3	2.8	0.8	Transitional	
		-0.3	3.55					Transitional	1.4
		0	3.25	10	32.4	2.9	0.9	Transitional	
		-0.3	3.55					Transitional	1.7
		0	3.25	100	40.4	3.2	1.2	Transitional	
		-0.3	3.55					Transitional	2.1
NW-3	3.65	0	3.75	1	27.3	2.8	0.8	Transitional	
		-0.6	4.35					Transitional	1.5
		0	3.75	10	32.4	2.9	0.9	Transitional	
		-0.6	4.35					Transitional	2.0
		0	3.75	100	40.4	3.2	1.2	Transitional	
		-0.6	4.35					Transitional	2.7
NW-4	4.19	0	4.29	1	27.3	2.8	0.8	Transitional	
		-0.8	5.09					Transitional	1.1
		0	4.29	10	32.4	2.9	0.9	Transitional	
		-0.8	5.09					Transitional	1.6
		0	4.29	100	40.4	3.2	1.2	Transitional	
		-0.8	5.09					Transitional	2.3
NW-5	4.42	0	4.29	1	27.3	2.8	0.8	Transitional	
		-1.0	5.29					Transitional	1.2
		0	4.29	10	32.4	2.9	0.9	Transitional	
		-1.0	5.29					Transitional	1.8
		0	4.29	100	40.4	3.2	1.2	Transitional	
		-1.0	5.29					Transitional	2.7

4.7.2 South West Fetch

Latest future subsidence estimates along the SW fetch show a typical subsidence of 0.3 m with extreme subsidence of 0.8 m in CVC's northern mining area (Figure 7) where original bed levels were -4 to -8 m AHD. The short wind fetches associated a SW orientation leads to short wind waves with spectral wave periods (Tp) of 1 to 3 s. For the SW fetch with the maximum worst case subsidence, the majority of all waves generated by ambient winds up to 19.4 m/s (30 min duration) are classified as deepwater waves. Deepwater waves by definition will not "feel" the bottom. Waves generated by wind speeds greater than 19.4 m/s winds (30 min duration) for the subject fetch are classed as transitional and will begin to interact with the lake bottom. These waves will also respond to changes of the lake bed due to subsidence by increasing slightly in velocity and decreasing in height, however, these wind conditions occur infrequently (less than once per year) and so will have minimal expected impact on the area. The percentage increase in velocity due to deepening is also shown in Table 9 and Table 10. Note that these increases would return to the existing values in shallow water. Note that for 100 year ARI conditions, the maximum velocity increase is 0.8%. Detailed numerical wave modelling (such as SWAN) would be required to further quantify this process.

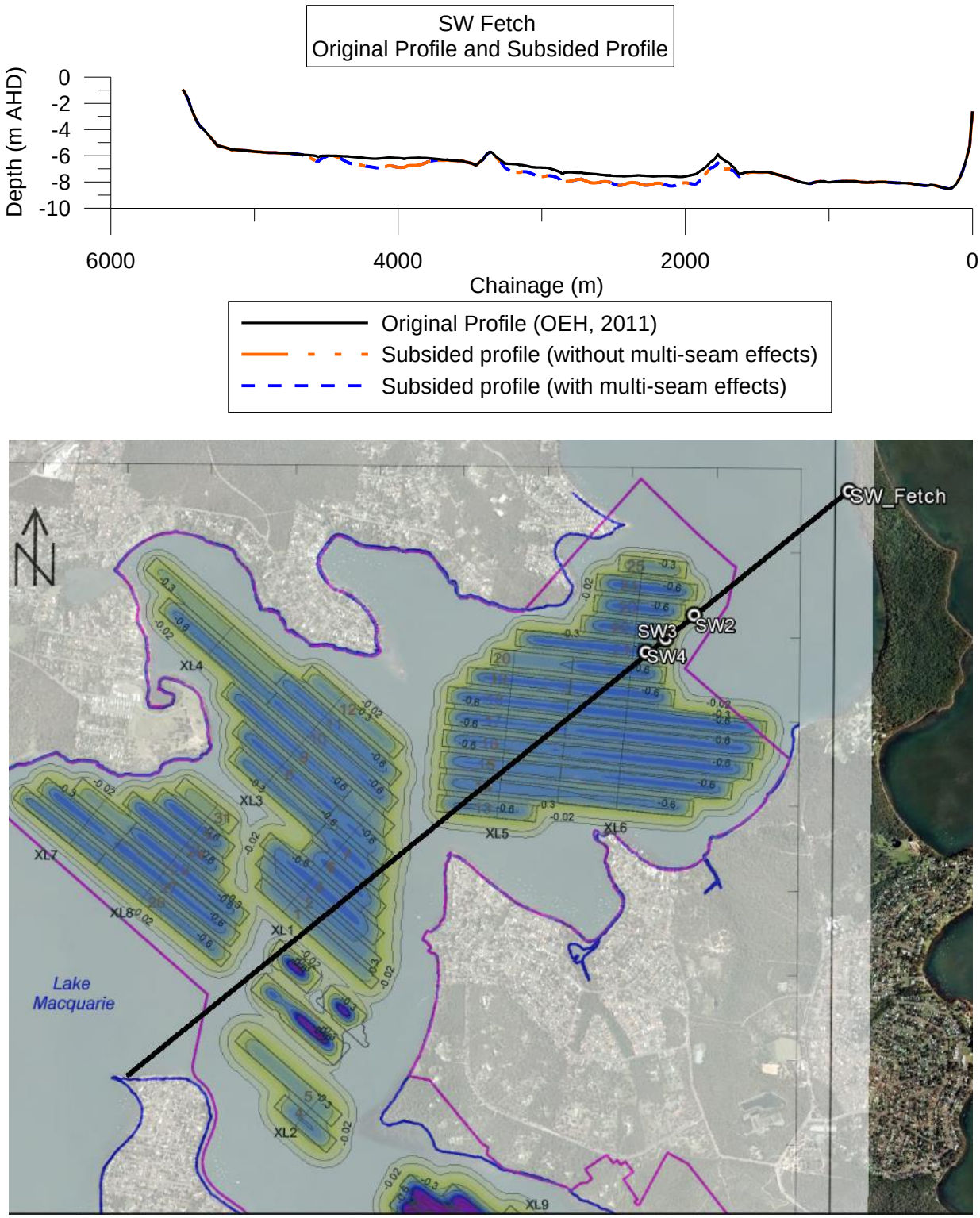


Figure 8: SW Long section showing original and subsided profile overlayed on DGS Figure 27.1: Predicted worst-case cumulative subsidence contours including multi-seam effects.

Table 9: Wave Analysis for SW fetch with Ambient Conditions

Point	Original Bed Level	Subsidence	Water Depth	U, 30 min duration	Tp	Hso	Wave type	Change in velocity
	m AHD	m	m	m/s	s	m		%
SW-2	6.9	0	7.00	2.1	1.3	0.1	Deepwater	
		-0.3	7.30				Deepwater	0.0
		0	7.00	5.0	1.7	0.2	Deepwater	
		-0.3	7.30				Deepwater	0.0
		0	7.00	11.7	2.3	0.4	Deepwater	
		-0.3	7.30				Deepwater	0.0
		0	7.00	19.4	2.7	0.7	Deepwater	
		-0.3	7.30				Deepwater	0.0
		0	7.00	27.7	3.1	0.9	Transitional	
		-0.3	7.30				Transitional	0.1
SW-3	6.53	0	6.63	2.1	1.3	0.1	Deepwater	
		-0.5	7.13				Deepwater	0.0
		0	6.63	5.0	1.7	0.2	Deepwater	
		-0.5	7.13				Deepwater	0.0
		0	6.63	11.7	2.3	0.4	Deepwater	
		-0.5	7.13				Deepwater	0.0
		0	6.63	19.4	2.7	0.7	Deepwater	
		-0.5	7.13				Deepwater	0.1
		0	6.63	27.7	3.1	0.9	Transitional	
		-0.5	7.13				Transitional	0.2
SW-4	6.30	0	6.40	2.1	1.3	0.1	Deepwater	
		-0.7	7.10				Deepwater	0.0
		0	6.40	5.0	1.7	0.2	Deepwater	
		-0.7	7.10				Deepwater	0.0
		0	6.40	11.7	2.3	0.4	Deepwater	
		-0.7	7.10				Deepwater	0.0
		0	6.40	19.4	2.7	0.7	Deepwater	
		-0.7	7.10				Deepwater	0.1
		0	6.40	27.7	3.1	0.9	Transitional	
		-0.7	7.10				Transitional	0.3

Table 10: Wave Analysis for SW fetch with Extreme Conditions

Point	Original Bed Level	Subsidence	Water Depth	ARI	U, 30 min duration	Tp	Hso	Wave type	Change in velocity
	m AHD	m	m	Years	m/s	s	m		%
SW-2	6.90	0	7.00	1	27.2	3.0	0.9	Transitional	
		-0.3	7.30					Deepwater	0.1
		0	7.00	10	32.3	3.2	1.1	Transitional	
		-0.3	7.30					Transitional	0.2
		0	7.00	100	40.2	3.5	1.3	Transitional	
		-0.3	7.30					Transitional	0.3
SW-3	6.53	0	6.63	1	27.2	3.0	0.9	Transitional	
		-0.5	7.13					Transitional	0.2
		0	6.63	10	32.3	3.2	1.1	Transitional	
		-0.5	7.13					Transitional	0.3
		0	6.63	100	40.2	3.5	1.3	Transitional	
		-0.5	7.13					Transitional	0.5
SW-4	6.30	0	6.40	1	27.2	3.0	0.9	Transitional	
		-0.7	7.10					Transitional	0.3
		0	6.40	10	32.3	3.2	1.1	Transitional	
		-0.7	7.10					Transitional	0.5
		0	6.40	100	40.2	3.5	1.3	Transitional	
		-0.7	7.10					Transitional	0.8

4.7.3 Wave reflection

In some circumstances, waves may reflect off the side of dredged channels (which are similar to the subsidence in this study) and alter foreshore alignment. This process occurs predominantly with long period ocean swells in shallow water. As stated above, waves in the study area are short period and predominantly deepwater under ambient conditions. That is, they do not "feel" the bottom, so this is unlikely for the study area.

5. Cross Shore Profile

Like most estuaries, Lake Macquarie is slowly infilling with sediment. This comes from marine sources near the mouth, fluvial sources contributed by lake tributary catchments and urban runoff.

The impact of the subsidence on the cross shore profile was considered using two methods, namely:

- The eShorance model (Stephens, 2010); and
- The method of Hallermeier (1983).

The depth of closure is defined as the seaward limit of significant cross-shore sediment transport processes.

The eShorance model was developed specifically to consider the impacts of sea level rise on profile response in Lake Macquarie. It recommends that the slope of the nearshore profile be calculated by measuring the depth about 10 m from the shore. This would be a depth of less than 1 m near both fetch locations.

Hallermeier (1983) provides a method to define closure depths based on three profile zones, namely the littoral zone, buffer zone and offshore zone. This leads to an inner closure depth defined at the seaward limit of the littoral zone and an outer closure depth at the limit of the buffer zone. An initial estimate of the seaward extent of the littoral zone from the method of Hallermeier indicates a closure depth of about 1.3 m at Chain Valley Bay which is consistent with the value from eShorance.

Sediment is likely to be deposited in the subsided areas, but wave processes will not substantially erode sediment from the upper beach, since all areas predicted to encounter substantial subsidence are in water depths of more than 3 m.

Also shown in Figure 9 is a Dean Equilibrium beach profile (Dean, 1977) compared to the bathymetry along the NW fetch. The Dean profile is the typical equilibrium profile that would form under wave dominated conditions out to the depth of closure and is based on the water depth and sediment characteristics. It can be seen that the actual profile is flatter than the Dean equilibrium profile for the range of grain sizes considered which concurs with the eShorance closure depth of approximately 1 m.

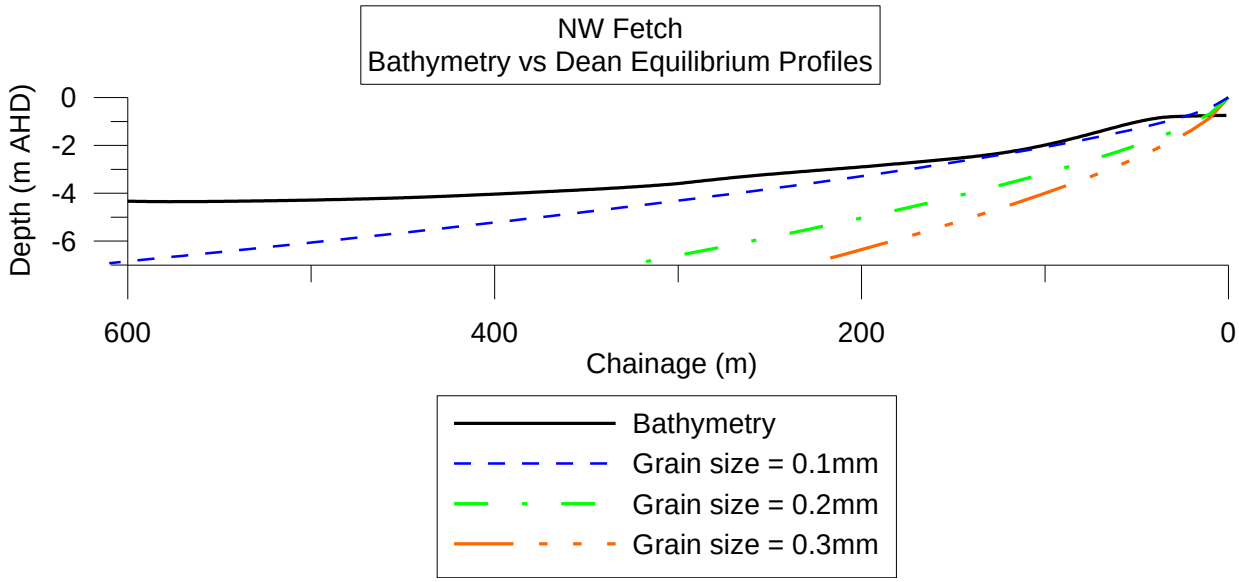


Figure 9: Bathymetry data compared to the Dean Equilibrium Profile (Dean, 1977)

6. Tidal Prism

The tidal prism is defined as the volume of water in an estuary between mean high tide and low tide (Luketina, 1998). Only the extent of intertidal land areas will alter the tidal prism. Subsidence occurring underwater in the Chain Valley Bay area will lead to an increase in the water volume stored in the lake, however, subsidence below the low tide level will not alter the tidal prism. The tidal range of the lake is ±0.05 m and the average water level is 0.1 m AHD meaning that land subsidence below 0.05 m AHD does not affect the tidal prism. All subsided areas are well below this level.

The tidal range in Lake Macquarie is determined by frictional losses through the entrance at Swansea Channel. Initial construction of the training walls was completed in 1887. These have enhanced the hydraulic efficiency of the entrance and promoted inlet scour which is still progressing.

Analysis by Watterson *et al.* (2010) indicates that the tidal range within Lake Macquarie is likely to double in approximately 80 years which is associated with a 225% larger tidal prism. This change is reported to be driven equally by projected sea level rise and continuation of inlet scour presently occurring in response to the entrance training walls. The magnitude of this increase on saltmarsh areas is likely to substantially outweigh any effects that may be caused by the proposed mining activity.

7. Summary

A desktop assessment using conservative techniques has been provided regarding the potential impacts of predicted mine subsidence on the wave climate and associated foreshore erosion and recession within Lake Macquarie. Two fetch orientations from the NW and SW have been considered in this assessment. The predicted subsidence around Chain Valley Bay will not affect the wave climate sufficiently to have adverse shoreline impacts. Ambient waves are small and have short periods, and therefore do not "feel" the bottom in the subsided areas. Under strong ambient wind conditions of 20 knots (10 min duration) through the NW fetch studied, wave velocities would increase by less than 0.2 % due to the proposed mining subsidence and would return to pre-subsidence values in shallower water close to shore.

Wind waves from the NW with a 1 year ARI would increase in velocity by up to 1.2% in the deeper portions of the Chain Valley Bay, and up to 2.7% in 100 year ARI conditions. Wind waves from the SW with a 100 year ARI would increase in velocity by up to 0.8%. These velocities would prevail for a very small proportion of the time and would return to pre-subsidence values in shallower water close to shore.

The predicted mine subsidence considered in this report would not alter the tidal prism within Lake Macquarie. Factors such as the increasing tidal range due to entrance scour, future management of the entrance and sea level rise are likely to be more important for the future viability of saltmarsh.

Please contact James Carley in the first instance on 02 80719800 should you require further information.

Yours sincerely,

G P Smith
Manager

References

Australian/New Zealand Standard AS/NZS 1170.2:2011, "Structural Design Actions Part 2: Wind Actions", Standards Australia

Bureau of Meteorology (2015), accessed on 28/04/2015 via <http://www.bom.gov.au/>

Brooks/Cole-Thomson (2005), accessed on 28/04/2015 via <http://science.kennesaw.edu/~jdirnber/oceanography/LecuturesOceanogr/LecWaves/1006.jpg>

Creese, R.G., Glasby T.M., West G. and Gallen C. (2009), Mapping the habitats of NSW estuaries. Industry & Investment NSW Fisheries Final Report Series 113. Port Stephens, NSW, Australia. ISSN 1837-2112. 95pp

Dean, R.G. (1977),. "Equilibrium Beach Profiles": U.S. Atlantic and Gulf Coasts. Department of Civil Engineering, Ocean Engineering Report No. 12. Newark, Delaware: University of Delaware 45pp

Hallermeier, R.J. (1983) "Sand Transport Limits in Coastal Structure Design". *Proceedings, Coastal Structures '83*. American Society of Civil Engineers, pp 703-716

Hunt, J. (1979), "Direct Solution of Wave Dispersion Equation," Journal of the Waterways, Port, Coastal and Ocean Division, No. WW4, AXE, pp 457-459.

Luketina, D. (1998), "Simple Tidal Prism Models Revisited". Estuarine, Coastal and Shelf Science; Vol. 46. pp. 77-84

Shore Protection Manual (SPM, 1984) US Army Corps of Engineers

Stephens, H. (2010), Estuarine Shoreline Response to Sea Level Rise, *Technical Report* for Lake Macquarie City Council

US Army Corps of Engineers (2002), *EM1110 Coastal Engineering Manual*

Watterson, E. Burston, J. Stevens, H. and Messiter, D. (2010), "The Hydraulic And Morphological Response of a Large Coastal Lake to Rising Sea Levels", Climate Change 2010: Practical Responses to Climate Change. Barton, A.C.T.: Engineers Australia, 2010: [97]-[109]

WMA water (2012)"Lake Macquarie Waterway Flood Study", report prepared for Lake Macquarie City Council

Appendix H

Assessment of significance

Appendix H — Assessment of significance

H

H.1 Threatened species habitat assessment

The likelihood of occurrence for each threatened species previously recorded within 10 km of the survey area was assessed against the criteria in Table H.1.

Table H.1 Assessment criteria

Likelihood	Description	Further assessment required?
Recorded	The species was observed in survey area.	Yes
High	It is highly likely that a species inhabits the survey area due to the presence of suitable habitat, and has been recorded recently in the surrounding area.	Yes
Moderate	Potential habitat is present in the survey area, although it has not been recorded recently in the survey area and surrounds. The species is unlikely to be dependent (ie. for breeding) on habitat within the survey area.	Yes
Low	It is unlikely that the species inhabits the survey area, and may be an occasional visitor. Habitat similar to the survey area is widely distributed in the local area, meaning that the species is not dependent (ie for breeding) on it.	No
None	Suitable habitat is absent from the survey area.	No

The results of the assessment are presented in Table H.2.

Table H.2 Threatened species recorded or with the potential to occur within 10 km of the survey area

Species	Source	Status		Habitat requirements	Likelihood of occurrence	Further assessment required?
		TSC Act	EPBC Act			
FLORA						
Biconvex Paperbark *Melaleuca biconvex*	PMST	V	V	Not recorded within a 10 km radius of the survey area. Biconvex Paperbark is only found in NSW, with scattered and dispersed populations found in the Jervis Bay area in the south and the Gosford-Wyong area in the north. Biconvex Paperbark generally grows in damp places, often near streams or low-lying areas on alluvial soils of low slopes or sheltered aspects. Flowering occurs over just 3-4 weeks in September and October. This species re-sprouts following fire.	Low	No
Black-eyed Susan *Tetratheca juncea*	NPWS Atlas	V	V	Several records from CVC (EMM unpublished data 2014) and within 10 km of the survey area. Black-eyed Susan is usually found in low open forest/woodland with a mixed shrub understorey and grassy groundcover. However, it has also been recorded in heathland and moist forest. The majority of populations occur on low nutrient soils associated with the Awaba Soil Landscape. While some studies show the species has a preference for cooler southerly aspects, it has been found on slopes with a variety of aspects. It generally prefers well-drained sites below 200m elevation and annual rainfall between 1000 - 1200mm. The preferred substrates are sandy skeletal soil on sandstone, sandy-loam soils, low nutrients; and clayey soil from conglomerates, pH neutral. It usually spreads via underground stems which can be up to 50 cm long. Consequently, individual plants may be difficult to identify. It also reproduces sexually but this requires insect pollination. Large populations of this species are particularly important.	**High**	**Yes**
Bynoe's Wattle *Acacia bynoeana*	NPWS Atlas	E	V	Several records within 10 km of the survey area. Occurs in heath or dry sclerophyll forest on sandy soils. Seems to prefer open, sometimes slightly disturbed sites such as trail margins, edges of roadside spoil mounds and in recently burnt patches. Associated overstorey species include Red Bloodwood, Scribbly Gum, Parramatta Red Gum, Saw Banksia and Narrow-leaved Apple.	Low	No

Table H.2 Threatened species recorded or with the potential to occur within 10 km of the survey area

Species	Source	Status		Habitat requirements	Likelihood of occurrence	Further assessment required?
		TSC Act	EPBC Act			
Camfield's Stringybark *Eucalyptus camfieldii*	PMST	V	V	Not known from within 10 km of the survey area. Occurs in poor coastal country in shallow sandy soils overlying Hawkesbury sandstone. Coastal heath mostly on exposed sandy ridges. Occurs mostly in small scattered stands near the boundary of tall coastal heaths and low open woodland of the slightly more fertile inland areas. Associated species frequently include stunted species of Narrow-leaved Stringybark (*E. oblonga*), Brown Stringybark (*E. capitellata*) and Scribbly Gum (*E. haemastoma*). Population sizes are difficult to estimate because its extensive lignotubers may be 20 m across. A number of stems arise from these lignotubers giving the impression of individual plants. Flowering period is irregular, flowers recorded throughout the year. Poor response to too frequent fires.	Low	No
Charmhaven Apple *Angophora inopina*	NPWS Atlas	V	V	Several records within 10 km of the survey area. This species is a member of the *A. bakeri* complex. None of the related species are known from the same area as *A. inopina*, although A. bakeri does occur sporadically in the ranges to the west, and near Kurri Kurri. Occurs most frequently in four main vegetation communities: (i) *Eucalyptus haemastoma–Corymbia gummifera–Angophora inopina* woodland/forest; (ii) *Hakea teretifolia–Banksia oblongifolia* wet heath; (iii) *Eucalyptus resinifera–Melaleuca sieberi–Angophora inopina* sedge woodland; (iv) *Eucalyptus capitellata–Corymbia gummifera–Angophora inopina* woodland/forest. Ecological knowledge about this species is limited. Is lignotuberous, allowing vegetative growth to occur following disturbance. However, such vegetative reproduction may suppress the production of fruits/seeds, necessary for the recruitment of new individuals to a population, and the time between such disturbance and the onset of sexual reproduction is not known. Flowering appears to take place principally between mid-December and mid-January, but is generally poor and sporadic. Preliminary experiments indicate that neither pollination nor seed viability are limiting factors in the life cycle.	Low	No

Table H.2 Threatened species recorded or with the potential to occur within 10 km of the survey area

Species	Source	Status		Habitat requirements	Likelihood of occurrence	Further assessment required?
		TSC Act	EPBC Act			
Earp's Gum *Eucalyptus parramattensis* subsp. *decadens*	PMST	V	V	Not known from within 10 km of the survey area. There are two separate meta-populations of E. parramattensis subsp. decadens. The Kurri Kurri meta-population is bordered by Cessnock—Kurri Kurri in the north and Mulbring—Abedare in the south. It generally occupies deep, low-nutrient sands, often those subject to periodic inundation or where water tables are relatively high.It occurs in dry sclerophyll woodland with dry heath understorey. It also occurs as an emergent in dry or wet heathland. Often where this species occurs, it is a community dominant. In the Kurri Kurri area, *E. parramattensis* subsp. *decadens* is a characteristic species of 'Kurri Sand Swamp Woodland in the Sydney Basin Bioregion', an endangered ecological community under the TSC Act. This species flowers from November to January.	None	No
Heath Wrinklewort *Rutidosis heterogama*	PMST	V	V	Not known from within 10 km of the survey area. Grows in heath on sandy soils and moist areas in open forest, and has been recorded along disturbed roadsides.	Low	No
Illawarra Greenhood *Pterostylis gibbosa*	PMST	E	E	Not known from within 10 km of the survey area. All known populations grow in open forest or woodland, on flat or gently sloping land with poor drainage. In the Hunter region, the species grows in open woodland dominated by Narrow-leaved Ironbark (*E. crebra*), Forest Red Gum (*E. tereticornis*)and Black Cypress Pine (*Callitris endlicheri*). The Illawarra Greenhood is a deciduous orchid that is only visible above the ground between late summer and spring, and only when soil moisture levels can sustain its growth. The leaf rosette grows from an underground tuber in late summer, followed by the flower stem in winter. After a spring flowering, the plant begins to die back and seed capsules form (if pollination has taken place). As with many other greenhoods, male fungus gnats are believed to be the pollinator. The Illawarra Greenhood can survive occasional burning and grazing because of its capacity to reshoot from an underground tuber.	None	No

Table H.2 Threatened species recorded or with the potential to occur within 10 km of the survey area

Species	Source	Status		Habitat requirements	Likelihood of occurrence	Further assessment required?
		TSC Act	EPBC Act			
Leafless Tongue Orchid *Cryptostylis hunteriana*	NPWS Atlas	V	V	Several records from the Delta Electricity Perimeter Lands (EMM unpublished data 2014). The larger populations of these species typically occur in woodland dominated by Scribbly Gum (*Eucalyptus sclerophylla*), Silvertop Ash (*E. sieberi*), Red Bloodwood (*Corymbia gummifera*) and Black Sheoak (*Allocasuarina littoralis*); appears to prefer open areas in the understorey of this community and is often found in association with the Large Tongue Orchid (*C. subulata*) and the Tartan Tongue Orchid (*C. erecta*). Little is known about the ecology of the species; being leafless it is expected to have limited photosynthetic capability and probably depends upon a fungal associate to meet its nutritional requirements from either living or dead organic material. In addition to reproducing from seed, it is also capable of vegetative reproduction and thus forms colonies which can become more or less permanent at a site.	**High**	**Yes**
Magenta Lilly Pilly *Syzygium paniculatum*	NPWS Atlas	E	V	Two records within 10 km of the survey area. On the central coast, the Magenta Lilly Pilly occurs on gravels, sands, silts and clays in riverside gallery rainforests and remnant littoral rainforest communities.	None	No
Omeo's Storksbill *Pelargonium* sp. Striatellum	PMST	E	E	Not known from within 10 km of the survey area. Omeo's Storksbill has a specific habitat that is usually just above the high-water level of irregularly inundated or ephemeral lakes, in the transition zone between surrounding grasslands or pasture and the wetland or aquatic communities. It sometimes colonises exposed lake beds during dry periods. It occurs in habitats that are mostly or wholly included in the two Endangered Ecological Communities (EECs): 'Natural Temperate Grassland of the Southern Tablelands of NSW and the Australian Capital Territory' and 'Upland Wetlands of the New England Tablelands (New England Tableland Bioregion) and the Monaro Plateau (South Eastern Highlands Bioregion)', as listed under the EPBC Act.	None	No
Rough Doubletail *Diuris praecox*	NPWS Atlas	V	V	One record within 10 km of the survey area. Rough Doubletail grows on hills and slopes of near-coastal districts in open forests which have a grassy to fairly dense understorey. Exists as subterranean tubers most of the year. It produces leaves and flowering stems in winter.	None	No

Table H.2 Threatened species recorded or with the potential to occur within 10 km of the survey area

Species	Source	Status		Habitat requirements	Likelihood of occurrence	Further assessment required?
		TSC Act	EPBC Act			
Siah's Backbone *Streblus pendulinus*	PMST	-	E	Not known from within 10 km of the survey area. Siah's Backbone occurs from Cape York Peninsula to Milton, south-east New South Wales (NSW), as well as Norfolk Island. On the Australian mainland, Siah's Backbone is found in warmer rainforests, chiefly along watercourses. The altitudinal range is from near sea level to 800 m above sea level. The species grows in well developed rainforest, gallery forest and drier, more seasonal rainforest.	None	No
Small-flower Grevillea *Grevillea parviflora* subsp. *parviflora*	PMST	V	V	Not known from within 10 km of the survey area. Small-flower Grevillea occurs in a range of vegetation types from heath and shrubby woodland to open forest. In Sydney it has been recorded from Shale Sandstone Transition Forest and in the Hunter in Kurri Sand Swamp Woodland. However, other communities occupied include Corymbia maculata - Angophora costata open forest in the Dooralong area, in Sydney Sandstone Ridgetop Woodland at Wedderburn and in Cooks River / Castlereagh Ironbark Forest at Kemps Creek. Often occurs in open, slightly disturbed sites such as along tracks. Plants are capable of suckering from a rootstock and most populations demonstrate a degree of vegetative spread, particularly after disturbance such as fire.	None	No
Thick-lipped Spider Orchid *Caladenia tessellata*	PMST	E	V	Not known from within 10 km of the survey area. Thick-lipped Spider Orchid is generally found in grassy sclerophyll woodland on clay loam or sandy soils, though the population near Braidwood is in low woodland with stony soil. The single leaf regrows each year. Flowers appear between September and November (but apparently generally late September or early October in extant southern populations).	None	No
Variable Midge Orchid *Genoplesium insigne*	NPWS Atlas	E	CE	Two records from within 10 km of the survey area. Variable Midge Orchid grows in patches of Kangaroo Grass (*Themeda australis*) amongst shrubs and sedges in heathland and forest. Associated vegetation at Chain Valley Bay is described as dry sclerophyll woodland dominated by Scribbly Gum (*Eucalyptus haemastoma*), Red Bloodwood (*Corymbia gummifera*), Smooth-barked Apple (*Angophora costata*) and Black She-oak (*Allocasuarina littoralis*). Fewer than twenty plants are recorded from three localities, while the number of plants present at the fourth locality (Chain Valley Bay) is not known. Flowering period is September to October.	**High**	**Yes**

Table H.2 Threatened species recorded or with the potential to occur within 10 km of the survey area

Species	Source	Status		Habitat requirements	Likelihood of occurrence	Further assessment required?
		TSC Act	EPBC Act			
Wyong Sun Orchid *Thelymitra adorata*	PMST	CE	CE	Not known from within 10 km of the survey area. Currently known from a few localised occurrences in the area bounded by the towns of Wyong, Warnervale and Wyongah on the New South Wales Central Coast, within the Wyong Local Government Area. Occurs from 10-40 m a.s.l. in grassy woodland or occasionally derived grassland in well-drained clay loam or shale derived soils. The vegetation type in which the majority of populations occur (including the largest colony) is a Spotted Gum - Ironbark Forest with a diverse grassy understorey and occasional scattered shrubs.	None	No
FAUNA - Birds						
Barking Owl *Ninox connivens*	NPWS Atlas	V	-	One record within 10 km of the survey area. The Barking Owl inhabits woodland and open forest, including fragmented remnants and partly cleared farmland. This species roosts in shaded portions of tree canopies, including tall midstorey trees with dense foliage such as *Acacia* and *Casuarina* species.	**Moderate**	**Yes**
Black Bittern *Ixobrychus flavicollis*	NPWS Atlas	V	-	Two records within 10 km of the survey area. The Black Bittern inhabits both terrestrial and estuarine wetlands, generally in areas of permanent water and dense vegetation. Where permanent water is present, the species may occur in flooded grassland, forest, woodland, rainforest and mangroves.	Low	No
Black Falcon *Falco subniger*	NPWS Atlas	V	-	One record within 10 km of the survey area. The Black Falcon is found along tree-lined watercourses and in isolated woodlands, mainly in arid and semi-arid areas. Black Falcons nest along tree-lined creeks and rivers of inland drainage systems.	Low	No
Black-faced Monarch *Monarcha melanopsis*	PMST	-	Mi	Not known from within 10 km of the survey area. The Black-faced Monarch occurs mainly in rainforest ecosystems but sometimes is found in nearby open eucalypt forests in gullies with a dense, shrubby, or patchy understorey.	None	No
Black-necked Stork *Ephippiorhynchus asiaticus*	NPWS Atlas	E	-	Black-necked Storks are mainly found on shallow, permanent, freshwater terrestrial wetlands, and surrounding marginal vegetation, including swamps, floodplains, watercourses and billabongs, freshwater meadows, wet heathland, farm dams and shallow floodwaters, as well as extending into adjacent grasslands, paddocks and open savannah woodlands.	Low	No

Table H.2 Threatened species recorded or with the potential to occur within 10 km of the survey area

Species	Source	Status		Habitat requirements	Likelihood of occurrence	Further assessment required?
		TSC Act	EPBC Act			
Brown Treecreeper (eastern subspecies) *Climacteris picumnus victoriae*	NPWS Atlas	V	-	Two records from within 10 km of the survey area. The Brown Treecreeper is found in eucalypt woodlands (including Box-Gum Woodland) and dry open forest of the inland slopes and plains inland of the Great Dividing Range. The Brown Treecreeper mainly inhabits woodlands dominated by stringybarks or other rough-barked eucalypts, usually with an open grassy understorey. Fallen timber is an important habitat component for foraging.	Low	No
Cattle Egret *Ardea ibis*	NPWS Atlas	-	Mi	Not known within 10 km of the survey area. The Cattle Egret occurs in tropical and temperate grasslands, wooded lands and terrestrial wetlands.	None	No
Diamond Firetail *Stagnopleura guttata*	NPWS Atlas	V	-	One record within 10 km of the survey area. The Diamond Firetail is found in grassy eucalypt woodlands, including Box-Gum Woodlands and Snow Gum (*Eucalyptus pauciflora*) Woodlands. The species also occurs in open forest, mallee, Natural Temperate Grassland, and in secondary grassland derived from other communities.	None	No
Eastern Bristlebird *Dasyornis brachypterus*	PMST	E	E	Not known within 10 km of the survey area. Habitat of the Eastern Bristlebird is characterised by dense, low vegetation including heath and open woodland with a heathy understorey; in northern NSW, this species occurs in open forest with tussocky grass understorey; all of these vegetation types are fire prone.	Low	No
Eastern Osprey *Pandion cristatus*	NPWS Atlas	V	-	Favour coastal areas, especially the mouths of large rivers, lagoons and lakes. Feed on fish over clear, open water. Breed from July to September in NSW. Nests are made high up in dead trees or in dead crowns of live trees, usually within one kilometre of the sea.	Low. No nests were recorded.	No
Fork-tailed Swift *Apus pacificus*	NPWS Atlas	-	MI	One record within 10 km of the survey area. In Australia, the Fork-tailed Swift mostly occurs over inland plains but sometimes above foothills or in coastal areas. This species can also occur over cliffs and beaches and also over islands and sometimes well out to sea.	Low	No
Gang-gang Cockatoo *Callocephalon fimbriatum*	NPWS Atlas	V	-	One record within 10 km of the survey area. In summer, the Gang-gang Cockatoo is generally found in tall mountain forests and woodlands, particularly in heavily timbered and mature wet sclerophyll forests. In winter, they may occur at lower altitudes in drier more open eucalypt forests and woodlands, and often found in urban areas.	Low	No

Table H.2 Threatened species recorded or with the potential to occur within 10 km of the survey area

Species	Source	Status		Habitat requirements	Likelihood of occurrence	Further assessment required?
		TSC Act	EPBC Act			
Glossy Black-Cockatoo *Calyptorhynchus lathami*	NPWS Atlas	V	-	Several records within 10 km of the survey area. The Glossy Black Cockatoo inhabits open forest and woodlands of the coast and the Great Dividing Range up to 1000 m in which stands of She-oak species, particularly Black She-oak (*Allocasuarina littoralis*), Forest She-oak (*A. torulosa*) or Drooping She-oak (*A. verticillata*) occur.	**Moderate**	**Yes**
Grey-crowned Babbler (eastern subspecies) *Pomatostomus temporalis temporalis*	NPWS Atlas	V	-	One record within 10 km of the survey area. Inhabits open Box-Gum Woodlands on the slopes, and Box-Cypress-pine and open Box Woodlands on alluvial plains. Birds are generally unable to cross large open areas. Live in family groups that consist of a breeding pair and young from previous breeding seasons. Feed on invertebrates, either by foraging on the trunks and branches of eucalypts and other woodland trees or on the ground, digging and probing amongst litter and tussock grasses. Build and maintain several conspicuous, dome-shaped stick nests about the size of a football. A nest is used as a dormitory for roosting each night. Nests are usually located in shrubs or sapling eucalypts, although they may be built in the outermost leaves of low branches of large eucalypts. Nests are maintained year round, and old nests are often dismantled to build new ones. Breed between July and February. Territories range from one to fifty hectares (usually around ten hectares) and are defended all year. Territorial disputes with neighbouring groups are frequent and may last up to several hours, with much calling, chasing and occasional fighting.	None	No
Little Eagle *Hieraaetus morphnoides*	NPWS Atlas	V	-	One record within 10 km of the survey area. The Little Eagle is found throughout the Australian mainland excepting the most densely forested parts of the Dividing Range escarpment. It occurs as a single population throughout NSW. This species occupies open eucalypt forest, woodland or open woodland. Sheoak or *Acacia* woodlands and riparian woodlands of interior NSW are also used.	Low. No nests were recorded.	No
Little Lorikeet *Glossopsitta pusilla*	NPWS Atlas	V	-	Multiple records within 10 km of the survey area. The Little Lorikeet is distributed widely across the coastal and Great Divide regions of eastern Australia from Cape York to South Australia. It forages primarily in the canopy of open *Eucalyptus* forest and woodland, yet also finds food in *Angophora, Melaleuca* and other tree species. Riparian habitats are particularly used by this species, due to higher soil fertility and hence greater productivity.	**High**	**Yes**

Table H.2 Threatened species recorded or with the potential to occur within 10 km of the survey area

Species	Source	Status		Habitat requirements	Likelihood of occurrence	Further assessment required?
		TSC Act	EPBC Act			
Masked Owl *Tyto novaehollandiae*	NPWS Atlas	V	-	Three records within 10 km of the survey area. The Masked Owl lives in dry eucalypt forests and woodlands from sea level to 1100 m. Its diet typically consists of tree-dwelling and ground mammals, especially rats.	**High**	**Yes**
Powerful Owl *Ninox strenua*	NPWS Atlas	V	-	Multiple records within 10 km of the survey area. In NSW, the Powerful Owl is widely distributed throughout the eastern forests from the coast inland to tablelands, with scattered, mostly historical records on the western slopes and plains. This species roosts by day in dense vegetation comprising species such as Turpentine (*Syncarpia glomulifera)*, Black She-oak (*Allocasuarina littoralis)*, Blackwood (*Acacia melanoxylon)*, Rough-barked Apple (*Angophora floribunda)*, Cherry Ballart (*Exocarpus cupressiformis)* and a number of eucalypt species.	**High**	**Yes**
Rainbow Bee-eater *Merops ornatus*	NPWS Atlas	-	Mi	Two records within 10 km of the survey area. The Rainbow Bee-eater is distributed across much of mainland Australia, and occurs on several near-shore islands. It is not found in Tasmania, and is thinly distributed in the most arid regions of central and Western Australia. It usually occurs in open, cleared or lightly-timbered areas that are often, but not always, located in close proximity to permanent water. The Rainbow Bee-eater is also common in cleared and semi-cleared habitats ie farmland.	Low	No
Regent Honeyeater *Anthochaera phrygia*	NPWS Atlas	CE	E	Several records within 10 km of the survey area. The Regent Honeyeater mainly inhabits temperate woodlands and open forests of the inland slopes of south-east Australia. These birds are also found in drier coastal woodlands and forests in some years. Every few years non-breeding flocks are seen foraging in flowering coastal Swamp Mahogany (*Eucalyptus robusta*) and Spotted Gum (*Corymbia maculata*) forests, particularly on the central coast and occasionally on the upper north coast. Birds are occasionally seen on the south coast.	**Moderate**	**Yes**
Rose-crowned Fruit Dove *Ptilinopus regina*	NPWS Atlas	V	-	Several records within 10 km of the survey area. Rose-crowned Fruit-doves occur mainly in sub-tropical and dry rainforest and occasionally in moist eucalypt forest and swamp forest, where fruit is plentiful. They are shy pigeons, not easy to see amongst the foliage, and are more often heard than seen. They feed entirely on fruit from vines, shrubs, large trees and palms, and are thought to be locally nomadic as they follow the ripening of fruits. Some populations are migratory in response to food availability - numbers in north-east NSW increase during spring and summer then decline in April or May.	None	No

Table H.2 Threatened species recorded or with the potential to occur within 10 km of the survey area

Species	Source	Status		Habitat requirements	Likelihood of occurrence	Further assessment required?
		TSC Act	EPBC Act			
Rufous Fantail *Rhipidura rufifrons*	PMST	-	Mi	Not known from within 10 km of the survey area. In east and south-east Australia, the Rufous Fantail mainly inhabits wet sclerophyll forests, often in gullies dominated by eucalypts such as Tallow-wood (*Eucalyptus microcorys*), Mountain Grey Gum (*E. cypellocarpa*), Narrow-leaved Peppermint (*E. radiata*), Mountain Ash (*E. regnans*), Alpine Ash (*E. delegatensis*), Blackbutt (*E. pilularis*) or Red Mahogany (*E. resinifera*); usually with a dense shrubby understorey often including ferns.	None	No
Satin Flycatcher *Myiagra cyanoleuca)*	PMST	-	Mi	Not known from within 10 km of the survey area. The Satin Flycatcher is widespread in eastern Australia and vagrant to New Zealand (Blakers et al. 1984; Coates 1990). Satin Flycatchers inhabit heavily vegetated gullies in eucalypt-dominated forests and taller woodlands, and on migration, occur in coastal forests, woodlands, mangroves and drier woodlands and open forests.	None	No
Scarlet Robin *Petroica boodang*	NPWS Atlas	V	-	Recorded from the Vales Point Power Station Perimeter Lands. In NSW, the Scarlet Robin occurs from the coast to the inland slopes. This species lives in both mature and regrowth vegetation. It occasionally occurs in mallee or wet forest communities, or in wetlands and tea-tree swamps. Scarlet Robin habitat usually contains abundant logs and fallen timber: these are important components of its habitat.	**High**	**Yes**
Sooty Owl *Tyto tenebricosa*	NPWS Atlas	V	-	One record within 10 km of the survey area. The Sooty Owl occurs in rainforest, including dry rainforest, subtropical and warm temperate rainforest, as well as moist eucalypt forests.	None	No
Spectacled Monarch *Monarcha trivirgatus*	PMST	-	Mi	Not known from within 10km of the site. The Spectacled Monarch prefers thick understorey in rainforests, wet gullies and waterside vegetation, as well as mangroves.	None	No
Speckled Warbler *Chthonicola sagittata*	NPWS Atlas	V	-	One record from within 10 km of the survey area. The Speckled Warbler lives in a wide range of *Eucalyptus* dominated communities that have a grassy understorey, often on rocky ridges or in gullies. Typical habitat would include scattered native tussock grasses, a sparse shrub layer, some eucalypt regrowth and an open canopy.	None	No

Table H.2 Threatened species recorded or with the potential to occur within 10 km of the survey area

Species	Source	Status		Habitat requirements	Likelihood of occurrence	Further assessment required?
		TSC Act	EPBC Act			
Superb Fruit Dove *Ptilinopus superbus*	NPWS Atlas	V	-	Two records within 10 km of the survey area. Lives mainly within rainforests but will feed in adjacent mangroves or eucalypt forests. Nests are well hidden within the rainforest habitat and are built in trees from 10 to 30m off the ground. The nest consists of a flimsy structure of twigs, constructed in the fork of a branch. Feeding on pittosporums, Lilly Pillies, blackberries and isolated figs. Typically distributed along eastern Queensland and southern New Guinea, but also found as far south as Tasmania in low numbers.	Low	No
Swift Parrot *Lathamus discolor*	NPWS Atlas	E	E	Multiple records from within 10 km of the survey area. The Swift Parrot migrates to the Australian south-east mainland between March and October. On the mainland they occur in areas where eucalypts are flowering profusely or where there are abundant lerp (from sap-sucking bugs) infestations.	**High**	**Yes**
Turquoise Parrot *Neophema pulchella*	NPWS Atlas	V	-	One record within 10 km of the survey area. Inhabiting the steep, rocky ridges and gullies, hills, river-flats, valleys and nearby plains of the Great Dividing Range, the Turquoise Parrot is found in open forest and eucalyptus woodlands with a low shrub understorey and grassy ground-cover. Generally, distribution of the species is patchy, determined by areas of suitable habitat and ranges from north-eastern Victoria through NSW to south-eastern Queensland. Individuals generally breed from August to January, usually nesting less than two metres above the ground. Nests may be located in hollows of small trees, dead eucalyptus or in holes or stumps, fence posts or even logs lying on the ground.	Low	No
Varied Sittella *Daphoenositta chrysoptera*	NPWS Atlas	V	-	Multiple records within 10 km of the survey area. Recorded in the Vales Point Power Station Perimeter Lands (EMM unpublished data 2014). The Varied Sittella inhabits eucalypt forests and woodlands, especially those containing rough-barked species and mature smooth-barked gums with dead branches, mallee and Acacia woodland. This species feeds on arthropods gleaned from crevices in rough or decorticating bark, dead branches, standing dead trees and small branches and twigs in the tree canopy.	**High**	**Yes**

Table H.2 Threatened species recorded or with the potential to occur within 10 km of the survey area

Species	Source	Status		Habitat requirements	Likelihood of occurrence	Further assessment required?
		TSC Act	EPBC Act			
White-bellied Sea Eagle *Haliaeetus leucogaster*	NPWS Atlas	-	Mi	Previously recorded at the ventilation fan site and the CVC pit top area roosting in Swamp Oak Forest (EMM unpublished data 2014). The White-bellied Sea-Eagle is found in coastal habitats (especially those close to the sea-shore) and around terrestrial wetlands in tropical and temperate regions of mainland Australia and its offshore islands. The habitats occupied by the sea-eagle are characterised by the presence of large areas of open water (larger rivers, swamps, lakes and the sea).	**Recorded**	**Yes**
White-fronted Chat *Epthianura albifrons*	NPWS Atlas	V	-	One record within 10 km of the survey area. Gregarious species, usually found foraging on bare or grassy ground in wetland areas, singly or in pairs. They are insectivorous, feeding mainly on flies and beetles caught from or close to the ground. Have been observed breeding from late July through to early March, with 'open-cup' nests built in low vegetation. Nests in the Sydney region have also been seen in low isolated mangroves. Nests are usually built about 23 cm above the ground (but have been found up to 2.5 m above the ground).	Low	No
White-throated Needletail *Hirundapus caudacutus*	NPWS Atlas	-	Mi	Several records within 10 km of the survey area. The White-throated Needletail occurs in open forest, rainforest, heathland, grassland and swamps. The species breeds in wooded lowlands and sparsely vegetated hills, as well as mountains covered with coniferous forests.	Low	No
FAUNA - Frogs						
Giant Barred Frog *Mixophyes iteratus*	PMST	E	E	Not known from within 10 km of the survey area. Found on forested slopes of the escarpment and adjacent ranges in riparian vegetation, subtropical and dry rainforest and wet sclerophyll forests. This species is associated with flowing streams with high water quality, though habitats may contain weed species. They occur amongst deep, damp leaf litter in rainforests, moist eucalypt forest and nearby dry eucalypt forest, at elevations below 1000 m. They breed around shallow, flowing rocky streams from late spring to summer. Females lay eggs onto moist creek banks or rocks above water level, from where tadpoles drop into the water when hatched. Their distribution occurs along the coast and ranges from south-eastern Queensland to the Hawkesbury River in NSW. North-eastern NSW, particularly the Coffs Harbour-Dorrigo area, is now a stronghold.	None	No

Table H.2 Threatened species recorded or with the potential to occur within 10 km of the survey area

Species	Source	Status		Habitat requirements	Likelihood of occurrence	Further assessment required?
		TSC Act	EPBC Act			
Giant Burrowing Frog *Heleioporus australiacus*	PMST	V	V	Not known from within 10 km of the survey area. The Giant Burrowing Frog is found in heath, woodland and open dry sclerophyll forest on a variety of soil types except those that are clay based. They spend more than 95% of their time in non-breeding habitat in areas up to 300 m from breeding sites. Whilst in non-breeding habitat, the Giant Burrowing Frog burrows below the soil surface or in the leaf litter.	None	No
Green and Golden Bell Frog *Litoria aurea*	PMST	E	V	Not known from within 10 km of the survey area. Inhabits marshes, dams and stream-sides, particularly those containing bullrushes (*Typha spp.)* or spikerushes (*Eleocharis spp*.). Optimum habitat includes water-bodies that are unshaded, free of predatory fish such as Plague Minnow (*Gambusia holbrooki*), have a grassy area nearby and diurnal sheltering sites available. Some sites, particularly in the Greater Sydney region occur in highly disturbed areas, such as brick pitts, landfill areas, disused industrial sites and cleared lands. Formerly distributed from the NSW north coast near Brunswick Heads, southwards along the NSW coast to Victoria where it extends into east Gippsland. Records from west to Bathurst, Tumut and the ACT region. Since 1990 there have been approximately 50 recorded locations in NSW, most of which are small, coastal, or near coastal populations. These locations occur over the species' former range, however they are widely separated and isolated. Large populations in NSW are located around the metropolitan areas of Sydney, Shoalhaven and mid north coast (one an island population). There is only one known population on the NSW Southern Tablelands.	Low	No
Littlejohns Tree Frog *Littoria littlejohni*	PMST	V	V	Not known from within 10 km of the survey area. The Littlejohn's Tree Frog has a distribution that includes the plateaus and eastern slopes of the Great Dividing Range from Watagan State Forest (90 km north of Sydney) south to Buchan in Victoria. Non-breeding habitat is heath based forests and woodlands where it shelters under leaf litter and low vegetation, and hunts for invertebrate prey either in shrubs or on the ground.	None	No

Table H.2 Threatened species recorded or with the potential to occur within 10 km of the survey area

Species	Source	Status		Habitat requirements	Likelihood of occurrence	Further assessment required?
		TSC Act	EPBC Act			
Stuttering Frog *Mixophyes balbus*	PMST	E	V	Not known from within 10 km of the survey area. The Stuttering Frog is restricted to the eastern slopes of the Great Divide, from the Cann River catchment in far East Gippsland, Victoria, to tributaries of the Timbarra River near Drake, New South Wales. They are found in association with permanent streams through temperate and sub-tropical rainforest and wet sclerophyll forest, rarely in dry open tableland riparian vegetation.	None	No
Wallum Froglet *Crinia tinnula*	NPWS Atlas	V	-	Multiple records within 10 km of the survey area. Wallum Froglets are found in wallum swamps and associated low land meandering watercourses on coastal plains. This species is primarily restricted to coastal areas of southern Queensland and northern New South Wales and is thought to be confined to acid paperbark swamps and a range of habitats from heath plains to rainforests. The species is a late winter breeder and breeds in low (acidic) pH areas.	None	No
FAUNA -Mammals						
Brush-tailed Rock Wallaby *Petrogale penicillata*	PMST	E	V	Not known from 10 km of the survey area. In NSW the Brush-tailed Rock Wallaby occurs from the Queensland border in the north to the Shoalhaven in the south, with the population in the Warrumbungle Ranges being the western limit. This species occupies rocky escarpments, outcrops and cliffs with a preference for complex structures with fissures, caves and ledges, often facing north. The Brush-tailed Rock Wallaby browse on vegetation in and adjacent to rocky areas eating grasses and forbs as well as the foliage and fruits of shrubs and trees.	None	No
Eastern Bentwing Bat *Miniopterus schreibersii oceanensis*	NPWS Atlas	V	-	Multiple records from within 10 km of the survey area. Eastern Bentwing Bats occur along the east and north-west coasts of Australia. Caves are the primary roosting habitat for this species, but they also use derelict mines, storm-water tunnels, buildings and other man-made structures. The Eastern Bentwing Bat forms discrete populations centred on a maternity cave that is used annually in spring and summer for the birth and rearing of young.	**High**	**Yes**

Table H.2 Threatened species recorded or with the potential to occur within 10 km of the survey area

Species	Source	Status		Habitat requirements	Likelihood of occurrence	Further assessment required?
		TSC Act	EPBC Act			
Eastern Cave Bat *Vespadelus troughtoni*	NPWS Atlas	V	-	One record within 10 km of the survey area. The Eastern Cave Bat is found in a broad band on both sides of the Great Dividing Range from Cape York to Kempsey, with records from the New England Tablelands and the upper north coast of NSW. The western limit appears to be the Warrumbungle Range, and there is a single record from southern NSW, east of the ACT. Little is known of the biology, feeding, breeding and behaviour of this species. They are usually found in dry open forest and woodland, near rocky cliffs or overhangs. It has been recorded roosting in disused mine workings and caves, and is occasionally found in wet eucalypt forest and rainforest.	Low	No
Eastern False Pipistrelle *Falsistrellus tasmaniensis*	NPWS Atlas	V	-	Four records within 10 km of the survey area. The Eastern False Pipistrelle is found on the south-east coast and ranges of Australia, from southern Queensland to Victoria and Tasmania. This species prefers moist habitats, with trees taller than 20 m, generally roosts in eucalypt hollows, but has also been found under loose bark on trees or in buildings.	Low	No
Eastern Freetail Bat *Mormopterus norfolkensis*	NPWS Atlas	V	-	Multiple records within 10 km of the survey area. The Eastern Freetail-Bat is found along the east coast from south Queensland to southern NSW. The Eastern Freetail Bat occurs in dry sclerophyll forest, woodland, swamp forests and mangrove forests east of the Great Dividing Range. This species roosts mainly in tree hollows but will also roost under bark or in man-made structures.	**High**	**Yes**
Greater Broadnosed Bat *Scoteanax rueppellii*	NPWS Atlas	V	-	Multiple records within 10 km of the survey area. The Greater Broad-nosed Bat is found mainly in the gullies and river systems that drain the Great Dividing Range, from north-eastern Victoria to the Atherton Tableland. It extends to the coast over much of its range. In NSW it is widespread on the New England Tablelands, however does not occur at altitudes above 500 m. This species utilises a variety of habitats from woodland through to moist and dry eucalypt forest and rainforest, though it is most commonly found in tall wet forest.	Low	No
Grey-headed Flying-fox *Pteropus poliocephalus*	NPWS Atlas	V	V	Multiple records within 10 km of the survey area. Recorded at the CVC pit top area (EMM unpublished data 2013). Grey-headed Flying foxes occur in subtropical and temperate rainforests, tall sclerophyll forests and woodlands, heaths and swamps as well as urban gardens and cultivated fruit crops. Roosting camps are generally located within 20 km of a regular food source and are commonly found in gullies, close to water, in vegetation with a dense canopy.	**High**	**Yes**

Table H.2 Threatened species recorded or with the potential to occur within 10 km of the survey area

Species	Source	Status		Habitat requirements	Likelihood of occurrence	Further assessment required?
		TSC Act	EPBC Act			
Koala *Phascolarctos cinereus*	NPWS Atlas	V	V	Two records within 10 km of the survey area. In NSW, the koala mainly occurs on the central and north coast with some populations in the west of the Great Dividing Range. The Koala inhabits eucalypt woodlands and forests. They feed on the foliage of more than 70 eucalypt species and 30 non-eucalypt species, but in any one area will select preferred browse species.	**Moderate**	**Yes**
Large-eared Pied Bat *Chalinobus dwyeri*	PMST	V	V	Not known within 10km of the site. The Large-eared Pied Bat roosts in caves (near their entrances), crevices in cliffs, old mine workings and in the disused, bottle-shaped mud nests of the Fairy Martin (*Petrochelidon ariel*), frequenting low to mid-elevation dry open forest and woodland close to these features.	None	No
Little Bentwing Bat *Miniopterus australis*	NPWS Atlas	V	-	Multiple records within 10 km of the survey area. The Little Bentwing Bat is distributed on the East coast and ranges of Australia from Cape York in Queensland to Wollongong in NSW. It is generally found in well-timbered areas. Little Bentwing-bats roost in caves, tunnels, tree hollows, abandoned mines, stormwater drains, culverts, bridges and sometimes buildings during the day, and at night forage for small insects beneath the canopy of densely vegetated habitats.	**Moderate**	**Yes**
Long-nosed Potoroo *Potorous tridactylus tridactylus*	PMST	V	V	Not known within 10 km of the survey area. The Long-nosed Potoroo inhabits coastal heaths and dry and wet sclerophyll forests. A dense understorey with occasional open areas is an essential part of this species' habitat, and may consist of grass-trees, sedges, ferns or heath, or of low shrubs of tea-trees or melaleucas.	Low	No
New Holland Mouse *Pseudomys novaehollandiae*	NPWS Atlas	-	V	Six records from the nearby Munmorah State Conservation Area. The New Holland Mouse is known to inhabit open heathlands, woodlands and forests with a heathland understorey and vegetated sand dunes. It is a social animal, living predominantly in burrows shared with other individuals.	**Moderate**	**Yes**

Table H.2 Threatened species recorded or with the potential to occur within 10 km of the survey area

Species	Source	Status		Habitat requirements	Likelihood of occurrence	Further assessment required?
		TSC Act	EPBC Act			
Southern Myotis *Myotis macropus*	NPWS Atlas	V	-	Multiple records within 10 km of the survey area. The Southern Myotis is found in the coastal band from the north-west of Australia, across the top-end and south to western Victoria. It is rarely found more than 100 km inland, except along major rivers. They generally roost in groups of 10 - 15 close to water in caves, mine shafts, hollow-bearing trees, storm water channels, buildings, under bridges and in dense foliage. Southern Myotis forage over streams and pools catching insects and small fish by raking their feet across the water surface.	Low	No
Spotted-tailed Quoll *Dasyurus maculatus*	NPWS Atlas	V	E	Three records within 10 km of the survey area. The Spotted-tailed Quoll inhabits a range of habitat types, including rainforest, open forest, woodland, coastal heath and inland riparian forest, from the sub-alpine zone to the coastline. Individual animals use hollow-bearing trees, fallen logs, small caves, rock crevices, boulder fields and rocky-cliff faces as den sites.	**Moderate**	**Yes**
Squirrel Glider *Petaurus norfolcensis*	NPWS Atlas	V	-	Previously recorded from the Vales Point Power Station Perimeter Lands. Inhabits dry sclerophyll forest and woodland where it is absent from the dense coastal ranges. Forages on pollen and nectar and the gum that acacias produce. Also eats sap from gums and the green seeds of the Golden Wattle. Associated with dry hardwood forest and woodlands. Habitats typically include gum-barked and high nectar-producing species, including winter flowering species. The presence of hollow-bearing eucalypts is a critical habitat value. The Squirrel Glider is sparsely distributed along the east coast and immediate inland districts from western Victoria to north Queensland.	**Moderate**	**Yes**
FAUNA - Reptiles						
Broad-headed Snake *Hoplocephalus bungaroides*	PMST	E	V	Not known from within 10 km of the survey area. The Broad-headed Snake is largely confined to Triassic and Permian sandstones, including the Hawkesbury, Narrabeen and Shoalhaven groups, within the coast and ranges in an area within approximately 250 km of Sydney. It shelters in rock crevices and under flat sandstone rocks on exposed cliff edges during autumn, winter and spring.	None	No

Notes: 1. PMST – Protected Matters Search Tool (DoE 2015), NPWS Atlas – Atlas of NSW Wildlife.

2. E – endangered, V – vulnerable, Mi – migratory, (-) – not listed.

H.2 Significant impact criteria in accordance with the TSC Act

Section 5A of the *Environment Planning and Assessment Act 1979* provides the criteria that must be considered in the assessment of the significance of potential impacts on all threatened species listed under the TSC Act. Assessment of Significance (known as the seven-part test) is made up of the following seven questions:

2. In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction;

3. In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction;

4. In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

    a) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction;

    b) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction;

5. In relation to the habitat of a threatened species, population or ecological community:

    a) the extent to which habitat is likely to be removed or modified as a result of the action proposed;

    b) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action;

    c) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality;

6. Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly);

7. Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan; and

8. Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

Assessments of significance are undertaken in accordance with *Threatened species assessment guidelines: The assessment of significance* (DEC 2007).

H.2.1 Assessments of significance

Communities and species requiring additional assessment, as identified in Table H.2, and which are listed as threatened under the TSC Act were assessed using the seven-part test. Seven-part tests have been prepared in accordance with the criteria presented in H.1. Assessments have been undertaken for guilds of species or communities which have similar habitat requirements. The results of tests have been tabulated for ease of reading and are presented in the following sections.

i Swamp Sclerophyll Forest EEC

Swamp Sclerophyll Forest on coastal floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions is listed as an endangered ecological community under the NSW TSC Act.

Swamp Mahogany Swamp Forest, which is representative of Swamp Sclerophyll Forest EEC in the survey area, surrounds the ventilation fan site. Up to approximately 0.03 ha of the community in this area will be cleared by the proposed bushfire protection works. The community is associated with humic clay loams and sandy loams, on waterlogged or periodically inundated alluvial flats and drainage lines associated with coastal floodplains.

An assessment of impact criteria has been completed to assess potential impacts of the proposed bushfire protection works on this threatened ecological community (Table H.3).

Table H.3 Assessment of impact criteria for Swamp Sclerophyll Forest EEC

Criteria	Discussion
1: life cycle of threatened species	N/A
2: life cycle of endangered population	N/A
3: EEC extent of removal and modification	The survey area contains a patch of Swamp Sclerophyll Forest EEC around the ventilation fan site. A small area of the community (0.28 ha) will be partially cleared/disturbed for the proposed bushfire protection works. Substantial areas outside the survey area have been mapped as containing Swamp Sclerophyll Forest EEC. It is therefore unlikely that the removal of these discrete areas on an existing edge around the facility could have an adverse effect on the extent of the community, or potentially place it at risk of extinction in the locality. Potential indirect impacts of the proposed bushfire protection works that could cause modification of these communities include increased edge effects and introduction or spread of weeds. To minimise these potential impacts, weed control and monitoring will continue to be implemented in the area under the BMP. Additionally, an ecologist will complete a pre-disturbance survey to determine important structural components of the community to be retained in the APZ, including large trees.
4: habitat removal, fragmentation, isolation and importance	The proposed modification will partially clear/disturb approximately 0.28 ha of Swamp Sclerophyll Forest EEC. The works will not fragment or isolate the existing area of the community or habitat for the community, as impacts will occur on the edge of the local occurrence. The Chain Valley Colliery BMP will be updated to include measures to protect the EEC during APZ maintenance, and will be implemented to minimise the potential impacts of fragmentation.
5: critical habitat	Critical habitat under the TSC Act has not been declared for Swamp Sclerophyll Forest EEC.

Table H.3 Assessment of impact criteria for Swamp Sclerophyll Forest EEC

Criteria	Discussion
6: consistency with recovery or threat abatement plans	A recovery or threat abatement plan has not been prepared for Swamp Sclerophyll Forest EEC. However, a number of management actions have been identified to aid in its recovery. The actions focus on research and conservation management at priority sites. The survey area has not been identified as a priority site and therefore the modification does not interfere with the EEC's recovery.
7: key threatening processes	The impacts to key threatening processes '*clearing of native vegetation*' have been considered for the modification. Under the final determination (NSWSC 2011), clearing is defined as the destruction of a sufficient proportion of one or more strata (layers) within a stand or stands of native vegetation so as to result in the loss, or long term modification, of the structure, composition and ecological function of stand or stands. Given the small area to be disturbed and the selective nature of vegetation disturbance, the proposed modification will not result in this key threatening process.
Conclusion	The proposed modification is unlikely to result in significant impacts to Swamp Sclerophyll Forest EEC as: • it only clears/disturbs approximately 0.28 ha of the community; • it will not further fragment or isolate the community in the locality; and • it is not inconsistent with management actions for recovery of the community.

ii Threatened flora: Black-eyed Susan (*Tetratheca juncea*), Leafless Tongue Orchid (*Cryptostylis hunteriana*), Variable Midge Orchid (*Genoplesium insignis)*

Black-eyed Susan is listed as a vulnerable species under the TSC Act. It is a low shrub that grows in clumps of single or multiple stems. It is usually found in low open forest/woodland with a mixed shrub understorey and grassy groundcover. However, it has also been recorded in heathland and moist forest. The species was not recorded in the survey area. However several records exist from the locality in the Delta Electricity Perimeter Lands (EMM unpublished data 2014) and within 10 km of the survey area. Surveys were undertaken outside the flowering time for this species, when it is difficult to detect.

The **Leafless Tongue-orchid** is listed as a vulnerable species under the TSC Act. The species does not appear to have well defined habitat preferences and is known from a range of communities, including swamp-heath and woodland. The species was not recorded in the survey area, however several records exist from the Delta Electricity Perimeter Lands (EMM unpublished data 2014) and suitable habitat is considered to be present in the survey area in Scribbly Gum Red Bloodwood Heathy Woodland. Surveys were undertaken outside the flowering time for this species, when it is not detectable.

The **Variable Midge Orchid** is a terrestrial orchid with a solitary cylindrical leaf that encloses the flowering stem which is listed as endangered under the TSC Act. The species was not recorded in the survey area, however it is known to occur in Chain Valley Bay in similar habitat and there are two records within 10 km of the site. Surveys were undertaken outside the flowering time for this species, when it is not detectable.

An assessment of impact criteria under Part 5a of the EP& A Act has been completed for these threatened plant species (Table H.4).

Table H.4 Assessment of impact criteria for threatened flora

Criteria	Discussion
1: Life cycle of threatened species	The life cycle of flora species can be affected in the following main ways: • impacts to pollination (internal mechanisms or impacts to pollinators) – insect pollinators are likely for these species, and it is considered unlikely that the proposed bushfire protection works would impact pollination mechanisms; • ability of the plant to produce flowers – the proposed bushfire protection works are not expected to affect the ability of individual plants to produce flowers, this is more likely to be affected by other environmental effects such as rainfall; • ability of the plant to produce and set seed – the proposed bushfire protection works is not expected to impact the ability of the species to produce and set seed; • ability to germinate – the germination requirements of these species are not known; and • ability of seedlings to grow – the proposed bushfire protection works could produce high levels of dust which could affect photosynthesis capabilities and growth of seedlings and adult plants in surrounding areas. Approximately 0.79 ha of potential habitat will be partially disturbed for these species. The proposed bushfire protection works will not remove known habitat or individuals of this species and is unlikely to impact pollinators. The proposed bushfire protection works are therefore considered unlikely to affect the breeding cycle of vulnerable flora species, should they occur within the survey area.
2: Life cycle of endangered population	This question refers to endangered populations, therefore is not relevant to this assessment.
3: EEC extent and modification	This question refers to TECs, therefore is not relevant to this assessment.
4: Habitat removal, fragmentation, isolation and importance	The proposed bushfire protection works will result in partial disturbance of approximately 0.79 ha of potential habitat for these vulnerable flora species. No individuals have been recorded within the survey area, however recent surveys were undertaken outside the flowering period. Pre-disturbance surveys will be completed by an ecologist during the flowering period of all three species to determine if they occur in the proposed APZ. Threatened plant populations, if found, will be protected by delineation fencing and population health will be monitored as part of the BMP. Retained habitats may be susceptible to indirect impacts including increased dust levels and edge effects in areas adjacent to the existing pit top area. However, if these species were to occur within the survey area, the proposed bushfire protection works are considered unlikely to isolate or decrease the quality of habitat in the locality for them.
5: Critical habitat	Critical habitat has not been declared for these species.
6: Consistency with recovery or threat abatement plans	There are no recovery plans for the vulnerable plant species. Recovery actions centre around identifying habitat and populations and protecting habitat. The proposed bushfire protection works is therefore considered unlikely to interfere substantially with the recovery of the species. The survey area is outside identified management site for the Leafless Tongue-orchid and the Variable Midge Orchid.
7: Key threatening processes	The impacts to key threatening processes '*clearing of native vegetation*' have been considered for the modification. Under the final determination (NSWSC 2011), clearing is defined as the destruction of a sufficient proportion of one or more strata (layers) within a stand or stands of native vegetation so as to result in the loss, or long term modification, of the structure, composition and ecological function of stand or stands. Given the small area to be disturbed and the selective nature of vegetation disturbance, the proposed modification will not result in this key threatening process.

Table H.4 Assessment of impact criteria for threatened flora

Criteria	Discussion
Conclusion	The proposed bushfire protection works are not expected to result in significant impacts to threatened plants as: • it does not remove any known individuals from the local area; • pre- disturbance surveys will be completed during the flowering period of each species to determine their occurrence in the proposed APZ; • if found, threatened plant populations will be protected in the APZ and their health will be monitored under the BMP; and • indirect impacts to potential habitats retained within the survey area will be managed according to the BMP.

iii Threatened owls: Barking Owl (*Ninox connivens*), Masked Owl (*Tyto novaehollandiae*) and Powerful Owl (*Ninox strenua*)

The **Barking Owl** is listed as a vulnerable species under the TSC Act. Nesting habitat within the survey area occurs as tree hollows (in living or dead trees where hollows measure greater than 20 cm diameter and are greater than 4 m above the ground in Ironbark, box and riparian woodlands (OEH 2015)). These areas also provide prey species such as Common Ringtail Possum and Sugar Glider. In addition, wooded areas, and grassland up to 250 m from wooded areas also provide foraging habitat for this species (OEH 2015).

The **Masked Owl** is listed as a vulnerable species under the TSC Act. Potential foraging habitat is present in the survey area within all vegetation types and along the edges of woodlands. Nesting occurs in trees with hollows of greater than 40 cm in diameter (OEH 2015), in cliffs or caves. Breeding is irregular and unpredictable for the Masked Owl, occurring from late summer to spring but mostly March to July (DEC, 2006).

The **Powerful Owl** is listed as a vulnerable species under the TSC Act. Potential breeding and foraging habitat for the Powerful Owl is present within the survey area in eucalypt woodlands. The species roosts by day in dense vegetation. The Powerful Owl requires large tree hollows (at least 0.5 m deep) for nesting (trees with diameter at breast height of 80-240 cm) (DEC 2006).

An assessment of impact criteria under Part 5a of the EP& A Act has been completed to assess potential impacts of the proposed modification to threatened owls (Table H.5).

Table H.5 Assessment of impact criteria for the threatened owls

Criteria	Discussion
1: life cycle of threatened species	Small, discrete areas of vegetation containing large hollow-bearing trees, which are potential breeding resources for these species, may be removed for the proposed modification. This could limit recruitment of species and displace breeding pairs. However, no evidence of breeding was observed in the survey area during the survey. These hollow trees will be prioritised for retention in the APZs. However, if retention is not possible, nest boxes will be placed in suitable locations outside the APZ to compensate for lost hollows. The proposed bushfire protection works may also have indirect impacts on habitat surrounding the survey area and owls may be deterred from breeding in these areas due to increased noise, light and potentially dust. However, any such impacts will be minor and are already likely to be operating in these areas given the surrounding land uses. It is therefore unlikely that breeding habitat or life cycles of these species could be impacted such that viable local populations could be placed at risk of extinction.
2: life cycle of endangered population	This question refers to endangered populations, therefore is not relevant to this assessment.
3: EEC extent and modification	This question refers to TECs, therefore is not relevant to this assessment.
4: habitat removal, fragmentation, isolation and importance	The proposed bushfire protection works will result in the partial clearing/disturbance of up to 1.04 ha of woodland and up to 5 hollow-bearing trees representing potential foraging, roosting and breeding habitat for these species. These hollow trees will be prioritised for retention in the APZs. However, if retention is not possible, nest boxes will be placed in suitable locations outside the APZ to compensate for lost hollows. The works will not fragment habitat for threatened owls as they are a highly mobile species and continuous vegetation in surrounding areas will be retained.
5: critical habitat	Critical habitat has not been declared for any of these species.
6: consistency with recovery or threat abatement plans	A recovery plan is in place for the Masked Owl and Powerful Owl (DEC 2006). Two recovery objectives are applicable to the proposed bushfire protection works: • 'ensure the impacts on large forest owls and their habitats are adequately assessed during planning and environmental assessment process'; and • 'minimise further loss and fragmentation of habitat by protection and more informed management of significant owl habitat'. The proposed bushfire protection works are consistent with these objectives as significant owl habitat is not present. Priority actions for the Barking Owl focus on increasing knowledge of the species requirements, and to incorporate consideration of habitat as a high priority in the assessment of property for reserve establishment. The proposed bushfire protection works do not interfere with these objectives.
7: key threatening processes	The impacts to key threatening processes '*clearing of native vegetation*' have been considered for the modification. Under the final determination (NSWSC 2011), clearing is defined as the destruction of a sufficient proportion of one or more strata (layers) within a stand or stands of native vegetation so as to result in the loss, or long term modification, of the structure, composition and ecological function of stand or stands. Given the small area to be disturbed and the selective nature of vegetation disturbance, the proposed modification will not result in this key threatening process.

Table H.5 Assessment of impact criteria for the threatened owls

Criteria	Discussion
Conclusion	The proposed bushfire protection works are not expected to result in significant impacts to the Barking Owl, Powerful Owl and Masked Owl as: • there will only be a minor reduction in available foraging and breeding habitat; • an ecologist will complete a pre-disturbance survey to determine the feasibility of retaining hollow trees in the APZ; • if hollow trees cannot be retained, nest boxes will be placed in suitable locations to compensate for lost hollows; and • foraging and breeding resources are abundant in the wider locality.

iv Woodland birds: Glossy Black-Cockatoo (*Calyptorhynchus lathami)*, Swift Parrot (*Lathamus discolor*), Little Lorikeet (*Glossopsitta pusilla*), Regent Honeyeater (*Anthochaera phrygia*), Scarlet Robin (*Petroica boodang*) and Varied Sittella (*Daphoenositta chrysoptera*)

The **Glossy Black-cockatoo** is listed as a vulnerable species under the TSC Act. Potential foraging habitat is present for this species where Black She-oaks (*Allocasuarina littoralis*) occur. The species was not recorded in the survey area, however there are several records within 10 km and it provides potential foraging habitat. Potential nesting habitat for this species was recorded in large hollow-bearing eucalypts, however surveys were undertaken in the breeding period (March to August) and breeding habitat was not identified in the survey area.

The **Swift Parrot** is listed as an endangered species under the TSC Act. Potential foraging habitat for this species is available throughout the survey area, although it was not recorded onsite. Favoured feed trees occur within the survey area and include winter flowering species such as Swamp Mahogany (*Eucalyptus robusta*) and Red Bloodwood (*Corymbia gummifera)*. The Swift Parrot breeds in Tasmania during spring and summer, migrating in the autumn and winter months to south-eastern Australia from Victoria and the eastern parts of South Australia to south-east Queensland (OEH 2015).

The **Little Lorikeet** is listed as a vulnerable species under the TSC Act. The species forages primarily in the canopy of open Eucalyptus forest and woodland, yet also finds food in Angophora, Melaleuca and other tree species. Riparian habitats are particularly used, due to higher soil fertility and hence greater productivity. Nest hollows are located at heights of between 2 m and 15 m, mostly in living, smooth-barked eucalypts. Hollow openings are very small, approximately 3 cm in diameter (OEH 2015). It has high site fidelity with nesting areas, which are usually in proximity to feeding areas. However, nomadic movements, following food availability are common (OEH 2015).

The **Regent Honeyeater** is listed as a critically endangered species under the TSC Act. It mainly inhabits temperate woodlands and open forests of the inland slopes of south-east Australia. Birds are also found in drier coastal woodlands and forests in some years. Every few years, non-breeding flocks are seen foraging in flowering coastal Swamp Mahogany and Spotted Gum forests, particularly on the central coast and occasionally on the upper north coast (OEH 2015).

The **Scarlet Robin** is listed as a vulnerable species under the TSC Act. It lives in dry eucalypt forests and woodlands. The understorey is usually open and grassy with few scattered shrubs and usually contains abundant logs and fallen timber as these are important components of its habitat. This species was recorded from the Vales Point Power Station Perimeter Lands (Ecotone Ecological Consultants 2010) and suitable foraging habitat is present in the survey area. However, breeding habitat is not present as the Scarlet Robin breeds on ridges, hills and foothills of the western slopes, the Great Dividing Range and eastern coastal regions; this species is occasionally found up to 1,000 metres in altitude (OEH 2015).

The **Varied Sittella** is listed as a vulnerable species under the TSC Act. It inhabits eucalypt forests and woodlands, especially those containing rough-barked species and mature smooth-barked gums with dead branches, mallee and Acacia woodland. The species was recorded in the Vales Point Power Station Perimeter Lands (EMM unpublished data 2014) and suitable habitat is present in the survey area. Builds a cup-shaped nest of plant fibres and cobwebs in an upright tree fork high in the living tree canopy, and often re-uses the same fork or tree in successive years (OEH 2015).

An assessment of impact criteria under Part 5a of the EP& A Act has been completed to assess potential impacts of the modification on these threatened woodland birds (Table H.6).

Table H.6 Seven part test for the threatened woodland birds

Criteria	Discussion
1: Life cycle of threatened species	The modification may result in the removal of potential breeding habitat (in the form of hollows or trees) for all species, excluding the Swift Parrot and Regent Honeyeater. Given the lack of Glossy Black-cockatoo's at the site during the survey, it is considered unlikely that they are breeding within the survey area. Impacts on these habitat resources have the potential to affect breeding success, limit recruitment and decrease the local population size in the long-term. However, given that only up to 5 hollow-bearing trees will be removed and a handful of other potential breeding resources, and given the availability of such resources throughout the locality, these impacts are considered minor for the species in the long-term. An ecologist will complete a pre-disturbance survey to delineate these features and determine if they can be retained in the APZ. If retention is not possible, nest boxes will be placed in suitable areas adjacent to the APZ to compensate for lost hollows. Indirect impacts such as night light may also interrupt these species and affect breeding success in the survey area, though such impacts are only likely to be minor.
2 : Life cycle of endangered population	This question refers to endangered populations, therefore is not relevant to this assessment.
3: EEC extent and modification	This question refers to TECs, therefore is not relevant to this assessment.
4: Habitat removal, fragmentation, isolation and importance	Foraging habitat is widely distributed within the survey area and surrounds. Up to 1.04 ha of woodland representing foraging habitat for these woodland bird species and up to 5 hollow-bearing trees will be cleared/disturbed for the proposed bushfire protection works. The works will not fragment habitat for threatened woodland birds as they are a highly mobile species and continuous vegetation in surrounding areas will be retained.
5: Critical habitat	Critical habitat has not been declared for any of these threatened woodland birds.
6: Consistency with recovery or threat abatement plans	A recovery plan has been prepared for the Regent Honeyeater and the Swift Parrot. Relevant to the proposal, both plans focus on protecting nesting and foraging habitat. The proposed bushfire protection works will remove a small area of potential foraging habitat, however it is not known habitat and is therefore not inconsistent with the objectives of the plan. No recovery plan, or threat abatement plan exists for the remaining threatened woodland birds. The survey area does not occur within any identified management sites for the recovery of the Glossy Black-cockatoo. Identified recovery actions (OEH 2015) include the protection of old growth forests and habitat from damage or disturbance. Hollow-bearing trees will be retained in the APZ if possible. If retention is not possible, nest boxes will be placed in suitable areas adjacent to the APZ to compensate for lost hollows.

Table H.6 Seven part test for the threatened woodland birds

Criteria	Discussion
7: Key threatening processes	The impacts to key threatening processes '*clearing of native vegetation*' have been considered for the modification. Under the final determination (NSWSC 2011), clearing is defined as the destruction of a sufficient proportion of one or more strata (layers) within a stand or stands of native vegetation so as to result in the loss, or long term modification, of the structure, composition and ecological function of stand or stands. Given the small area to be disturbed and the selective nature of vegetation disturbance, the proposed modification will not result in this key threatening process. '*Loss of hollow-bearing trees*' has also been considered'. Hollow-bearing trees will be retained in the APZ if possible. If retention is not possible, nest boxes will be placed in suitable areas adjacent to the APZ to compensate for lost hollows to minimise the impacts of this key threatening process.
Conclusion	The proposed bushfire protection works are not expected to result in significant impacts to threatened woodland birds as: • there will only be a minor reduction in available foraging habitat; • only a small amount of potential breeding habitat will be disturbed; • an ecologist will conduct a pre-disturbance survey to determine the feasibility of retaining hollow trees in the APZ; • if hollow trees cannot be retained, nest boxes will be placed in suitable locations to compensate for lost hollows; and • foraging and breeding resources are abundant in the wider locality.

v Microbats: Eastern Bentwing Bat (*Miniopterus schreibersii oceanensis*), Eastern Freetail Bat (*Mormopterus norfolkensis*) and Little Bentwing Bat (*Miniopterus australis*)

The **Eastern Bentwing Bat** is listed as a vulnerable species under the TSC Act. Habitat (non-breeding) is present for this species in eucalypt woodland and open grasslands (Churchill 2008). This species migrates to maternity roosts in limestone caves in October and gives birth from December to January. Females leave maternity sites in March to seek out cold caves for winter hibernation. Eastern Bentwing Bats roost in other caves and road culverts for the remainder of the year (OEH 2015).

The **Eastern Freetail Bat** is listed as a vulnerable species under the TSC Act. The species occur in dry sclerophyll forest, woodland, swamp forests and mangrove forests east of the Great Dividing Range. Roost mainly in tree hollows but will also roost under bark or in man-made structures (OEH 2015).

The **Little Bentwing Bat** is listed as a vulnerable species under the TSC Act. It occurs in moist eucalypt forest, rainforest, vine thicket, wet and dry sclerophyll forest, Melaleuca swamps, dense coastal forests and Banksia scrub. Generally found in well-timbered areas. The species roost in caves, tunnels, tree hollows, abandoned mines, stormwater drains, culverts, bridges and sometimes buildings during the day, and at night forage for small insects beneath the canopy of densely vegetated habitats (OEH 2015).

The survey area provides potential foraging habitat for these microbat species. Breeding and roosting habitat is also potentially present for the Eastern Freetail Bat, but absent for the other microbats that roost in caves.

An assessment of impact criteria under Part 5a of the EP& A Act has been completed to assess potential impacts of the proposed modification to threatened microbats (Table H.7).

Table H.7 Assessment of impact criteria for the threatened microbats

Criteria	Discussion
1: Life cycle of threatened species	The survey area only provides potential breeding habitat for the Eastern Freetail Bat within hollow-bearing trees. Impacts on these habitat resources have the potential to affect breeding success, limit recruitment and decrease the local population size in the long-term. However, given that only up to 5 hollow-bearing trees will be potentially removed, and given the availability of such resources throughout the locality, these impacts are considered minor for the species in the long-term. An ecologist will complete a pre-disturbance survey to delineate hollow trees and determine if they can be retained in the APZ. If retention is not possible, nest boxes will be placed in suitable areas adjacent to the APZ to compensate for lost hollows. Indirect impacts such as night light may also interrupt these species and affect breeding success in the survey area, though such impacts are only likely to be minor.
2: Life cycle of endangered population	This question refers to endangered populations, therefore is not relevant to this assessment.
3: EEC extent and modification	This question refers to TECs, therefore is not relevant to this assessment.
4: Habitat removal, fragmentation, isolation and importance	Foraging habitat is widely distributed within the survey area, with only sheltering habitat and potential breeding habitat in hollow-bearing trees. Up to 1.04 ha of woodland representing foraging habitat for these species and up to 5 hollow-bearing trees may will be cleared/disturbed for the proposed bushfire protection works. An ecologist will complete a pre-disturbance survey to delineate these features and determine if they can be retained in the APZ. If retention is not possible, nest boxes will be placed in suitable areas adjacent to the APZ to compensate for lost hollows. The works will not fragment habitat for threatened microbats as they are a highly mobile species and continuous vegetation in surrounding areas will be retained.
5: Critical habitat	Critical habitat has not been declared for any of these threatened microbats.
6: Consistency with recovery or threat abatement plans	No recovery plan, threat abatement plan or priority action statement exists for these threatened microbats. Identified recovery actions (OEH 2015) include the protection of roosting sites from damage or disturbance. The proposed modification is not consistent with these recovery actions. The survey area is outside the identified management sites for the recovery of the Glossy Black-cockatoo.
7: Key threatening processes	The impacts to key threatening processes '*clearing of native vegetation*' have been considered for the modification. Under the final determination (NSWSC 2011), clearing is defined as the destruction of a sufficient proportion of one or more strata (layers) within a stand or stands of native vegetation so as to result in the loss, or long term modification, of the structure, composition and ecological function of stand or stands. Given the small area to be disturbed and the selective nature of the proposed vegetation disturbance, the proposed modification will not result in this key threatening process. '*Loss of hollow-bearing trees*' has also been considered'. Hollow-bearing trees will be retained in the APZ if possible. If retention is not possible, nest boxes will be placed in suitable areas adjacent to the APZ to compensate for lost hollows to minimise the impact of this key threatening process.
• Conclusion	The proposed bushfire protection works is not expected to result in significant impacts to threatened microbats as: • there will only be a minor reduction in available foraging habitat; • foraging resources are abundant in the wider locality; and • only a small amount of potential breeding or roosting habitat for the Eastern Freetail Bat will be disturbed; • an ecologist will conduct a pre-disturbance survey to determine the feasibility of retaining hollow trees in the APZ; and • if hollow trees cannot be retained, nest boxes will be placed in suitable locations to compensate for lost hollows.

vi Grey-headed Flying Fox (*Pteropus poliocephalus*)

The **Grey-headed Flying Fox** is listed as a vulnerable species under the TSC Act. This species is known to inhabit rainforest, forest and woodlands, heaths and swamps, as well as urban gardens where there is an abundance of nectar and pollen (OEH 2015). The survey area provides potential foraging habitat in the canopy of scattered flowering eucalypt and melaleuca trees and the species has been recorded at the CVC pit top area near the dams (EMM unpublished data 2014). Breeding and roosting habitat is absent within the survey area.

An assessment of impact criteria under Section 5a of the EP&A Act has been completed to assess the potential impacts of vegetation disturbance for bushfire protection on the Grey-headed Flying Fox (Table H.8).

Table H.8 Assessment of impact criteria for the Grey-headed Flying Fox

Criteria	Discussion
1. Life cycle of threatened species	Potential foraging habitat for the Grey-headed Flying-fox is available in the canopies of scattered eucalyptus and melaleuca trees of the survey area, where they may forage on the nectar and flowers. However, the survey area does not provide breeding habitat for this species.
2. Life cycle of endangered population	This question refers to endangered populations, therefore is not relevant to this assessment.
3. EEC extent and modification	This question refers to TECs, therefore is not relevant to this assessment.
4. Habitat removal, fragmentation, isolation and importance	Breeding or roosting habitat for the Grey-headed Flying Fox is absent from the survey area. Up to 1.04 ha of foraging habitat will be cleared/disturbed by the proposed bushfire protection works, in which trees will be selectively removed to meet the 15% canopy cover for the IPA and 30% for the OPA. The works will not fragment habitat for the Grey-headed Flying-fox as they are a highly mobile species and continuous vegetation in surrounding areas will be retained.
5. Critical habitat	Critical habitat has not been listed for this threatened species.
6. Consistency with recovery or threat abatement plans	Action statements for this species aim to ensure the species is secure in the wild in NSW and that its geographic range in NSW is extended or maintained. Objectives for recovery of this species include reducing the impact of threatening process and stopping its decline within its range and conserving the functional role of the species in seed dispersal and pollination. The proposed bushfire protection works will not interfere with these objectives as only a small patch of potential foraging habitat will be disturbed.
7. Key threatening processes	The proposed bushfire protection works constitute and increase 'disturbance of native vegetation', 'removal of dead wood and dead trees', 'loss of hollow-bearing trees' and 'predation by European Red Fox'. The BMP will detail measures to minimise these impacts.
Conclusions	Vegetation disturbance for proposed bushfire protection works will not have a significant impact on the Grey-headed Flying Fox as: • there will only be a minor reduction in available foraging habitat; • foraging resources are abundant in the wider locality; and • no breeding or roosting habitat will be removed.

vii Threatened mammals: Squirrel Glider (*Petaurus norfolcensis*) and Spotted-tailed Quoll (*Dasyurus maculatus maculatus*)

The **Squirrel Glider** is listed as a vulnerable species under the TSC Act. It was recorded in 2004, in woodland adjoining the pit top area (OEH 2015) and from the Vales Point Power Station Perimeter Lands. The species inhabits mature or old growth Blackbutt-Bloodwood forest with heath understorey in coastal areas (OEH 2015). Potential habitat exists across the survey area wherever hollows for sheltering are available.

The **Spotted-tailed Quoll** is listed as a vulnerable species under the TSC Act. It utilises a range of habitats including open forest and open woodland, which are available in the survey area. Shelter habitat is available in caves, among rocks, hollow logs and low tree hollows (OEH 2015).

An assessment of impact criteria under Part 5a of the EP& A Act has been completed to assess potential impacts of the proposed modification to threatened mammals (Table H.9).

Table H.9 Assessment of impact criteria for the threatened mammals

Criteria	Discussion
1: life cycle of threatened species	Although not recorded in the survey area, potential habitat exists for both threatened mammal species. Potential breeding habitat in the form of hollow-bearing trees (up to 5 trees) may be removed for the proposed bushfire protection works. However, given recent records and survey effort completed in the survey area and surrounds, these species are likely to only be present as vagrants or temporary visitors moving through the area between habitat patches. Therefore the survey area is not likely to constitute important breeding habitat and the proposed bushfire protection works will not impact on the lifecycle of these species. An ecologist will complete a pre-disturbance survey to delineate hollow trees and determine if they can be retained in the APZ. If retention is not possible, nest boxes will be placed in suitable areas adjacent to the APZ to compensate for lost hollows.
2: life cycle of endangered population	This question refers to endangered populations, therefore is not relevant to this assessment.
3: EEC extent and modification	This question refers to TECs, therefore is not relevant to this assessment.
4: habitat removal, fragmentation, isolation and importance	The following habitat will be cleared/disturbed as a result of the proposed bushfire protection works: • up to 1.04 ha of woodland representing potential foraging, sheltering and breeding habitat for the Squirrel Glider and Spotted-tailed Quoll; and • up to 5 hollow-bearing trees. An ecologist will complete a pre-disturbance survey to delineate these features and determine if they can be retained in the APZ. If retention is not possible, nest boxes will be placed in suitable areas adjacent to the APZ to compensate for lost hollows. The proposed bushfire protection works are unlikely to fragment habitats or isolate areas of vegetation within the locality. As the occurrence of such species is likely to be opportunistic and temporary, it is considered that retained vegetation will provide suitable habitat and movement corridors for these mammals into the future.
5: critical habitat	Critical habitat has not been declared for these threatened mammals.
6: consistency with recovery or threat abatement plans	A recovery action relevant to the proposed bushfire protection works from the National Recovery Plan for the Spotted-tailed Quoll (Long and Nelson 2004) is to 'reduce the rate of loss and fragmentation of Spotted-tailed Quoll habitat'. Given that no known habitat for this species will be removed and potential habitat will not be fragmented, it is considered that the proposed bushfire protection works are not inconsistent with this action.

Table H.9 Assessment of impact criteria for the threatened mammals

Criteria	Discussion
	The Squirrel Glider does not have a recovery plan. However recovery actions for the species involve the retention of hollow-bearing trees. While the proposed bushfire protection works will require the removal of hollow-bearing trees, impacts will be minimised on these habitat features where possible.
7: key threatening processes	The impacts to key threatening processes '*clearing of native vegetation*' have been considered for the modification. Under the final determination (NSWSC 2011), clearing is defined as the destruction of a sufficient proportion of one or more strata (layers) within a stand or stands of native vegetation so as to result in the loss, or long term modification, of the structure, composition and ecological function of stand or stands. Given the small area to be disturbed and the selective nature of proposed vegetation disturbance, the proposed modification will not result in this key threatening process. '*Loss of hollow-bearing trees*' has also been considered'. Hollow-bearing trees will be retained in the APZ if possible. If retention is not possible, nest boxes will be placed in suitable areas adjacent to the APZ to compensate for lost hollows to minimise the impacts of this key threatening process.
Conclusion	The proposed bushfire protection works is not expected to result in significant impacts to threatened mammal species as: • the species have a low likelihood of occurrence in the survey area, given the abundance of more suitable habitat in the locality; • if present, they are expected to occur as vagrants or temporary visitors moving between patches of habitat; • an ecologist will conduct a pre-disturbance survey to determine the feasibility of retaining hollow trees in the APZ; and • if hollow trees cannot be retained, nest boxes will be placed in suitable locations to compensate for lost hollows.

H.3 Significant impact criteria in accordance with the EPBC Act

The following sections provide the criteria that must be considered in the assessment of all threatened species listed under the EPBC Act. There are separate criteria for each listing category under the EPBC Act, in accordance with *'EPBC Act Policy Statement 1.1 Significant Impact Guidelines: Matters of National Environmental Significance'* (DEH 2006).

H.3.1 Significant impact criteria for critically endangered and endangered ecological communities

An action is likely to have a significant impact on a critically endangered or endangered ecological community if there is a real chance or possibility that it will:

- reduce the extent of an ecological community;
- fragment or increase fragmentation of an ecological community, for example by clearing vegetation for roads or transmission lines;
- adversely affect habitat critical to the survival of an ecological community;
- modify or destroy abiotic (non-living) factors (such as water, nutrients, or soil) necessary for an ecological community's survival, including reduction of groundwater levels, or substantial alteration of surface water drainage patterns;

- cause a substantial change in the species composition of an occurrence of an ecological community, including causing a decline or loss of functionally important species, for example through regular burning or flora or fauna harvesting;

- cause a substantial reduction in the quality or integrity of an occurrence of an ecological community, including, but not limited to:

  - assisting invasive species, that are harmful to the listed ecological community, to become established; or

  - causing regular mobilisation of fertilisers, herbicides or other chemicals or pollutants into the ecological community which kill or inhibit the growth of species in the ecological community; or

- interfere with the recovery of an ecological community.

H.3.2 Significant impact criteria for critically endangered and endangered species

An action is likely to have a significant impact on a critically endangered or endangered species if there is a real chance or possibility that it will:

- lead to a long-term decrease in the size of a population;

- reduce the area of occupancy of the species;

- fragment an existing population into two or more populations;

- adversely affect habitat critical to the survival of a species;

- disrupt the breeding cycle of a population;

- modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline;

- result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat;

- introduce disease that may cause the species to decline; or

- interfere with the recovery of the species.

H.3.3 Significant impact criteria for vulnerable species

An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:

- lead to a long-term decrease in the size of an important population of a species;

- reduce the area of occupancy of an important population;

- fragment an existing important population into two or more populations;

- adversely affect habitat critical to the survival of a species;

- disrupt the breeding cycle of an important population;
- modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline;
- result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species habitat;
- introduce disease that may cause the species to decline; or
- interfere substantially with the recovery of the species.

H.3.4 Significant impact criteria for listed migratory species

An action is likely to have a significant impact on a migratory species if there is a real chance or possibility that it will:

- substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species;
- result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species; or
- seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species.

H.3.5 Assessments of impact criteria

Assessments of impact criteria have been prepared for species listed under the EPBC Act, in accordance with the criteria above.

i Vulnerable plants: Black-eyed Susan, Leafless Tongue Orchid, Variable Midge Orchid

See Section H.2.1 (ii) for a description of the vulnerable plants. An assessment of impact criteria has been completed to assess potential impacts on vulnerable plants (Table H.10).

Table H.10 Assessment of impact criteria for vulnerable plants

Criteria	Discussion
1: Long-term decrease of an important population	If these species were to occur within the survey area it would not be considered an important population, as previous records exist in the Delta Electricity Perimeter Lands and the locality for all species. Therefore, any population in the survey area would be part of a larger local population and would not be: • a key source population either for pollination or dispersal; • a population that is necessary for maintaining genetic diversity; and/or • a population that is near the limit of the species range.
2: Reduce area of occupancy of an important population	The survey area is not considered to contain an important population of vulnerable flora.

Table H.10 Assessment of impact criteria for vulnerable plants

Criteria	Discussion
3: Fragment an important population	The survey area is not considered to contain an important population of vulnerable flora.
4: Adversely affect critical habitat	Critical habitat has not been identified for these vulnerable flora species. However, as no individuals have been detected in the survey area, and given the availability of similar and better quality habitat in the locality, it is not expected to provide critical habitat for this species.
5: Disrupt the breeding cycle of an important population	The life cycle of flora species can be affected in the following main ways: • impacts to pollination (internal mechanisms or impacts to pollinators) – insect pollinators are likely for these species, and it is considered unlikely that the proposed bushfire protection works would impact pollination mechanisms; • ability of the plant to produce flowers – the proposed bushfire protection works are not expected to affect the ability of individual plants to produce flowers, this is more likely to be affected by other environmental effects such as rainfall; • ability of the plant to produce and set seed – the proposed bushfire protection works is not expected to impact the ability of the species to produce and set seed; • ability to germinate – the germination requirements of these species are not known; and • ability of seedlings to grow – the proposed bushfire protection works could produce high levels of dust which could affect photosynthesis capabilities and growth of seedlings and adult plants in surrounding areas. Approximately 1.04 ha of potential habitat will be impacted. The proposed bushfire protection works will not remove known habitat or individuals of this species and is unlikely to impact pollinators. The proposed bushfire protection works are therefore considered unlikely to affect the breeding cycle of vulnerable flora species, should they occur within the survey area.
6: Modify, destroy, remove or isolate or decrease availability or quality of habitat	The proposed bushfire protection works will result in clearing/disturbance of approximately 1.04 ha of potential habitat for vulnerable flora species. No individuals have been recorded within the survey area, however recent surveys were undertaken outside the flowering period. Pre-disturbance surveys will be completed by an ecologist during the flowering period of all three species to determine if they occur in the proposed APZ. Threatened plant populations, if found, will be protected by delineation fencing and population health will be monitored as part of the BMP. Retained habitats may be susceptible to indirect impacts including increased dust levels and edge effects in areas adjacent to the existing pit top area. However, if these species were to occur within the survey area, the proposed bushfire protection works are considered unlikely to isolate or decrease the quality of habitat in the locality for them.
7: Result in invasive species	The disturbance to native vegetation for the modification has the potential to increase weed invasion in potential habitats for vulnerable species. Measures to control and suppress weeds in the bushfire protection areas will be included within the BMP.
8: Introduce disease	Control of soil-borne disease will be included as part of the BMP. Wash-down procedures for weeds and soil will be included, to reduce the risk of introducing *Phytophthora cinnamomi* or other disease that could affect potential habitat of the species.
9: Interfere with recovery	There are no recovery plans for the vulnerable plant species. Recovery actions centre around identifying habitat and populations and protecting habitat. Pre-disturbance surveys will be completed by an ecologist during the flowering period of all three species to determine if they occur in the proposed APZ. Threatened plant populations, if found, will be protected by delineation fencing and population health will be monitored as part of the BMP. The proposed bushfire protection works is therefore considered unlikely to interfere substantially with the recovery of the species.

Table H.10 Assessment of impact criteria for vulnerable plants

Criteria	Discussion
Conclusion	The proposed bushfire protection works is not expected to result in significant impacts to vulnerable flora species: • it does not remove any known individuals from the local area; • pre-disturbance surveys will be completed during the flowering period of each species to determine their occurrence in the proposed APZ; • if found, threatened plant populations will be protected in the APZ and their health will be monitored under the BMP; and • indirect impacts to potential habitats retained within the survey area will be managed according to the BMP.

ii Endangered woodland birds: Swift Parrot (*Lathamus discolor*) and Regent Honeyeater (*Xanthomyza phrygia*)

See Section H.2.1 (iv) for a description of the Swift Parrot and Regent Honeyeater. An assessment of impact criteria has been completed to assess potential impacts of the modification on these endangered woodland birds (Table H.11).

Table H.11 Assessment of impact criteria for endangered woodland birds

Criteria	Discussion
1: Long-term decrease in population size	Regent Honeyeaters and Swift Parrots breed outside the survey area. Therefore the modification will not impact on breeding habitat or breeding success for these species. The proposed bushfire protection works will result in the loss of some potential winter foraging habitat from the local area. However, similar vegetation exists in the wider local area and proposed vegetation disturbance is considered to be minor. Therefore it is considered that the removal of potential winter foraging habitat is unlikely to lead to a long-term decrease In population size for either species.
2: Reduce area of occupancy	Swift Parrots and Regent Honeyeaters show very high site fidelity, returning to sites that have previously been used on a cyclic basis. However, as site use depends on the availability of foraging resources, the species are unlikely to be recorded at the same site every year (DoE 2015). Neither species was been recorded within the survey area previously, and therefore the proposed bushfire protection works are unlikely to reduce the area of occupancy of these species.
3: Fragment a population	The removal of an area of potential foraging habitat will not fragment populations of these highly mobile species.
4: Adversely affect critical habitat	Winter-flowering habitat for these species may be important to their long-term survival. Such habitat exists in the survey area. However, habitat within the survey area has not been identified as critical habitat for these species.
5: Disrupt the breeding cycle of a population	The breeding cycle of these species will not be disrupted as it occurs outside of the survey area.
6: Decrease availability or quality of habitat	Approximately 1.04 ha of potential winter foraging habitat for these species will be disturbed by the proposed APZ, in which vegetation cover will be disturbed to 15% and 30% in the IPA and OPA, respectively. Large areas of similar habitat occur throughout the locality.
7: Result in invasive species	Following disturbance for the proposed bushfire protection works, these species may be subject to competition from the native (however territorial) Noisy Miner which is present across much of the survey area.
8: Introduce disease	These species are subject to *Psittacine Circoviral* (Beak and Feather) Disease. The proposed bushfire protection works is unlikely to increase the incidence of this disease.

Table H.11 Assessment of impact criteria for endangered woodland birds

Criteria	Discussion
9: Interfere with recovery	Recovery actions for these two species (Swift Parrot Recovery Team 2001) centre upon the maintenance and enhancement of habitat at key sites. The actions are not consistent with these outcomes as potential habitat will be removed.
Conclusion	The modification is not expected to result in significant impacts to the Regent Honeyeater or Swift Parrot as: • the species have a low likelihood of occurrence in the survey area due to the lack of previous records in the immediate locality; • the species breed outside the survey area; and • large areas of potential wintering habitat will be retained.

iii Vulnerable mammals: Grey-headed Flying Fox (*Pteropus poliocephalus*)

See Section H.2.1 (vi) for a description of the Grey-headed Flying Fox. An assessment of significance has been completed to assess potential impacts of vegetation disturbance for bushfire protection on this threatened species (H.12).

Table H.12 Assessment of significance for the Grey-headed Flying Fox

Criteria	Discussion
1: Long-term decrease of an important population	The survey area does not contain an important population of the Grey-headed Flying Fox.
2: Reduce area of occupancy of an important population	The survey area does not contain an important population of the Grey-headed Flying Fox.
3: Fragment an existing population	The survey area does not contain an important population of the Grey-headed Flying Fox.
4: Adversely affect critical habitat	The survey area is not considered critical habitat to the Grey-headed Flying Fox as they are a highly mobile species and these areas form only a small portion of their home range. The survey area does not contain maternity camps for breeding.
5: Disrupt the breeding cycle of an important population	The survey area does not provide breeding habitat for an important population of this species.
6: Decrease availability or quality of habitat	The proposed bushfire protection works may cause a minor reduction in available foraging habitat for the species in the locality. However, as vegetation disturbance will only be minor when considering the amount of habitat in the locality, this is not expected to decrease the availability or quality of habitat such that the species would decline.
7: Result in invasive species	The proposed bushfire protection works are not expected to increase the threat of invasive species to the Grey-headed Flying Fox.
8: Introduce disease	Grey-headed Flying Fox is known to be susceptible to the Australian Bat Lyssavirus (ABL), however only a small proportion of flying foxes actually carry the disease. Future development will not remove any breeding habitat for this species and will only cause minor disturbance to potential foraging habitat. As a result, construction of the APZ is not expected to increase the likelihood, introduction, or spread of this disease.

Table H.12 Assessment of significance for the Grey-headed Flying Fox

Criteria	Discussion
9: Interfere with the recovery of the species	Recovery actions for the Grey-headed Flying Fox include reducing the impact of threatening process on this species and stopping its decline throughout the species' range, conserving the functional roles of the species in seed dispersal and pollination, improving the standard of information available in order to increase community knowledge of the species and reducing the impact of negative public attitude on the species. Construction of the APZ does not interfere with these activities and are not expected to interfere with the recovery of the Grey-headed Flying Fox as only a small patch of potential foraging habitat is being removed.
Conclusion	Construction of the APZ is not expected to result in significant impacts to the Grey-headed Flying Fox as: • only a small area of potential foraging habitat will be removed; • breeding habitat will be not be removed; and • they are a highly mobile species with alternative foraging resources nearby.

iv Endangered mammals: Spotted-tail Quoll (*Dasyurus maculatus maculatus*) and New Holland Mouse (*Pseudomys novaehollandiae*)

See Section H.1.1 (vii) for a description of the Spotted-tail Quoll. An assessment of impact criteria has been completed to assess potential impacts of the proposed modificaiton on this endangered mammal (Table H.13).

Table H.13 Assessment of impact criteria for endangered mammals

Criteria	Discussion
1: Long-term decrease in population size	Maintenance of territories of female Spotted-tail Quolls (particularly their prey items, breeding dens and connectivity between these dens) are of critical importance to the conservation of the species, as the distribution of males appears to be largely influenced by the presence of breeding adult females (Belcher and Darrant 2004). The territories of the local population, should one occur, is unlikely to be impacted given the minor nature of the proposed bushfire protection works as this species has a large home-range size and is likely to be using it in association with other areas of woodland. If it is using the survey area, the proposed bushfire protection works are unlikely to impact the long-term survival of the species within the region.
2: Reduce area of occupancy	The proposed bushfire protection works will disturb the potential area of occupancy of this species by 0.79 ha.
3: Fragment a population	It is unlikely that the survey area supports a local population of the species, given the availability of better quality habitat surrounding the survey area and within nearby conservation areas. As such, individuals likely to use the survey area as a movement corridor or supplementary habitat are unlikely to be directly impacted by the proposed bushfire protection works. This species uses landscape features such as vegetated creek lines for dispersal throughout its territory (Strahan 1995). The proposed bushfire protection works will not result in the fragmentation of potential movement corridors or isolation of habitat patches.
4: Adversely affect critical habitat	Habitat in the survey area is not considered critical to the survival of the Spotted-tail Quoll as if they occur, it would only be as vagrants or temporary visitors, moving between patches of better quality habitat.

Table H.13 Assessment of impact criteria for endangered mammals

Criteria	Discussion
5: Disrupt the breeding cycle of a population	The breeding cycle of this species may be disrupted through the removal of hollow-bearing trees which are potential breeding habitat. The breeding cycle may also be subject to disturbances adjacent to habitat including light, dust and noise, particularly for dispersing individuals looking for mates. However, such impacts already exist at CVC's pit top and ventilation fan site areas. Pre-disturbance surveys will be completed by an ecologist to determine the feasibility of retaining hollow-bearing trees in the APZ. If hollow-bearing trees cannot be retained, nest boxes will be installed in suitable areas adjacent to the APZ to compensate for lost hollows. Cut timber will also be placed adjacent to the APZ to create shelter habitat for the Spotted-tail Quoll and other ground-dwelling fauna.
6: Decrease availability or quality of habitat	Spotted-tail Quolls have large home ranges (620 – 2,560 ha for males and 90 - 650 ha for females (Claridge *et al*, 2005)), making it difficult for individuals to disperse to alternative breeding sites outside the survey area and causing intraspecific competition, should the survey area represent an area of habitat for this species. However, given the minor nature of the proposed bushfire protection works, any likely impacts will be minor.
7: Result in invasive species	The European Red Fox is known to prey upon the Spotted-tailed Quoll (Murray and Poore 2004). European Red Fox numbers may increase slightly in remnant habitat areas as a result of the proposed modification, which will create new access tracks and clearing for movement into surrounding bushland. Measures to restrict the spread of feral animals through the survey area will be enacted to minimise this potential impact.
8: Introduce disease	The Spotted-tail Quoll is not known to be susceptible to any diseases.
9: Interfere with recovery	A recovery action relevant to the proposed bushfire protection works from the National Recovery Plan for the Spotted-tailed Quoll (Long and Nelson 2004) is to 'reduce the rate of loss and fragmentation of Spotted-tailed Quoll habitat'. Maintenance of territories of female Spotted-tail Quolls (particularly their prey items, breeding dens and connectivity between these dens) are of critical importance to the conservation of the species, as the distribution of males appears to be largely influenced by the presence of breeding adult females (Belcher and Darrant 2004). The proposed works will not significantly interfere with the maintenance of territories and therefore will not interfere with the recovery of the species.
Conclusion	The modification is not expected to result in significant impacts to the Spotted-tail Quoll as: • they have a low likelihood of occurrence in the survey area due to the absence of high quality habitat and availability of more suitable habitat in surrounding areas; • the works are unlikely to reduce or interfere with territories given their home range sizes; • an ecologist will complete a pre-disturbance survey to determine the feasibility of retaining hollow trees in the APZ; and • if hollow trees cannot be retained, nest boxes will be placed in suitable areas adjacent to the APZ to compensate for lost hollows.

v Migratory birds: White-bellied Sea Eagle

The White-bellied Sea-Eagle is found in coastal habitats (especially those close to the sea-shore) and around terrestrial wetlands in tropical and temperate regions of mainland Australia and its offshore islands. It was recorded adjacent to the survey area at the CVC pit top area roosting in Swamp Oak Forest (EMM unpublished data 2014). However, no nests were identified during the surveys in the survey area or surrounds.

An assessment of significance has been completed to assess potential impacts on these migratory birds (Table H.14).

Table H.14 Assessment of significance for migratory birds

Assessment part	Discussion
1: substantially modify important habitat	The survey area does not constitute an area of important habitat for the White-bellied Sea Eagle, as an ecologically significant proportion (as defined under the guidelines (DEH,2006)) of its population does not reside in the survey area, no breeding occurs in the area, it is not at the limit of their range and they are not known to be declining.
2 : result in invasive species	The proposed bushfire protection works are not expected to increase the threat of invasive species to the White-bellied Sea Eagle.
3: disrupt lifecycle of ecologically significant proportion of population	An ecologically significant proportion of this species does not reside in the survey area. In addition, they do not breed in the survey area, foraging habitat is not available within the survey area and the proposed modification is unlikely to disrupt migration patterns.
Conclusion	The modification is not expected to result in significant impacts to the White-bellied Sea Eagle as: • an ecologically significant proportion of the species is not known to reside in the survey area; and • the survey area does not contain important habitat.

H.4 References

Belcher CA and Darrant JP 2004, *Home range and spatial organization of the marsupial carnivore, Dasyurus maculatus maculatus (Marsupialia: Dasyuridae) in south-eastern Australia*. Journal of Zoology. 262:271-280.

Churchill S 2008, *Australian Bats: second edition,* Reed New Holland Publishers, Crows Nest.

Department of Environment and Conservation (DEC) 2006, *Recovery Plan for the Large Forest Owls,* Department of Environment and Conservation NSW, Sydney.

Department of Environment and Conservation (DEC) 2007, *Threatened species assessment guidelines: The assessment of significance,* Department of Environment and Conservation NSW, Sydney.

Department of the Environment (DoE) 2015, *Species Profile and Threat Database,* www.environment.gov.au/cgi-bin/sprat/public/sprat.pl, viewed 15 April 2015.

Ecotone Ecological Consultants 2010, *Flora and Fauna Investigations Vales Point Power Station Perimeter Lands Biodiversity Update,* report to Aurecon Australia and Delta Electricity.

Long K and Nelson J 2004, *Recovery Plan for Dasyurus maculatus (Spotted-tail Quoll) 2005-2009,* Department of Environment and Heritage, Canberra.

New South Wales Scientific Committee (NSWSC) 2004, *Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and South East Corner bioregions – endangered ecological community listing,* www.environment.nsw.gov.au/determinations/SwampOakFloodplainEndSpListing.htm, viewed 14 April 2015.

New South Wales Scientific Committee (NSWSC) 2011, *Clearing of native vegetation – key threatening process listing,* www.environment.nsw.gov.au/determinations/ClearingNativeVegKTPListing.htm, viewed 14 April 2015.

Office of Environment and Heritage (OEH) 2015, *Threatened Species Profile Search,* www.environment.nsw.gov.au/threatenedSpeciesApp/, viewed 14 April 2015.

Swift Parrot Recovery Team 2001, *National Recovery Plan for the Swift Parrot (Lathamus discolor),* Swift Parrot Recovery Team, Carlton Victoria.

Appendix I

Aboriginal cultural heritage assessment

Appendix I — Aboriginal cultural heritage assessment

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21 May 2015

Chris Ellis
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Re: Chain Valley Colliery Modification 2 - Aboriginal cultural heritage assessment

Dear Chris,

1 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. CVC is operated by LakeCoal Pty Ltd (LakeCoal).

LakeCoal has engaged EMGA Mitchell McLennan Pty Limited (EMM) to prepare a Statement of Environmental Effects (SEE) to accompany an application to modify CVC's development consent (SSD-5465) to, amongst other things, increase extraction of run-of-mine (ROM) coal at CVC from 1.5 million tonnes per annum (Mtpa) to 2.1 Ntpa (the proposed modification).

As part of the SEE an Aboriginal cultural heritage assessment (ACHA) has been completed in accordance with NSW Office of Environment and Heritage (OEH) guidelines including the *Aboriginal Cultural Heritage: Standards & Guidelines Kit* (NPWS 1997), and the *Draft Guidelines for Aboriginal Cultural Heritage Impact Assessment and Community Consultation* (DEC 2005). This letter constitutes the ACHA.

2 Overview of the proposed modification

LakeCoal is seeking approval to modify SSD-5465 under Section 96(2) of the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act) to allow for:

- an increase in the maximum rate of ROM coal extraction at CVC from 1.5 Mtpa to 2.1 Mtpa;
- mine design changes, primarily the re-orientation of miniwall panels in CVC's northern mining area;
- an increase in full time personnel from 160 to approximately 220; and
- minor vegetation clearing/disturbance adjacent to some infrastructure at CVC's pit top and the ventilation fan site at Summerland Point to enable the extension/establishment of asset protection zones (APZs) for bushfire protection purposes (see Figure 1).

The mine design changes will result in a minor change to spatial limits of the proposed mining activities, however all secondary extraction will remain limited to areas beneath Lake Macquarie with protection barriers for the foreshore and seagrass continuing to apply (see Figure 1). There will be no change to CVC surface infrastructure and only a small area (approximately 0.3 ha) of additional clearing will be required to accommodate the development of an asset protection zone around existing surface infrastructure.

For the purposes of this assessment, the above modification elements will be referred to as the proposed modification.

It is noted that an underground linkage is approved between CVC and the adjacent Mannering Colliery (MC), which operates under major project approval (MP06_0311). LakeCoal is also seeking a separate modification of MP06_0311 to increase the coal throughput at MC from 1.1 mtpa to 1.3 mtpa. This will allow for all production at CVC beyond the existing limit of 1.5 mtpa to be sent via MC to Vales Point Power Station.

3 Method

The methods used to identify potential Aboriginal cultural heritage sites and/or values associated with the propose modification comprised:

- review of the previous archaeological investigations undertaken at CVC;
- consultation with the registered Aboriginal parties (RAPs); and
- conducting an extensive search of the Aboriginal Heritage Information Management System (AHIMS) database to identify previously recorded Aboriginal sites.

It was not considered necessary to survey the areas being disturbed by the proposed modification for the reasons outlined in Section 5.5.

4 Aboriginal consultation

4.1 Process

Aboriginal consultation was undertaken for both the *Heritage Impact Assessment Chain Valley Colliery Continuation of Mining* (AECOM 2011) and the *Chain Valley Colliery Mining Extension 1 Project* (EMM 2013) prepared to accompany the application for SSD-5465. Consultation was based on the most up to date guidelines at the time including the *Interim Community Consultation Requirements for Applicants* (ICCRs, DEC 2004), the *Draft Guidelines for Aboriginal Cultural Heritage Impact Assessment and Community Consultation* (DEC 2005) and the *Aboriginal cultural heritage consultation requirements for proponents* (DECCW 2010). This resulted in the identification of RAPs with an interest in CVC and its ongoing operations. Consultation also occurred during both the initial development and subsequent revision of the approved Heritage Management Plan (HMP).

Comment on this report was sought from the RAPs and is contained in Section 4.3. A record of consultation and correspondence with the RAPs for this ACHA is provided in Appendix A.

4.2 Registered Aboriginal Parties

The RAPs referenced above comprise:

- Bahtabah Local Aboriginal Land Council;
- Darkinjung Local Aboriginal Land Council;
- Cacatua Culture Consultants;
- Awabakal Traditional Owners Aboriginal Corporation;
- Awabakal Descendants Traditional Owners Aboriginal Corporation; and

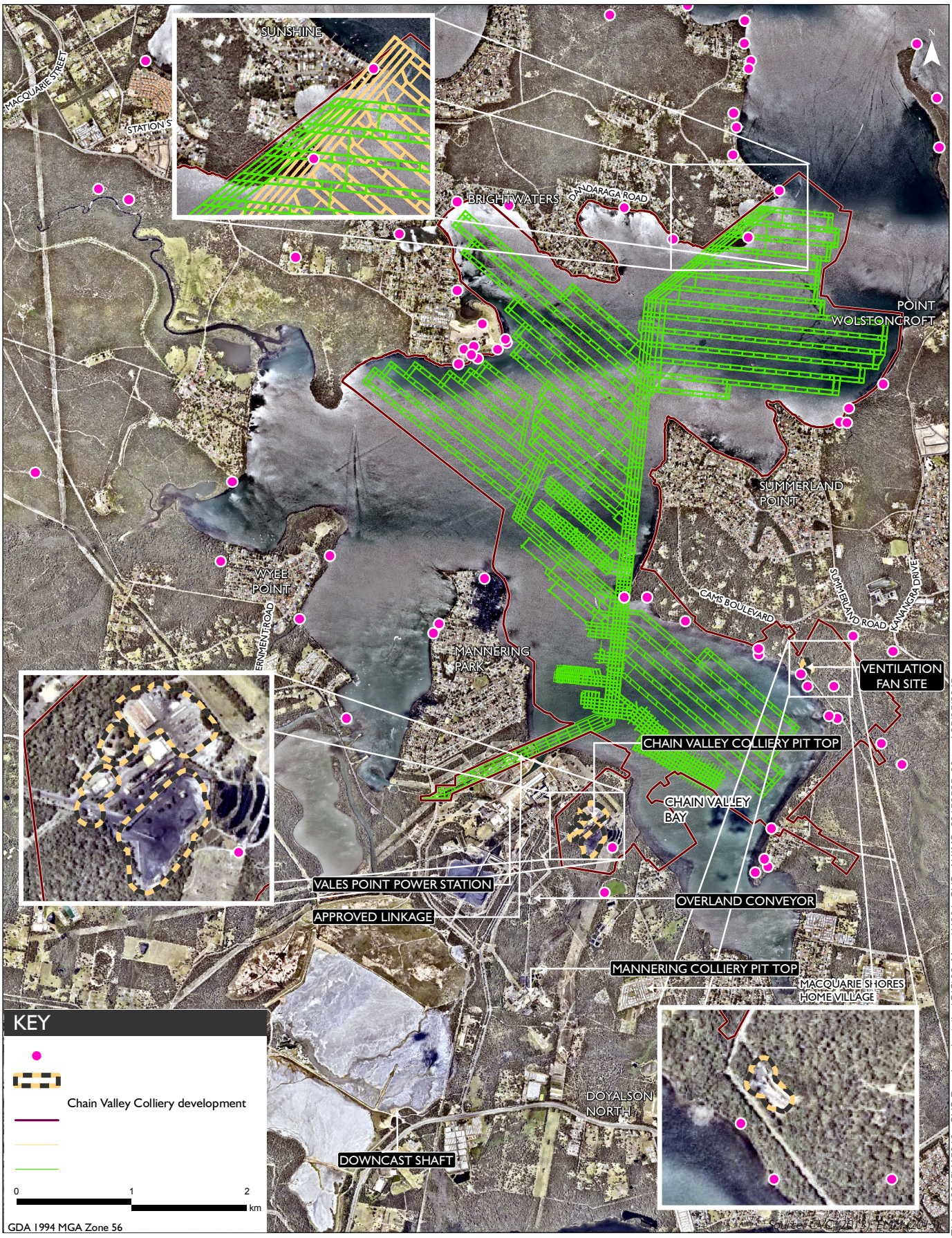
- Guringai Tribal Link Aboriginal Corporation.

It is also noted that the Awabakal and Guringai People have a registered native title claim application over the Central Coast of NSW covering areas of Crown land and water, which would include the waters of Lake Macquarie (refer Federal Court Application No NSD780/2013 for further details). The parties included in this registered claim are being consulted in regards to this modification.

4.3 Draft report review and feedback

A draft version of this report was provided to the RAPs on 13 April 2015. The Darkinjung Local Aboriginal Land Council provided a response to the report on 1 May 2015 which is contained in Appendix A. It noted overall satisfaction with the recommendations made by EMM and commented on the importance of the Lake Macquarie Aboriginal cultural landscape to the local Aboriginal community as a physical link to their ancestors and past. In addition the Darkinjung Local Aboriginal Land Council noted their desire to participate in the assessments of the vegetation clearing of the asset protection zone and advocated for continued protection of Aboriginal sites in or within the vicinity of the project area. No objections were raised in relation to the proposed modification.

As at the 25 May 2015 no other comments have been received in relation to the proposed modification. All groups were sent a final copy of the report.



EMM
EMGA Mitchell McLennan

Proposed modification layout and AHIMS sites

Chain Valley Colliery - Modification 2

Figure 1

5 Existing environment

5.1 Landscape context

CVC is located in a region known as the Central Coast Lowlands of NSW. This region is characterised by low lying terrain, alluvial plains and dune fields in coastal areas. The Central Coast Lowlands are dominated by the coastal Macquarie, Tuggerah and Munmorah Lakes.

Climatic conditions in the Lake Macquarie region have been stable for approximately 10,000 years and would have provided a good environment for human habitation. Natural resources, including the flora and fauna that may have provided food and material resources, are linked to the hydrology, geology and soil types in a region.

The geology of the region includes sandstone, interbedded sandstone and siltstone. Caves and overhangs created in sandstone cliffs and boulders may have been used for shelter while Lake Macquarie and the creeks that feed into the lake would have provided an abundance of food resources for Aboriginal people. The soils within the region form part of two soil landscapes: the Doyalson; and the Wyong.

Land around the proposed modification has been subject to disturbance. Of particular importance is the disturbance from residential development along the Lake Macquarie shoreline which has resulted in extensive vegetation clearing. In areas which have not been subject to residential development, logging and timber getting has been common since settlement in the 1820s. CVC has been in operation since 1962 and areas used for or impacted by mining activities have been subject to disturbance.

5.2 Ethno-historical context

Discussions with relevant Aboriginal groups has identified that the Lake Macquarie region is of significance as it is a connection with ancestors and cultural heritage. The evidence of Aboriginal occupation in the landscape is highly valued and is a reminder to the Aboriginal community of their country and spirituality.

The dominant Aboriginal language group for the Lake Macquarie region was that of Awabakal-speaking people, though little was recorded about their territorial boundaries (Tindale 1974). The information recorded did suggest that the Hunter Valley Aboriginal groups, including the Awabakal, had a high level of interaction and intertribal relationships (Tindale 1974).

Extensive information about the Awabakal is available from the writings of L.E Threlkeld who established a mission in 1825 at Toronto on the shores of Lake Macquarie and, for seventeen years, recorded the language, traditions and material culture of the Awabakal people. He also observed the rich food resources of Lake Macquarie including fish, molluscs and wildlife. The Awabakal exploited this resource using canoes, spears, and wood and stone tools (Threlkeld in Gunson 1974).

5.3 Previous archaeological investigations

Extensive previous archaeological studies have been completed in the Lake Macquarie region. These studies have provided information on the types of sites present and their distribution in the landscape. Previous studies in the Lake Macquarie area have identified that Aboriginal subsistence was focused on the estuarine shell beds on the lake margins. There is a strong association with shell midden sites and the lake shore, whereas stone artefact sites are often mixed with midden sites but also distributed adjacent to watercourses in the hinterland of Lake Macquarie. Table 5.1 provides further information on the relevant archaeological reports.

Table 5.1 Relevant archaeological reports

Report title and author	Overview
Archaeological excavations at Swansea, annual report, Dyall 1975	A midden was excavated in the Swansea area. It contained shell, stone tools and bone. A large number of backed blades were recorded in the stone tool assemblage recovered from the midden. During this season, Dyall also excavated twelve burial and cremation sites.
Assessment of the Prehistoric Heritage in the Lake Macquarie Area, Haglund 1986	A review of Aboriginal archaeological sites in the Lake Macquarie area was undertaken with over 150 sites recorded. They included shell middens (48), open campsites (65), rock shelters (some with art) (10), grinding grooves (25), scarred trees (1), quarries (2) and one natural mythological site. As a result of the review, a seasonal model for occupation of the area was devised. The seasonal model suggested winter inland occupation and summer coastal occupation. The estuarine area of Lake Macquarie formed the resource bridge between the hinterland and the coast. The implication from this model is that the sites located along the shore of Lake Macquarie may be small transitory camps between the two main occupation areas.
Archaeological survey of proposed tourist resort 0020 at Summerland Point Lake Macquarie NSW, Brayshaw 1989	A survey of the Lake Macquarie foreshore was undertaken for the proposed development of a resort. The survey identified one midden site, west of Bonny Boy Gully. It contained a thin layer of shell and possible hearthstones. Flaked artefacts were rare or absent.
Archaeological investigation of Morisset Peninsula Sewerage Scheme, Dallas & Navin 1993	A survey of the proposed Morisset sewerage scheme was completed along the Morisset and Sunshine Peninsulas. A number of midden sites were identified, two of which are located within the boundaries of the proposed modification (see Sections 4.4 and 4.5).
Lake Macquarie Aboriginal Heritage Study Stage 1a, Umwelt 2009a, Lake Macquarie Aboriginal Heritage Study Stage 1b Survey, Umwelt 2009b, Sustainable Management of Aboriginal Cultural Heritage in the Lake Macquarie Local Government Area: Lake Macquarie Aboriginal Heritage Management Strategy, Umwelt 2011	Lake Macquarie City Council commissioned a series of reports to understand the Aboriginal heritage of the Lake Macquarie LGA. A two stage Aboriginal heritage study was completed which involved extensive desktop research to predict site distribution and landscape sensitivity, followed by field investigations to refine the desktop results. Umwelt identified 16 areas which they considered were able to address gaps in knowledge for Aboriginal heritage in the LGA. These 16 areas fell into five landscape groups. 1. Lake foreshore areas, which had an archaeological record of midden sites, artefact scatters and isolated finds. It was considered that these areas were accessed by Aboriginal people due to the fish and shellfish resources available and were stayed at for short periods of time. 2. Major creek catchments, which had an archaeological record of artefact scatters, isolated finds, grinding grooves and scarred trees. These areas were considered to have a high level of cultural sensitivity. It was suggested that places close to both estuarine and freshwater areas would have provided diversity of resources and supported occupation by significant numbers of people. 3. Minor creek catchments, which had an archaeological record of artefact scatters, grinding grooves, middens, rock shelters and Potential Archaeological Deposits (PADs). These areas were considered to contain a diversity of resources. 4. Mountainous inland areas, which had an archaeological record of artefact scatters, grinding grooves, crying trees, burial sites, scarred trees, potholes/water wells, stone arrangements/direction markers, rock shelters and Aboriginal pathways. This area had a large proportion of grinding grooves suggesting it was visited due to its sandstone outcrops. 5. Coastal areas, which had an archaeological record of midden sites. A lack of ground surface visibility made site identification difficult. The Aboriginal Heritage Study was followed in 2011 by an Aboriginal Heritage Management Strategy which provided guidelines for the management of Aboriginal heritage in the LGA. It also identified areas of high conservation value in the Lake Macquarie LGA.
Cultural Heritage Report Wyee Point Reserve, RPS 2010	A due diligence assessment was undertaken in a proposed development over the Wyee Point Reserve. One midden was recorded and the extent of a previously recorded midden was determined.
Cultural Heritage Assessment Mannering Colliery, RPS 2011b	RPS undertook a cultural heritage study for the extension of mining at MC. During the field surveys, two new Aboriginal sites were identified: a midden and a culturally

Table 5.1 Relevant archaeological reports

Report title and author	Overview
	modified tree. In addition, the riparian zone of Wyee Creek was identified as an area of Aboriginal heritage sensitivity. It was recommended that should subsidence exceed 20 mm in areas of Aboriginal or historic heritage sensitivity that works should cease immediately and an assessment of potential impacts to Aboriginal or historic heritage items should be undertaken.
Myuna Colliery Extension of Mining Cultural Heritage Assessment, RPS 2011c	A cultural heritage assessment was undertaken for the extension of mining at Myuna Colliery. The survey identified six new Aboriginal sites with five assessed as of moderate significance and one site assessed as of high significance. The sites included middens, modified trees and cultural sites located on the shores of Lake Macquarie. Management recommendations included the development of an Aboriginal Cultural Heritage Management Plan and archaeological monitoring if mining was to occur under Aboriginal sites.
Heritage Impact Assessment Chain Valley Colliery Continuation of Mining, AECOM 2011.	The impact of the Colliery on historic and Aboriginal heritage was assessed with desktop analysis and fieldwork. Three phases of fieldwork identified five new shell midden sites along the Lake Macquarie foreshore. Along with the new sites, six previously recorded sites were revisited. The potential for minor subsidence impacts on one site was considered as it was located above an area selected for mining first workings. Although subsidence was predicted to be less than 20 mm, monitoring of the site is being undertaken in accordance with the HMP.

5.4 AHIMS search

An extensive search of the AHIMS register was conducted on 17 August 2014 for an area of 5 km by 5 km surrounding CVC's pit top (the search area). The search area was sufficient to define the pattern of previously recorded Aboriginal sites in the landscape as it covered adjacent catchments. The search revealed a total of 112 registered sites, the majority of which occurred along the Lake Macquarie foreshore. As shown in Table 5.2, middens were the most common site type recorded and accounted for 59% of the total sites registered. Isolated finds and scarred trees accounted for 14% and 9% of the total sites respectively. The results of the search are presented in Appendix B. No Aboriginal sites were located in the proposed modification area.

Table 5.2 AHIMS registered sites within the search area

Site type	Number of sites	Percentage
Isolated find	18	14%
Open camp site	3	3%
Midden	65	59%
Scarred tree	10	9%
Midden/open camp site	3	3%
Unknown	3	3%
Grinding groove	2	2%
Aboriginal place	1	1%
Potential Archaeological Deposit (PAD)	5	4%
Ochre quarry	1	1%
Aboriginal place/PAD	1	1%
Total	**112**	**100%**

The results of the search are presented in Appendix B. Figure 1 shows the Aboriginal sites' relationship to the proposed modification. A number of sites are mapped as located within Lake Macquarie, which is the

result of incorrect coordinates. These sites are actually located on the Lake's foreshore and will not be impacted by the modification.

One site, 45-7-0157, is located in the northern extent of CVC's mining area. Another site, 45-7-0154, is located on the foreshore in close proximity to the south. This site is, however, not within the proposed modification area. These sites are shown on Figure 1 and details given below.

- 45-7-0157 – a midden site also known as M7, located at Fishery Point within the suburb of Sunshine. It was recorded in 1993 as part of a study for the Morisset sewerage scheme. It was in poor condition and badly disturbed by a vehicle and boat ramp and foreshore reclamation. Consent to destroy the site was issued in June 1994. The majority of the site was removed but a small portion remains in the adjacent reserve. This site was visited by EMM and RAPs in 2013 (see Section 5.5).

- 45-7-0154 – a midden site also known as M10 at the apex of Casuarina Point, within Casuarina Point Reserve in the suburb of Sunshine. It was recorded in 1993 as part of a study for the Morisset sewerage scheme. It was in poor condition and badly disturbed by the construction of housing and a stormwater drain. Consent to destroy the site was issued in June 1994. The majority of the site was removed leaving approximately one square metre of heavily disturbed shell, (Umwelt 2003).This site was visited by EMM and RAPs in 2013 (see Section 5.5).

No sites are located in the asset protection zone for the pit top. There are two sites in the vicinity of the asset protection zones around the ventilation fan site. These sites are shown on Figure 1 and details given below.

- 45-7-0271 – a midden site also known as CV-08-09, located along the Lake Macquarie foreshore approximately 100 m from the existing mine ventilation fan site. The predominant shell type is cockle (*Anadara trapezia*). The site, which covers an area of approximately 2 m^2, was surveyed and identified by AECOM and RAPs in 2011 (see Section 5.5).

- 45-7-0273 – a midden site also known as CV-09-09 located along the Lake Macquarie foreshore approximately 100 m from the existing mine ventilation fan site. The predominant shell type is the cockle . The site, which covers an area of approximately 10 m^2, was surveyed and identified by AECOM and RAPs in 2011 (see Section 5.5).

5.5 Previous surveys

Due to the previous detailed survey of the four Aboriginal sites listed above and their inclusion in the HMP, resurvey of the proposed modification is not required. Previous surveys include:

- 2011 - A survey by archaeologists and RAPs was conducted of the area surrounding the mine ventilation fan site at CVC, as part of the heritage assessment process for the CVC Continuation of Mining Project (AECOM 2011). Sites 45-7-0271 and 45-7-0273 were identified during this survey but were determined to be safe from impact by the Project. Both sites identified by AECOM 2011 are included in the HMP for the project and subject to passive management.

- 2013 - As part of the Aboriginal heritage assessment and consultation process for the CVC Mining Extension 1 project (EMM 2013), an inspection was conducted for evidence of the two registered Aboriginal sites (45-7-0157 and 45-7-0154) in the northern extent of CVC's mining area which were identified as subject to possible impact through subsidence. Present on the site inspection were:

    - Shane Frost (Awabakal Descendants Traditional Owners Aboriginal Corporation);

    - Kerrie Brauer (Awabakal Traditional Owners Aboriginal Corporation);

    - Tracey Howie (Guringai Tribal Link Aboriginal Corporation);

- Peter Leven (Awabakal Local Aboriginal Land Council);
- Chris Ellis Environmental Officer (LakeCoal Pty Limited); and
- Rebecca Newell and Pamela Kottaras (EMM archaeologists).

The inspection of Aboriginal site 45-7-0157 revealed that the portion of the site not removed under the 1994 Consent to Destroy was generally in good condition with some evidence of erosion on the immediate shoreline and shell remains visible in Casuarina Point Reserve. It was situated in a small park with one bench and a number of trees (Photograph 1). The extent of the visible site boundaries were identified using GPS. An updated site card was submitted to AHIMS.

The inspection of Aboriginal site 45-7-0154 revealed that the portion of the site not removed under the 1994 Consent to Destroy was generally in good condition, with the visible extent being more concentrated closer to the water. Site 45-7-0154 is a midden on a steep rise adjacent to Lake Macquarie (Photograph 2). The site as described in the AHIMS site card remained visible, but was found to extend further along the shoreline than previously documented. The extent of the visible site boundaries were identified using GPS. An updated site card was submitted to AHIMS.

Photograph 1 Site 45-7-0157 facing north showing extent of midden as well as the impact from the creation of the park.

Photograph 2 Site 45-7-0154 facing north-east showing extent of midden.

6 Impact assessment

Two elements of the proposed CVC modification have the potential to impact on Aboriginal heritage: the mine design changes in CVC's northern mining area (Figure 1); and the minor disturbance around CVC's pit top area and ventilation system (approximately 0.3 ha) proposed to be cleared for bushfire protection purposes (Figure 1).

The proposed mine design changes will involve an extension of the mining area under the suburb of Sunshine, with the two Aboriginal sites (45-7-0154 and 45-7-0157) located in the vicinity. Due to the mine design changes, Site 45-7-0154 is now no longer above the mining area. Consequently, the proposed modification would result in a positive impact for Site 45-7-0154.

The proposed modification will result in a small additional encroachment of the underground mining area on Site 45-7-0157, which is subject to negligible subsidence impacts from the currently-approved CVC mining activities. This encroachment will not result in a change in the proposed impact to this site as all secondary extraction will remain limited to areas beneath Lake Macquarie and the established protection barriers for the foreshore and seagrass will continue to apply. The draft subsidence impact report predicts subsidence in the Sunshine area will be less than 20 mm and is classified as "negligible". As such, site 45-7-0157 will continue to be subject to negligible subsidence impacts as a result of the modification. Recommendations for the management of site 45-7-0157 are provided in Section 6.

The creation of asset protection zones around areas of infrastructure will result in disturbance to the ground surface through the removal of trees and the operation of machinery. The pit top area is highly

disturbed and does not contain any Aboriginal objects. As such, the creation of an asset protection zone around the pit top area will not impact any Aboriginal sites.

Two Aboriginal sites (45-7-0271 and 45-7-0154) are located in the vicinity of the asset protection zone for the ventilation fan site. These Aboriginal sites are located over 100 m away from areas of vegetation clearance and will not be accessed during the creation of the asset protection zone. These sites remain protected by the implementation of the HMP. As such, the creation of an asset protection zone around the ventilation fan site will not impact any Aboriginal sites.

No other Aboriginal objects or sites will be impacted by the modification.

7 Conclusion and recommendations

This ACHA has identified that, as is the case under SSD-5465, Aboriginal site 45-7-0157 may be subject to subsidence impacts at a negligible level as a result of the proposed modification. This site is currently included within the monitoring program identified in the HMP, which will commence at least 3 months prior to mining activities in the vicinity of the site. The monitoring will include:

- establishing a fixed datum point with defined relative level to Australian Height Datum by registered surveyor;
- placing stakes with horizontal markings on either extent of the site to enable accurate recording of landscape shifts;
- establishing a control reference point with defined Relative Level outside proposed subsidence areas, such as a building;
- photographing from the fixed datum point to enable photographic comparison. Photographs will be large format with clear distinguishable features; and
- producing a letter report to be retained by LakeCoal and sighted as requested by the RAPs.

It is recommended that Site 45-7-0154 now be removed from the monitoring program as it will no longer be undermined.

The current monitoring process described above is sufficient to manage the potential impacts of this proposed modification. It is recommended that the HMP is updated consistent with this assessment and that no additional monitoring or management beyond those identified in the updated HMP are required.

Yours sincerely

Rebecca Newell
Archaeologist
rnewell@emgamm.com
9493 9539

References

AECOM, 2011, *Heritage Impact Assessment Chain Valley Colliery Continuation of Mining,* report prepared for LakeCoal Pty Limited.

Brayshaw H, 1989, Archaeological *survey of proposed tourist resort 0020 at Summerland Point Lake Macquarie NSW*, report to Bexford Pty Ltd.

Bureau of Meteorology, 2012, Climate Statistics for Australian Locations – Nora Head. http://www.bom.gov.au.

Dallas M, 1986, *Pipeline route between Gwandalan and Mannering Park Sewage Treatment works*, report to the Public Works Department of NSW.

DEC, 2005, *Guidelines for Aboriginal Cultural Heritage Impact Assessment and Community Consultation*.

DECCW 2010, *Aboriginal Cultural Heritage Consultation Requirements for Proponents* 2010.

Dyall L, 1975, *Archaeological excavations at Swansea*, annual report.

EMM, 2013, *Chain Valley Colliery Mining Extension 1 Project*, report prepared LakeCoal Pty Limited.

EMM, 2013a, *Chain Valley Colliery Mining Extension 1 Project Aboriginal Cultural Heritage Assessment,* report prepared LakeCoal Pty Limited.

Griffiths T, 1992, *Inspection for Aboriginal Sites and Relics of Proposed Water Sports Club and Holiday Cabins, Kanangra Drive, Gwandalan NSW*, report.

Haglund L, 1986, *Assessment of the Prehistoric Heritage in the Lake Macquarie Area*, report to the Lake Macquarie City Council.

Murphy C, 1993, *Soil Landscapes of the Gosford-Lake Macquarie 1:100 000 Sheet Report*, Department of Conservation and Land Management.

RPS 2011a *Cultural Heritage Assessment Mandalong Mine Ventilation Air Methane Abatement Demonstration Project*, report prepared for Centennial Mandalong Pty Ltd.

- 2011b *Cultural Heritage Assessment Mannering Colliery*, report prepared for Centennial Mandalong Pty Ltd.

- 2011c *Myuna Colliery Extension of Mining Cultural Heritage Assessment,* report prepared for Centennial Mandalong Pty Ltd.

Threlkeld L, in Gunson, N, 1974, *Australian Reminiscences and Papers of L E Threlkeld Missionary to the Aborigines (1824-1859)*, Canberra : Australian Institute of Aboriginal Studies.

Tindale N, 1974, *Aboriginal tribes of Australia, their terrain, environmental controls, distribution, limits, and proper names,* Berkeley: University of California Press.

Umwelt, 2009a, *Lake Macquarie Aboriginal Heritage Study Stage 1a,* report to Lake Macquarie City Council.

- 2009b *Lake Macquarie Aboriginal Heritage Study Stage 1b Survey*, report to Lake Macquarie City Council.

2011 *Sustainable Management of Aboriginal Cultural Heritage in the Lake Macquarie Local Government Area: Lake Macquarie Aboriginal Heritage Management Strategy,* report prepared for Lake Macquarie City Council.

Appendix A

Aboriginal consultation documents

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13 April 2015

<<RAP ADDRESS>>

Re: Chain Valley Colliery Modification 2 - Aboriginal cultural heritage assessment

Dear <<RAP CONTACT>>,

LakeCoal has engaged EMGA Mitchell McLennan Pty Limited (EMM) to prepare a Statement of Environmental Effects (SEE) to accompany an application to modify the Chain Valley Colliery (CVC) development consent (SSD-5465).

The proposed modification to SSD-5465 seeks:

- an increase in the maximum ROM coal extraction from 1.5 mtpa to 2.1 mtpa;
- re-orientation of miniwall panels in CVC's northern mining area and minor amendments to the development consent boundary;
- an increase of full time personnel from 160 to approximately 220; and
- minor vegetation clearing adjacent to some existing surface infrastructure to enable the establishment of asset protection zones for bushfire protection purposes.

As part of the SEE a draft Aboriginal cultural heritage assessment (ACHA) has been prepared in accordance with NSW Office of Environment and Heritage (OEH) guidelines, including the *Aboriginal Cultural Heritage: Standards & Guidelines Kit* (NPWS 1997), and the *Draft Guidelines for Aboriginal Cultural Heritage Impact Assessment and Community Consultation* (DEC 2005). A copy of the draft ACHA which includes a figure showing the change to the northern mining area and the proposed asset protection zone around the existing surface infrastructure is attached for your consideration.

As you are a previously registered Aboriginal stakeholder, we seek your views on the proposed modification, including your views on the cultural values of this area and the proposed management recommendations of the draft ACHA. Written comments should be sent to the address on the letterhead above, or by email to rnewell@emgamm.com before 1 May 2015.We look forward to receiving your feedback and continuing to consult with you regarding Aboriginal heritage aspects of the proposed modification.

Please do not hesitate to contact me on 9493 9500 if there are any queries in this matter.

Yours sincerely

Rebecca Newell
Archaeologist
rnewell@emgamm.com

Local Aboriginal Land Council
DARKINJUNG
168 Pacific Highway Watanobbi NSW 2259
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Phone (02) 4351 2930
Fax (02) 4351 2946
ABN 99 583 297 167
Email darkinjung@dlalc.org.au

1 May 2015

Rebecca Newell
EMM
PO Box 21
St Leonard's 1590

Dear Rebecca

Reference: Chain Valley Bay Colliery Modification 2- Aboriginal Cultural Heritage Assessments and Statement of Environmental Effects.

Thank you for the opportunity to formally respond to the document as noted above.

Darkinjung LALC has now reviewed the document and provides the following cultural values and recommendations that we wish EMM and Lake Coal to consider.

- The area of Lake Macquarie is part of a significant Aboriginal Cultural Landscape.
- Aboriginal sites are connected to each other within the landscape.
- This connection forms part of a complex Aboriginal cultural landscape; they hold spiritual and cultural importance to the local Aboriginal community through their physical link to our creator Baiame, the ancestors and the past.
- This enables us to continue to practice our land based faith and religion, to keep our culture strong which gives us a sense of place and identity.
- This connection attaches the community to land and traditions and allows us to carry out our responsibly and obligation to it. This strengthens bonds within our Aboriginal community and the living spirits of our ancestors which are imbued within the land.
- Darkinjung would like to be involved any assessments of the vegetation clearing of the assets protection zone.
- Continued protection of Aboriginal sites within or within the vicinity of the project area including sites 45-7-0271 and 45-7-0273.
- Please keep Darkinjung LALC informed of any further information in relation to the above assessment and Statement of Environmental Effects.

Overall Darkinjung LALC is satisfied with the recommendations within the Draft Chain Valley Bay Colliery Modification 2- Aboriginal Cultural Heritage Assessments and Statement of Environmental Effects.

If you wish to discuss these recommendations please do not hesitate to contact me on the number listed above

Kind regards

S. Hodgetts

Sharon Hodgetts
Senior Project Officer Culture and Heritage

Appendix B

AHIMS results

AHIMS Web Services (AWS)

Extensive search - Site list report

Your Ref Number : J14053

Client Service ID : 132174

SiteID	SiteName	Datum	Zone	Easting	Northing	Context	Site Status	SiteFeatures	SiteTypes	Reports
45-7-0131	Summerland Point;	AGD	56	366820	6332970	Open site	Valid	Shell : -, Artefact : -	Midden	
	Contact	**Recorders**	Helen Brayshaw					**Permits**		
45-7-0138	Bonny Boy Gully;	AGD	56	366820	6332970	Open site	Valid	Shell : -, Artefact : -	Midden	1846
	Contact	**Recorders**	Helen Brayshaw					**Permits**		
45-7-0144	Windemere Ck 1;	AGD	56	363000	6334600	Open site	Valid	Shell : -, Artefact : -	Midden	2237,102219
	Contact	**Recorders**	Anne Lloyd					**Permits**		
45-7-0151	M4;Balcolyn Street;	AGD	56	364620	6337170	Open site	Valid	Shell : -, Artefact : -	Midden	2685
	Contact	**Recorders**	Mary Dallas Consulting Archaeologists,Kerry Navin					**Permits**		
45-7-0154	M7 Fishery Point	AGD	56	366050	6334500	Open site	Valid	Shell : 2, Artefact : -	Midden	2685
	Contact	**Recorders**	Mary Dallas Consulting Archaeologists,Kerry Navin,Umwelt (Australia) Pty Limited					**Permits**	597	
45-7-0157	M10 Casuarina Point Reserve	AGD	56	366300	6334990	Open site	Valid	Shell : -, Artefact : -	Midden	2685
	Contact	**Recorders**	Mary Dallas Consulting Archaeologists,Kerry Navin					**Permits**	597	
45-7-0158	M11;Lakeview Road, Bardens Bay;	AGD	56	363500	6334110	Open site	Valid	Shell : -, Artefact : -	Midden	2685,102219
	Contact	**Recorders**	Mary Dallas Consulting Archaeologists,Kerry Navin					**Permits**	598	
45-7-0159	M12;Bulgonia Road, Bardens Bay;	AGD	56	363950	6334850	Open site	Valid	Shell : -, Artefact : -	Midden	2685,102219
	Contact	**Recorders**	Mary Dallas Consulting Archaeologists,Kerry Navin					**Permits**	611	
45-7-0161	M1;Hungary Point public reserve;	AGD	56	361610	6336400	Open site	Valid	Shell : -, Artefact : -	Midden	2685,102219
	Contact	**Recorders**	Mary Dallas Consulting Archaeologists,Kerry Navin					**Permits**		
45-7-0162	M2;Hungary Point Public Reserve;	AGD	56	361700	6336350	Open site	Valid	Shell : -, Artefact : -	Midden	2685,102219
	Contact	**Recorders**	Mary Dallas Consulting Archaeologists,Kerry Navin					**Permits**		
45-7-0163	M3;Crusader Camp, Yarrawonga Point;	AGD	56	363900	6336850	Open site	Valid	Shell : -, Artefact : -	Midden	2685,102219
	Contact	**Recorders**	Mary Dallas Consulting Archaeologists,Kerry Navin					**Permits**		
45-7-0164	M6;Silverwater;	AGD	56	366050	6336100	Open site	Valid	Shell : -, Artefact : -	Midden	2685
	Contact	**Recorders**	Mary Dallas Consulting Archaeologists,Kerry Navin					**Permits**		
45-7-0166	M8;Dandaraga Road, Sugar Bay;	AGD	56	365300	6334500	Open site	Valid	Shell : -, Artefact : -	Midden	2685
	Contact	**Recorders**	Mary Dallas Consulting Archaeologists,Kerry Navin					**Permits**		
45-7-0167	M9;Camp Brightwaters;	AGD	56	363500	6334880	Open site	Valid	Shell : -, Artefact : -	Midden	2685,102219
	Contact	**Recorders**	Mary Dallas Consulting Archaeologists,Kerry Navin					**Permits**		
45-7-0171	M13;Balcolyn;	AGD	56	364620	6337170	Open site	Valid	Shell : -, Artefact : -	Midden	2685
	Contact	**Recorders**	Mary Dallas Consulting Archaeologists,Kerry Navin					**Permits**		
45-7-0172	M5;Beach Road, Boat Harbour;	AGD	56	365500	6336580	Open site	Valid	Shell : -, Artefact : -	Midden	2685
	Contact	**Recorders**	Mary Dallas Consulting Archaeologists,Kerry Navin					**Permits**		
45-7-0173	BB1;Fullers Creek, Bonnells Bay;	AGD	56	360800	6336100	Open site	Valid	Shell : -, Artefact : -	Midden	2693,102219
	Contact	**Recorders**	Mary Dallas Consulting Archaeologists,Kerry Navin					**Permits**		

Report generated by AHIMS Web Service on 17/04/2014 for Rebecca Newell for the following area at Datum :GDA, Zone : 56, Eastings : 359462 - 369462, Northings : 6328206 - 6338206 with a Buffer of 1000 meters. Additional Info : due diligence assessment. Number of Aboriginal sites and Aboriginal objects found is 112

AHIMS Web Services (AWS)

Extensive search - Site list report

Your Ref Number : J14053

Client Service ID : 132174

SiteID	SiteName	Datum	Zone	Easting	Northing	Context	Site Status	SiteFeatures	SiteTypes	Reports
45-7-0174	BB2;Freshwater Creek, Bonnells Bay;	AGD	56	361100	6335990	Open site	Valid	Artefact : -	Isolated Find	2693,102219
	Contact	**Recorders**	Mary Dallas Consulting Archaeologists,Kerry Navin					**Permits**		
45-7-0176	Gwandalan;	AGD	56	367200	6333300	Open site	Valid	Shell : -, Artefact : -	Midden	2465,102129
	Contact	**Recorders**	Tom Griffiths					**Permits**		
45-7-0177	Camp Kanangra;	AGD	56	369500	6331500	Open site	Valid	Shell : -, Artefact : -	Midden	
	Contact	**Recorders**	Mr.David Lambert,Mr.Gavin Newton					**Permits**		
45-7-0178	Hembula Creek - Scarred Tree 1&2;HC-ST 1&2;	AGD	56	366800	6330400	Open site	Valid	Modified Tree (Carved or Scarred) : -	Scarred Tree	
	Contact	**Recorders**	Mr.Gavin Newton					**Permits**		
45-7-0179	Black Neds Point;	AGD	56	365150	6331450	Open site	Valid	Shell : -, Artefact : -	Midden	
	Contact	**Recorders**	L.M Nelson					**Permits**		
45-7-0181	Chain Valley Bay 1	AGD	56	366150	6329600	Open site	Valid	Shell : -, Artefact : -	Midden	101093
	Contact	**Recorders**	L.M Nelson					**Permits**		
45-7-0182	Chain Valley Bay 2;	AGD	56	366120	6330950	Open site	Valid	Shell : -, Artefact : -	Midden	
	Contact	**Recorders**	L.M Nelson					**Permits**		
45-7-0183	Diamond Drill Pt. North;	AGD	56	368050	6333200	Open site	Valid	Artefact : -, Shell : -	Midden	102129
	Contact	**Recorders**	L.M Nelson					**Permits**		
45-7-0184	Gwandalan;	AGD	56	368500	6331800	Open site	Valid	Shell : -, Artefact : -	Midden	
	Contact	**Recorders**	L.M Nelson					**Permits**		
45-7-0186	Pt Wolstonecraft 1;	AGD	56	368350	6334200	Open site	Valid	Shell : -, Artefact : -	Midden	
	Contact	**Recorders**	L.M Nelson					**Permits**		
45-7-0187	Pt Wolstonecraft 2;	AGD	56	367490	6336250	Open site	Valid	Shell : -, Artefact : -	Midden	
	Contact	**Recorders**	L.M Nelson					**Permits**		
45-7-0189	Sandy Beach 1;	AGD	56	364950	6331450	Open site	Valid	Shell : -, Artefact : -	Midden	
	Contact	**Recorders**	L.M Nelson					**Permits**		
45-7-0191	Publah Island 3;	AGD	56	368250	6337850	Open site	Valid	Shell : -, Artefact : -	Midden	
	Contact	**Recorders**	L.M Nelson					**Permits**		
45-7-0201	Nord 1 (N1)	AGD	56	369600	6332600	Open site	Valid	Shell : -, Artefact : -	Midden	3022
	Contact	**Recorders**	Iain Stuart					**Permits**	698	
45-7-0207	The Hole 1 (TH1)	AGD	56	361820	6329800	Open site	Valid	Artefact : -	Open Camp Site	3697,101093
	Contact	**Recorders**	Kerry Navin,Mr.Kelvin Officer,P Saunders					**Permits**		
45-7-0208	Pipers Point;	AGD	56	363200	6338550	Open site	Valid	Shell : -, Artefact : -	Midden	102219
	Contact	**Recorders**	L.M Nelson					**Permits**		
45-7-0213	Wangi Wangi Point;	AGD	56	368450	6338750	Open site	Valid	Shell : -, Artefact : -	Midden	

Report generated by AHIMS Web Service on 17/04/2014 for Rebecca Newell for the following area at Datum :GDA, Zone : 56, Eastings : 359462 - 369462, Northings : 6328206 - 6338206 with a Buffer of 1000 meters. Additional Info : due diligence assessment. Number of Aboriginal sites and Aboriginal objects found is 112

AHIMS Web Services (AWS)

Extensive search - Site list report

Your Ref Number : J14053

Client Service ID : 132174

SiteID	SiteName	Datum	Zone	Easting	Northing	Context	Site Status	SiteFeatures	SiteTypes	Reports
	Contact	**Recorders**	L.M Nelson					**Permits**		
45-7-0214	Sunshine Park;	AGD	56	365900	6335650	Open site	Valid	Shell : -, Artefact : -	Midden	
	Contact	**Recorders**	L.M Nelson					**Permits**		
14-7-0149	Gwandalan	AGD	56	368000	6333300	Open site	Valid	Shell : -, Artefact : -	Midden	102129
	Contact	**Recorders**	Tom Griffiths					**Permits**		
45-7-0233	Sunshine 2	AGD	56	365924	6335524	Open site	Valid	Shell : -		
	Contact Koompahtoo LALC	**Recorders**	Umwelt (Australia) Pty Limited					**Permits**		
45-7-0234	Sinshine Park , Sunshine	AGD	56	365895	6335284	Open site	Valid	Potential Archaeological Deposit (PAD) : 3		
	Contact	**Recorders**	Umwelt (Australia) Pty Limited					**Permits**		
45-7-0235	Winding creek 1	AGD	56	365997	6336449	Open site	Valid	Artefact : 2		
	Contact	**Recorders**						**Permits**		
45-3-3435	RPS HSO MwP1	AGD	56	359424	6334225	Open site	Valid	Shell : -, Potential Archaeological Deposit (PAD) : -		
	Contact	**Recorders**	RPS Australia East Pty Ltd-Blacktown					**Permits**		
45-7-0290	Gwandalan 1	AGD	56	368088	6329979	Open site	Valid	Shell : -		
	Contact	**Recorders**	Doctor.Tim Owen,ERM Australia Pty Ltd-Pyrmont					**Permits**		
45-7-0285	RPS PW 1	GDA	56	367769	6335969	Open site	Valid	Potential Archaeological Deposit (PAD) : -, Shell : -, Stone Arrangement : -, Modified Tree (Carved or Scarred) : -, Aboriginal Ceremony and Dreaming : -		
	Contact Awabakal LALC	**Recorders**	RPS Australia East Pty Ltd -Hamilton					**Permits**		
45-7-0287	RPS MP 1	GDA	56	364930	6336689	Open site	Valid	Modified Tree (Carved or Scarred) : -		
	Contact Awabakal LALC	**Recorders**	RPS Australia East Pty Ltd -Hamilton					**Permits**		
45-7-0316	RPS Wyee Point 2	GDA	56	362237	6331450	Open site	Valid	Shell : -		
	Contact	**Recorders**	RPS Australia East Pty Ltd -Hamilton,Ms.Laraine Nelson					**Permits**		

Report generated by AHIMS Web Service on 17/04/2014 for Rebecca Newell for the following area at Datum :GDA, Zone : 56, Eastings : 359462 - 369462, Northings : 6328206 - 6338206 with a Buffer of 1000 meters. Additional Info : due diligence assessment. Number of Aboriginal sites and Aboriginal objects found is 112

AHIMS Web Services (AWS)

Extensive search - Site list report

Your Ref Number : J14053

Client Service ID : 132174

SiteID	SiteName	Datum	Zone	Easting	Northing	Context	Site Status	SiteFeatures	SiteTypes	Reports
45-7-0317	RPS MP1	AGD	56	364930	6336689	Open site	Valid	Modified Tree (Carved or Scarred) : -		
	Contact	**Recorders**	RPS Australia East Pty Ltd -Hamilton,Ms.Laraine Nelson					**Permits**		
45-7-0292	RPS MP2	GDA	56	366342	6336208	Open site	Valid	Modified Tree (Carved or Scarred) : -		
	Contact	**Recorders**	RPS Australia East Pty Ltd -Hamilton,Ms.Laraine Nelson					**Permits**		
45-7-0293	RPS MP3	GDA	56	365058	6335017	Open site	Valid	Modified Tree (Carved or Scarred) : -		
	Contact	**Recorders**	RPS Australia East Pty Ltd -Hamilton,Ms.Laraine Nelson					**Permits**		
45-7-0190	Wyee Point	AGD	56	362398	6331810	Open site	Valid	Shell : -, Artefact : -	Midden	102219
	Contact	**Recorders**	L.M Nelson,RPS Australia East Pty Ltd -Hamilton,Ms.Laraine Nelson					**Permits**		
45-7-0291	RPS HSO M1	GDA	56	361555	6331952	Open site	Valid	Shell : -		
	Contact Koompahtoo LALC	**Recorders**	RPS Australia East Pty Ltd -Hamilton,Ms.Laraine Nelson					**Permits**		
45-7-0226	K 4 Koompahtoo	AGD	56	360390	6334990	Open site	Valid	Artefact : -	Isolated Find	99218,102219
	Contact	**Recorders**	William Smith					**Permits**		
45-3-3165	K 1 Koompahtoo	AGD	56	359490	6332490	Open site	Valid	Artefact : -	Open Camp Site	99218,102219
	Contact	**Recorders**	William Smith					**Permits**		
45-7-0225	K 3 Koompahtoo	AGD	56	360650	6334900	Open site	Valid	Artefact : -	Isolated Find	99218,102219
	Contact	**Recorders**	William Smith					**Permits**		
45-6-2516	Pipers Point Rocky Point;	AGD	56	363450	6339000	Open site	Valid	Shell : -, Artefact : -	Midden	102219
	Contact	**Recorders**	Bonhomme Craib & Associates					**Permits**		
45-7-0079	Crangan Bay;Stranger Gully;	AGD	56	368450	6330750	Open site	Valid	Shell : -, Artefact : -	Midden	
	Contact	**Recorders**	ASRSYS					**Permits**		
45-7-0086	Pulbar Island	AGD	56	368947	6336560	Open site	Valid	Shell : -, Artefact : -	Midden	
	Contact	**Recorders**	Glen Morris					**Permits**		
45-7-0087	Pulbar Island	AGD	56	368661	6337195	Open site	Valid	Artefact : -, Shell : -	Midden,Open Camp Site	
	Contact	**Recorders**	Unknown Author					**Permits**		
45-7-0089	Bonnells Bay;	AGD	56	361832	6335693	Open site	Valid	Shell : -, Artefact : -	Midden	102219
	Contact	**Recorders**	ASRSYS					**Permits**		
45-7-0090	Dora Creek;	AGD	56	362950	6338410	Open site	Valid	Shell : -, Artefact : -	Midden	102219
	Contact	**Recorders**	ASRSYS					**Permits**		
45-7-0001	Morisset Hospital	AGD	56	361550	6332450	Open site	Valid	Shell : -, Artefact : -	Midden	1263,102219
	Contact	**Recorders**	L.M Nelson,A.J Barrett					**Permits**		

Report generated by AHIMS Web Service on 17/04/2014 for Rebecca Newell for the following area at Datum :GDA, Zone : 56, Eastings : 359462 - 369462, Northings : 6328206 - 6338206 with a Buffer of 1000 meters. Additional Info : due diligence assessment. Number of Aboriginal sites and Aboriginal objects found is 112

AHIMS Web Services (AWS)

Extensive search - Site list report

Your Ref Number : J14053

Client Service ID : 132174

SiteID	SiteName	Datum	Zone	Easting	Northing	Context	Site Status	SiteFeatures	SiteTypes	Reports
45-7-0002	Goat Island;Dora Creek;	AGD	56	361438	6337149	Open site	Valid	Shell : -, Artefact : -	Midden	102219
	Contact	**Recorders**	Richard Wright					**Permits**		
45-7-0003	Vales Point;Lake Macquarie;	AGD	56	363738	6331615	Open site	Valid	Shell : -, Artefact : -	Midden	102219
	Contact	**Recorders**	Wyong Shire Council					**Permits**	730	
45-3-1553	Wyee Bay;Ruttleys Road;	AGD	56	362540	6330400	Open site	Valid	Shell : -, Artefact : -	Midden	
	Contact	**Recorders**	Val Attenbrow,Glen Morris					**Permits**		
45-7-0262	SJOG 7	GDA	56	364036	6333848	Open site	Valid	Grinding Groove : 6		
	Contact	**Recorders**	Mrs.Angela Besant					**Permits**		
45-7-0263	SJOG 6	GDA	56	364026	6333875	Open site	Valid	Shell : -		
	Contact	**Recorders**	Mrs.Angela Besant					**Permits**		
45-7-0242	Bonnells Bay PAD	AGD	56	362150	6335830	Open site	Not a Site	Potential Archaeological Deposit (PAD) : -		102219
	Contact S Scanlon	**Recorders**	Insite Heritage Pty Ltd					**Permits**	2234,2389	
45-7-0236	Fig Tree Point 1	AGD	56	365421	6337201	Open site	Valid	Shell : -		
	Contact	**Recorders**	Umwelt (Australia) Pty Limited					**Permits**		
45-7-0237	Jonny's Point 2	AGD	56	365997	6336449	Open site	Valid	Shell : -		
	Contact	**Recorders**	Umwelt (Australia) Pty Limited					**Permits**		
45-7-0238	Jonny's Point 1	AGD	56	365992	6336253	Open site	Valid	Artefact : 1		
	Contact	**Recorders**	Umwelt (Australia) Pty Limited					**Permits**		
45-7-0239	MP 1	AGD	56	362100	6334400	Open site	Valid	Potential Archaeological Deposit (PAD) : -		102219
	Contact T Russell	**Recorders**	Mrs.Angela Besant					**Permits**	2115	
45-7-0240	Dora Creek (Stingaree Road)	AGD	56	360613	6337218	Open site	Valid	Artefact : 3, Shell : -		102219
	Contact Searle	**Recorders**	Mrs.Angela Besant					**Permits**	2215	
45-7-0243	WWSS3-2	AGD	56	360438	6337770	Open site	Valid	Potential Archaeological Deposit (PAD) : -		100134,102219
	Contact S Scanlon	**Recorders**	AECOM Australia Pty Ltd (previously HLA-Envirosciences)					**Permits**	2273	
45-7-0253	Gwandalan 2	GDA	56	367386	6331169	Open site	Valid	Shell : -		
	Contact	**Recorders**	Doctor.Tim Owen					**Permits**		
45-7-0254	gwanddalan 1	GDA	56	368088	6329979	Open site	Valid	Shell : -		
	Contact	**Recorders**	Doctor.Tim Owen					**Permits**		
45-3-3166	K 2 Koompahtoo	AGD	56	359840	6332530	Open site	Valid	Artefact : -	Isolated Find	99218,102219
	Contact	**Recorders**	William Smith					**Permits**		

Report generated by AHIMS Web Service on 17/04/2014 for Rebecca Newell for the following area at Datum :GDA, Zone : 56, Eastings : 359462 - 369462, Northings : 6328206 - 6338206 with a Buffer of 1000 meters. Additional Info : due diligence assessment. Number of Aboriginal sites and Aboriginal objects found is 112

SiteID	SiteName	Datum	Zone	Easting	Northing	Context	Site Status	SiteFeatures	SiteTypes	Reports
45-7-0264	Lake Macquarie State Conservation Area-Point Wolstoncroft	GDA	56	367788	6335542	Open site	Valid	Artefact : -		
	Contact	**Recorders**	Darkinjung LALC					**Permits**		
45-7-0255	Trinity Point GG2 (Catherine Hill Bay)	GDA	56	363618	6333664	Open site	Valid	Grinding Groove : -		102219
	Contact	**Recorders**	Mrs.Angela Besant					**Permits**		
45-7-0256	Trinity Point Scarred Tree 2 (Catherine Hill Bay)	GDA	56	363749	6333815	Open site	Valid	Modified Tree (Carved or Scarred) : -		102219
	Contact	**Recorders**	Mrs.Angela Besant					**Permits**		
45-7-0257	Trinity Point Ochre (Catherine Hill Bay)	GDA	56	363958	6333791	Open site	Valid	Ochre Quarry : -		102219
	Contact	**Recorders**	Mrs.Angela Besant					**Permits**		
45-7-0258	Trinity Point IF1 (Catherine Hill Bay)	GDA	56	363730	6333744	Open site	Valid	Artefact : -		102219
	Contact	**Recorders**	Mrs.Angela Besant					**Permits**		
45-7-0338	RPS GWANDALAN IF1	GDA	56	368263	6331126	Open site	Valid	Artefact : 1		
	Contact	**Recorders**	RPS					**Permits**		
45-7-0320	RPS Mannering 1	GDA	56	363449	6331411	Open site	Valid	Shell : 1		
	Contact	**Recorders**	Ms.Laraine Nelson					**Permits**		
45-7-0321	RPS Mannering 2	GDA	56	363401	6331331	Open site	Valid	Modified Tree (Carved or Scarred) : 1		
	Contact	**Recorders**	Ms.Laraine Nelson					**Permits**		
45-7-0339	CV 001	GDA	56	364943	6329478	Open site	Valid	Artefact : 1		
	Contact	**Recorders**	Mrs.Rebecca Newell,EMGA Mitchell McLennan					**Permits**		
45-3-0334	Tiembula Creek Midden;Tiembula Creek;	AGD	56	366730	6330420	Open site	Valid	Shell : -, Artefact : -	Midden	1076
	Contact	**Recorders**	Mary Dallas Consulting Archaeologists					**Permits**		
45-3-1140	Morisset;	AGD	56	359290	6335970	Open site	Valid	Modified Tree (Carved or Scarred) : -	Scarred Tree	116,102219
	Contact	**Recorders**	Helen Brayshaw					**Permits**		
45-7-0227	St Johns 1	AGD	56	363680	6333520	Open site	Valid	Artefact : -		100896,102219
	Contact	**Recorders**	Mrs.Angela Besant					**Permits**	1947	
45-7-0228	St Johns 2	AGD	56	363720	6333820	Open site	Valid	Artefact : -		100896,101024,102219
	Contact	**Recorders**	Mrs.Angela Besant					**Permits**	1947	
45-7-0230	K3 KOOMPAHTOO	AGD	56	360650	6334900	Open site	Valid	Artefact : -		102219
	Contact	**Recorders**	Stephen Griffen					**Permits**		

Report generated by AHIMS Web Service on 17/04/2014 for Rebecca Newell for the following area at Datum :GDA, Zone : 56, Eastings : 359462 - 369462, Northings : 6328206 - 6338206 with a Buffer of 1000 meters. Additional Info : due diligence assessment. Number of Aboriginal sites and Aboriginal objects found is 112

AHIMS Web Services (AWS)

Extensive search - Site list report

Your Ref Number : J14053

Client Service ID : 132174

SiteID	SiteName	Datum	Zone	Easting	Northing	Context	Site Status	SiteFeatures	SiteTypes	Reports
45-7-0080	Mannering Park;	AGD	56	364780	6328890	Open site	Valid	Modified Tree (Carved or Scarred) : -	Scarred Tree	101093
	Contact	**Recorders**	ASRSYS					**Permits**		
45-7-0088	Pulbah Island 2	AGD	56	368445	6337000	Open site	Partially Destroyed	Aboriginal Ceremony and Dreaming : -	Aboriginal Place,Natural Mythological (Ritual)	
	Contact	**Recorders**	Kate Sullivan					**Permits**	1615	
45-7-0219	Pulbah Island 4	AGD	56	368500	6337000	Open site	Valid	Shell : -, Artefact : -	Midden	
	Contact	**Recorders**	Unknown Author					**Permits**		
45-7-0188	Pulbah Island 3	AGD	56	368250	6337850	Open site	Valid	Shell : -, Artefact : -	Midden	
	Contact	**Recorders**	L.M Nelson					**Permits**		
45-7-0244	St Johns 3	AGD	56	363560	6333600	Open site	Valid	Artefact : 1		100896,102219,102504
	Contact T Russell	**Recorders**	Mrs.Angela Besant					**Permits**	2845,2846	
45-7-0268	CV-04-09	GDA	56	368381	6331136	Open site	Valid	Shell : 1		
	Contact	**Recorders**	Mr.Geordie Oakes					**Permits**		
45-7-0269	CV-06-09	GDA	56	368061	6328867	Open site	Valid	Artefact : 1		
	Contact	**Recorders**	Mr.Geordie Oakes					**Permits**		
45-7-0270	CV-07-09	GDA	56	367043	6331305	Open site	Valid	Artefact : 1		
	Contact	**Recorders**	Mr.Geordie Oakes					**Permits**		
45-7-0271	CV-08-09	GDA	56	366587	6330975	Open site	Valid	Shell : 1		
	Contact	**Recorders**	Mr.Geordie Oakes					**Permits**		
45-7-0272	CV-09-09	GDA	56	366650	6330868	Open site	Valid	Shell : 1		
	Contact	**Recorders**	Mr.Geordie Oakes					**Permits**		
45-7-0273	CV-10-09	GDA	56	366875	6330868	Open site	Valid	Shell : 1		
	Contact	**Recorders**	Mr.Geordie Oakes					**Permits**		
45-7-0274	CV-12-09	GDA	56	367290	6330372	Open site	Valid	Artefact : 1		
	Contact	**Recorders**	Mr.Geordie Oakes					**Permits**		
45-7-0275	CV-14-09	GDA	56	367468	6330191	Open site	Valid	Shell : 1		
	Contact	**Recorders**	Mr.Geordie Oakes					**Permits**		
45-7-0276	CV-15-09	GDA	56	366304	6329303	Open site	Valid	Modified Tree (Carved or Scarred) : 1		
	Contact	**Recorders**	Mr.Geordie Oakes					**Permits**		
45-7-0277	CV-16-09	GDA	56	366335	6329635	Open site	Valid	Shell : 1		

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AHIMS Web Services (AWS)

Extensive search - Site list report

Your Ref Number : J14053

Client Service ID : 132174

SiteID	SiteName	Datum	Zone	Easting	Northing	Context	Site Status	SiteFeatures	SiteTypes	Reports
	Contact	Recorders	Mr.Geordie Oakes					Permits		
45-7-0278	CV-17-09	GDA	56	366273	6329369	Open site	Valid	Modified Tree (Carved or Scarred) : 1		
	Contact	Recorders	Mr.Geordie Oakes					Permits		
45-7-0279	CV-18-10	GDA	56	367003	6333279	Open site	Valid	Shell : 1		
	Contact	Recorders	Mr.Geordie Oakes					Permits		
45-7-0280	CV-19-10	GDA	56	366988	6333151	Open site	Valid	Shell : 1		
	Contact	Recorders	Mr.Geordie Oakes					Permits		
45-7-0281	CV-20-10	GDA	56	365588	6331434	Open site	Valid	Shell : 1		
	Contact	Recorders	Mr.Geordie Oakes					Permits		
45-7-0282	CV-21-10	GDA	56	366221	6331192	Open site	Valid	Shell : -		
	Contact	Recorders	Mr.Geordie Oakes					Permits		
45-7-0340	Nords Wharf 1	GDA	56	369821	6331865	Open site	Valid	Artefact : 1		
	Contact	Recorders	Mr.Aaron Fogel					Permits		
45-7-0341	Nords Wharf 2	GDA	56	369858	6331788	Open site	Valid	Artefact : 1		
	Contact	Recorders	Mr.Aaron Fogel					Permits		
45-7-0342	Nords Wharf 3	GDA	56	369788	6331822	Open site	Valid	Artefact : 1		
	Contact	Recorders	Mr.Aaron Fogel					Permits		
45-7-0343	Nords Wharf 4	GDA	56	369861	6331731	Open site	Valid	Artefact : 1		
	Contact	Recorders	Mr.Aaron Fogel					Permits		

Report generated by AHIMS Web Service on 17/04/2014 for Rebecca Newell for the following area at Datum :GDA, Zone : 56, Eastings : 359462 - 369462, Northings : 6328206 - 6338206 with a Buffer of 1000 meters. Additional Info : due diligence assessment. Number of Aboriginal sites and Aboriginal objects found is 112

Appendix J

Traffic and transport assessment

Appendix J — Traffic and transport assessment

J

12 May 2015

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Chris Ellis
Environmental Officer
LDO Group
16 Spitfire Place
Rutherford, NSW, 2320

Re: Chain Valley Colliery Modification 2 - traffic assessment

Dear Chris,

1 Introduction

Chain Valley Colliery (CVC) is an underground coal mine located at the southern end of Lake Macquarie, approximately 60 km south of Newcastle. CVC is operated by LakeCoal Pty Ltd (LakeCoal).

LakeCoal has engaged EMGA Mitchell McLennan Pty Limited (EMM) to prepare a Statement of Environmental Effects (SEE) to accompany an application to modify CVC's development consent (SSD-5465) under Section 96(2) of the *Environmental Planning and Assessment Act 1979* (EP&A Act), to allow for:

- an increase in the maximum run-of-mine (ROM) coal extraction from 1.5 million tonnes per annum (Mtpa) to 2.1 Mtpa;
- mine design changes, primarily the re-orientation of miniwall panels in CVC's northern mining area;
- an increase of full time personnel from 160 to approximately 220; and
- minor vegetation disturbance adjacent to some existing surface infrastructure to enable the extension or establishment of asset protection zones for bushfire protection purposes.

As part of the SEE, a traffic assessment has been prepared, which includes future traffic projections and SIDRA intersection analyses for the CVC access intersection with Ruttleys Road (at Construction Road) to determine its suitability to accommodate the increased traffic generated by the additional workforce under the proposed modification. This letter outlines the findings of the traffic assessment.

2 Existing workforce traffic generation

The total current CVC workforce is 161 persons of whom approximately 120 are full time employees and the remainder are classified as contractors. Historically, the mine has operated with much higher workforce numbers, with a peak workforce of approximately 380 persons during the mid 1980s.

The current workforce traffic movements are greatest on weekdays when on average 143 persons would normally travel to and from work within a 24 hr period for either the mine day, afternoon or night shifts. The average weekday and weekend workforce numbers for each shift (full time equivalent) at CVC are:

- weekday day shift including administrative staff (7.00 am to 3.00 pm) - 76 persons;

- weekday afternoon shift (1.30 pm to 11.00 pm) - 35 persons;
- weekday night shift (9.30 pm to 7.00 am) - 32 persons; and
- weekend shifts (7.00 am to 7.00 pm and 7.00 pm to 7.00 am) - 17 persons.

Assuming a 90% car driver ratio for the current CVC workforce, which is typical for a locality remote from major public transport services, the total daily car and other light vehicle traffic movements that are generated are 129 return car trips daily, which is 258 daily vehicle movements.

3 Traffic volumes and existing intersection traffic operations

The general weekday traffic usage for Ruttleys Road, south of Construction Road has been determined by a seven day tube traffic survey which was undertaken in August 2012 as part of the traffic assessment for the Chain Valley Colliery Mine Extension 1 Project environmental impact statement (EMM 2013). This survey determined the average daily two way traffic volume was 8,507 vehicle movements of which approximately 7.7% were heavy vehicles. With the prevailing traffic growth rates for this area, which were determined as part of the traffic assessment within EMM 2013 as corresponding to +2.3% per annum linear traffic growth, this daily traffic volume would increase in the future to the following levels.

- 9,094 daily vehicle movements in 2015 (x1.069 increase since 2012).
- 10,464 daily vehicle movements in 2022 (x1.230 increase since 2012).
- 11,442 daily vehicle movements in 2027 (x1.345 increase since 2012).

These future base traffic growth projections for Ruttleys Road will not substantially change the general traffic flows and the levels of service for the traffic which is using Ruttleys Road currently.

The current peak hour intersection traffic volumes were surveyed on Friday 20 March 2015 at the intersection of Ruttleys Road and Construction Road as part of this traffic assessment for the proposed modification. The traffic survey was completed while truck haulage to PWCS were being undertaken, ensuring typical heavy vehicle traffic volumes associated with haulage on public roads was captured.

The intersection traffic count results are summarised in Table 3.1 and included in full as Appendix A, where the earlier 'mine' peak traffic hour results and the actual peak hour traffic results are shown separately.

Table 3.1 Summary of mine peak hour traffic volumes including heavy vehicle

Road	Direction	CVC Morning peak hour (6.30 am -7.30 am)			CVC Afternoon peak hour (3.00 pm - 4.00 pm)		
		All traffic	Heavy vehicles	% Heavy vehicles for combined traffic flow*	All traffic	Heavy vehicles	% Heavy vehicles for combined traffic flow*
Construction Road (north-east of Ruttleys Road)	N'bound	54	12	25.8	14	8	20.6
	S'bound	35	11		54	6	
Ruttleys Road (south of Construction Road)	N'bound	279	30	9.2	346	14	4.2
	S'bound	278	21		431	19	
Ruttleys Road (north-west of Construction Road)	N'bound	271	11	5.7	406	14	4.0
	S'bound	253	19		361	17	

*Note: * % Heavy vehicle traffic is the average proportion based on the combined traffic flow in both directions*

The peak hourly traffic volumes on Construction Road and Ruttleys Road and the proportions of heavy vehicles in traffic are shown in Table 4.1 for the CVC peak hourly traffic periods which are 6.30 to 7.30 am and 3.00 to 4.00 pm, which correspond to the peak periods for the mine shift changeover traffic.

The morning peak hour for CVC-related traffic does not coincide at all with the peak period for other traffic movements in the locality which is typically 8.00 to 9.00 am (Appendix A). There is, however, a partial overlap of the afternoon peak hour for CVC-related traffic with the peak period for other traffic movements which is typically 3.30 to 4.30 pm (Appendix A).

The intersection traffic peak hours which have been investigated in this traffic assessment are the CVC traffic morning and afternoon peak hours which include the main mine workforce day shift start and finish traffic which occurs shortly before 7.00 am and shortly after 3.00 pm. This enables the assessment of the potential worst case impacts for the current and additional proposed mine traffic.

The performance of intersections in NSW is defined by Roads and Maritime Services (RMS) in terms of 'level of service' and 'degree of saturation' thresholds. Level of service is an index of the operating traffic delays at an intersection and is based on the average delays for either the entire intersection (where there are traffic signals) or a selected vehicle movement which is normally the right turn egress movement (for an un-signalised intersection). Degree of saturation provides an overall measure of the capability of the intersection to accommodate the traffic levels, with a degree of saturation of 1.0 indicating that an intersection is operating at capacity. A satisfactory degree of saturation is considered to be 0.90 or lower at a traffic signal controlled intersection and 0.80 or lower at other intersections.

The current RMS intersection operation standards for level of service are summarised in Table 3.2.

Table 3.2 Intersection level of service standards

Level of Service	Average delay (seconds per vehicle)	Traffic signals, roundabout	Priority intersection ('Stop' and 'Give Way')
A	Less than 14	Good operation	Good operation
B	15 to 28	Good with acceptable delays and spare capacity	Acceptable delays and spare capacity
C	29 to 42	Satisfactory	Satisfactory, but accident study required
D	43 to 56	Operating near capacity	Near capacity and accident study required
E	57 to 70	At capacity. At signals, incidents will cause excessive delays. Roundabouts require other control mode	At capacity; requires other control mode
F	Greater than 71	Unsatisfactory with excessive queuing	Unsatisfactory with excessive queuing; requires other control mode

Source: (RTA, 2002)

4 Proposed traffic generation

The proposed CVC workforce numbers, should the modification be approved, will be approximately 220 persons and the projected weekday and weekend workforce full time equivalent numbers and the increases due to the proposed modification, will be as follows.

- Weekday day shift (including admin staff) - 87 persons (an increase of 11).
- Weekday afternoon shift - 41 persons (an increase of 6).
- Weekday night shift - 41 persons (an increase of 9).

- Weekend shifts (each) - 54 persons (an increase of 37).

The majority of the additional CVC workforce would be working on the weekend shifts and there would be comparatively much lower increases in the weekday workforce.

Assuming the same 90% car driver ratio (Section 2) would apply for the additional workforce, there would be a approximately 10 additional vehicle movements inbound to CVC during the weekday day shift morning peak entry period (6.30 to 7.00 am) and approximately 8 additional vehicle movements outbound from CVC during the corresponding weekday night shift traffic departure period (7.00 to 7.30 am).

These periods are both within the assessed CVC morning peak hour traffic period, which is 6.30 to 7.30 am. The implications of the CVC morning peak traffic changes have been assessed for the Ruttleys Road/Construction Road intersection for the current year 2015 and the future year 2027. These years represent the start and end of the currently proposed mine life period. The assessment for 2015 includes the existing surveyed base mine traffic movements (as listed in Table 3.1) with the additional mine workforce traffic then also included. The assessment for 2027 also includes the locality traffic growth (at +2.3% annually) occurring for the through traffic movements on Ruttleys Road over the 12 years between 2015 and 2027.

With the additional workforce on the weekday day shift, there would also be approximately 10 additional vehicle movements occurring outbound from CVC during the current weekday day shift traffic departure period (3.00 to 3.30 pm).

Currently the weekday afternoon shift starts at 1.30 pm which is outside the 3.00pm to 4.00pm CVC afternoon peak traffic period. However this may change in the future, so the assessment has conservatively assumed that the 37 inbound afternoon shift vehicles could also occur in addition to the surveyed day shift outbound vehicles (Table 3.1) which occurred during the afternoon CVC peak traffic period 3.00pm to 4.00pm.

The implications of the CVC afternoon peak hour traffic changes have been assessed for the Ruttleys Road/Construction Road intersection for the current year (2015) and for 2027, which is the end year of the approved (and proposed) mine life. The assessment for 2015 includes the existing surveyed base mine traffic movements (as listed in Table 3.1) with the additional mine workforce traffic then also included. The assessment for 2027 includes these movements and the locality traffic growth (at +2.3% annually) also occurring for the two through traffic movements on Ruttleys Road over the 2015 to 2027 period..

All the other daytime and evening traffic peak periods for the facility, the traffic movements for the CVC mine workforce and operations would remain unchanged at the Ruttleys Road/Construction Road intersection.

5 Comparison of intersection operations

The existing intersection layout configuration showing the number and the length of the approach traffic lanes for each road, is included in Appendix B.

SIDRA intersection analyses for the base year 2015 morning and afternoon peak hour traffic volumes and for the proposed additional traffic are included in detail in Appendix B and are summarised in Table 5.1.

The intersection traffic results in Table 5.1 show the Ruttleys Road and Construction Road intersection is not congested currently, with the existing traffic volumes, and is operating with either good or satisfactory peak hour operating delays (level of service either B or C), where the highest traffic delays (for the right turn egress traffic) are generally 30 seconds or less and the intersection degrees of saturation are generally low at 0.22 or less.

Table 5.1 Peak hour intersection performance for 2015 base and the CVC modification traffic

Intersection Assessment	Peak Hour Period	Vehicles (pcu*)	Degree of Saturation	Average Delay (seconds/vehicle)	Level of Service
Ruttleys Road and Construction Road (existing traffic volumes in 2015)	Morning peak hour (6.30 am - 7.30 am)	616	0.151	22.5	B
	Afternoon peak hour (3.00 pm -4.00 pm)	848	0.224	30.2	C
Ruttleys Road and Construction Road (with the proposed CVC modification traffic)	Morning peak hour (6.30 am - 7.30 am)	635	0.154	21.5	B
	Afternoon peak hour (3.00 pm -4.00 pm)	898	0.235	30.3	C

** Intersection vehicle accounts are increased by factor x1.05 by SIDRA to correspond to passenger car units (pcu).*

The results in Table 5.1 show that the additional workforce traffic movements generated by the proposed modification in 2015 (including the relocation of the existing afternoon shift start time to around 3.00 pm) will have minimal effect on the existing intersection operations. Only during the afternoon peak hour (3.00 to 4.00 pm) will the average traffic delays increase for the traffic which is turning from Construction Road onto Ruttleys Road, by approximately 0.1 second, with a correspondingly minimal change in the intersection degree of saturation from 0.224 to 0.235.

The SIDRA intersection analyses results for the future base year 2027 morning and afternoon peak hour traffic volumes and for the proposed additional traffic are included in detail in Appendix C and are summarised in Table 5.2.

Table 5.2 Peak hour intersection performance for 2027 base and the CVC modification traffic

Intersection Assessment	Peak Hour Period	Vehicles (pcu*)	Degree of Saturation	Average Delay (seconds/vehicle)	Level of Service
Ruttleys Road and Construction Road (existing traffic volumes in 2027)	Morning peak hour (6.30 am - 7.30 am)	760	0.188	26.5	B
	Afternoon peak hour (3.00 pm -4.00 pm)	1063	0.284	42.5	D
Ruttleys Road and Construction Road (with the proposed CVC modification traffic)	Morning peak hour (6.30 am - 7.30 am)	779	0.191	25.2	B
	Afternoon peak hour (3.00 pm -4.00 pm)	1113	0.294	43.5	D

** Intersection vehicle accounts are increased by factor x1.05 by SIDRA to correspond to passenger car units (pcu).*

In the 2027 base traffic situation, with no additional project workforce traffic, the Ruttleys Road and Construction Road intersection will not generally be congested in the morning peak traffic period and will have good operating delays (level of service B). However, in the afternoons, the peak hour operating delays will be classified as near capacity (level of service D) and the highest traffic delays (for the right turn egress traffic) will be approximately 42 to 43 seconds, although the intersection degree of saturation will remain relatively low at 0.284.

With the additional workforce traffic movements which will be generated by the proposed modification in 2027 (including the relocation of the existing afternoon shift start time to around 3.00 pm) will still generally have minimal effect on the future intersection operations (Table 5.2) with unchanged levels of service. During the afternoon peak hour (3.00 to 4.00 pm) the intersection traffic delays for the traffic which is turning right from Construction Road onto Ruttleys Road, will increase by approximately 1 second, with a corresponding minor increase in the intersection degree of saturation from 0.284 to 0.294.

6 Car parking

The on-site car parking areas at CVC are distributed around the northern and western sides of the main administration building, and are located approximately 330 m inside the mine entrance from Construction Road.

During the time of the peak daytime parking demand on a typical weekday (which is at the dayshift /afternoon shift overlap), approximately 100 cars are parked in these areas. These car parking areas have proven to be adequate for the current peak parking demand.

The mine workforce car parking areas have previously accommodated the car parking demand for a peak mine workforce of approximately 380 persons during the mid 1980s. As a consequence, no additional workforce car parking areas are anticipated to be required for the current mine workforce numbers or the additional mine dayshift or afternoon shift vehicles (15) which would be likely to be parked at CVC on a typical weekday under the proposed modification.

7 Conclusion

The intersection of Ruttleys Road with Construction Road which provides access to and from CVC is currently operating with either good or satisfactory peak hour intersection delays in 2015 (level of service either B or C).

By the year 2027, with the background through traffic for the traffic using Ruttleys Road continuing to grow at a rate of +2.3% annually, the morning peak hour intersection level of service will remain at level of service B although the afternoon peak hour level of service will have changed to 'D'.

Notwithstanding this predicted change to the future base case traffic conditions at the intersection, the future intersection peak hour traffic delays and level of service will not be adversely affected as a consequence of the proposed modification and accordingly no intersection improvements or other traffic management measures would be required.

Yours sincerely

Tim Brooker
Senior Transport Planner
tbrooker@emgamm.com

Appendix A

Intersection traffic count results

R.O.A.R. DATA

Reliable, Original & Authentic Results

Ph.88196847, Fax 88196849.
Mobile.0418239019

Client : EMGA
Job No/Name : 5543 MANNERING PARK Rutleys Rd (
Day/Date : Friday 20th March 2015

Mine Traffic Peak Hour is 06.30 - 07.30

Actual Traffic Peak Hour is 08.00 - 09.00

PEDS	NORTH	EAST	SOUTH	
Time Per	Rutleys Rd	Construction	Rutleys Rd	TOT
0630 - 0645				0
0645 - 0700		NOT		0
0700 - 0715		REQUIRED		0
0715 - 0730				0
0730 - 0745				0
0745 - 0800				0
0800 - 0815				0
0815 - 0830				0
0830 - 0845				0
0845 - 0900				0
0900 - 0915				0
0915 - 0930				0
Per End	0	0	0	0

PEDS	NORTH	EAST	SOUTH	
Peak Per	Rutleys Rd	Construction	Rutleys Rd	TOT
0630 - 0730	0	0	0	0
0645 - 0745	0	0	0	0
0700 - 0800	0	0	0	0
0715 - 0815	0	0	0	0
0730 - 0830	0	0	0	0
0745 - 0845	0	0	0	0
0800 - 0900	0	0	0	0
0815 - 0915	0	0	0	0
0830 - 0930	0	0	0	0
PEAK HR	0	0	0	0

Others	NORTH		EAST		SOUTH		
	Rutleys Rd		Construction		Rutleys Rd		
Time Per	T	L	R	L	R	T	TOT
0630 - 0645	41	11	0	0	14	50	116
0645 - 0700	75	5	1	4	6	71	162
0700 - 0715	52	3	1	8	0	51	115
0715 - 0730	72	1	5	5	2	55	140
0730 - 0745	81	1	0	0	3	45	130
0745 - 0800	77	2	1	1	5	61	147
0800 - 0815	113	0	1	2	0	60	176
0815 - 0830	95	3	2	2	1	86	189
0830 - 0845	86	0	0	3	2	62	153
0845 - 0900	86	0	0	0	0	73	159
0900 - 0915	72	0	2	2	0	62	138
0915 - 0930	77	1	1	1	0	68	148
Per End	927	27	14	28	33	744	1773

Trucks	NORTH		EAST		SOUTH		
	Rutleys Rd		Construction		Rutleys Rd		
Time Per	T	L	R	L	R	T	TOT
0630 - 0645	3	0	0	3	4	0	10
0645 - 0700	3	0	1	4	6	7	21
0700 - 0715	0	0	0	1	1	6	8
0715 - 0730	5	0	0	2	1	5	13
0730 - 0745	5	0	0	3	2	2	12
0745 - 0800	5	1	0	0	1	3	10
0800 - 0815	6	2	0	0	2	5	15
0815 - 0830	4	1	1	2	3	6	17
0830 - 0845	2	2	0	0	3	6	13
0845 - 0900	3	0	0	5	2	2	12
0900 - 0915	3	1	1	2	1	4	12
0915 - 0930	6	0	0	3	1	3	13
Per End	45	7	3	25	27	49	156

Combined	NORTH		EAST		SOUTH		
	Rutleys Rd		Construction		Rutleys Rd		
Time Per	T	L	R	L	R	T	TOT
0630 - 0645	44	11	0	3	18	50	126
0645 - 0700	78	5	2	8	12	78	183
0700 - 0715	52	3	1	9	1	57	123
0715 - 0730	77	1	5	7	3	60	153
0730 - 0745	86	1	0	3	5	47	142
0745 - 0800	82	3	1	1	6	64	157
0800 - 0815	119	2	1	2	2	65	191
0815 - 0830	99	4	3	4	4	92	206
0830 - 0845	88	2	0	3	5	68	166
0845 - 0900	89	0	0	5	2	75	171
0900 - 0915	75	1	3	4	1	66	150
0915 - 0930	83	1	1	4	1	71	161
Per End	972	34	17	53	60	793	1929

Others	NORTH		EAST		SOUTH		
	Rutleys Rd		Construction		Rutleys Rd		
Peak Per	T	L	R	L	R	T	TOT
0630 - 0730	240	20	7	17	22	227	533
0645 - 0745	280	10	7	17	11	222	547
0700 - 0800	282	7	7	14	10	212	532
0715 - 0815	343	4	7	8	10	221	593
0730 - 0830	366	6	4	5	9	252	642
0745 - 0845	371	5	4	8	8	269	665
0800 - 0900	380	3	3	7	3	281	677
0815 - 0915	339	3	4	7	3	283	639
0830 - 0930	321	1	3	6	2	265	598
PEAK HR	380	3	3	7	3	281	677

Trucks	NORTH		EAST		SOUTH		
	Rutleys Rd		Construction		Rutleys Rd		
Peak Per	T	L	R	L	R	T	TOT
0630 - 0730	11	0	1	10	12	18	52
0645 - 0745	13	0	1	10	10	20	54
0700 - 0800	15	1	0	6	5	16	43
0715 - 0815	21	3	0	5	6	15	50
0730 - 0830	20	4	1	5	8	16	54
0745 - 0845	17	6	1	2	9	20	55
0800 - 0900	15	5	1	7	10	19	57
0815 - 0915	12	4	2	9	9	18	54
0830 - 0930	14	3	1	10	7	15	50
PEAK HR	15	5	1	7	10	19	57

Combined	NORTH		EAST		SOUTH		
	Rutleys Rd		Construction		Rutleys Rd		
Peak Per	T	L	R	L	R	T	TOT
0630 - 0730	251	20	8	27	34	245	585
0645 - 0745	293	10	8	27	21	242	601
0700 - 0800	297	8	7	20	15	228	575
0715 - 0815	364	7	7	13	16	236	643
0730 - 0830	386	10	5	10	17	268	696
0745 - 0845	388	11	5	10	17	289	720
0800 - 0900	395	8	4	14	13	300	734
0815 - 0915	351	7	6	16	12	301	693
0830 - 0930	335	4	4	16	9	280	648
PEAK HR	395	8	4	14	13	300	734

R.O.A.R. DATA

Reliable, Original & Authentic Results

Ph.88196847, Fax 88196849.
Mobile.0418239019

Client : EMGA
Job No/Name : 5543 MANNERING PARK Rutleys Rc
Day/Date : Friday 20th March 2015

Mine Traffic Peak Hour is 15.00 - 16.00

Actual Traffic Peak Hour is 15.30 - 16.30

PEDS	NORTH	EAST	SOUTH	
Time Per	Rutleys Rd	Construction	Rutleys Rd	TOT
1500 - 1515				0
1515 - 1530		NOT		0
1530 - 1545		REQUIRED		0
1545 - 1600				0
1600 - 1615				0
1615 - 1630				0
1630 - 1645				0
1645 - 1700				0
1700 - 1715				0
1715 - 1730				0
1730 - 1745				0
1745 - 1800				0
Per End	0	0	0	0

PEDS	NORTH	EAST	SOUTH	
Peak Per	Rutleys Rd	Construction	Rutleys Rd	TOT
1500 - 1600	0	0	0	0
1515 - 1615	0	0	0	0
1530 - 1630	0	0	0	0
1545 - 1645	0	0	0	0
1600 - 1700	0	0	0	0
1615 - 1715	0	0	0	0
1630 - 1730	0	0	0	0
1645 - 1745	0	0	0	0
1700 - 1800	0	0	0	0
PEAK HR	0	0	0	0

Others	NORTH		EAST		SOUTH		
	Rutleys Rd		Construction		Rutleys Rd		
Time Per	T	L	R	L	R	T	TOT
1500 - 1515	68	0	5	1	0	75	149
1515 - 1530	95	0	4	11	0	74	184
1530 - 1545	133	3	4	9	0	86	235
1545 - 1600	92	1	6	8	2	90	199
1600 - 1615	86	0	0	2	2	75	165
1615 - 1630	104	0	1	3	0	117	225
1630 - 1645	68	0	2	1	0	55	126
1645 - 1700	104	1	1	0	0	100	206
1700 - 1715	95	0	1	2	0	91	189
1715 - 1730	98	0	1	2	0	122	223
1730 - 1745	104	0	0	2	2	113	221
1745 - 1800	77	2	2	2	0	111	194
Per End	1124	7	27	43	6	1109	2316

Trucks	NORTH		EAST		SOUTH		
	Rutleys Rd		Construction		Rutleys Rd		
Time Per	T	L	R	L	R	T	TOT
1500 - 1515	1	1	0	0	0	1	3
1515 - 1530	1	1	0	0	1	6	9
1530 - 1545	3	0	0	1	0	1	5
1545 - 1600	6	1	3	2	4	6	22
1600 - 1615	4	1	0	5	1	2	13
1615 - 1630	2	1	0	6	0	1	10
1630 - 1645	3	0	0	1	0	3	7
1645 - 1700	0	1	0	0	1	0	2
1700 - 1715	2	0	0	0	1	1	4
1715 - 1730	2	0	0	1	2	1	6
1730 - 1745	0	0	0	1	0	1	2
1745 - 1800	1	0	1	0	0	2	4
Per End	25	6	4	17	10	25	87

Combined	NORTH		EAST		SOUTH		
	Rutleys Rd		Construction		Rutleys Rd		
Time Per	T	L	R	L	R	T	TOT
1500 - 1515	69	1	5	1	0	76	152
1515 - 1530	96	1	4	11	1	80	193
1530 - 1545	136	3	4	10	0	87	240
1545 - 1600	98	2	9	10	6	96	221
1600 - 1615	90	1	0	7	3	77	178
1615 - 1630	106	1	1	9	0	118	235
1630 - 1645	71	0	2	2	0	58	133
1645 - 1700	104	2	1	0	1	100	208
1700 - 1715	97	0	1	2	1	92	193
1715 - 1730	100	0	1	3	2	123	229
1730 - 1745	104	0	0	3	2	114	223
1745 - 1800	78	2	3	2	0	113	198
Per End	1149	13	31	60	16	1134	2403

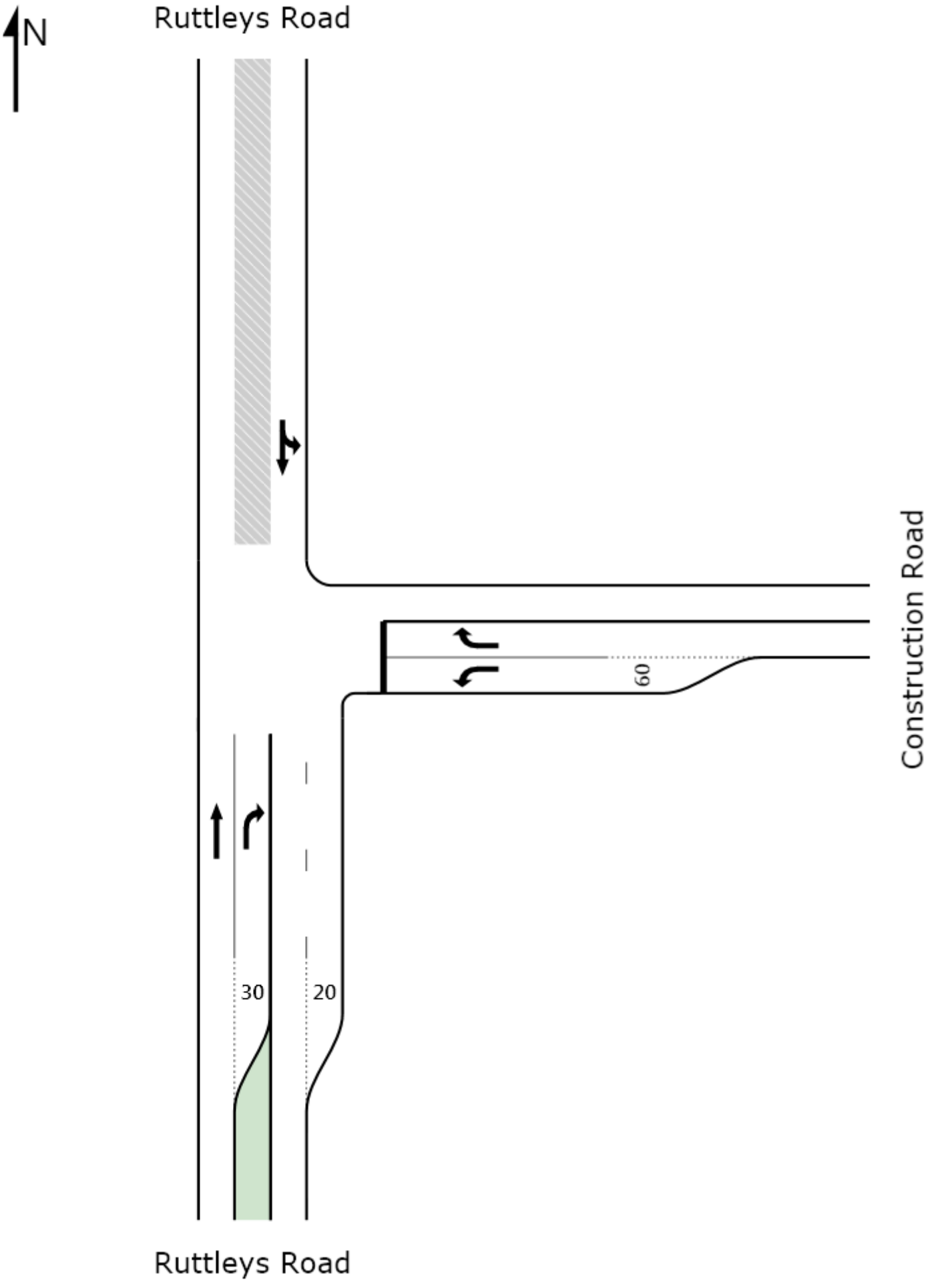
Others	NORTH		EAST		SOUTH		
	Rutleys Rd		Construction		Rutleys Rd		
Peak Per	T	L	R	L	R	T	TOT
1500 - 1600	388	4	19	29	2	325	767
1515 - 1615	406	4	14	30	4	325	783
1530 - 1630	415	4	11	22	4	368	824
1545 - 1645	350	1	9	14	4	337	715
1600 - 1700	362	1	4	6	2	347	722
1615 - 1715	371	1	5	6	0	363	746
1630 - 1730	365	1	5	5	0	368	744
1645 - 1745	401	1	3	6	2	426	839
1700 - 1800	374	2	4	8	2	437	827
PEAK HR	415	4	11	22	4	368	824

Trucks	NORTH		EAST		SOUTH		
	Rutleys Rd		Construction		Rutleys Rd		
Peak Per	T	L	R	L	R	T	TOT
1500 - 1600	11	3	3	3	5	14	39
1515 - 1615	14	3	3	8	6	15	49
1530 - 1630	15	3	3	14	5	10	50
1545 - 1645	15	3	3	14	5	12	52
1600 - 1700	9	3	0	12	2	6	32
1615 - 1715	7	2	0	7	2	5	23
1630 - 1730	7	1	0	2	4	5	19
1645 - 1745	4	1	0	2	4	3	14
1700 - 1800	5	0	1	2	3	5	16
PEAK HR	15	3	3	14	5	10	50

Combined	NORTH		EAST		SOUTH		
	Rutleys Rd		Construction		Rutleys Rd		
Peak Per	T	L	R	L	R	T	TOT
1500 - 1600	399	7	22	32	7	339	806
1515 - 1615	420	7	17	38	10	340	832
1530 - 1630	430	7	14	36	9	378	874
1545 - 1645	365	4	12	28	9	349	767
1600 - 1700	371	4	4	18	4	353	754
1615 - 1715	378	3	5	13	2	368	769
1630 - 1730	372	2	5	7	4	373	763
1645 - 1745	405	2	3	8	6	429	853
1700 - 1800	379	2	5	10	5	442	843
PEAK HR	430	7	14	36	9	378	874

Appendix B

Year 2015 SIDRA Intersection Analysis


N
Ruttleys Road
Construction Road
60
30
20
Ruttleys Road

MOVEMENT SUMMARY

Site: AM Existing Ruttleys and Construction Roads 6.30 to 7.30 am

Ruttleys Road - Construction Road
Stop (Two-Way)

Movement Performance - Vehicles											
Mov ID	Turn	Demand Flow veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Ruttleys Road											
2	T	258	7.3	0.139	0.0	LOS A	0.0	0.0	0.00	0.00	80.0
3	R	36	35.3	0.054	15.2	LOS B	0.2	1.7	0.42	0.72	56.0
Approach		294	10.8	0.139	1.8	NA	0.2	1.7	0.05	0.09	76.1
East: Construction Road											
4	L	28	37.0	0.047	18.6	LOS B	0.2	1.5	0.42	0.89	54.1
6	R	8	12.5	0.027	22.5	LOS B	0.1	0.7	0.63	0.94	48.1
Approach		37	31.4	0.047	19.5	LOS B	0.2	1.5	0.47	0.90	52.6
North: Ruttleys Road											
7	L	21	0.0	0.151	10.9	LOS A	0.0	0.0	0.00	1.26	58.9
8	T	264	4.4	0.151	0.0	LOS A	0.0	0.0	0.00	0.00	80.0
Approach		285	4.1	0.151	0.8	NA	0.0	0.0	0.00	0.09	78.0
All Vehicles		616	8.9	0.151	2.4	NA	0.2	1.7	0.05	0.14	75.0

Level of Service (LOS) Method: Delay (RTA NSW).
Vehicle movement LOS values are based on average delay per movement
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.
SIDRA Standard Delay Model used.

MOVEMENT SUMMARY

Site: AM Proposed Ruttleys and Construction Roads 6.30 to 7.30 am

Ruttleys Road - Construction Road
Stop (Two-Way)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flow veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Ruttleys Road											
2	T	258	7.3	0.139	0.0	LOS A	0.0	0.0	0.00	0.00	80.0
3	R	41	30.8	0.059	14.8	LOS B	0.2	1.8	0.42	0.72	56.2
Approach		299	10.6	0.139	2.0	NA	0.2	1.8	0.06	0.10	75.7
East: Construction Road											
4	L	33	32.3	0.051	18.0	LOS B	0.2	1.6	0.42	0.89	54.3
6	R	13	8.3	0.038	21.5	LOS B	0.1	1.0	0.63	0.95	48.6
Approach		45	25.6	0.051	19.0	LOS B	0.2	1.6	0.47	0.91	52.6
North: Ruttleys Road											
7	L	26	0.0	0.154	10.9	LOS A	0.0	0.0	0.00	1.24	58.9
8	T	264	4.4	0.154	0.0	LOS A	0.0	0.0	0.00	0.00	80.0
Approach		291	4.0	0.154	1.0	NA	0.0	0.0	0.00	0.11	77.5
All Vehicles		635	8.6	0.154	2.8	NA	0.2	1.8	0.06	0.16	74.2

Level of Service (LOS) Method: Delay (RTA NSW).
Vehicle movement LOS values are based on average delay per movement
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.
SIDRA Standard Delay Model used.

MOVEMENT SUMMARY

Site: PM Existing Ruttleys and Construction Roads 3.00 to 4.00 pm

Ruttleys Road - Construction Road
Stop (Two-Way)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flow veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Ruttleys Road											
2	T	357	4.1	0.188	0.0	LOS A	0.0	0.0	0.00	0.00	80.0
3	R	7	71.4	0.019	21.7	LOS B	0.1	0.8	0.57	0.78	51.0
Approach		364	5.5	0.188	0.4	NA	0.1	0.8	0.01	0.02	79.1
East: Construction Road											
4	L	34	9.4	0.049	16.4	LOS B	0.2	1.3	0.47	0.91	54.0
6	R	23	13.6	0.115	30.2	LOS C	0.4	3.0	0.78	1.00	42.0
Approach		57	11.1	0.115	22.0	LOS B	0.4	3.0	0.60	0.95	48.4
North: Ruttleys Road											
7	L	7	42.9	0.224	13.5	LOS A	0.0	0.0	0.00	1.53	58.9
8	T	420	2.8	0.224	0.0	LOS A	0.0	0.0	0.00	0.00	80.0
Approach		427	3.4	0.224	0.2	NA	0.0	0.0	0.00	0.03	79.5
All Vehicles		848	4.8	0.224	1.8	NA	0.4	3.0	0.04	0.08	76.1

Level of Service (LOS) Method: Delay (RTA NSW).
Vehicle movement LOS values are based on average delay per movement
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.
SIDRA Standard Delay Model used.

MOVEMENT SUMMARY

Site: PM Proposed Ruttleys and Construction Roads 3.00 to 4.00 pm

Ruttleys Road - Construction Road
Stop (Two-Way)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flow veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Ruttleys Road											
2	T	357	4.1	0.188	0.0	LOS A	0.0	0.0	0.00	0.00	80.0
3	R	27	19.2	0.038	15.0	LOS B	0.1	1.1	0.50	0.76	55.1
Approach		384	5.2	0.188	1.1	NA	0.1	1.1	0.04	0.05	77.6
East: Construction Road											
4	L	39	8.1	0.057	16.3	LOS B	0.2	1.5	0.47	0.92	54.0
6	R	28	11.1	0.141	30.3	LOS C	0.5	3.6	0.79	1.00	41.8
Approach		67	9.4	0.141	22.2	LOS B	0.5	3.6	0.61	0.95	48.1
North: Ruttleys Road											
7	L	26	12.0	0.235	11.6	LOS A	0.0	0.0	0.00	1.33	58.9
8	T	420	2.8	0.235	0.0	LOS A	0.0	0.0	0.00	0.00	80.0
Approach		446	3.3	0.235	0.7	NA	0.0	0.0	0.00	0.08	78.4
All Vehicles		898	4.6	0.235	2.5	NA	0.5	3.6	0.06	0.13	74.6

Level of Service (LOS) Method: Delay (RTA NSW).
Vehicle movement LOS values are based on average delay per movement
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.
SIDRA Standard Delay Model used.

Appendix C

Year 2027 SIDRA Intersection Analysis

MOVEMENT SUMMARY

Site: AM 2027 Ruttleys and Construction Roads 6.30 to 7.30 am

Ruttleys Road - Construction Road
Stop (Two-Way)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flow veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Ruttleys Road											
2	T	329	5.8	0.175	0.0	LOS A	0.0	0.0	0.00	0.00	80.0
3	R	36	35.3	0.053	15.9	LOS B	0.2	1.8	0.48	0.76	55.0
Approach		365	8.6	0.175	1.6	NA	0.2	1.8	0.05	0.07	76.7
East: Construction Road											
4	L	28	37.0	0.053	19.6	LOS B	0.2	1.7	0.48	0.91	53.1
6	R	8	12.5	0.035	26.5	LOS B	0.1	0.9	0.72	0.99	44.7
Approach		37	31.4	0.053	21.2	LOS B	0.2	1.7	0.53	0.93	50.9
North: Ruttleys Road											
7	L	21	0.0	0.188	10.9	LOS A	0.0	0.0	0.00	1.28	58.9
8	T	337	3.4	0.188	0.0	LOS A	0.0	0.0	0.00	0.00	80.0
Approach		358	3.2	0.188	0.6	NA	0.0	0.0	0.00	0.08	78.4
All Vehicles		760	7.2	0.188	2.1	NA	0.2	1.8	0.05	0.12	75.6

Level of Service (LOS) Method: Delay (RTA NSW).
Vehicle movement LOS values are based on average delay per movement
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.
SIDRA Standard Delay Model used.

MOVEMENT SUMMARY

Site: AM 2027 Proposed Ruttleys and Construction Roads 6.30 to 7.30 am

Ruttleys Road - Construction Road
Stop (Two-Way)

Movement Performance - Vehicles											
Mov ID	Turn	Demand Flow veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Ruttleys Road											
2	T	329	5.8	0.175	0.0	LOS A	0.0	0.0	0.00	0.00	80.0
3	R	41	30.8	0.058	15.5	LOS B	0.2	2.0	0.47	0.76	55.2
Approach		371	8.5	0.175	1.7	NA	0.2	2.0	0.05	0.08	76.3
East: Construction Road											
4	L	33	32.3	0.058	18.9	LOS B	0.2	1.8	0.47	0.92	53.3
6	R	13	8.3	0.049	25.2	LOS B	0.2	1.3	0.72	1.00	45.4
Approach		45	25.6	0.058	20.7	LOS B	0.2	1.8	0.54	0.94	50.9
North: Ruttleys Road											
7	L	26	0.0	0.191	10.9	LOS A	0.0	0.0	0.00	1.26	58.9
8	T	337	3.4	0.191	0.0	LOS A	0.0	0.0	0.00	0.00	80.0
Approach		363	3.2	0.191	0.8	NA	0.0	0.0	0.00	0.09	78.0
All Vehicles		779	7.0	0.191	2.4	NA	0.2	2.0	0.06	0.14	74.9

Level of Service (LOS) Method: Delay (RTA NSW).
Vehicle movement LOS values are based on average delay per movement
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.
SIDRA Standard Delay Model used.

MOVEMENT SUMMARY

Site: PM 2027 Ruttleys and Construction Roads 3.00 to 4.00 pm

Ruttleys Road - Construction Road
Stop (Two-Way)

Movement Performance - Vehicles											
Mov ID	Turn	Demand Flow veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Ruttleys Road											
2	T	456	3.2	0.239	0.0	LOS A	0.0	0.0	0.00	0.00	80.0
3	R	7	71.4	0.025	25.1	LOS B	0.1	1.0	0.67	0.86	47.5
Approach		463	4.3	0.239	0.4	NA	0.1	1.0	0.01	0.01	79.2
East: Construction Road											
4	L	34	9.4	0.059	17.7	LOS B	0.2	1.5	0.53	0.95	52.7
6	R	23	13.6	0.182	42.5	LOS D	0.6	4.6	0.87	1.01	34.7
Approach		57	11.1	0.182	27.8	LOS B	0.6	4.6	0.67	0.97	43.5
North: Ruttleys Road											
7	L	7	42.9	0.284	13.5	LOS A	0.0	0.0	0.00	1.54	58.9
8	T	536	2.2	0.284	0.0	LOS A	0.0	0.0	0.00	0.00	80.0
Approach		543	2.7	0.284	0.2	NA	0.0	0.0	0.00	0.02	79.6
All Vehicles		1063	3.9	0.284	1.8	NA	0.6	4.6	0.04	0.07	76.1

Level of Service (LOS) Method: Delay (RTA NSW).
Vehicle movement LOS values are based on average delay per movement
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.
SIDRA Standard Delay Model used.

MOVEMENT SUMMARY

Site: PM 2027 Proposed Ruttleys and Construction Roads 3.00 to 4.00 pm

Ruttleys Road - Construction Road
Stop (Two-Way)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flow veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Ruttleys Road											
2	T	456	3.2	0.239	0.0	LOS A	0.0	0.0	0.00	0.00	80.0
3	R	27	19.2	0.046	16.2	LOS B	0.2	1.3	0.56	0.81	53.5
Approach		483	4.1	0.239	0.9	NA	0.2	1.3	0.03	0.05	77.9
East: Construction Road											
4	L	39	8.1	0.068	17.6	LOS B	0.2	1.7	0.54	0.96	52.6
6	R	28	11.1	0.222	43.5	LOS D	0.7	5.7	0.88	1.01	34.1
Approach		67	9.4	0.222	28.6	LOS C	0.7	5.7	0.68	0.98	42.8
North: Ruttleys Road											
7	L	26	12.0	0.294	11.6	LOS A	0.0	0.0	0.00	1.35	58.9
8	T	536	2.2	0.294	0.0	LOS A	0.0	0.0	0.00	0.00	80.0
Approach		562	2.6	0.294	0.5	NA	0.0	0.0	0.00	0.06	78.7
All Vehicles		1113	3.7	0.294	2.4	NA	0.7	5.7	0.05	0.11	74.6

Level of Service (LOS) Method: Delay (RTA NSW).
Vehicle movement LOS values are based on average delay per movement
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA: Intersection LOS and Major Road Approach LOS values are Not Applicable for two-way sign control since the average delay is not a good LOS measure due to zero delays associated with major road movements.
SIDRA Standard Delay Model used.

Appendix K

Greenhouse gas assessment

Appendix K— Greenhouse gas assessment

K

Pacific Environment Limited

Consulting • Technologies • Monitoring • Toxicology

Report

Chain Valley COLLIERY – MODIFICATION 2 – Greenhouse Gas Assessment

LakeCoal Pty Ltd c/o EMGA Mitchell McLennan Pty Limited

Job ID. 20106C

5 May 2015

PROJECT NAME:	Chain Valley COLLIERY – MODIFICATION 2 – Greenhouse Gas Assessment
JOB ID:	20106C
PREPARED FOR:	LakeCoal Pty Ltd c/o EMGA Mitchell McLennan Pty Limited
APPROVED FOR RELEASE BY:	Judith Cox
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1 GREENHOUSE GAS ASSESSMENT

1.1 Project Overview

Chain Valley Colliery (CVC) is an underground coal mine located at the southern end of Lake Macquarie, approximately 60km south of Newcastle. The mine is owned and operated by LakeCoal Pty Ltd (LakeCoal).

Pacific Environment was engaged by EMGA Mitchell McLennan Pty Ltd (EMM) on behalf of LakeCoal to complete a greenhouse gas assessment (GHG) for a second modification to the CVC Mining Extension Project (SSD-5465). The proposed modification is to allow:

- an increase in the maximum rate of ROM coal extraction at CVC from 1.5 Mtpa to 2.1 Mtpa;
- the re-orientation of miniwall panels in CVC's northern mining area and minor amendments to the development consent boundary;
- an increase in full time personnel from 160 to approximately 220; and
- minor vegetation clearance and disturbance adjacent to some infrastructure at CVC's pit top and at the ventilation fan site at Summerland Point to enable the establishment and/or extension of asset protection zones (APZs) for bushfire management purposes.

It is noted that an underground linkage is approved between CVC and the adjacent Mannering Colliery (MC) (MP 06_0311) within the Fassifern Seam workings. All production beyond the existing limit of 1.5 Mtpa will be sent via MC to Vales Point Power Station (VPPS), with a separate modification of MP 06_0311 being sought to increase the amount of coal processing and handling permissible at MC from 1.1 Mtpa to 1.3 Mtpa to the increased delivery to VPPS. Accordingly, there will be no change to CVC surface infrastructure nor to the maximum coal haulage on public roads under the proposed modification.

The potential impact of the proposed modification as compared to the approved development is limited to the increase in the maximum rate of run-of-mine (ROM) coal extraction at CVC from 1.5 to 2.1 Mtpa. It is noted that the additional 600,000 tonnes per annum (tpa) is the maximum increase only. The extractable resource does not allow for this increase to be sustained for the duration of the consent period. Notwithstanding, to provide a highly conservative assessment, this study assumes that an additional 600,000 tpa would be produced for the remainder of the development consent period (refer to Section 1.3).

Actual GHG emissions and energy consumption at CVC will continue to be measured and reported on an annual basis under its participation in the Commonwealth Government's National Greenhouse and Energy Report System (refer to Section 1.6).

1.2 Introduction

GHG emissions have been estimated based on the methods outlined in the following documents:

- The World Resources Institute/World Business Council for Sustainable Development (WRI/WBCSD) Greenhouse Gas Protocol *The Greenhouse Gas Protocol – A Corporate Accounting and Reporting Standard Revised Edition* (**WRI/WBCSD, 2004**) (GHG Protocol).
- National Greenhouse and Energy Reporting (Measurement) Amendment Determination 2008.
- The Australian Government Department of the Environment (DoE) National Greenhouse Accounts (NGA) Factors 2014 (**DoE, 2014**).

The GHG Protocol establishes an international standard for accounting and reporting of GHG emissions. It has been adopted by the International Standard Organisation, endorsed by GHG initiatives (such as the Carbon Disclosure Project), and is compatible with existing GHG trading schemes. Three 'scopes' of emissions (scope 1, scope 2 and scope 3) are defined for GHG accounting and reporting purposes, as described below and shown schematically in **Figure 1.1**. This terminology has been adopted in Australian GHG reporting and measurement methods and has been employed in this assessment.

The 'scope' of an emission is relative to the reporting entity. Indirect (scope 2 and scope 3) emissions related to one facility would be reportable as direct (scope 1) emissions from another facility.

1) Scope 1: Direct Greenhouse Gas Emissions

Direct GHG emissions are defined as those emissions that occur from sources that are owned or controlled by the reporting entity and are those emissions that are principally the result of the following types of activities undertaken by that entity:

- Generation of electricity, heat or steam. These emissions result from combustion of fuels in stationary sources.
- Physical or chemical processing. Most of these emissions result from manufacture or processing of chemicals and materials (e.g. the manufacture of cement, aluminium, etc.).
- Transportation of materials, products, waste and employees. These emissions result from the combustion of fuels in entity owned/controlled mobile combustion sources (e.g. trucks, trains, ships, aeroplanes, buses and cars).
- Fugitive emissions resulting from intentional or unintentional releases (e.g. equipment leaks from joints, seals, packing and gaskets; CH_4 emissions from coal mines and venting); hydrofluorocarbon emissions during the use of refrigeration and air conditioning equipment, and CH_4 leakages from gas transport.

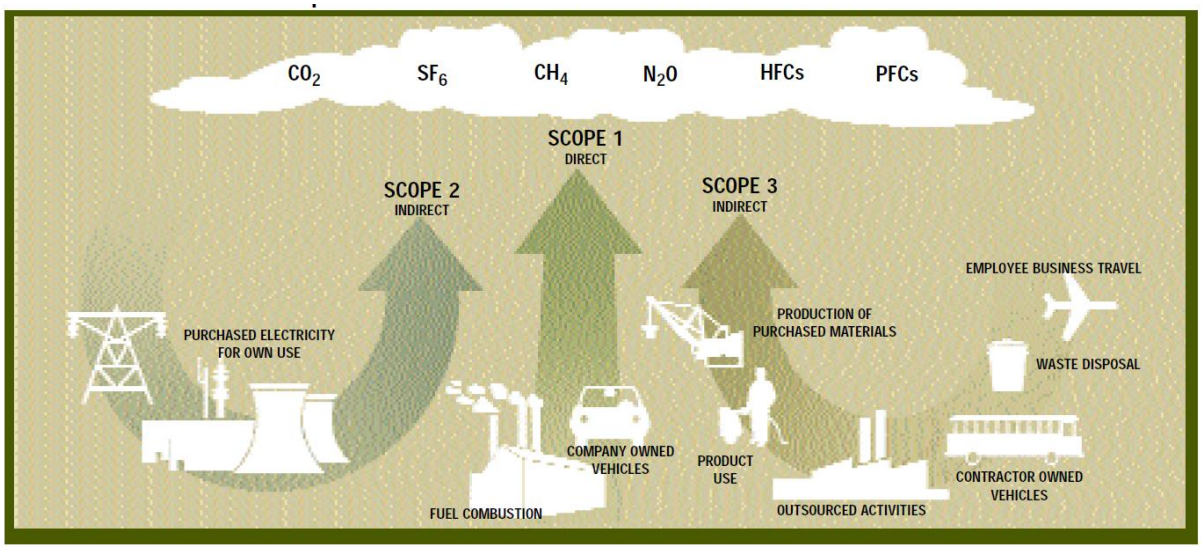
2) Scope 2: Energy Product Use Indirect Greenhouse Gas Emissions

Scope 2 GHG emissions are a category of indirect emissions that account for those arising from the generation of purchased energy products (principally, electricity, steam/heat and reduction materials used for smelting) by the entity. In relation to coal mines, Scope 2 emissions typically cover purchased electricity, defined as electricity that is purchased or otherwise brought into the organisational boundary of the entity.

3) Scope 3: Other Indirect Greenhouse Gas Emissions

Scope 3 emissions are defined as those emissions that are a consequence of the activities of an entity, but which arise from sources not owned or controlled by that entity. Some examples of scope 3 activities provided in the GHG Protocol are extraction and production of purchased materials, transportation of purchased fuels, and use of sold products and services.

In the case of the proposed modification, scope 3 emissions would include emissions associated with the transportation and combustion of product coal, as well as the minor emissions associated with the extraction, processing and transport of fuel used onsite. The GHG Protocol provides that reporting scope 3 emissions is optional. If an organisation believes that scope 3 emissions are a significant component of the total emissions inventory, these can be reported along with scope 1 and scope 2. However, the GHG Protocol notes that reporting scope 3 emissions can result in double counting of emissions and can also make comparisons between organisations and/or products difficult because reporting is voluntary. Double counting needs to be avoided when compiling national (country) inventories under the Kyoto Protocol. The GHG Protocol also recognises that compliance regimes are more likely to focus on the "point of release" of emissions (i.e. direct emissions) and/or indirect emissions from the purchase of electricity.



Source: Figure 3, **WRI/WBCSD, 2004**

Figure 1.1: Overview of scopes and emissions across a reporting entity

1.3 Greenhouse Gas Emission Estimates

Carbon dioxide (CO_2) and methane (CH_4) comprise the most significant GHGs arising from CVC. These gases are formed and released during the combustion of fuels used on site and as fugitive emissions occurring during the mining process, due to the liberation of CH_4 and CO_2 from coal seams.

Inventories of GHG emissions can be developed using published emission factors. Different gases have different greenhouse warming effects (referred to as global warming potentials, or GWPs) and emission factors take into account the GWPs of the gases created during combustion. The estimated emissions are referred to in terms of carbon dioxide equivalent (CO_2-e) emissions by applying the relevant GWP. The GHG assessment has been conducted using the NGA Factors, published by the **DoE (2014)**.

Project-related GHG sources included in the assessment are as follows:

Scope 1:

- Fuel consumption (diesel) during on-site mining operations.
- Release of fugitive CH_4 and CO_2 during mining.

Scope 2:

- Indirect emissions associated with purchased electricity brought into the organisational boundary to supplement the on-site electricity generation.

Scope 3:

- Indirect emissions associated with purchased electricity brought into the organisational boundary to enable mining operations to occur.
- Indirect emissions associated with the production and transport of fuels.
- Emissions from coal transportation.
- Emissions from the use of the product coal.

Other minor emissions, such as those from oil and grease, represent less than 0.1% of the total emissions, and accordingly, have not been included within the GHG assessment.

Table 1.1 presents a summary of the total Scope 1, Scope 2 and Scope 3 GHG emissions from the approved development and the increase due to the proposed modification. Details on emissions by year and type are provided in **Table 1.2**. Full details of all calculations are provided in **Appendix A**.

Table 1.1: Comparison of Annual CVC Greenhouse Gas Emissions

Parameter	Approved Development	Increase Due to Proposed Modification	Total
ROM (Mtpa)	1.5	0.6	2.1
Annual average GHG Emissions (Mt CO_{2-e})			
Scope 1 Emissions	0.590	0.134	0.724
Scope 2 Emissions	0.018	0.008	0.026
Scope 3 Emissions	3.593	1.434	5.027
Total	**4.199**	**1.576**	**5.777**

Table 1.2: Summary of Additional Annual Greenhouse Gas Emissions due to the Modification

Year	Scope 1 Emissions ($t CO_{2-e}$)					Scope 2 Emissions ($t CO_{2-e}$)	Scope 3 Emissions ($t CO_{2-e}$)					
	Diesel	Fugitive Gas	Post-Mining	Total (mod)	*Total (project)*	Electricity	Diesel	Electricity	Transport	Coal Burning	2 Total (mod)	*Total (project)*
2015	614	125,090	8,400	134,104	*469,363*	8,104	47	1,225	0	1,432,566	1,433,838	*5,026,450*
2016	614	125,090	8,400	134,104	*469,363*	8,104	47	1,225	0	1,432,566	1,433,838	*5,026,450*
2017	614	125,090	8,400	134,104	*469,363*	8,104	47	1,225	0	1,432,566	1,433,838	*5,026,450*
2018	614	125,090	8,400	134,104	*469,363*	8,104	47	1,225	0	1,432,566	1,433,838	*5,026,450*
2019	614	125,090	8,400	134,104	*469,363*	8,104	47	1,225	0	1,432,566	1,433,838	*5,026,450*
2020	614	125,090	8,400	134,104	*469,363*	8,104	47	1,225	0	1,432,566	1,433,838	*5,026,450*
2021	614	125,090	8,400	134,104	*469,363*	8,104	47	1,225	0	1,432,566	1,433,838	*5,026,450*
2022	614	125,090	8,400	134,104	*469,363*	8,104	47	1,225	0	1,432,566	1,433,838	*5,026,450*
2023	614	125,090	8,400	134,104	*469,363*	8,104	47	1,225	0	1,432,566	1,433,838	*5,026,450*
2024	614	125,090	8,400	134,104	*469,363*	8,104	47	1,225	0	1,432,566	1,433,838	*5,026,450*
2025	614	125,090	8,400	134,104	*469,363*	8,104	47	1,225	0	1,432,566	1,433,838	*5,026,450*
2026	614	125,090	8,400	134,104	*469,363*	8,104	47	1,225	0	1,432,566	1,433,838	*5,026,450*
2027	614	125,090	8,400	134,104	*469,363*	8,104	47	1,225	0	1,432,566	1,433,838	*5,026,450*
Total	**7,985**	**1,626,165**	**109,200**	**1,743,349**	***6,101,722***	**105,358**	**609**	**15,926**	**0**	**18,623,358**	**18,639,893**	**65,343,855**

Notes:
Totals may have minor discrepancies due to rounding.

2.1 Impact on the Environment

According to the Intergovernmental Panel on Climate Change's (IPCC) Fifth Assessment Report, global surface temperature has increased by 0.89°C ± 0.2°C during the 100 years ending 2012 (**IPCC, 2013**). The IPCC has determined "*most of the observed increase in globally averaged temperatures since the mid-twentieth century is very likely due to the observed increase in anthropogenic greenhouse gas concentrations*". "Very likely" is defined by the IPCC as greater than 90% probability of occurrence (**IPCC, 2013**).

Climate change projections specific to Australia have been determined by the CSIRO and the Australian Bureau of Meteorology (BoM), based on global emissions scenarios predicted by the latest IPCC assessment (**CSIRO, 2015**). These projections supersede those released by CSIRO and the BoM in 2007. Although the findings are similar to those of the 2007 projections, the range of emissions scenarios is broader than those used for the 2007 projections. The latest projections begin with concentration levels, rather than socio-economic assumptions followed by inferred emissions.

The projected changes have been prepared for four Representative Concentration Pathways (RCPs), which represent the following scenarios for emissions of greenhouse gases, aerosols and land-use change, relative to the 1996-2005 period:

- RCP8.5 (high emissions) - represents a future with little curbing of emissions, with CO_2 concentrations continuing to rapidly rise, reaching 940 parts per million (ppm) by 2100.
- RCP6.0 (intermediate emissions) - represents lower emissions, achieved by application of some mitigation strategies and technologies. This scenario results in the CO_2 concentration rising less rapidly than RCP8.5, but still reaching 660 ppm by 2100.
- RCP4.5 (intermediate emissions) - represents a similar scenario to RCP6.0, but emissions peak earlier (around 2040), and the CO_2 concentration reaches 540 ppm in 2100.
- RCP2.6 (low emissions) -assumes a very strong emissions reductions from a peak at around 2020 to reach a CO_2 concentration at about 420 ppm by 2100. This pathway would require early participation from all emitters, including developing countries, as well as the application of technologies for actively removing carbon dioxide from the atmosphere.

For climate change projections, a regionalisation scheme using natural resource management regional boundaries has been used to divide Australia up into 8 clusters and 15 sub-clusters. For the projections described above, **Table 1.3**presents the changes in annual temperature relative to the 1986-2005 period for the east coast south sub-cluster in which the CVC coal mine is located.

Table 1.3: Projected Changes in Annual Temperature (relative to the 1986-2005 period)

2030 – RCP2.6 (low emissions scenario)	2030 –RCP4.5 (intermediate emissions scenario)	2030 – RCP8.5 (high emissions scenario)	2090 – RCP2.6 (low emissions scenario)	290 – RCP4.5 (intermediate emissions scenario)	2090 – RCP8.5 (high emissions scenario)
Temperature (°C)					
0.7 (0.5 to 1.1)	0.9 (0.6 to 1.1)	1 (0.7 to 1.3)	1 (0.6 to 1.5)	1.8 (1.3 to 2.5)	3.7 (2.9 to 4.6)

Notes: The table gives the median (50th percentile) change with the 10th and 90th percentile range given within brackets. RCP6.0 is not included due to a smaller sample of model simulations available compared to the other RCPs.(CSIRO, 2015).
Source: CSIRO (2015) Climate Change in Australia – Technical Report 2015, Commonwealth Scientific and Industrial Research Organisation.

The CSIRO also details projected changes to other meteorological parameters (for example rainfall, potential evaporation, wind speed, relative humidity and solar radiation) and the predicted changes to the prevalence of extreme weather events (for example droughts, bush fires and cyclones).

The potential social and economic impacts of climate change to Australia are detailed in the Garnaut Climate Change Review (**Garnaut, 2008**), which draws on IPCC assessment work relevant at the time

and the 2007 CSIRO climate projections. The Garnaut review details the negative and positive impacts associated with predicted climate change with respect to:

- Agricultural productivity.
- Water supply infrastructure.
- Urban water supplies.
- Buildings in coastal settlements.
- Temperature related deaths.
- Ecosystems and biodiversity.
- Geopolitical stability and the Asia Pacific region.

CVC's contribution to climate change, and associated impacts, from the increase in annual emissions arising from the proposed modification, if approved, would be in proportion with its contribution to global GHG emissions. Average annual Scope 1 and Scope 2 emissions from the proposed modification (0.142Mt CO_2-e) is conservatively assessed to represent approximately 0.02% of Australia's commitment under the Kyoto Protocol (591.5 Mt CO_2-e) and a very small portion of global GHG emissions, given that Australia contributed approximately 1.25% of global GHG emissions in 2012(**PBL Netherlands Environmental Assessment Agency, 2013**).

A comparison of predicted annual increase in GHG emissions arising as a result of from the proposed modification with global, Australian and NSW emissions inventories are presented in **Table 1.4**.

Table 1.4: Comparison of Greenhouse Gas Emissions

Geographic coverage	Source coverage	Timescale	Emissions Mt CO_2-e	Reference
Modification	Scope 1 and 2	Average annual	0.142	This report.
Global	Consumption of fossil fuels	Total since industrialisation 1750 - 1994	865,000	IPCC (2007a). Figure 7.3 converted from Carbon unit basis to CO_2 basis. Error is stated greater than ±20%.
Global	CO_2-e emissions	2012	34,500	PBL Netherlands Environmental Assessment Agency, 2013
Global	CO_2-e emission increase 2011 to 2012	2012	500	PBL Netherlands Environmental Assessment Agency, 2013.
Australia	1990 Base	1990	547.7	United Nations Framework on Climate Change – Kyoto Protocol base year data http://unfccc.int/ghg_data/kp_data_unfccc/base_year_data/items/4354.php
Australia	Kyoto target	Average annual 2008 - 2012	591.5	Based on 1990 net emissions multiplied by 108% Australia's Kyoto emissions target.
Australia	Total	2012	554.6	Taken from the National Greenhouse Gas Inventory 2012 http://www.environment.gov.au/system/files/resources/6b894230-f15f-4a69-a50c-5577fecc8bc2/files/national-inventory-report-2012-vol1.pdf
NSW	Total	2011/12	154.7	Taken from the State and Territory National Greenhouse Gas Inventory (2011/12) http://www.environment.gov.au/system/files/resources/255447ab-3c51-412e-9756-921ef23cb8aa/files/state-territory-inventories-11-12.pdf

The commitment from the Australian Government to reduce GHG emissions is proposed to be achieved through the introduction of the Australian Government's *Direct Action Plan*. The centrepiece of the plan is Emissions Reduction Fund which will provide incentives for emissions reduction activities across the Australian economy.

2.2 GHG Emissions Intensity

The estimated Scope 1 GHG emissions intensity of the CVC, should the proposed modification be approved, is approximately 0.224 t CO_2-e/t saleable coal. **Figure 1.2** (derived from **Deslandes, 1999**) shows the GHG intensity of CVC compared to other Australian coal mines, with the emissions intensity being at the lower end of the range for gassy underground mines.

By far the largest source of scope 1 GHG emissions are fugitive CH_4 and CO_2 emissions (~94%) followed by emissions from post-mining activities (~6%) (refer to **Table 1.2**).

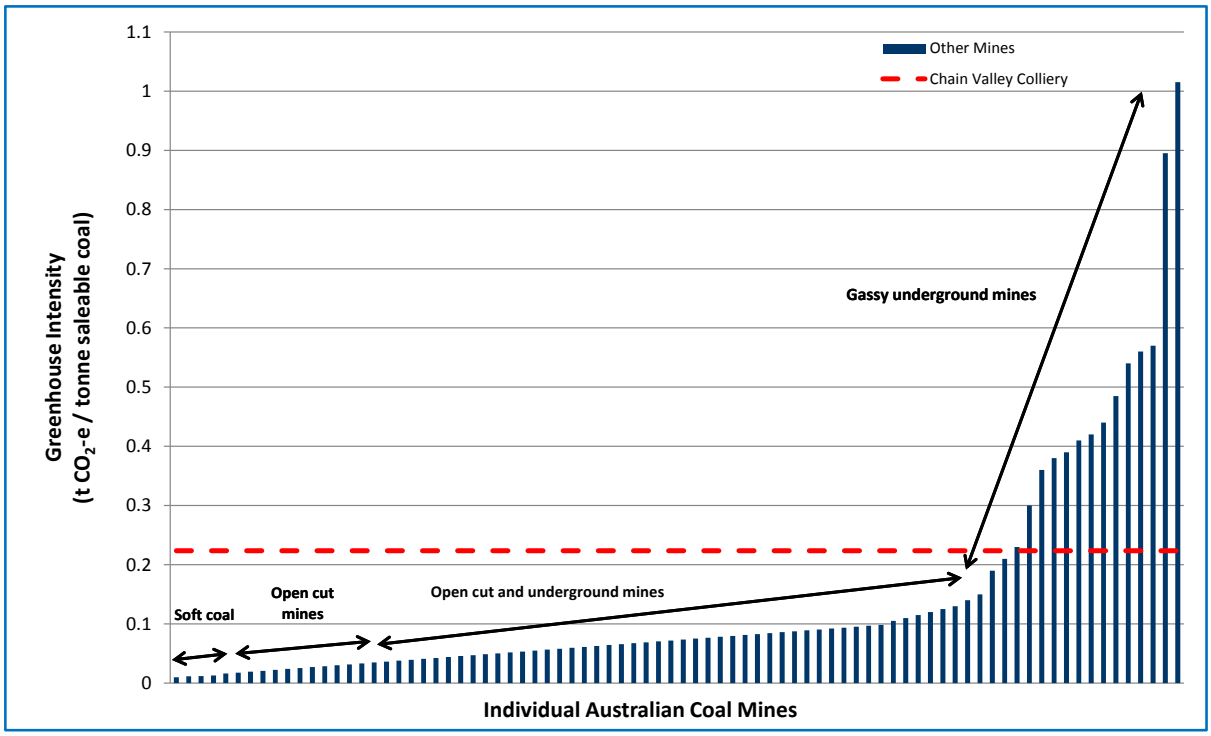


Figure 1.2: GHG Intensity Comparison

2.3 Project Greenhouse Gas and Energy Reduction Measures

LakeCoal is committed to implementing reasonable and feasible GHG mitigation measures. Ongoing monitoring and management of GHG emissions and energy consumption at CVC is achieved through LakeCoal's participation in the Commonwealth Government's National Greenhouse and Energy Report System (NGERS). Under NGERS requirements, relevant sources of GHG emissions and energy consumption must be measured and reported on an annual basis, allowing major sources and trends in emissions/energy consumption to be identified. Some of the practices used and investigations being undertaken to manage and minimise greenhouse gas emissions at CVC are shown below.

- Use of electric winder, not diesel transport, as the primary man and materials transport for the mine.
- Sealing of miniwall panels to reduce methane emissions from the goaf.
- Use of ventilation control devices in sections of the mine not in use enabling them not to be ventilated (unless required for safety purposes), thereby reducing fugitive emissions.
- Investigation into the long term coal haulage to Newcastle by rail instead of road will be undertaken and its feasibility reported on every two years, or until haulage by rail is commenced.
- Whenever possible, direct loading of coal haulage trucks in preference of stockpiling and reclaiming.

- Use of real time gas (methane and carbon dioxide), temperature, pressure and associated volumetric flow monitoring at the ventilation shaft site to allow accurate measurement of ventilation (including methane and carbon dioxide) emissions, which will then allow further feasibility assessment of reuse options.
- Ensuring maintenance, calibration and record keeping is undertaken on the main ventilation shaft and fans to allow calculation of greenhouse gas emissions.
- Maintaining records for monthly electricity use and monthly ROM coal production to allow calculation of greenhouse gas emissions.

CVC does not currently utilise pre- or post- drainage methods which would potentially liberate high concentrations of methane from the underground workings. As such, flaring is not currently a potential way to reduce greenhouse gas emissions from the mine.

3 REFERENCES

ABS (2012)."9208.0 - Survey of Motor Vehicle Use, Australia, 12 months ended 30 June 2012".

CSIRO (2015)."Climate Change in Australia – Technical Report 2015".

Deslandes (1999). "Energy/Greenhouse Benchmarking Study of Coal Mining Industry, a study undertaken for Mineral Resources and Energy Program, Australian Geological Survey Organisation & Energy Efficiency Best Practice Program". Department of Industry, Science and Resources.

DoE (2014) "National Greenhouse Account (NGA) Factors". Published by the Australian Government Department of the Environment.http://www.environment.gov.au/climate-change/greenhouse-gas-measurement/publications/national-greenhouse-accounts-factors-dec-2014

Garnaut, R (2008). "The Garnaut Climate Change Review". Cambridge University Press.

IPCC (2013). "Working Group I Contribution to the IPCC Fifth Assessment Report Clime Change 2013: The Physical Science Basis: Final Draft Underlying Scientific-Technical Assessment". Prepared by the IPCC, 30 September 2013. Available from: http://www.ipcc.ch/report/ar5/wg1/ (accessed 17 March 2015).

PBL Netherlands Environmental Assessment Agency (2013)."Trends in Global CO2 Emissions. 2013 Report". Available from http://edgar.jrc.ec.europa.eu/news_docs/pbl-2013-trends-in-global-co2-emissions-2013-report-1148.pdf (accessed 17 March 2015).

WRI/WBCSD (2004). "The Greenhouse Gas Protocol – A Corporate Accounting and Reporting Standard Revised Edition March 2004".

Appendix A GREENHOUSE GAS EMISSION CALCULATIONS

A.1 FUEL CONSUMPTION

Greenhouse gas emissions from diesel consumption were estimated using the following equation:

$$E_{ij} = \frac{Q_i \times EC_i \times EF_{ijoxec}}{1000}$$

Where:

E_{ij}	=	Emissions of GHG from diesel combustion	(t CO_2-e)[1]
Q_i	=	Quantity of fuel	(GJ)[2]
EC_i	=	Energy content of fuel	(GJ/kL)[3]
EF_{ijoxec}	=	Emission factor (Scope 1) for diesel combustion	(kg CO_2-e/GJ)[4]

[1] t $CO_{2\text{-}e}$ = tonnes of carbon dioxide equivalent
[2] GJ = giga joules
[3] GJ/kL = gigajoules per kilolitre
[4] kg CO_2-e/GJ = kilograms of carbon dioxide equivalents per gigajoule

Based on diesel usage in FY2013-14 at CVC, it was calculated that 0.0003816 kL of diesel are used for each tonne of ROM coal removed[a]. Assuming an increase in ROM removal rate from the proposed modification of 0.6 Mt/y, this equates to annual fuel usage of 801.3 kL/y (0.0003816 kL/t ROM * 600,000 t ROM/y)[b].

Scope 1 fuel consumption emissions have been calculated using the energy content and emission factors from Table 3 of the National Greenhouse Accounts (NGA) Factors 2014 (**DoE, 2014**) as presented in **Table A.1**.

Table A.1: Diesel consumption GHG emission factors

Fuel type	Energy Content (GJ/kL)	Emission factor (kg $CO_{2\text{-}e}$/GJ)			
		Scope 1			Scope 3
		CO_2	CH_4	N_20	CO_2
Diesel oil	38.6	69.2	0.1	0.2	5.3

Source: Table 3 and Table 40, **DoE, 2014**

The estimated annual and total GHG emissions from diesel usage arising as a consequence of the increase in annual production at CVC are presented in **Table A.2**.

Table A.2: Estimated $CO_{2\text{-}e}$ (tonnes) for diesel consumption

Year	ROM (tpa)	Diesel Usage (GJ/y)	Emissions (t $CO_{2\text{-}e}$)		
			Scope 1	Scope 3	Total
2015	600,000	8,837	614	47	661
2016	600,000	8,837	614	47	661
2017	600,000	8,837	614	47	661
2018	600,000	8,837	614	47	661
2019	600,000	8,837	614	47	661
2020	600,000	8,837	614	47	661
2021	600,000	8,837	614	47	661
2022	600,000	8,837	614	47	661
2023	600,000	8,837	614	47	661
2024	600,000	8,837	614	47	661
2025	600,000	8,837	614	47	661
2026	600,000	8,837	614	47	661
2027	600,000	8,837	614	47	661
Total		**114,885**	**7,985**	**609**	**8,593**

[a] July 2013 to June 2014
Diesel usage = 422.823 kL
Total ROM removed = 1,108,095 t
Intensity factor = 422.823 kL/1,108,095 t = 0.0003816 kL/t
[b] NB: not all values will be exact due to rounding.

A.2 ELECTRICITY

GHG emissions from electricity usage were estimated using the following equation:

$$E_{CO_2-e} = \frac{Q \times EF}{1000}$$

Where:

E_{CO2-e}	=	Emissions of GHG from electricity usage	(t CO_2-e/annum)
Q	=	Estimated electricity usage	(kWh/annum)[1]
EF	=	Emission factor (Scope 2 or Scope 3) for electricity usage	(kg CO_2-e/kWh)[2]

[1]kWh/annum = kilowatt hours per annum

[2] kgCO_2-e/kWh = kilograms of carbon dioxide equivalents per kilowatt hour

Based on historical electricity usage at CVC it was calculated that approximately 15.71 kWh of electricity are used for each tonne of ROM coal removed[c]. Assuming an increase in ROM removal rate from the proposed modification of 0.6 Mt/y, this equates to annual electricity usage of 32,983,216 kWh/y (15.71 kWh /t ROM * 600,000 t ROM/y)[d].

Scope 2 and Scope 3 emissions have been calculated using the energy content and emission factors sourced from the NGA Factors (**DoE, 2014**) and presented in **Table A.3**.

Table A.3: Consumption of purchased electricity GHG emission factors

Fuel type	Emission factor (kg CO_2-e/kWh)	
	Scope 2	Scope 3
Consumption purchased electricity	0.86	0.13

Source: Table 41, **DoE, 2014**

The estimated annual and total GHG emissions from electricity usage arising as a consequence of the increase in annual production at CVC are presented in **Table A.4**.

Table A.4: Estimated CO_2-e (tonnes) for Electricity

Year	ROM (tpa)	Electricity Usage (kWh/y)	Emissions (t CO_2-e)		
			Scope 2	Scope 3	Total
2015	600,000	9,423,776	8,104	1,225	9,330
2016	600,000	9,423,776	8,104	1,225	9,330
2017	600,000	9,423,776	8,104	1,225	9,330
2018	600,000	9,423,776	8,104	1,225	9,330
2019	600,000	9,423,776	8,104	1,225	9,330
2020	600,000	9,423,776	8,104	1,225	9,330
2021	600,000	9,423,776	8,104	1,225	9,330
2022	600,000	9,423,776	8,104	1,225	9,330
2023	600,000	9,423,776	8,104	1,225	9,330
2024	600,000	9,423,776	8,104	1,225	9,330
2025	600,000	9,423,776	8,104	1,225	9,330
2026	600,000	9,423,776	8,104	1,225	9,330
2027	600,000	9,423,776	8,104	1,225	9,330
Total	**7,800,000**	**122,509,087**	**105,358**	**15,926**	**121,284**

[c] July 2013 to June 2014
Electricity usage = 17,404,065 kWh
Total ROM removed = 1,108,095 t
Intensity factor = 17,404,065 kWh /1,108,095 t = 15.71 kWh/t

[d] NB: not all values will be exact due to rounding.

A.3 FUGITIVE EMISSIONS – MINE VENTILATION

Fugitive emissions from Proposal were estimated using the following method:

Method 4 – Continuous Emission Measurement (Subdivision 1.3.2.1 of the NGER (Measurement) Determination).

$$M_{jct} = \frac{MM_j \times P_{ct} \times FR_{ct} \times C_{jct}}{RT_{ct}}$$

Where:

MM_{jct}	=	Mass of emissions in tonnes of gas type released per second (t/s)
MM_j	=	Molecular mass of gas type (j) in tonnes per kilomole (t/KMol);
P_{ct}	=	Pressure of the gas stream in kilopascals (kPA)
FR_{ct}	=	Flow rate of the gas stream in cubic metres per second (m^3/s)
C_{jct}	=	Proportion of gas type (j) in the volume of the gas stream (%)
R	=	Universal gas constant in joules per kelvin.mol (J/K.Mol)
T_{ct}	=	Temperature (in degrees kelvin) (K)

Table A.5 details the assumptions and data sources used in the calculations.

Table A.5: Assumptions for Fugitive Emission calculations

Emission	Molecular Mass (t/kMol)	Pressure of gas stream (kPa)[a]	Flow rate (m^3/s) [b]	Proportion in gas stream (%)[c]	Temperature (K) [d]
CH_4	16.04×10^{-3}	98.9	210	0.13	293.3
CO_2	44.01×10^{-3}	98.9	210	0.06	293.3

Notes:

(a) Annual average FY13-14.
(b) Maximum flow rate of ventilation fans as provided by LakeCoal.
(c) Pro-rated based on the proposed modification to 0.6 Mtpa from actual FY13-14 data provided by LakeCoal from real time gas monitoring.
(d) Provided by LakeCoal from real time temperature monitoring on collar of ventilation shaft

The mass of emissions from the above formula are then converted into $CO_{2\text{-}e}$ tonnes per second (x 21 for methane due to global warming potential) and then converted to annual emissions based on the ventilation fans running 24 hours per day, 365 days per year.

The estimated annual and total GHG emissions from fugitive methane arising as a consequence of the increase in annual production at CVC are presented in **Table A.6**.

Table A.6: Estimated CO_2-e (tonnes) for Fugitive Emissions

Year	Scope 1 Emissions (t $CO_{2\text{-}e}$)
2015	125,090
2016	125,090
2017	125,090
2018	125,090
2019	125,090
2020	125,090
2021	125,090
2022	125,090
2023	125,090
2024	125,090
2025	125,090
2026	125,090
2027	125,090
Total	**1,626,165**

A.4 POST-MINING

Emissions for Scope 1 post-mining activities (e.g. storage of coal in stockpiles) are calculated using the following method:

Method 1 – post-mining activities related to gassy mines (Subdivision 3.2.2.4 of the NGER (Measurement) Determination).

This method states the emission factors to be 0.014 t CO_2-e / t ROM coal extracted at the mine.

The estimated annual and total GHG emissions from post-mining activities arising as a consequence of the increase in annual production at CVC are presented in **Table A.7**

Table A.7: Estimated CO_2-e (tonnes) from post-mining – scope 1

Year	ROM (tpa)	Scope 1 Emissions from post-mining activities (t CO_2-e)
2015	600,000	8,400
2016	600,000	8,400
2017	600,000	8,400
2018	600,000	8,400
2019	600,000	8,400
2020	600,000	8,400
2021	600,000	8,400
2022	600,000	8,400
2023	600,000	8,400
2024	600,000	8,400
2025	600,000	8,400
2026	600,000	8,400
2027	600,000	8,400
Total	**7,800,000**	**109,200**

A.5 COAL TRANSPORTATION

As no additional coal will be transported via road, no additional emissions will be generated via this mode.

A.6 ENERGY PRODUCTION - USE OF PRODUCT COAL

The Scope 3 emissions associated with the combustion of product coal were estimated using the following equation:

$$E_{CO_2-e} = \frac{Q \times EC \times EF}{1000}$$

Where:

E_{CO2-e}	=	Emissions of GHG from coal combustion	(t CO_2-e)
Q	=	Quantity of product coal burnt	(t)
EC	=	Energy Content Factor for bituminous coal	(GJ/t)[1]
EF	=	Emission factor for bituminous coal combustion	(kg CO_2-e/GJ)

[1] GJ/t = gigajoules per tonne

The quantity of thermal coal burnt in Mtpa is converted to GJ using an energy content factor for black (bituminous) coal of 27 GJ/t.

The GHG emission factor and energy content for coal were sourced from the NGA Factors (**DoE, 2014**), as presented in **Table A.8**.

Table A.87: Energy Production GHG emission factors

Fuel type	Energy Content (GJ/t)	Emission factor (kg CO2-e/GJ)		
		CO_2	CH_4	N_20
Bituminous coal	27.0	88.2	0.03	0.2

Source: Table 1, **DoE, 2014**

The emissions associated with the use of the increased product coal arising as a consequence of the increase in annual production at CVC are presented in **Table A.9**.

Table A.98: Estimated CO_2-e (tonnes) for Energy Production

Year	Thermal Product Coal (tpa)	Scope 3 Emissions (t CO2-e)
2015	600,000	1,432,566
2016	600,000	1,432,566
2017	600,000	1,432,566
2018	600,000	1,432,566
2019	600,000	1,432,566
2020	600,000	1,432,566
2021	600,000	1,432,566
2022	600,000	1,432,566
2023	600,000	1,432,566
2024	600,000	1,432,566
2025	600,000	1,432,566
2026	600,000	1,432,566
2027	600,000	1,432,566
Total	**7,800,000**	**18,623,358**

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