Centennial Coal

NSW DEPARTMENT OF PLANNING & ENVIRONMENT

ANNUAL ENVIRONMENTAL MANAGEMENT REPORT 2014

Centennial Mandalong Mine

For the period 1 January 2014 to 31 December 2014

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Abbreviations		
	AEMR	Annual Environmental Management Report
	ANZECC	Australia and New Zealand Environment and Conservation Council
	Co2-eT	Emissions in CO2 equivalent tonnes
	Coal Handling Plant	CHP
	CO2	Carbon Dioxide
	CH4	Methane

	DPE	Department of Planning & Environment
	DRE	NSW Department of Trade and Investment – Division of Resources and Energy (DRE)
	EIS	Environmental Impact Statement
	EPA	Environment Protection Authority
	EPL	Environment Protection Licence
	EC	Electrical Conductivity
	GHG	Greenhouse Gas
	LMCC	Lake Macquarie City Council
	MMCCC	Mandalong Mine Community Consultative Committee
	MSB	Mine Subsidence Board
	MOP	Mining Operations Plan
	NPWS	National Parks and Wildlife Service
	NOW	NSW Office of Water
	OEH	Office of Environment & Heritage
	PPV	Peak Particle Velocity
	SMP	Subsidence Management Plan
	SSR	Safe Serviceable and Repairable
	SEE	Statement of Environmental Effects
	UMEMP	Underground Mining Environmental Management Plan

1 INTRODUCTION

1.1 OVERVIEW

The Mandalong Mine is owned and operated by Centennial Mandalong Pty Ltd (Centennial Mandalong), a subsidiary of Centennial Coal Company Limited (Centennial). Centennial completed the purchase of Powercoal including the Mandalong Mine in August 2002. Centennial was subsequently purchased by Banpu Public Company Limited (Banpu) in October 2010.

The Mandalong Mine comprises the underground workings and surface infrastructure of:

- The Mandalong Mine underground workings including a longwall panel and development units and surface infrastructure near Morisset;
- The Cooranbong Services Site underground workings and surface infrastructure of the Cooranbong Entry Site, near Dora Creek; and
- The Delta Entry Site, which encompasses an entry and coal delivery system, near Wyee at the Vales Point Rail Unloader Facility.

The Mandalong Mine is a modern underground longwall operation located in the Lake Macquarie area near Morisset west of the M1 Motorway. The Mine is situated approximately 130 km north of Sydney and supplies coal to the domestic power and export market. The Mandalong Mine was proposed by Powercoal Pty Ltd after an extensive exploration program. An Environmental Impact Statement (EIS) was submitted in 1997 and a Commission of Inquiry held in 1998. The Mine was granted development consent DA 97/800, in October 1998. After obtaining development consent, Centennial constructed the Mandalong Mine site and decline tunnel to access the Mandalong mining area. Longwall mining operations at Mandalong commenced in January 2005. The Mine has approval to extract up to six million tonnes per annum of coal from the West Wallarah Seam using the longwall mining method.

Development consent DA 35/2/2004 granted in July 2004 by the then NSW Department of Planning & Infrastructure approved the construction and operation of the coal handling and clearance system at the Delta Entry Site. Construction of the Delta Coal Clearance System was completed in 2006. The Cooranbong Services Site and the Delta Entry Site contain coal handling infrastructure, enabling the Mandalong Mine to process and convey as permitted by their respective development consents up to eight million tonnes of coal per annum. These sites are maintained under current mine leases as referred to Section 1.4.

1.2 SCOPE

This Annual Environmental Management Report (AEMR) details the progress of environmental management covering the Mandalong Mine, Cooranbong Services Site and Delta Entry Site collectively, for the period 1 January 2014 to 31 December 2014. The AEMR has been prepared in accordance with the Mandalong Mine conditions of consent as detailed in Section 1.5.

1.3 SUMMARY OF WORKS

Mandalong Mine

The majority of construction activities at the Mandalong Mine were completed by the end of 2004 in preparation for the workforce relocating from Cooranbong Colliery. In November 2004 Mandalong Mine became an operating mine site with personnel accessing the Mandalong underground workings via the decline tunnel. Completed facilities at the Mandalong Mine Site (refer to plan MG10069) include:

- Surface to underground decline (1 in 8 gradient – 1400 metres in length);
- Bathhouse and Administration buildings;
- Store Warehouse;
- Diesel Refuelling Station and Storage Shed;
- Machinery Washdown Bay;

- Mechanical Workshop;
- Equipment and materials storage areas;
- Fire Fighting and Emergency Equipment Store;
- Compressor Sheds;
- Electrical Sub-Station;
- Mine Fan;
- Methane Gas Drainage Plant;
- Two Gas Flares;
- VAM-RAB Facility;
- Solcenic Mixing Plant; and
- Waste sorting area.

Construction of the VAM-RAB facility adjacent to the Mine's ventilation fan was completed in 2013. Civil works for construction of the gas flares was also completed in 2013, with automated operations also commencing in 2013. Further details on both the VAM-RAB facility and the gas flares are provided in Section 5.7 of the AEMR.

Delta Entry Site

The Delta Entry Site consists of the Delta Coal Clearance System and decline tunnel. The Delta coal clearance system conveys coal from the underground mining areas by a 4.5 km long underground conveyor within the coal seam. Coal is then conveyed up the decline tunnel, to the surface at the Delta Entry Site. At the surface coal is transported by conveyor to the transfer tower and then into the crusher building to be sized. After coal is sized it is then transported by conveyor onto the Wyee overland conveyor and supplied to the Vales Point Power Station.

Construction on the coal conveyor systems was completed by the end of 2005.

Cooranbong Services Site

The Cooranbong Services Site consists of a Coal Handling Plant (CHP) and mine support infrastructure which includes decline tunnels, coal stockpiles, conveyors, mine fan, and workshop buildings. The CHP and supporting infrastructure remain in use at the Cooranbong Services Site to supply coal to the Eraring Power Station.

Construction of the approved CHP upgrades commenced in June 2009 with the removal of the decommissioned north drift conveyor gantry and drive head buildings. Construction of the CHP upgrades and haul road were completed in May 2010. The CHP and road haulage infrastructure is shown in Plan MG11217 and consists of:

- Installation of new prefabricated aerial conveyor system;
- The installation of a 1200T truck loading bin;
- The construction of infrastructure for a nominal 100 000 T ROM stockpile;
- Upgrade works to the existing CHP (ROM bin) to maximise throughput;
- The installation of new electrical systems, incorporating energy saving components;
- The installation of a Plant Control System, incorporating remote monitoring via camera systems, and improved diagnostics to reduce plant downtime;
- Construction of internal road network capable of supporting B-Double haul trucks;
- A 100T, 27 m long truck weighbridge;

- Security fencing; and
- Drainage and water treatment systems to contain and manage dirty water from the new ROM, conveyor and road network.

Coal loading and haulage operations from the truck loading bin and 100 000 T ROM stockpile in 2014 were undertaken by Giacci Bros Pty Ltd. Coal handling operations were undertaken by Transfield at the Cooranbong CHP. Coal deliveries to customers in 2014 are described in Section 4.2.

Mandalong Haulage Road

A 3.5 kilometre section of new private haul road and rail overpass bridge was constructed in 2009 and 2010 immediately north of Cooranbong Services Site and connects with the existing Newstan – Eraring private haul road. This haul road is designed to facilitate the transport of coal from the Mandalong Mine to the Newstan Colliery surface facilities for processing and transport into the export market.

The Mandalong haul road provides the benefit that coal trucks do not need to use public roads and reduces the noise and dust impacts on the local community. The road was constructed along a horizontal alignment which has been selected to avoid threatened flora species and minimise environmental impact.

The construction consisted of stripping topsoil/vegetation to an average depth of 100 mm across the whole site, approximately 260,000 m^3 of cut to fill in clay, highly weathered rock, and moderately weathered rock which was carried out to achieve pavement sub-grades and the overall formation levels. The pavement material was imported to satisfy the structural requirements of the design life and criteria. The road is sealed with asphalt, line marked and signposted to Australian standards.

A new overpass Bridge approximately 33m long, 11m wide was constructed over the Main Northern Railway to the approved design and methodology of Railcorp. The bridge is a single span concrete structure with precast concrete Super-T girders.

The disturbed areas across the site were stabilised with topsoil and revegetated where appropriate as described in Section 9.2. Drainage culverts were installed in four locations to maintain existing creek flows. Several fauna overpass and underpass structures were included in the construction. Several sediment basins were installed to manage dirty water from the roadway and clean water diversion drains were constructed to intercept water from entering the dirty water system to avoid contamination. The entire western length of the haul road is fenced with fauna friendly security chainmesh.

1.4 REGULATORY FRAMEWORK

1.4.1 Development Consents

The Mandalong Mine, which is an extension of the old Cooranbong Colliery, was originally granted Development Consent DA 97/800 by the then Minister for Urban Affairs and Planning on 14 October 1998 under Part 4 of the EP&A Act following the submission of the *Cooranbong Colliery Life Extension Project Environmental Impact Statement* (Umwelt, 1997) and a Commission of Inquiry. The currently approved Mandalong Mine comprises the underground workings and surface infrastructure of the:

- Mandalong Mine, including the Mandalong Mine Access Site, encompassing underground workings and associated surface infrastructure near Morisset; and
- Cooranbong Services Site encompassing a coal delivery system and surface infrastructure (coal handling and processing) near Dora Creek.

The other operations directly related to the currently approved Mandalong Mine are the two components which comprise the Delta Link Project, namely:

- The construction and use of the Mandalong Coal Delivery System for the underground transportation of coal from the Mandalong Mine to the Delta Entry Site; and
- The receipt and handling of coal at the Wyee Coal Handling Plant at the Delta Entry Site.

The approved Mandalong Mine, and the other operations which directly relate to it, are currently regulated by three planning approvals.

Development Consent DA 97/800 for the Mandalong Mine - being development application DA 97/800 lodged with LMCC on 27 November 1997 and described in the *Cooranbong Colliery Life Extension Project Environmental Impact Assessment* (Umwelt, 1997), including the Applicants submissions to the Commission of Inquiry, and as modified on nine occasions as follows:

- **MOD 1 (August 2001) -** minor changes to the conditions of consent relating to the preparation of subsidence management plans and notification of landholder requirements, as described in the modification application prepared by Powercoal, dated 29 March 2001.
- **MOD 2 (February 2005) -** installation of methane drainage plant and the transport of 1,000 tonnes of mined coal by road, as described in *Mandalong Mine Methane Drainage Plant and Coal Haulage, Statement of Environmental Effects*, dated 28 October 2004 and prepared by Sinclair Knight Merz.
- **MOD 3 (March 2006) -** installation and operation of enclosed methane gas flare units for high purity methane drainage gas. This was undertaken in response to condition 60a(iii) imposed as part of MOD 2, which required Centennial Mandalong to submit a report on the progress towards implementing greenhouse gas abatement measures. This modification is as described in the *Statement of Environmental Effects for the Installation and Operation of Enclosed Methane Gas Flare Units*, dated February 2006 and prepared by Umwelt.
- **MOD 4 (July 2009) -** installation and operation of gas engines (yet to be constructed) to produce up to 12 megawatts of electricity using high purity methane drainage gas, increase the coal production rate from 4 Mtpa to 6 Mtpa, relocate a ballast borehole and update subsidence conditions. This modification is as described in the Environmental Assessment entitled *Mandalong Mine Modification to Development Consent Environmental Assessment*, dated September 2008.
- **MOD 5 (November 2009) -** coal from Mandalong Mine (Cooranbong Services Site) permitted to be washed at Newstan Colliery and a temporary increase in the volume of coal transported by conveyor from the Cooranbong Services Site to the Eraring Power Station stockpiles for subsequent road haulage to Newstan Colliery (until construction of the Cooranbong Private Haul Road was complete). This modification is as described in the Statement of Environmental Effects entitled *Washing of Mandalong Coal at Newstan Section 96(A) Application Statement of Environmental Effects*, dated October 2009.
- **MOD 6 (November 2009) -** changes to the locations and heights of approved (but not previously constructed) coal handling infrastructure at the Cooranbong Services Site. This modification is as described in the Statement of Environmental Effects entitled *Relocation of Infrastructure within the Mandalong Services Site Section 96(1A) Application Statement of Environmental Effects*, dated November 2009.
- **MOD 7 (October 2011) -** installation and operation of a new technology known as a ventilation air methane regenerative after burner (VAM-RAB) as a trial unit to demonstrate the ability of the technology to capture and abate ventilation air methane from the underground mine. This modification is as described in the *Environmental Assessment: Ventilation Air Methane Abatement Demonstration Project, Mandalong Mine – Section 75W Modification*, dated June 2011 and additional information provided in the document entitled *Mandalong Mine Ventilation Air Methane Abatement Demonstration Project – Response to Submissions* dated September 2011.
- **MOD 8 (August 2012) -** increase in the volume of coal permitted to be transported from the Cooranbong Services Site to both Newstan Colliery and the Eraring Power Station from 2 Mtpa to up to 4 Mtpa and back haulage of middlings (middle quality coal product) from Newstan Colliery to the Cooranbong Services Site for subsequent supply to the Eraring Power Station. This modification is as described in the *Environmental Assessment: Mandalong Mine – Cooranbong Entry Site – Cooranbong Distribution Project – Section 75W Modification to Development Consent DA 97/800*, dated May 2012 and additional *Noise Mitigation Assessment*, dated 31 May 2012.

- **MOD 9 (February 2013) -** administrative amendment to conditions 1A(c) and (d) to allow the coal delivery limits approved as part of MOD 8 (i.e. up to 4 Mtpa from Cooranbong Services Site to both Newstan Colliery and the Eraring Power Station).
- **MOD 10 (November 2014) -** a minor modification to conditions 1A(b) and 1A (c) for a small increase in the amount of coal allowed to be delivered from the underground workings to the Cooranbong Entry Site from 4 Mtpa to 4.1 Mtpa in 2014 only.

Development Consent DA 35-2-2004 for the Delta Entry Site – being for the transportation of coal to the Delta Entry Site via the underground Mandalong Coal Delivery System, as approved by development consent DA 35-2-2004 and described in the *Delta Link Project – Statement of Environmental Effects* (Umwelt, 2004). This development consent is held by Centennial Mandalong.

Development Consent DA 2501/2004 for the Wyee Coal Handling Plant at the Delta Entry Site – as approved by development consent DA-2501/2004 and described in the *Delta Link Project – Statement of Environmental Effects* (Umwelt, 2004) and revised information letter dated 27 April 2004. This development consent is held by Delta Electricity.

1.4.2 Mining Authorities

The Mandalong Mine holding comprises a number of leases as shown in Table 1 listing the leases within the Mine's Colliery holding. No changes to the Mining Authorities occurred in 2014.

1.4.3 Environment Protection Licence

Centennial Mandalong holds Environment Protection Licence (EPL) 365 under the Protection of the Environment Operations Act 1997 for the Mandalong Mine, Cooranbong Services Site and the Delta Entry Site.

1.4.4 Authorisations and Exploration Licences

The Mandalong Mine holding comprises a number of leases. **Table 1** sets out the leases within the Mine's Colliery Holding Boundary.

One Mandalong Mine Exploration Licence was renewed during 2014. EL 4443 will now expire on 23/10/17. Renewal of EL6317 is pending.

In 2013, the Mandalong Mine applied to NSW Department of Trade and Investment – Division of Resources and Energy (DRE) for a new Mining Operations Plan (MOP) for an agreed period of two (2) years. The two year time frame was selected to coincide with the anticipated approval of the Mandalong Southern Extension Project. The MOP was prepared to satisfy conditions of the various mining leases covered by the MOP and prepared with reference to the *NSW Trade & Investment, Regional Infrastructure and Services – Division of Resources & Energy: Mining Operations Plan (MOP) Guidelines September 2013* (DRE, 2013) as well as Development Consent Conditions 10, 11 and 12. The MOP was approved by DRE on 24 December 2013 for the period 1 January 2014 to 30 November 2015. A new version of the MOP will be prepared in 2015.

A summary of the development consents, mining and exploration lease and licenses held by Mandalong Mine are listed in **Table 1**.

Table 1: Mandalong Mine Development Consent, Mining and Exploration Leases and Licences

Name	Description	Issued By	Expiry Date	Renewal Procedure
Consolidated Coal Lease 762	Title to Cooranbong Workings includes some surface land – some environmental conditions	Dept. Primary Industry (Mineral Resources)	13/10/2022	Manager Title and Property- North
Consolidated Coal Lease 746 (sublease)	Title for Cooranbong Workings includes some surface land – some environmental conditions	Dept. Primary Industry (Mineral Resources)	31/12/2028	Manager Title and Property- North
Mining Purposes Lease 191	Title to surface land for water tanks at Cooranbong – requires annual environmental management report on anniversary	Dept. Primary Industry (Mineral Resources)	24/2/2023	Manager Title and Property- North
Mining Purposes Lease 329	Title to surface land for old water supply line from Eraring Power Station – requires annual environmental management report on anniversary	Dept. Primary Industry (Mineral Resources)	4/8/2015	Manager Title and Property- North This MPL is surplus to requirements and will not be renewed
Mining Lease 1443	Mandalong Project Mining Lease – includes some surface land	Dept. Primary Industry (Minerals Resources)	01/03/2020	Manager Title and Property- North
Mining Lease 1431	Title to surface land for proposed shaft at the back of Morisset	Dept. Primary Industry (Mineral Resources)	27/5/2019	Manager Title and Property- North
Mining Lease 1543	Mining Lease – Mandalong Mine Project	Dept. Primary Industry (Mineral Resources)	25/11/2024	Manager Title and Property- North
Mining Lease 1553	Mining Lease Delta Link Project – includes surface land	Dept. Primary Industry (Mineral Resources)	07/09/2025	Manager Title and Property- North
Exploration Licence 6317	Exploration Licence (renewed 2nd Nov 2009)	Dept. Primary Industry (Mineral Resources)	08/08/2014*	Manager Title and Property- North
Exploration Licence 4443	Exploration Licence	Dept. Primary Industry (Mineral Resources)	23/10/2017	Manager Title and Property- North

Name	Description	Issued By	Expiry Date	Renewal Procedure
Exploration Licence 4968	Exploration Licence	NSW Trade & Investment – Division of Resources & Energy	31/07/2017	Manager Title and Property- North
Exploration Licence 4969	Exploration Licence	Dept. Primary Industry (Mineral Resources)	31/07/2017	Manager Title and Property- North
Exploration Licence 5892	Exploration Licence	NSW Trade & Investment – Division of Resources & Energy	31/07/2017	Manager Title and Property- North
Authorisation 404	Exploration Licence	NSW Trade & Investment – Division of Resources & Energy	31/07/2017	Manager Title and Property- North
Mine Operations Plan (MOP)	Summary of Mining Activities – Mandalong	NSW Trade & Investment – Division of Resources & Energy	30/11/2015	Application two months prior to expiry date.
Environmental Protection Licence 365	Permits scheduled activity “coal mining” and discharge of water from licensed discharge points.	Environment Protection Authority	Perpetual	Requires payment and Annual Return February each year
Mandalong Mine Development Consent No.97/800	Permits development and works to occur as described in the EIS.	NSW Department of Planning	October 2020	Requires new development consent after expiry date for mine leases.
Mandalong Mine Development Consent No. DA 35-2-2004	Permits construction and operation of the Delta Coal Handling Facility	NSW Department of Planning	July 2021	Requires new development consent after expiry date for mine leases.

Note: * Renewal pending

1.5 CONSENT CONDITIONS – AEMR REQUIREMENTS

Conditions 105-107 of DA97/800 (MOD 10) detail the requirements for an AEMR. Condition 15 of the Delta development consent requires an Annual Report to be submitted as part of the Mandalong Mine AEMR. These specific conditions are provided in **Appendix 1**.

The 2013 AEMR (Centennial Mandalong, 2013) was provided to DPE, DRE, LMCC, NOW, EPA, OEH and the Mandalong Mine CCC consistent with Consent Condition 106(i).

DRE in their letter dated 24 September 2014 found that the AEMR was acceptable for the reporting period and completed a site inspection on 11 September 2014. Further detail on the site inspection and DRE's requirements for the 2014 AEMR are provided in Section 3.3 of this AEMR.

There were no other requirements or actions to be addressed relating to the 2014 AEMR from DPE, NOW, OEH, LMCC or the EPA.

As required by consent condition 105(v) a listing of any variations to approvals during the reporting period are provided in Section 1.4.

Consent Condition 24 requires a Land Access, Management and Compensation Security in the form of a Bank Guarantee and that evidence of the Guarantee shall be provided in the Annual Environmental Management Report (AEMR). A copy of the current Bank Guarantee is included in **Appendix 2**.

The remainder of this AEMR specifies the specific consent conditions being addressed at the beginning of each section.

2 COMPLIANCE WITH CONSENT CONDITIONS

A summary of the compliance with the Mandalong Mine development consent DA97/800 has been determined through a compliance review in accordance with consent condition 105(i). This review applies to the DA 97/800 (MOD 10).

2.1 CONSENT CONDITION 105 (I) – COMPLIANCE AUDIT MANDALONG MINE

A compliance review on the performance of the Mandalong Mine against the conditions of consent has been completed. The results of the review are tabulated and displayed in **Appendix 3**. There are no other statutory approvals relevant to Condition 105(i) requiring a compliance review in 2014.

2.2 CONSENT CONDITION 108 – INDEPENDENT ENVIRONMENTAL AUDIT

An Independent Environmental Audit of Mandalong's operations was completed by URS in May 2013. The audit report is publically available on the Centennial Mandalong website, and a copy was provided to CCC members and the then Department of Planning & Infrastructure in June 2013.

An update to the Mandalong Mine action plan prepared in response to the recommendations listed in the 2013 Independent Environmental Audit is included in **Appendix 13**.

The next Independent Environmental Audit of the Mandalong Mine in accordance with consent condition 108 is required to be completed prior to March 31, 2016.

3 ENVIRONMENTAL MANAGEMENT

The following is a summary of the specific requirements of relevant government departments with respect to the Mandalong Mine, in accordance with condition 105(ii) of DA97/800 (MOD 10). Information is also provided on the Delta Entry Site.

3.1 ENVIRONMENT PROTECTION AUTHORITY (EPA) REQUIREMENTS

Mandalong Mine, Cooranbong Services Site and Delta Entry Site – Centennial Mandalong holds EPL 365 under the *Protection of the Environment Operations Act 1997* for the Mandalong Mine operations. There were no amendments or variations made by the EPA to EPL 365 in 2014.

The EPA has not indicated any additional requirements for environmental management other than the legislative requirements and condition of consent requirements for the reporting period.

3.2 NSW OFFICE OF WATER (NOW) REQUIREMENTS

Mandalong, Cooranbong Services and Delta Entry Sites – NOW has not indicated any additional requirements for environmental management other than the legislative requirement and condition of consent requirements for the reporting period.

3.3 NSW DEPARTMENT OF TRADE AND INVESTMENT – DIVISION RESOURCES AND ENERGY REQUIREMENTS

Mandalong, ***Cooranbong Services and Delta Entry Sites*** – DRE in their letter dated 24 September 2014 found that the AEMR was acceptable for the reporting period and completed a site inspection on 11 September 2014. In the course of the DRE inspection, some issues were identified that either required comment or continued management as detailed in the DRE Action Plan included as **Table 2.**

Table 2 DRE Inspection Action Plan

Number	DRE Observation	DRE Action	Mandalong Response
1	VAM-RAB Trials	Include the results of the trial in the 2014 AEMR.	Addressed in Section 5.7 of the AEMR.
2	Poor housekeeping associated with the general waste area	Separate and clean up waste.	The procedure for waste management at the Mandalong Pit Top is for all waste to be placed directly into the waste bunker. Waste sorting then removes steel and timber for recycling and other recoverable items to reduce the volume of waste taken to landfill. Waste sorting is undertaken by a contractor on Tuesday's and Friday's. The DRE inspection was completed on a Thursday at a time in which the bunker was 75% full of waste materials ready for sorting.

Number	DRE Observation	DRE Action	Mandalong Response
3	Wallabies observed on-site	Presence of wallabies on site next to the sediment ponds despite fencing. Fix the fence to avoid that wildlife gets entrapped in the sediment.	There is no perimeter fencing around the Mandalong Pit Top Sediment Ponds and there have been no recorded events of wildlife being entrapped in sediment in the last 10 years of operations. Therefore at this time a wildlife proof fence is not required.
4	Offset area	Monitor the progression of revegetation against targets / criterion and report in AEMR.	Addressed in Section 5.8.2 of the AEMR.
5	Ponding and wetland	Monitor ponding due to longwall extraction, which turns into wetland.	Addressed in Section 7.3 of the AEMR.
6	Poor stockpile management	Remove weeds and promote vegetation cover of the emergency stockpile – Delta site.	Weeds were removed and re-seeding of the Stockpile was undertaken in 2014.
7	Management of surplus equipment / materials	Recycle / dispose of equipment / materials which did not sell at auction and are unlikely to sell in the near future. Continue to monitor and rationalise surplus / redundant equipment / materials on an annual basis as a minimum.	The Cooranbong Services Site clean-up is progressing following an auction of excess materials and equipment which was completed in 2014. The Cooranbong ROM Bin Stanchion was decommissioned in 2014.
8	Minor amendments	Resubmit amended version of AEMR in digital form to DRE.	An amended version of the AEMR in digital form was posted to DRE on 28/10/14.

3.4 LAKE MACQUARIE CITY COUNCIL (LMCC) REQUIREMENTS

Mandalong Mine, ***Cooranbong Services Site and Delta Entry Site*** – LMCC in 2014 did not indicate any specific environmental management requirements in addition to the legislative requirements and those previously agreed to in the Mandalong Haul Road Environmental Management Plans. Actions from the haul road management plans are discussed in Sections 5.8 and 9.

4 OPERATIONS DURING REPORTING PERIOD

4.1 EXPLORATION

Surface Exploration

Exploration in 2014 included the drilling of three surface exploration boreholes (CM121 to CM123).

Private landowners were notified of exploration drilling in advance of drilling commencing, with the Mine providing a letter including information on the program and background information on exploration. Further consultation with landowners included extending the 'Access Agreement' with Forests NSW for another 12 months (Forests NSW Occupation Permit HW50477 expires 30 June 2015) and residents within 450m of the proposed drill site were also informed in writing of any drilling activities within the area prior to work commencing. Exploration drill sites were surveyed and developed as described in the Mine's Exploration Drilling Review of Environmental Factors (GSS, 2008).

All three boreholes, were 'open hole' drilled to a nominal distance of 30m above the top West Wallarah Seam, and then cored to a nominal depth of 18m below the floor of the West Wallarah Seam with the exception of CM122. CM 122 was drilled 42m below the floor of the West Wallarah Seam and penetrated both of the Fassifern Seam measures to provide rock strength data for the refinement of the subsidence model. Inseam gas testing was undertaken on all three holes to provide data to assist with the design and layout of the mines inseam longhole gas drainage system. All bore holes were located in the Olney State Forest near to Prickly Ridge Road. The holes were drilled to infill our existing borehole database and provide information on coal thickness, structure, coal quality, and geotechnical characteristics of the seam overburden and floor. The data was also used to better define the extent of the igneous sill that is known to have intruded the West Wallarah Seam, allowing more accurate mine planning, and to maximise resource recovery.

The surface exploration boreholes were sealed with concrete and rehabilitated in 2014. Drill sites were reseeded with non-perennial grasses to stabilise the ground until the native vegetation re-established, as described in **Section 9.0**.

Further investigation including surface exploration drilling of these geological features will be undertaken in 2015 to accurately map their location, and will be used to plan future mine layout(s). Work will commence on re-locating some of the remaining 10 holes left in the Review of Environmental Factors early in 2015. These holes need to be moved to better reflect extent of the igneous sill. Private landowners will be notified on the proposed changes.

There was no exploration in the areas of the Cooranbong and Delta workings exploration licences in 2014.

Underground Exploration

A total of six underground roof core holes were drilled in Maingate 17 and Maingate 18. The holes were drilled to depths of 8m up into the roof. The information was used to refine the geological and geotechnical model of Mandalong mine.

In addition, inseam drill holes from Maingate 16, 17 and 18 were extended to define geological features such as dykes, sills and seam rolls. The purpose of the inseam drilling is primarily for gas drainage. The inseam drilling is also used to derive roof horizon profiles to refine the geological model.

Some geological features can only be identified through inseam drilling. The igneous intrusions in the seam can be silica rich dykes and cannot be identified from surface magnetic surveys. Therefore, inseam drilling is the most effective option to identify these geological features.

Mandalong Southern Extension Project

Centennial Mandalong holds an exploration licence EL6317 which adjoins the southern boundary of the existing Mandalong Mining Leases. The exploration program has approval for 53 partly cored boreholes. During 2014 two boreholes were drilled at the site of the proposed ventilation shafts. The information gathered will aid the shaft geotechnical design. All 53 holes have now been completed and any future exploration drilling will require a new Review of Environmental Factors and additional approval.

The seven nested ground water monitoring bores and a series of vibrating wire piezometers that were installed in 2011 have been monitored throughout the year for water level and water quality. This data along with the information from the continuous groundwater level data loggers within the alluvial monitoring bores has been used for the groundwater impact assessment for the Project.

The Environment Impact Statement (EIS) for the Project came off public exhibition in December 2013 and the Project team provided a 'Response to Submissions' document to the Department of Planning & Environment (DP&E) at the end of March 2014. Following feedback from a couple of government agencies a supplementary report was provided in July 2014. The Project team has spent the remainder of the year answering questions and providing information to DP&E relating to the EIS. In December 2014, DP&E provided a draft set of conditions of consent and have referred the Project to the Planning Assessment Commission for a merit review.

4.2 MINE PRODUCTION

The longwall mining method was used at Mandalong Mine to extract coal during the reporting period from the West Wallarah Seam. **Plan MG10815** shows the coal extracted from longwall panels and development units for the reporting period. Four continuous miner units operated during the reporting period developing the Maingate and Main Heading roadways for the longwall panels. The majority of coal produced was extracted from the longwall panels with a minor amount of coal produced from the continuous miner units developing the supporting roadways.

Run of Mine (ROM) coal production in 2014 was from three longwall panels, Longwalls 15, 16 and 17 and the development of Maingates 16, 17, 18 and 19 as well as the continuation of the Main Headings between 81 cut-through and 96 cut-through. A total of 5,939,000 tonnes of coal was produced, with the longwall panels producing 5, 459, 000 tonnes and 480, 000 tonnes produced from developing the supporting roadways.

Longwall 15 continued production for the first four months of 2014. Longwall equipment was then transferred to Longwall 16 during May, where production continued over the next six months. During November, Longwall 17 then commenced extraction and continued production to the end of report period, with an expected completion date in mid-2015.

Maingate development occurred in four panels during 2014, developing almost 14 km of roadways. Maingate 16 and Maingate 17 were completed in preparation for the extraction of Longwalls 16 and 17. Based on the benefits obtained from driving a relief roadway in the high stress zone at the Longwall 15 installation roadway location, relief roadways were developed in both panels, improving installation roadway conditions and subsequently longwall relocation times. The relief roadway for Longwall 18 was also driven from Maingate 17. Maingate 18 commenced development in April and by the end of 2014 had developed about three quarters of its planned length, while Maingate 19 commenced development during September.

Production in the Main Headings was ongoing, developing almost 5000 m of roadways and advancing 1000 m using two continuous miner units. The Main Headings completed the roadways required for the installation of Maingate 19 and changed orientation to follow the seam split. During 2014, almost 19 km of roadways were developed. The development unit production is summarised in **Table 3.**

Table 3 Development Unit Production Metres January 2014 – December 2014

Development Panels	Commencement Date (January 2014)	Finish Date	Developed Metres
Maingate 16	1/1/14	5/4/14	1,450
Maingate 17	1/1/14	12/10/14	6,073
Maingate 18	13/4/14	ongoing	5,766
Maingate 19	18/9/14	ongoing	518
Main Headings	1/1/14	ongoing	4,975
			18,782

A summary of the monthly and total annual production in 2014 is detailed in **Table 4**. ROM production for Mandalong Mine from 1 January 2014 to 31 December 2014 totalled 5,939,001 tonnes.

During the reporting period 2,691,270 and 1,856,298 tonnes of saleable coal were delivered to Eraring and Vales Point Power Stations respectively. **Table 4** shows the majority of ROM coal produced was delivered to the Cooranbong Services Site for processing through the coal handling plant before delivery via Eraring's overland conveyor to Eraring Power Station.

ROM coal was transported by trucks on the Mandalong private haul road with 1,408,503 tonnes sent to the Newstan Colliery washery. The washed coal was then transported by rail to the port of Newcastle for export.

Table 4: Production Tonnes and Product Movements in 2014

Month	ROM Production Tonnes (6 Mtpa limit)	Product to Vales Point PS (4 Mtpa limit)	Mandalong to Cooranbong (4.1 Mtpa limit)*	Product to Eraring PS (4 Mtpa limit)	Cooranbong to Newstan for Washing (4 Mtpa limit)
Jan 2014	527,276	0	527,276	318,418	162,024
Feb 2014	494,549	208,062	286,487	115,231	181,087
March 2014	524,760	237,820	286,940	167,147	161,186
April 2014	216,411	99,953	116,458	39,758	90,017
May 2014	328,641	63,024	265,617	150,762	89,483
June 2014	693,920	124,395	569,525	360,671	169,242
July 2014	836,862	256,570	580,292	394,936	216,046
Aug 2014	720,352	167,105	553,247	383,063	177,502
Sept 2014	579,010	148,450	430,560	330,305	161,353
Oct 2014	145,937	87,917	58,020	59,731	563
Nov 2014	390,466	189,191	201,275	199,481	0
Dec 2014	480,817	273,811	207,006	171,767	0
Total 2014 CY	**5,939,001**	**1,856,298**	**4,082,703***	**2,691,270**	**1,408,503**

* Note – Mod 10 approval in November 2014 to DA 97/800 conditions 1A(b) and 1A (c) for a small increase in the amount of coal allowed to be delivered from the underground workings to the Cooranbong Entry Site from 4 Mtpa to 4.1 Mtpa in 2014 only.

4.3 WASTE MANAGEMENT

Waste oil and greases are stored in tanks and drums within bunded areas for removal by a licenced waste management contractor for recycling or disposal. Oil water separation is achieved by the use of hydro-cyclone oil water separators at Mandalong and at the Cooranbong Services Site on flows from vehicle work and storage areas and the wash down bays.

Hydrocarbon spill kits are inspected weekly by a licenced waste management contractor and re-stocked as required. Oily rag bins and oil filter bins are also serviced on a weekly basis.

Office paper and cardboard is collected and recycled by a licenced waste management contractor on a weekly basis. Metals are collected and stored in steel bins at Mandalong and Cooranbong. In 2014, a total of 268.34 tonnes of scrap steel was recycled. This is a reduction compared to 2013 during which a total of 639.20 tonnes of scrap steel was recycled due to a major clean-up of equipment at Cooranbong.

General refuse and non-recyclable materials are sorted and stored in 30m steel bins at Mandalong and Cooranbong. The material was collected by a licenced waste management contractor for disposal in 2014. In 2014, 544 tonnes of refuse material was taken off-site for disposal, compared with 657.5 tonnes of refuse material in 2013.

Of the total waste collected at Mandalong in 2014, 67% was recycled including steel, timber, liquid waste, oils, paper and cardboard, filters grease, oily rags and oil filters. This compares with a recycling result of 70% in 2013.

5 MONITORING

Mandalong

Condition 105(iii) of DA97/800 (MOD 10) requires the presentation and discussion on all monitoring required under the consent and other approvals. **Table 5** summarises the monitoring required by the consent, current status and report section in the AEMR.

Table 5: Summary of Monitoring Requirements

Consent Condition No.	Monitoring Type	Status	Report Section
44 & 45	Noise Monitoring	Annual survey	5.5 & Appendix 8
49	Blast Monitoring	As required (underground dyke removal LW17)	5.6
51(c)	Air Quality Monitoring	Ongoing	5.1
57	Independent Noise and Dust Monitoring	Not Requested	n/a
60A	Greenhouse Gas reporting and abatement measures	Ongoing	5.7
63	Groundwater Monitoring Surface Water Monitoring	Ongoing Ongoing	5.2, 5.3 & Appendix 5 & 6.
72 and 74	Wetland Monitoring	Ongoing	5.8.1
76A (c)	Rehabilitation Monitoring	Annual survey for first five years (commenced 2012).	5.8.2 & Appendix 14.
82	Convict Road Monitoring	Ongoing	5.8.3
95	Meteorological Monitoring	Ongoing	5.4

Delta Entry Site

Condition 15(a) of DA 35-2-2004 for the operation of the Delta Entry Site requires the reporting of the amount of coal transported on the Mandalong coal delivery system. This is reported in Section 4.2 of the AEMR. Condition 15(b) of the Delta consent requires groundwater monitoring data to be reported, which is also addressed in Section 5.2 of this AEMR.

5.1 DEPOSITIONAL DUST MONITORING

Mandalong
Depositional dust monitoring has been undertaken at two locations around the Mandalong Site (DG5 & DG7) since September 1999. These gauges are positioned to monitor dust levels on the mine site, where as, the three gauges (DG6, DG8 & DG9) in the environmental impact assessment were utilised to determine the general background dust levels. One of the original dust gauges, in the vicinity of the Cooranbong Services Site (DG4) is still being monitored.

In September 2006 two additional dust gauges (D10 & D11) were installed (refer to Plan **MG10722D**) to extend the dust monitoring network to the west of the Mandalong Mine. In November 2009 one additional dust gauge (DG1) was installed on the western boundary of the Cooranbong Services Site to monitor dust levels from the CHP and stockpiles.

Table 6 describes the location of the dust gauges and these localities are shown on plans **MG10722D** and **MG10722C**.

Table 6: Description of Depositional Dust Gauges Location

Dust Gauge No	Locality
D1	Cooranbong Services Site (western boundary)
D4	41 Gradwells Road Dora Creek (near Cooranbong Services Site)
D5	Northern end Mandalong Mine Site (Adjoining Property)
D6	Mandalong Mine Site Eastern Boundary (Near Pollution Control Ponds)
D7	Rear of the former Project Office (Mandalong Site)
D8	West of main front entrance (Mandalong Site)
D9	184 Mandalong Road
D10	202 Mandalong Road West of Mandalong Mine
D11	North Western Boundary fence on Mandalong Mine

Delta Entry Site

Three dust deposition gauges were installed at the Delta Entry Site in July 2004. **Table 7** details the location of the dust gauges and their localities are shown on plan **MG10722C**. These gauges were positioned to monitor depositional dust around the Delta Entry Site.

Table 7: Location of Delta depositional dust gauges

Dust Gauge No	Locality
D1	North east side of settling ponds on decline site.
D2	Main gates to decline off Rutley's Road.
D3	Delta clearing left hand side Rutley's Road.

5.1.1 Depositional Dust Results

Mandalong

The Cooranbong Colliery Life Extension Project EIS stated that there were not expected to be any significant dust emissions during the operational phase of the Mandalong Mine Access Site as all coal will be conveyed underground from the site to the Coal Handling Plant at Cooranbong (Umwelt, 1997).

Depositional dust monitoring results are shown in **Table 8**. The results are presented as:

- long-term average (all data since the commencement of monitoring at its present location - Sept 1999 to present);
- average during the report period (January 2014 to December 2014); and
- Pre-construction average (September 1999 to August 2000).

The complete monthly depositional dust results are included in **Appendix 4**.

Table 8: Summary of depositional dust results between January 2014 and December 2014 surrounding Mandalong Mine.

	Insoluble Solids (Combustible Matter + Ash) g/m^2/month						
	DG5	**DG6**	**DG7**	**DG8**	**DG9**	**DG10**	**DG11**
Long Term Average	0.9	1.4	1.2	0.8	1.3	1.4	1.2
Average 2014 (AEMR Period)	0.7	1.9	1.6	0.8	1.4	1.9	1.4
Pre-Construction Average	0.7	0.8	3.4	0.8	0.9	*	*
EPA Dust Deposition Goal	**4.0**	**4.0**	**4.0**	**4.0**	**4.0**	**4.0**	**4.0**

* not available. Dust gauges installed after commencing construction.

Delta Entry Site

Depositional dust monitoring results are provided in **Table 9**. The complete monthly dust monitoring data for Delta are included in **Appendix 4**.

Table 9: Summary of Depositional Dust Results between January 2014 and December 2014 surrounding Delta Entry Site

	Insoluble Solids (Combustible Matter + Ash) g/m^2/month		
	DG1	**DG2**	**DG3**
Long Term Average	0.7	0.7	0.7
Average 2014 (AEMR Period)	0.7	0.8	0.8
EPA Dust Deposition Goal	**4.0**	**4.0**	**4.0**

Cooranbong Services Site

The Cooranbong Colliery Life Extension Project EIS predicted that dust emissions from the operational phase of the Cooranbong Preparation Plan were unlikely to cause a dust nuisance due to the distance to sensitive receptors (Umwelt, 1997). The Cooranbong Distribution Project EA (May 2012) modelling predictions for dust deposition also show that incremental and cumulative annual average dust deposition rates are predicted to be well below the impact criteria of 2g/m^2/month and 4g/m^2/month (assuming a background rate of 1.7g/m^2/month) at the nearest surrounding residences.

Annual average depositional dust results for 2014 and the EPA goal are provided in **Table 10**. The complete monthly dust monitoring data is provided in **Appendix 4**.

Table 10: Summary of Depositional Dust Results between January 2014 and December 2014 surrounding the Cooranbong Services Site

	Insoluble Solids (Combustible Matter + Ash) g/m^2/month	
	DG1	**DG4**
Long Term Average	1.6	1.2
Average 2014 (AEMR Period)	1.7	2.3
EPA Dust Deposition Goal	**4.0**	**4.0**

5.1.2 Data Interpretation

Mandalong Mine & Cooranbong Service Site

The development consent requires that the Mine does not increase the dust deposition rate by more than 2 g/m^2/month, averaged over any 12 month period, as shown in **Table 8**, **Table 9** and **Table 10**. All dust gauges recorded depositional dust levels that averaged an increase of less than 2 g/m^2/month in the 12 month period.

All dust gauges recorded results as shown in **Table 8**, **Table 9** and **Table 10** are well below the EPA air quality goal of annual dust deposition of 4 g/m^2/month. Dust levels at DG 8, 10 & 11 located at the nearest sensitive receivers and on the Mine's boundary were well below the EPA air goals, confirming that the Mine Access Site activities had minimal impact on surrounding air quality in 2014 as predicted in the Cooranbong Colliery Life Extension Project EIS (Umwelt, 1997).

Dust levels at DG1 and DG44 located at the nearest sensitive receivers and on the operational boundary at Cooranbong were well below the EPA air goals, confirming that the Cooranbong operational had minimal impact on surrounding air quality in 2014 as predicted in the Cooranbong Colliery Life Extension Project EIS (Umwelt, 1997) and the Cooranbong Distribution Project EA (May 2012).

Dust gauges 5 and 8 recorded 2014 annual averages lower than their respective long term averages. Dust gauges 1, 4, 5, 6, 7, 9, 10 and 11 recorded annual averages above the long-term average however; these increases were well below the EPA Air Quality Goals of 4 g/m^2/month.

All dust results for 2014 were well below the EPA annual dust deposition air quality goal of 4 g/m^2/month.

Table 11: Detailed Dust Monitoring and Analysis showing the Annual Rolling Average and Change in Deposition from the Pre-construction Average (PCA) for Dust Gauges DG6, DG8 and DG9

	DG6			DG8			DG9		
Date	Monitored Dust	12 Month Average	Change from PCA	Monitored Dust	12 Month Average	Change from PCA	Monitored Dust	12 Month Average	Change from PCA
16/01/14	0.7	1.0	0.2	0.7	0.8	-0.1	0.6	0.6	-0.3
14/02/14	1.6	1.1	0.3	0.8	0.8	-0.1	0.6	0.6	-0.4
17/03/14	1	1.1	0.3	0.7	0.9	-0.1	0.8	0.6	-0.3
17/04/14	4.6	1.5	0.7	1.0	0.9	0.0	0.6	0.5	-0.4
19/05/14	1.6	1.6	0.8	0.7	0.9	0.0	0.5	0.5	-0.4
19/06/14	2.4	1.7	0.8	0.7	0.9	0.0	3.8	0.8	-0.1
21/07/14	0.5	1.7	0.8	0.2	0.9	0.0	0.2	0.8	-0.1
21/08/14	*	1.7	0.8	0.4	0.9	0.0	0.4	0.8	-0.1
22/09/14	*	1.7	0.8	0.2	0.9	0.0	1.3	0.9	0.0
24/10/14	3.1	1.9	1.1	1.4	0.7	-0.2	3.1	1.2	0.2
24/11/14	1.3	1.9	1.0	0.9	0.7	-0.2	1.0	1.2	0.3
22/12/14	*	1.9	1.0	1.3	0.8	-0.2	4.0	1.4	0.5

* Sample not collected due to contamination.

Delta Entry

Average annual depositional dust results for dust gauges DG1, DG2 and DG3 are relatively low. The highest average depositional dust rate for the period was 0.8 g/m^2/month for DG 2 and DG 3. In 2014, DG2 and DG3 were also slightly above the long term annual average results. All results are well below the EPA air quality goal of 4 g/m^2/month and are provided in **Appendix 4**.

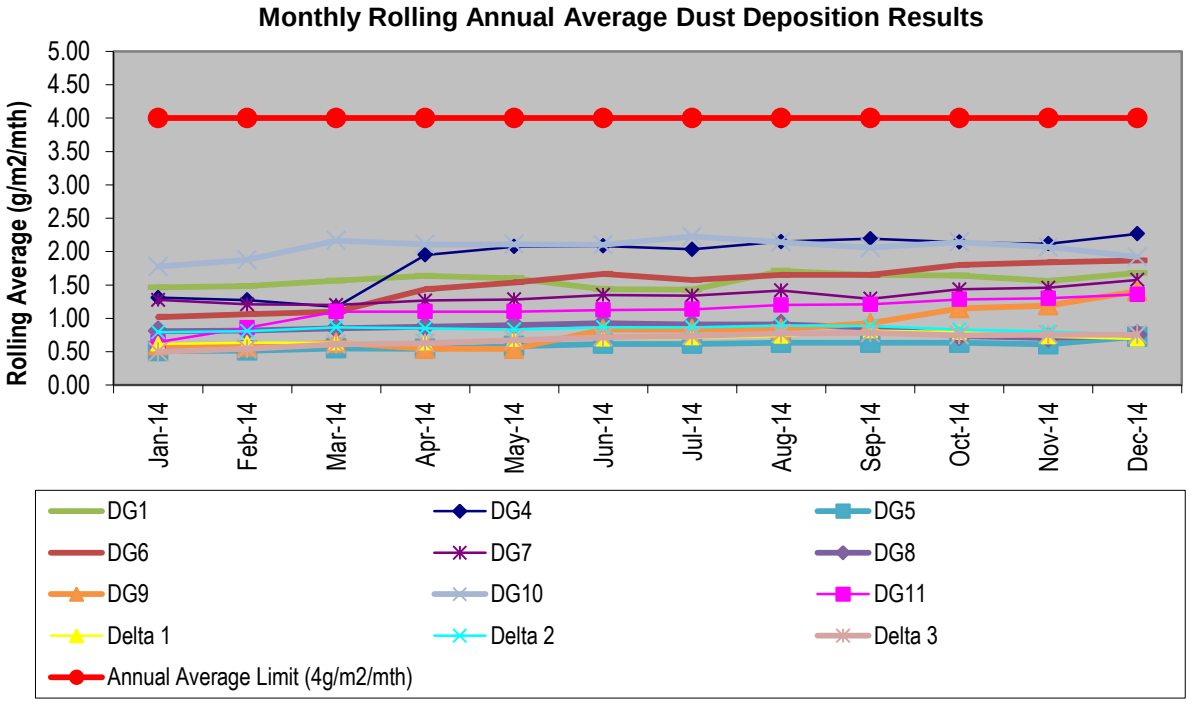


Figure 1: Monthly Rolling Annual Average Dust Deposition for 2014.

Particulate Matter

The Cooranbong Distribution Project EA (May 2012) concluded that incremental and cumulative annual average TSP concentrations were predicted to be well below the impact criterion of 90 ug/m^3 at the nearest sensitive residences. The EA also predicted that incremental and cumulative annual average PM10 concentrations will be below the impact criterion of 30 ug/m^3 at the nearest surrounding residences.

Continuous dust monitoring was installed in June 2013 at the Cooranbong Services Site to monitor total suspended particles (TSP) and particulate matter (PM10) as per the condition M2.2 of EPL365. The development consent requires that the Mine does not exceed the limit criteria of:

- 90ug/m^3 annual average for TSP;
- 30ug/m^3 annual average for PM10; and
- 50ug/m^3 24 hour average for PM10

TSP and PM10 monitoring results are shown in **Figure 2.** The results are presented as annual average for the monitoring period (July 2013 to December 2014). TSP and PM10 monitoring results to date since installation in June 2013 are in accordance with the predictions from the air quality impact assessment for the Cooranbong Distribution Project EA (May 2012).

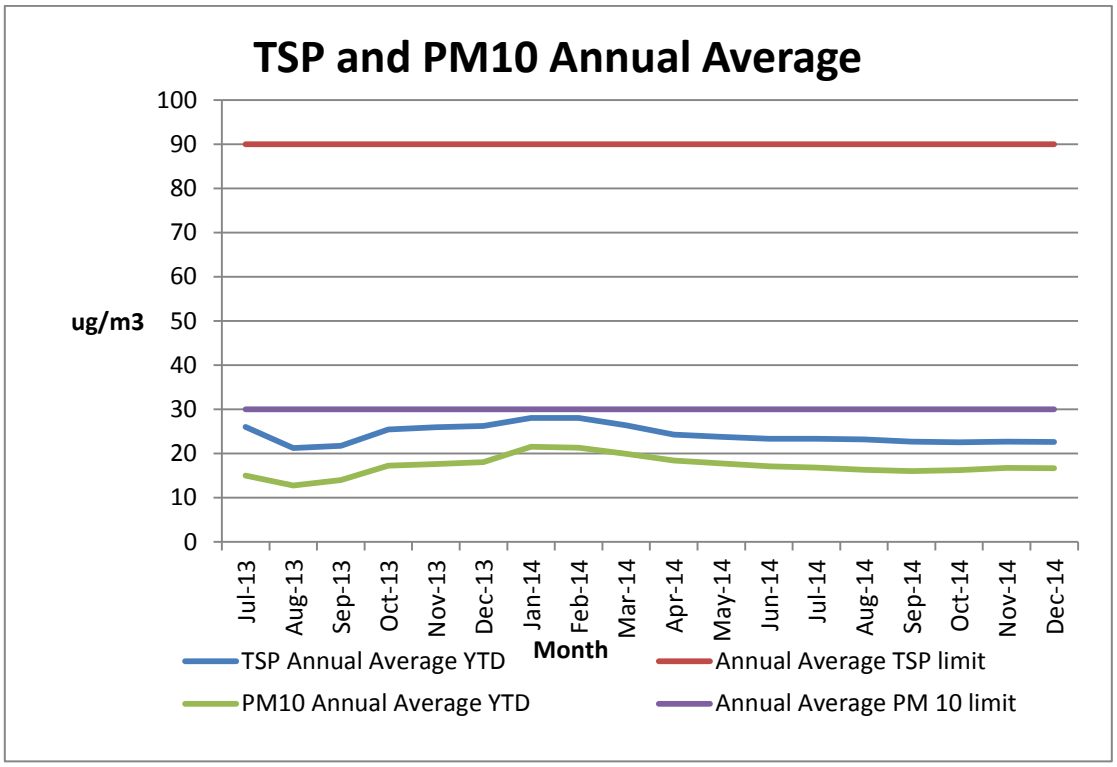


Figure 2: TSP and PM10 Annual Average Year to Date

5.2 GROUNDWATER MONITORING

Mandalong
Groundwater is monitored on a monthly frequency at the groundwater wells shown on the plan **MG10502**.

Delta
Construction of the Delta decline tunnel was completed in 2005. No groundwater monitoring was required in 2014 due to water reporting via inseam pumps to the Cooranbong Services Site and is monitored at LDP001.

5.2.1 Groundwater Monitoring Results

Mandalong
The groundwater monitoring results are summarised in **Table 12** and

Figure 3**, Figure 4 & Figure 5.** Hydrographs of the groundwater levels and Electrical Conductivity (EC) are included in the Australasian Groundwater and Environmental Consulting (AGE) report (2015) provided in **Appendix 5**.

Table 12: Average Groundwater Quality for the Mandalong Valley for the 12 month period from January 2014 to December 2014 ('Avg') and the Long-Term Average ('LTA').

Bore	pH		Ec (uS/cm)		Depth (m)	
	Avg	LTA	Avg	LTA	Avg	LTA
BH001	6.37	6.4	476	492.3	3.55	3.5
BH002	5.62	5.6	3690	4371.7	2.30	2.6
BH02C	5.53	5.4	1411	1600.5	2.52	2.8
BH02B	6.10	6.3	6329	6431.9	3.14	3.4
BH02A	7.25	7.2	5931	5937.7	21.31	19.5
BH003	6.22	6.4	3386	3024.9	3.37	3.5
BH03A	6.17	6.2	6998	6576.3	2.67	2.8
BH03B	6.89	6.8	10010	9825.7	17.65	16.4
BH004	6.02	6.2	13120	12947.4	0.89	0.8
BH005	6.70	5.0	2069	11581.3	1.11	1.3
BH006	6.31	6.4	4736	4606.2	2.87	2.8
BH06A	7.24	7.3	7361	7498.4	8.26	8.5
BH007	5.99	6.4	11343	9794.4	1.24	1.1
BH07B	6.69	8.6	8063	7764.1	9.80	7.7
BH008	6.62	6.6	7453	6886.9	1.98	2.1
BH009	6.11	6.3	252	356.3	1.98	2.2
BH09A	11.16	11.8	6109	6926.3	18.42	12.1
BH010	6.04	6.1	2528	2617.0	1.72	1.8
BH010A	7.45	7.6	6423	6118.4	4.90	4.3

Bore	pH		Ec (uS/cm)		Depth (m)	
	Avg	LTA	Avg	LTA	Avg	LTA
BH010B	11.15	11.5	5144	4986.3	23.08	14.4
BH011	5.84	5.9	5223	5185.5	0.79	0.9
BH012	6.47	6.7	8084	7189.3	1.46	1.4
BH013	6.57	6.6	457	3878.6	1.21	0.9
BH014	6.31	6.4	13984	12499.0	0.92	1.1
BH17A1	6.31	6.0	1163	1854.1	2.67	3.0
BH020A	6.19	6.2	7273	7235.7	1.47	1.7
BH020B	6.33	6.3	5311	537.0	1.62	1.7
BH021	7.95	8.1	7575	7508.3	53.25	53.2
BH021A	5.75	5.9	7283	6779.6	3.22	3.4
BH22A	6.36	6.4	5857	5523.3	1.92	2.1
BH22B	7.56	7.4	9915	10591.9	10.37	10.8
BH23	7.24	7.2	5909	5929.1	56.25	56.3
BH23A	7.42	7.4	5520	5633.3	16.38	12.3
BH23B	6.26	6.4	4321	4477.1	3.06	3.3
BH24A	6.59	6.7	9595	9297.1	2.72	1.8
BH24B	8.03	9.0	9201	9423.8	15.31	10.1
BH24C	7.54	8.2	8880	8963.9	35.37	13.8
BH25A	6.52	6.6	6478	5851.1	0.85	0.9
BH25B	7.16	7.2	6804	6342.5	5.24	4.2
BH25C	7.81	8.5	7318	6889.3	11.97	8.0
BH26A	6.02	6.3	11789	8808.5	1.80	1.8
BH26B	7.21	7.2	6750	6044.9	1.13	1.0
BH26C	8.24	8.2	5266	5432.1	11.60	8.8
BH27B	7.83	7.7	5808	5396.6	79.30	78.0
BH27C	8.07	8.0	4393	4434.2	93.41	84.7

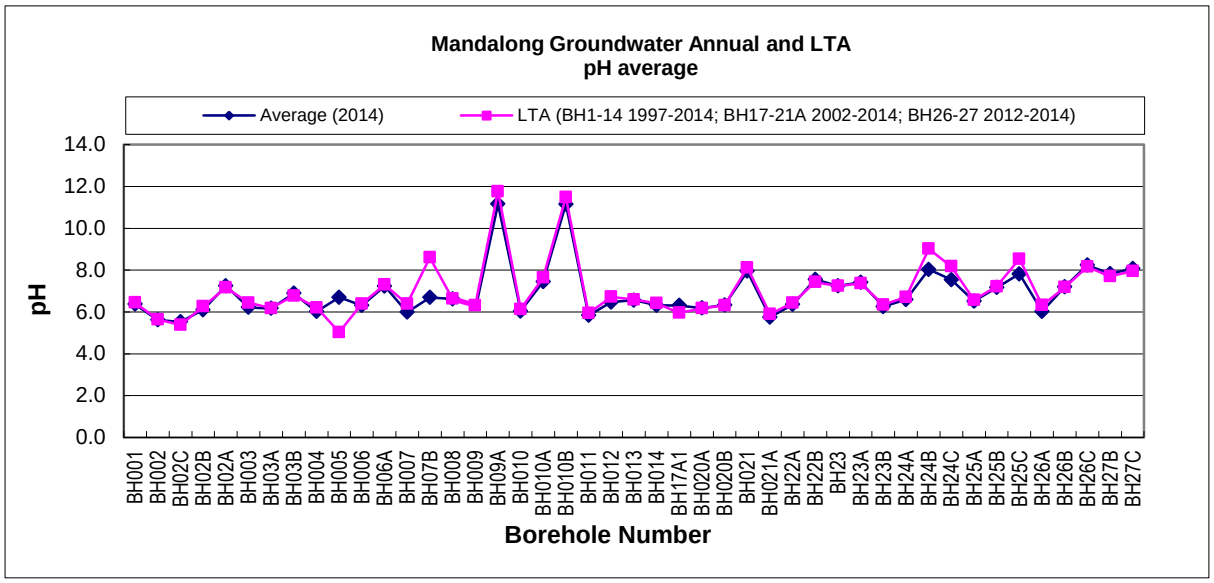


Figure 3: Long-Term Average (LTA) and Annual Average Groundwater pH

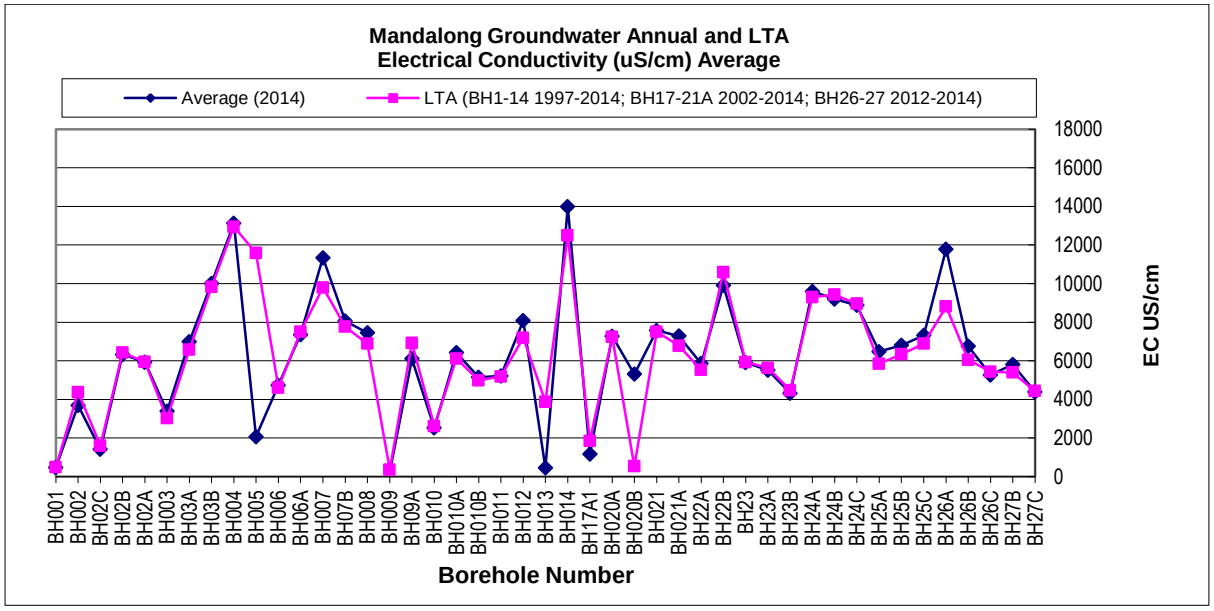


Figure 4: Long-term Average (LTA) and Annual Average Groundwater EC

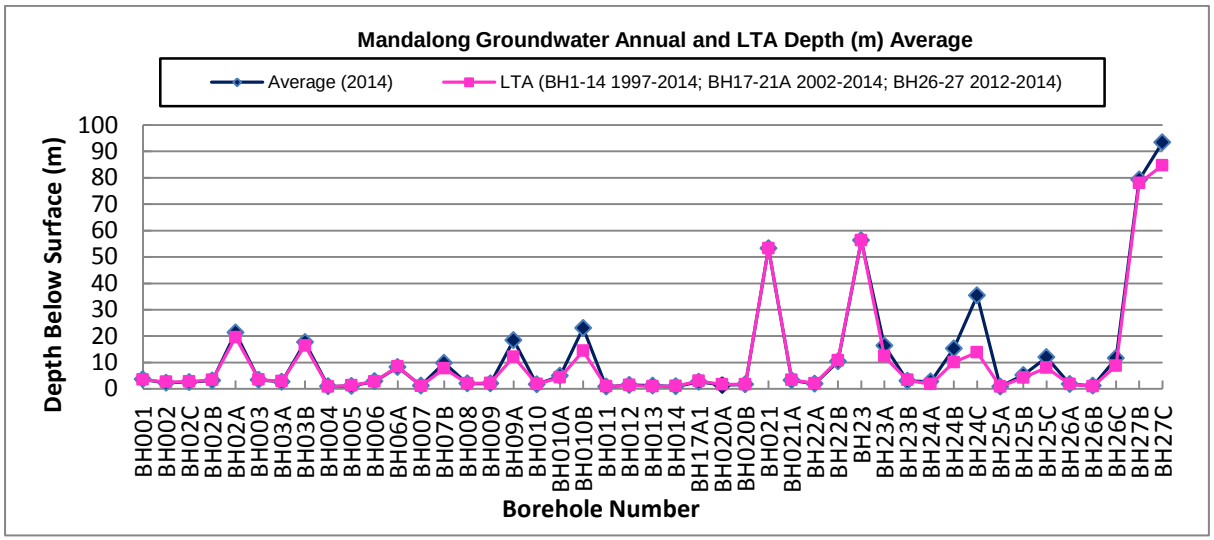


Figure 5: Long-term Average (LTA) and Annual Average Groundwater Borehole Depth (m)

Delta Entry

Groundwater monitoring at the Delta site was finalised at the completion of construction in December 2005. No groundwater is discharged at the Delta site. The Delta underground workings are limited to two Maingate roadways therefore, inseam groundwater make is minimal and is pumped via the existing inseam dewatering system to the Cooranbong longwall void area and discharged via LDP001 at the Cooranbong Services Site.

5.2.2 Data Interpretation

Mandalong

This section discusses the recorded groundwater data. The natural groundwater system shows some variability in quality and depth. The pH ranges from a low of 4.98 in December 2014 at BH002 to a high of 11.6 at BH09A in October 2014. The majority of boreholes display an annual pH average very similar to their respective long-term averages. BH05 and BH07B however showed a difference in the annual average pH compared to the long term average with the results further discussed in Section 8.1.3.2.

The electrical conductivity is characterised by variability. The freshest water (lowest EC) is found at BH009, with an EC of 168.7 µS/cm recorded in July 2014. The most saline water was found at BH014, with an EC of 16640 µS/cm recorded in July 2014. Most of the results are relatively consistent with the long-term trend. The greatest variation from the long term average was seen at BH07B.

The recorded depth is relative to the ground surface. The deepest water is found at BH27C averaging 93.41 m during the report period. The shallowest groundwater is found at BH011, which averaged 0.79m for the reporting period. **Figure 5** shows the annual average and long-term average depths are very similar with only minor variations for most boreholes.

In the 1997 Pacific Power International groundwater study of the overburden strata for the Cooranbong Colliery Life Extension Project EIS concluded that "*the height of interconnected fracturing above the extracted seam would range from 60 to 90 metres depending on the seam thickness and overburden lithology*". At the Mandalong Mine, the depth of cover ranges from 160 m to 350 m and therefore it was considered unlikely that mining will result in any significant vertical drainage of the surface alluvial aquifer (Umwelt, 1997). The Longwall panels at the Mandalong Mine have also been designed as relatively narrow in order to limit vertical fracturing and the potential to impact the alluvial aquifers and associated water courses.

The review of groundwater results by AGE *(2015)* presented in **Appendix 5** provides the following conclusions:

- *2014 groundwater level data indicates that there has been no impact to alluvial groundwater levels from mining. Also, all alluvial bores correlated closely with the CRD, indicating recharge is primarily related to rainfall.*
- *The monitoring data has confirmed the Kendorski (1993) model and previous assessments of the potential impact of goafing associated with longwall mining on the overlying aquifers, viz:*
  - *water levels in the alluvium and shallow overburden do not appear greatly impacted by mining.;*
  - *water bearing overburden strata at depths of greater than 90 m below ground level are depressurised/dewatered as a result of hydraulic connection with the longwall panel; and*
  - *the coal seam aquifer that is being mined is locally depressurised/dewatered.*
  -
- *Based on the analysis of the groundwater monitoring data, there has been no adverse long term impact on the alluvial aquifers or shallow overburden from longwall mining of panels LW1 to LW17. However, it is acknowledged that dewatering of the goafed zones in addition to the depressurisation of the deeper overburden has occurred due to mining.*

In summary, the monitoring data indicates that although mining has impacted groundwater levels in overburden rocks, there has been no long-term impact, even in faulted areas, on groundwater levels in the alluvial aquifers. Generally groundwater quality does not appear to be impacted long-term.

Therefore impacts to the surface alluvial aquifers to date have been shown to be in accordance with the predictions included in the Cooranbong Life Extension Project EIS.

A discussion on the groundwater results in relation to mining is contained within Section 8.1.3.2 of the AEMR and full review of the data in the AGE (2015) report is provided in **Appendix 5**.

5.3 SURFACE WATER MONITORING

Mandalong

There is an established surface water quality monitoring program for the Mandalong catchment conducted since periodic sampling commenced in 1996, with the program established on a regular frequency since August 1999. Graphs and monitoring data for each monitoring location are shown in **Appendix 6**. Three surface water monitoring points (SW13-15) above LDP001 & LDP002 at the Cooranbong Services Site and two monitoring points (SW16-17) in the receiving waters below the LDP's were added in late 2011. The monitoring locations are shown on the plans **MG10502** and **MG10722E** and are summarised below in **Table 13**.

Cooranbong Haul Road

The Cooranbong Haul Road crosses three ephemeral creeks in the Lords Creek sub-catchment. Six sediment basins have been constructed along the haul road to contain dirty water runoff. Monitoring of the water quality in the haul road sediment control dams was undertaken in 2014 to assess the effectiveness of water treatment prior to controlled releases. Water quality is required to meet the water quality criteria of EPL 365 prior to discharge as presented in Section 5.3.1.

Table 13: Summary of Monitoring Locations with Respect to Position within the Catchments

Location Reference	Creek Sub-catchment	Position along Creek Sub-catchment
SW008	Stockton Creek	Upper
SW004	Stockton Creek	Mid
SW012	Stockton Creek	Lower
SW011	Moran's Creek	Upper
SW003	Moran's Creek	Mid
SW006	Moran's Creek	Lower
SW002	Stockton and Moran's	At Confluence
SW001	Stockton Creek	Downstream Confluence
SW009	Pourmalong Creek	South
SW010	Pourmalong Creek	North
SW13	Muddy Lake (Unnamed tributary upstream LDP001).	Upper
SW14	Muddy Lake (Unnamed tributary upstream LDP002).	Upper
SW15	Muddy Lake (Unnamed tributary upstream LDP002).	Upper
SW16	Muddy Lake (Unnamed water body 1km downstream Simpson Rd Causeway Crossing)	Mid
SW17	Muddy Lake (North Dora Creek Village)	Lower
SW18	Outlet of Mandalong Mine Macrophyte Pond	Lower

5.3.1 Surface Water Monitoring Results

Mandalong

Surface water quality is monitored at 11 locations on a monthly or quarterly basis. These locations encompass four different catchment areas. The water is tested for pH, Total Suspended Solids (TSS) and Electrical Conductivity (EC). The annual and long-term average (LTA) results are summarised in **Table 14**.

Table 14: Average Surface Water Quality for the 12 month Period from January 2014 to December 2014 ('Annual') and the Long-term Average ('LTA').

Site Location	Catchment	pH		TSS		Specific Conductance uS/cm	
		Average	LTA	Average	LTA	Average	LTA
SW008	Stockton	7.0	6.0	7.7	31.2	696.7	858.0
SW004		7.0	6.7	15.3	18.7	648.3	634.7
SW012		6.7	6.0	20.0	33.0	1072.8	1177.3
SW18		7.46	7.31	46.0	37.53	622.88	578.06
SW011	Moran's	6.8	6.6	37.8	52.4	515.3	559.7
SW006		6.6	6.6	9.3	18.5	397.0	531.7
SW003		6.5	6.4	15.3	18.7	373.3	482.7
SW002	Stockton and Moran's Creek (Confluence)	7.0	7.0	3.5	14.7	9910.8	14675.6
SW001		7.1	7.1	7.5	12.1	28230.0	30258.1
SW009	Pourmalong	6.8	6.4	3.3	17.3	367.3	299.5
SW010		6.0	6.1	4.8	18.8	1105.8	432.1
SW13	Muddy Lake	4.3	5.6	4.2	15.5	3956.4	2364.1
SW14		7.01	7.04	7.36	16.09	764.55	557.74
SW15		5.83	5.87	70.5	79.31	63.0	91.5
SW16		8.31	8.22	38.67	23.81	3365.83	2611.78
SW17		8.25	8.15	4.42	621.8	2383.33	2814.86

Cooranbong

Water quality is monitored daily as per the requirements of EPL 365 at Licence Discharge Points (LDP) LDP001 and LDP002 located at the Cooranbong Services Site as shown on the plan **MG10722E**. The water is tested for pH, Total Suspended Solids (TSS), EC and Oil and Grease (mg/L). The average annual results at LDP001 & LDP002 are summarised in **Table 15** and **Table 16**. Graphs of the LDP001 & LDP002 water quality results for these parameters are provided in **Figure 6** and **Figure 7** and in **Appendix 6**. Discharge from LDP001 at the Cooranbong Services Site did not occur between February and October 2014 due to a cessation in pumping for the replacement of the extraction Borehole Pump at Cooranbong.

Table 15: Cooranbong Entry– Average Quality of Discharge Water Discharged through EPA Licensed Discharge Point 1 (LDP001)

Average Water Quality Monitoring Required by EPA Licence 365			
AEMR Period	**pH**	**TSS (mg/L)**	**Oil & Grease (mg/L)**
LDP001	7.96	1.32	0.05

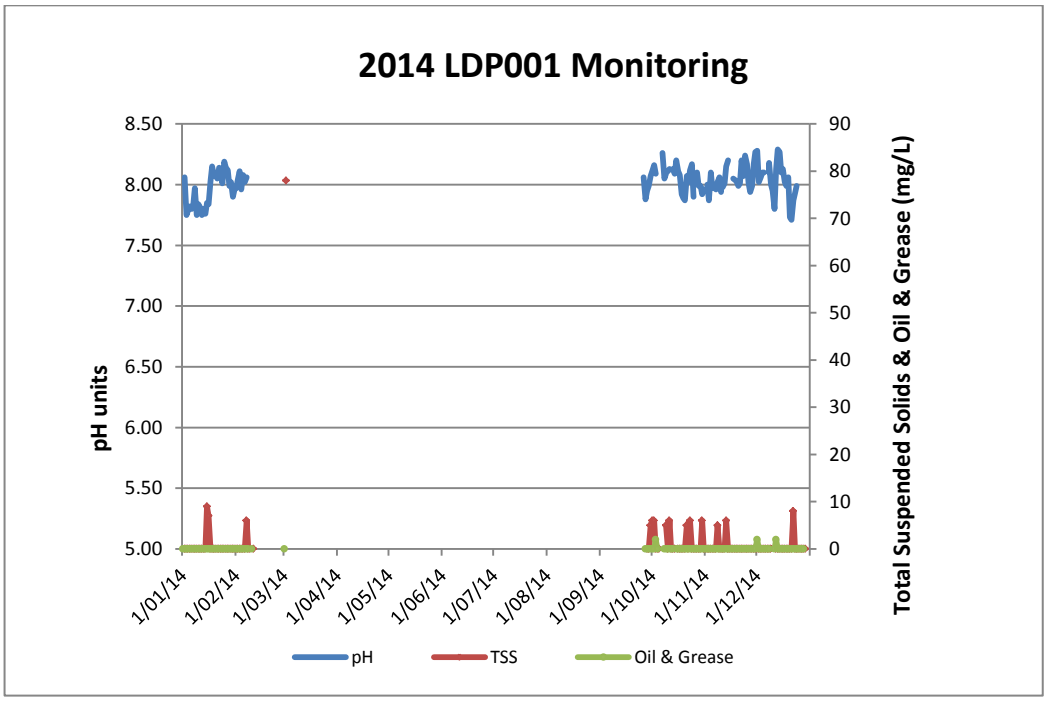


Figure 6: LDP001 Water Quality Monitoring

Table 16: Cooranbong Entry –Average Quality of Discharge Water Discharged through EPA Licensed Discharge Point 2 (LDP002)

Average Water Quality Monitoring Required by EPA Licence 365			
AEMR Period	**pH**	**TSS (mg/L)**	**Oil & Grease (mg/L)**
LDP002	4.99	95	0

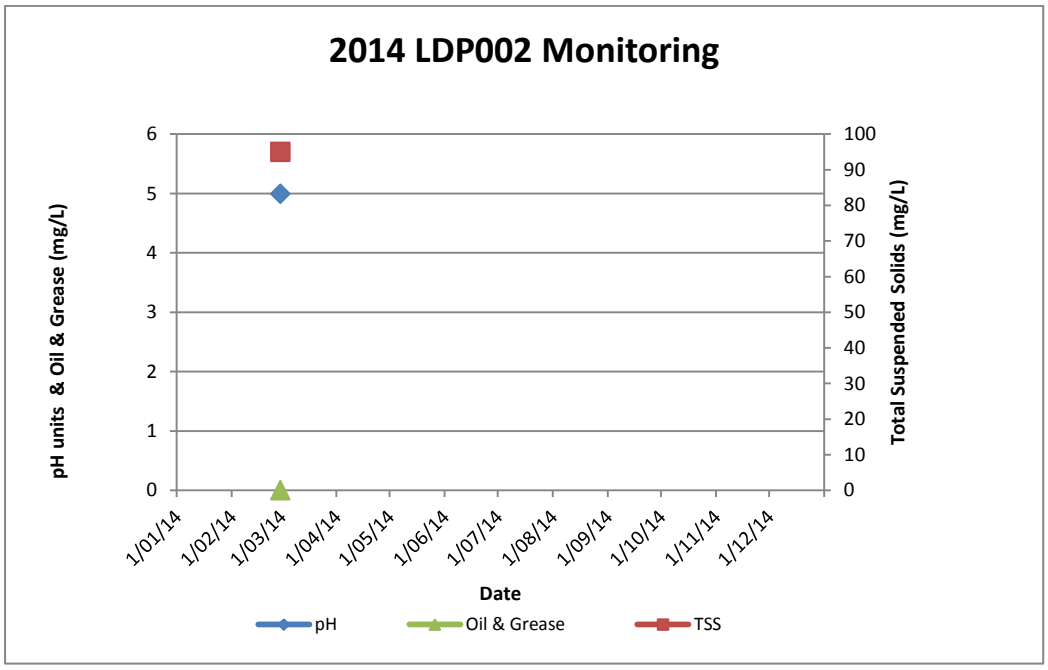


Figure 7: LDP002 Water Quality Monitoring

5.3.2 Data Interpretation

The results presented in **Table 14** are characteristic of the natural conditions of the area, particularly Stockton and Moran's Creek. Both Stockton and Moran's creek are the main drainage systems for the Mandalong area. Stockton Creek is located within the current longwall mining area (LW1-16) and Moran's Creek is also located within the current longwall mining area (LW15-17).

Mandalong

Surface waters are tested for pH, Total Suspended Solids (TSS) and Specific Conductance/Electrical Conductivity (EC) and the annual and long-term average (LTA) results are summarised in **Table 14**. **Appendix 6** contains graphs of EC, pH and TSS for each of the surface water monitoring points sampled in 2014. The Cooranbong Services Site monitoring sites SW13, SW14, SW15, SW16 and SW17 were sampled on a monthly basis. The monitoring sites SW001, SW002, SW003, SW004, SW006, SW008, SW009, SW010, SW011, and SW012 were sampled on a quarterly basis during the reporting period.

The EC (salt content) for the 2014 period shows a relatively consistent level compared to the long-term average. The average EC recorded for sites SW001, SW002, SW003, SW006, SW008, SW011, SW012, SW15 and SW17 for this period is lower than the long-term average.

The average total suspended solids (TSS) for 2014 are relatively low and are characteristic of natural surface water conditions in creeks. SW15 (Muddy Lake) recorded the highest annual average TSS of 70.5 mg/L in 2014. At sites SW001, SW002, SW003, SW004, SW006, SW008, SW009, SW010, SW011, SW012, SW13, SW14, SW15, and SW17, the 2014 average was lower than the LTA.

At the majority of monitoring points, the results showed an annual average pH similar to the long-term average. SW13 had the lowest pH average of 4.3 in 2014. The highest pH average recorded during 2014 was 8.31 recorded at SW016.

Cooranbong

Plan **MG10722B** shows the location of the discharge monitoring points LDP001 and LDP002. The results shown in **Table 15** indicate an average pH 7.96 at LDP001 was similar to the 2013 average pH of 7.94. An average Total Suspended Solids (TSS) result at LDP001 of 1.32 mg/L was recorded in 2014. LDP002's average TSS of 95 mg/L, pH 4.99 and low levels of Oil and Grease 0mg/L were

higher than the 2013 average (TSS 36 mg/L, pH 7.01, O&G 0.66 mg/L), however there was only one discharge and sampling event at LDP002 in 2014.

EPL 365 permits the Mandalong Mine to discharge a maximum of 5 ML/day from LDP001 and exceed this limit when 10 mm rainfall has fallen in the prior 24 hours. The average daily discharge volume of 0.696 ML was recorded at LDP001 in 2014 and the highest daily discharge was 3.731 ML in November 2014.

Surface water runoff from the hardstand area at the Cooranbong Services Site drains to the 5 ML dam as shown in plan **MG10722B** to provide settling capacity to treat suspended solids. Water runoff from the workshop, hydrocarbon storage areas drain to an oil water separator to remove oily water before entering the dam.

Cooranbong Haul Road

Monitoring for the surface water in the six sediment control dams on the haul road was conducted to determine compliance with the EPA licence limits prior to discharge. Water was discharged from the sediment basins on nine occasions in 2014. Prior to discharge the sediment control dams where treated by adding a flocculent to the water to remove suspended solids. Treated water discharged from the sediment control dams ranged in quality from 14mg/L to 49 mg/L TSS and pH 6.5-7.9 in 2014. No oil and grease was evident in any of the discharge events. Water quality in the haul road sediment control dams met the water quality discharge criteria detailed in the EPL and the Cooranbong Haul Road Surface Water Management Plan.

5.4 METEOROLOGICAL MONITORING

An automatic weather station has provided on site meteorological monitoring results since June 1999. The weather station records wind speed and direction, temperature, evaporation and rainfall.

5.4.1 Wind Monitoring Results

Wind speed data is shown in **Table 17**. Wind speed and direction are shown graphically in **Figure 8, Figure 9 , Figure 10** and **Figure 11**.

Table 17: Average and Maximum Instantaneous Wind Speed Recorded at Mandalong Mine for the Period January 2014 to December 2014.

Month	Wind Speed (m/sec)	
	Average	Maximum
January	1.89	2.55
February	1.69	3.01
March	1.14	1.86
April	0.95	1.82
May	0.91	3.23
June	1.33	3.85
July	1.21	2.77
August	1.27	2.55
September	1.19	3.04
October	1.18	1.88
November	1.57	2.99
December	1.74	4.07

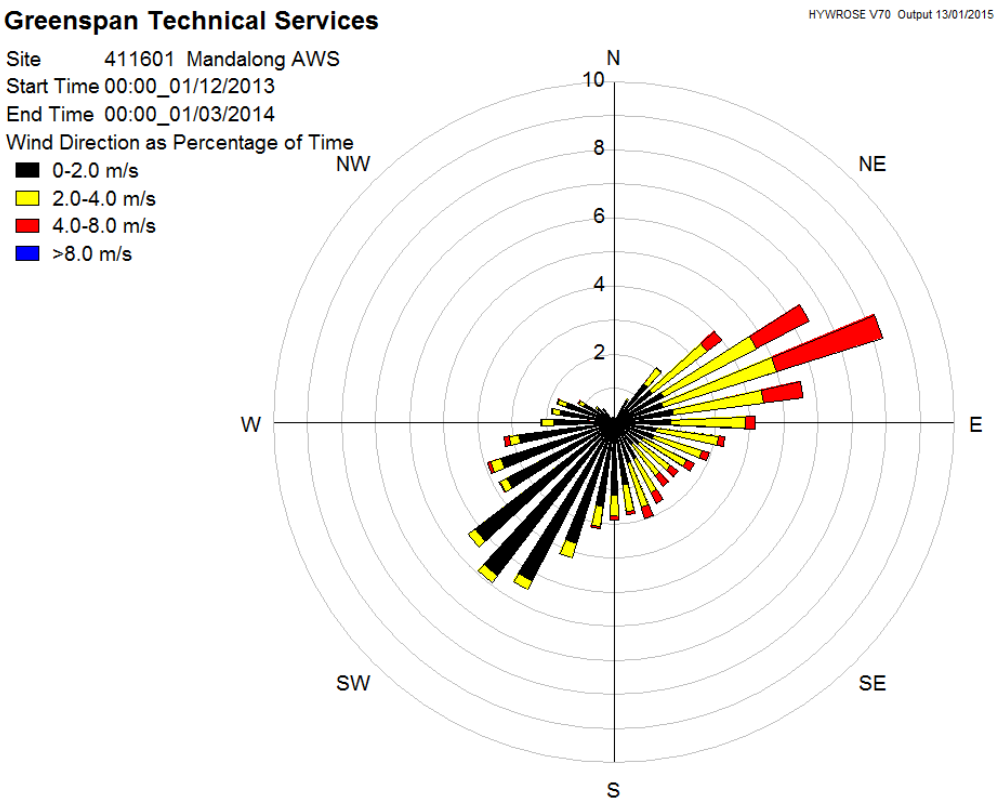


Figure 8: Average Daily Wind Direction Recorded for Summer 2014

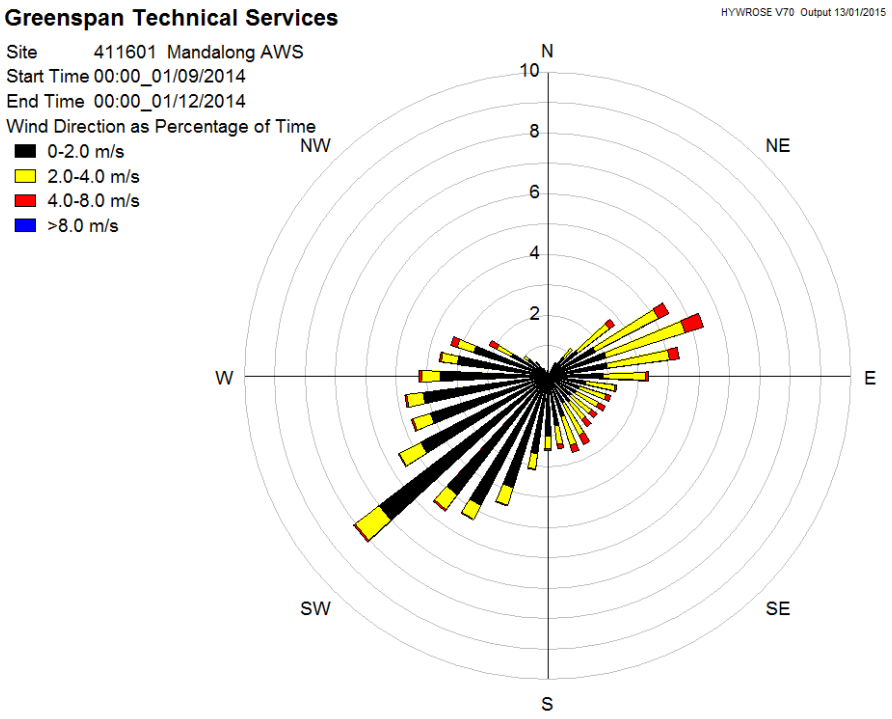


Figure 9: Average Daily Wind Direction Recorded for Spring 2014

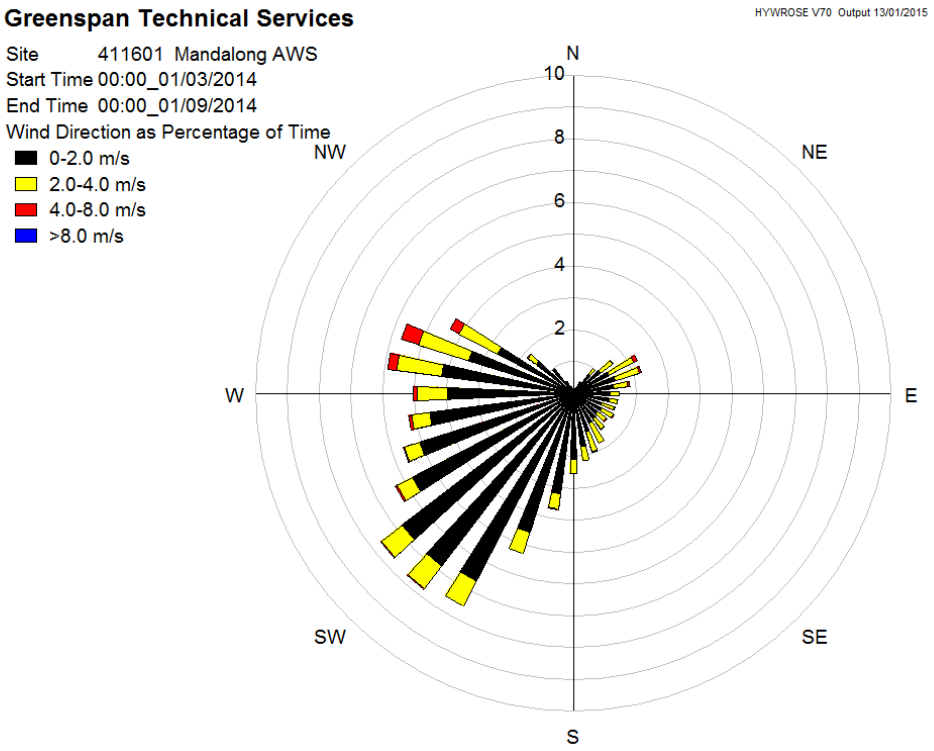


Figure 10: Average Daily Wind Direction Recorded for Autumn and Winter 2014.

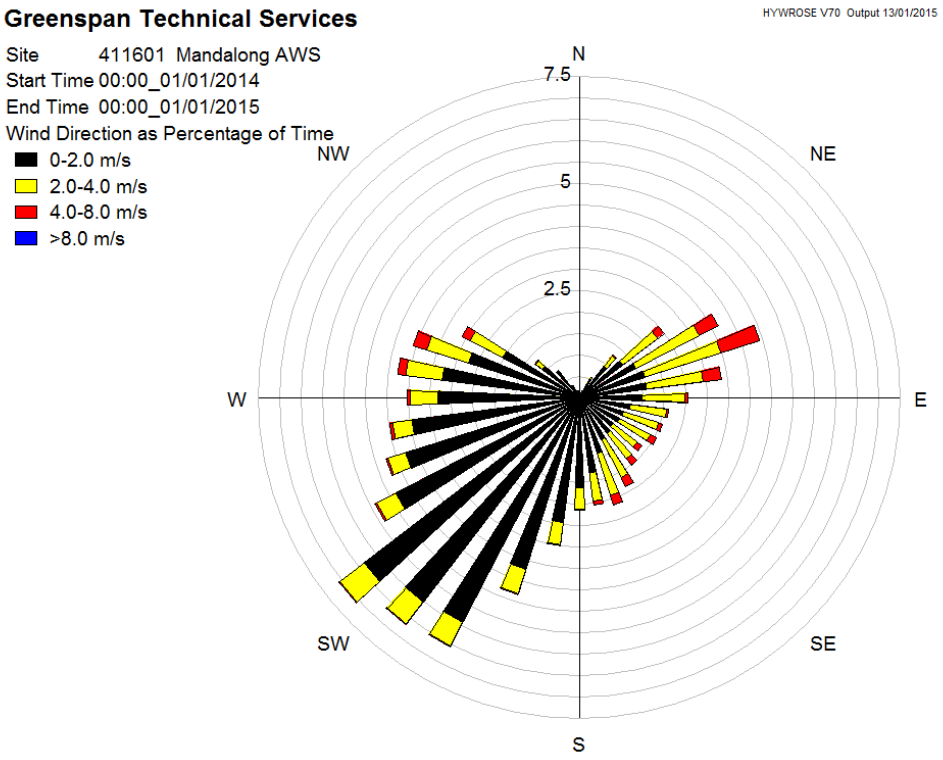


Figure 11: Annual Percentage of Wind Direction for the Period of 2014

5.4.2 Data Interpretation

Table 17 indicates the highest daily maximum wind speed (4.071 m/s) occurred in December 2014. The highest average daily wind speed (1.89 m/s) was recorded in January 2014.

Figure 8 indicates that the wind is predominantly from the north east and south west direction for the summer period in 2014.

Figure 9 shows that the wind is predominantly from the north east and south west during spring in 2014.

Figure 10 indicates that wind from the south west is the most common during Autumn to Winter in 2014.

Figure 11 indicates that dominate wind direction for the 2014 period was from the south west.

5.4.3 Rainfall Monitoring Results

The total monthly rainfall data is shown below in **Table 18**. Monthly rain data recorded at Mandalong Mine's weather station is tabulated and shown graphically in **Appendix 7**.

Table 18: Rainfall at Mandalong Mine for the Period January 2014 to December 2014.

2014 Month	Mandalong Mine Total Rainfall (mm)
January	27.4
February	299
March	132
April	111.8
May	26.6
June	55.8
July	10.2
August	150
September	42.2
October	32.8
November	31.4
December	138.6
Total	**1057.8**

5.4.4 Data Interpretation

A total of 1057.8 mm of rainfall was recorded at the Mandalong Mine site during the reporting period. The total annual rainfall for 2014 was less than the total rainfall (1320mm) recorded in 2013. The wettest period was in February 2014 recording 299mm.

5.4.5 Evaporation and Temperature Monitoring Results

The average daily evaporation rates (mm/day) and maximum and average temperatures are recorded at the Mandalong Mine Meteorological station. Results for the reporting period are shown in **Table 19**.

Table 19: Average Daily Evaporation (mm) and Temperature Data for the Period January 2014 to December 2014

Period 2014	Average Daily Evaporation (mm)	Minimum Temperature (°C)	Maximum Temperature (°C)
January	4.10	10.27	37.58
February	3.41	9.08	33.42
March	2.55	8.86	31.77
April	1.88	6.26	29.04
May	1.76	2.92	26.35
June	1.41	-0.47	22.25
July	1.56	-2.75	24.53
August	2.55	-0.54	21.69
September	2.67	2.66	32.16
October	2.91	4.87	37.86
November	4.07	7.85	40.05
December	3.99	10.59	36.45
Annual Average	**2.74**	**4.96**	**31.10**

5.4.6 Data Interpretation

The average daily evaporation rates are highest in summer and spring and tend to decrease during autumn and winter. This is consistent with maximum air temperatures. The highest temperature was recorded in November 2014 at 40.05°C. The highest average daily evaporation of 4.10mm occurred in January 2014.

5.5 NOISE MONITORING

Annual noise monitoring was conducted to assess operational noise levels compared to the noise limits specified by consent condition 44 and EPL 365 in accordance with the Noise Monitoring & Management Plan (NMMP) approved by NSW DP&I (condition 45) in December 2013. The NMMP requires Centennial Mandalong to survey noise from the operation annually. A copy of the report including all monitoring results is provided in the report titled "Annual Compliance Noise Monitoring" by SLR Consulting (2014b) in **Appendix 8**.

Operator attended noise surveys were conducted at each of the ten (10) locations for a minimum of 1.5 hours during the day; 30 minutes during the evening; and 1 hour during the night, to determine the character and relative contribution of ambient noise sources and mine contributions.

Measurements were conducted during worst case operational scenarios for both the Mandalong and Cooranbong sites in order to capture associated worst case noise levels.

The Cooranbong Colliery Life Extension Project EIS predicted that the noise emissions from the Mine Access Site during the operational phase at all the EIS assessment locations comply with or only marginally (1 or 2 dBa) exceed the recommended night-time noise limits, during neutral meteorological, adverse north-westerly winds and adverse temperature inversion conditions (Umwelt, 1997).

The noise impact assessment completed as part of the Cooranbong Distribution Project EA (May 2012) predicted that operational noise levels at Cooranbong will meet the project-specific noise criteria at all nominated residential locations with the exception of Residences 23 and 26 under temperature inversion conditions. The noise impact assessment predicted that compliance with the project-specific noise criteria for Residences 23 and 26 will be achieved following the installation of cladding on the Cooranbong Coal Handling Plant and the with installation of an acoustic barrier adjacent to the export truck loading bin. Both of these projects were completed in 2013.

Summary of Noise Monitoring Results

SLR were engaged by Centennial Mandalong to conduct a noise compliance assessment for the Mandalong Mine and Cooranbong Services Site in accordance with the NMMP.

Operator-attended noise measurements were conducted at the ten (10) focus locations during the day on Monday 18 August 2014 and Wednesday 20 August 2014 and during the evening and night-time periods on Wednesday 20 August 2014 and Thursday 21 August 2014. Measurements were conducted during worst case operational scenarios for both the Mandalong and Cooranbong sites in order to capture associated worst case noise levels.

Mine operations noise contributions were found to be within the relevant consent condition, EIS predictions and EPL limits at all monitoring locations in 2014.

5.6 BLAST MONITORING

Mandalong

Blast Monitoring was conducted by SLR (2014a) between 6 and 17 June 2014 and the results are provided in **Appendix 8**. Monitoring of ground vibration and over pressure levels was conducted during underground shot firing used to remove a stone and dyke material in Maingate 17. A ground vibration monitor was installed on the Centennial property located off Sauls Road, situated above the underground dyke. Similarly overpressure and ground vibration monitoring was also installed at the Mandalong Mine, in front of the Mine portal to monitor overpressure and vibration during shot firing.

The EPA recommends that blasting overpressure and ground vibration be assessed in accordance with the Australian and New Zealand Environment Council's (ANZECC) "*Technical basis for guidelines to minimise annoyance due to blasting overpressure and ground vibration*" (ANZECC, 1990).

The ANZECC guideline provides the following recommended criteria in relation to blasting overpressure and ground vibration:

"Airblast

- *The recommended maximum level for airblast is 115 dB (Lin Peak)*
- *The level of 115 dB may be exceeded on up to 5% of the total number of blasts over a period of 12 months. However, the level should not exceed 120 dB (Lin Peak) at and time.*
- *Ground Vibration*
- *The recommended maximum level for ground vibration is 5 mm/sec (peak particle velocity (ppv).*
- *The ppv level of 5 mm/sec may be exceeded on up to 5% of the total number of blasts over a period of 12 months. The level should not exceed 10 mm/sec at any time."*
- *Experience has shown that for almost all sites a ppv of less than 1 mm/sec is generally achieved. It is recognised that it is not practicable to achieve a ppv of this level at all sites and hence a recommended maximum level of 5 mm/sec has been selected. However, it is recommended that a level of 2 mm/sec (ppv) be considered as the long term regulatory goal for the control of ground vibration.*

Results of vibration monitoring conducted during June 2014 indicate that the peak vector sum vibration level measured at 229 Sauls Road, Mandalong was above the relevant comfort criteria (by 0.35mm/s) during the blast event. Analysis of measured vibration data indicated that other high peak vibration events (not associated with blasting) were measured before and after the blasting event on 14 June 2014.

These relatively high vibration levels are likely due to other local activities around the vibration monitor during the time of blasting eg. animals (such as dogs) near the monitor. At no time during the monitoring period did the PPV vibration levels exceed 10mm/s.

Vibration levels recorded during June 2014 at the Mandalong portal site are consistent with background vibration levels in the area when blasting did not occur and are well below the relevant criteria.

Blast overpressure monitoring results are below the respective limit of 115 dB (Lin peak) at the Mandalong portal site. It is relevant to note that this is potentially the most affected location and if lower than criteria here then will be met at the nearest residences.

Delta and Cooranbong Entry Sites

There was no blasting carried out at the Delta and Cooranbong Entry sites during 2014.

5.7 GREENHOUSE GAS MONITORING

Consent conditions 60A (i) & (iv) requires Mandalong Mine to monitor greenhouse gas (GHG) emissions and report these in the AEMR. In accordance with Centennial Coal's standard for GHG reporting the 2014 financial year (FY 1st July 2013 to 30th June 2014), emissions in CO2 equivalent tonnes (Co2-eT) as defined in the *National Greenhouse and Energy Reporting Act 2007* are provided in **Table 20**. Total GHG emission of the 2014 FY period of 805,228 Co2-eT is lower than the 2013 FY emissions of 1,049,795 Co2-eT.

The majority of GHG emissions in 2014 were caused by fugitive methane contributing to 79 % of all GHG emissions. In the 2014 FY period Mandalong achieved a 30% reduction in emissions of Co2-eT as a result of ventilation changes and due to the implementation of the gas flares. Mandalong Mine as discussed below is currently working towards GHG reduction measures to abate fugitive methane emissions.

Table 20: Total GHG Emissions from Mandalong Mine in 2014 Financial Year

Emissions Summary (Co2-eT) July 2013 to June 2014	Total
Electricity	56,363
Diesel	2,334
Petroleum Based Oils and Greases (PBOG)	214
SF6	7
Fugitives - CH4	635,226
Fugitives - CO2	41,490
Surface Fugitive - Post Mining	69,594
TOTAL	**805,228**

Greenhouse Gas Abatement Investigations Measures

As reported previously in AEMR's, Centennial Coal has invested in technologies to reduce fugitive methane GHG emissions from the Mandalong Mine. A three stage process is planned to address this Greenhouse Abatement. Construction of Stage 1 and Stage 2 were completed in November 2013.

Stage 1 Gas Flares - A consent modification approval was obtained in 2005 to construct multiple enclosed flares planned to be used to reduce fugitive methane GHG emissions from the Mine's surface gas drainage plant. Civil works for construction of the gas flares commenced in October 2012, with final commissioning completed and automated operations commencing in November 2013. The construction of the enclosed gas flare will assist with abating drainage gas emissions of up to 1,500 litre/sec flow rate.

Stage 2 Ventilation Air Methane Regenerative After Burner (VAM RAB) – Approval for a modification to DA97/800 was sought in 2011, to allow for the installation and ongoing operation of a single VAM RAB unit as a demonstration project to examine the performance capability. Approval was granted by the Planning Assessment Commission (PAC) on behalf of the Minister for the then Department of Planning and Infrastructure on 11 November 2011.

The VAM RAB technology initially proposed for Mandalong includes installation and operation of a single VAM RAB unit as part of a demonstration project to demonstrate capture and abatement of approximately 10 cubic metres per second (m^3/s), or one-thirtieth, of the mine's total VAM. The VAM RAB system overcomes the problem of low concentration methane by directing the ventilation air into a large oxidation vessel, and oxidising the methane to carbon dioxide. This technology is based on well tested coke-oven principles, utilised in the steel industry.

This project, undertaken on behalf of the NSW Government and the underground coal industry, is co-funded by the Department of Trade and Investment, Regional Infrastructure and Services (DTIRIS) via the NSW Clean Coal Fund (NSW CCF).

Civil construction works on the surface pad for the VAM RAB unit commenced in December 2011 and were completed in November 2013. The VAM RAB demonstration plant has been heated up on a number of occasions during the last six months of 2014 and some minor configuration changes made and it is expected to complete its commissioning processes in 2015.

To build on these current research and development (R&D) efforts into ways of reducing dilute methane from coal mine ventilation, Centennial has proposed a project to safely connect a commercial scale VAMRAB to one of its mine fans. The project has received funding from the Commonwealth Department of Resources, Energy and Tourism through the Coal Mining Abatement Technology Support Package (CMATSP). CMATSP aims to support industry efforts to develop and demonstrate technologies that will provide future solutions to safely reduce fugitive methane emissions from coal mines.

Matching funding has been received from ACA Low Emission Technologies (ACALET). This is an industry body that administers the COAL21 Fund, the voluntary levy paid by black coal producers to research clean coal technologies. The $30M project will build and test a VAM RAB plant that will be able to process between 100 and 150 m^3/s of mine air and a safety duct to allow for a safe connection to the mine. It will be a first of type in Australia.

The plant will be located adjacent to the mine's main fans and gas flare infrastructure. This R&D Project is currently in the initial planning phases, and will progress to the detailed design stage in 2015. Centennial Mandalong will apply for development consent for the project in 2015, which will include an environmental assessment of the potential impacts to our close neighbours and the environment. The successful completion of the Project would see an approximate 30% reduction in annual greenhouse emissions from the Mandalong Mine site and provide a technology option to the broader underground mining industry.

Stage 3 Gas Engines In July 2009 Mandalong Mine received approval from the then DP&I to construct and operate multiple methane gas engines to generate electricity. If the generation facility is implemented, power will be supplied to the site and excess power sold to the grid. The flare units will remain available as back-up or for peak gas flows.

5.8 ADDITIONAL MONITORING

5.8.1 Wetland Monitoring

The Cooranbong Colliery Life Extension Project EIS predicted that the preferred longwall design (250 metre wide longwall panels) would result in some substantial changes to the existing wetlands within the Mandalong Valley, and as a result the extent of the wetlands may increase if drainage mitigation works were not undertaken (Umwelt, 1997). The EIS also predicted alteration to contours over the area which "…*may result in some of the current wetlands drying out or changing in shape or extent, other areas are likely to become inundated, with new wetland areas forming adjacent to or interconnected with the original wetlands*." (Umwelt, 1997)

The current longwall mining width at the Mandalong Mine is 160 metres which significantly reduces maximum subsidence levels to around 20% of those predicted in the EIS. This reduction in longwall mining width has reduced the impacts on wetlands within the Mandalong valley to below the levels that were predicted in the EIS.

Condition 74 of development consent for the Mine requires monitoring and management of wetlands in the mining area. The Wetlands Management and Monitoring Plan (WMP) approved by LMCC was prepared by Hunter Eco (Hunter Eco, 2009), identifying eight wetlands for monitoring (**Figure 12).** Wetlands 1, 2, and 3 are located outside of the subsidence zone and are control sites while the remaining five wetlands are within the proposed mining area. In April 2009 a baseline report was prepared by Hunter Eco which described the status of the wetlands prior to any subsidence having occurred.

Two monitoring rounds occurred in April 2014 (Hunter Eco, 2014a) and January 2015 (Hunter Eco, 2015). The following is a summary monitoring results from the current report *"Mandalong Wetlands Monitoring Report"* by Hunter Eco (2015), provided in **Appendix 12**.

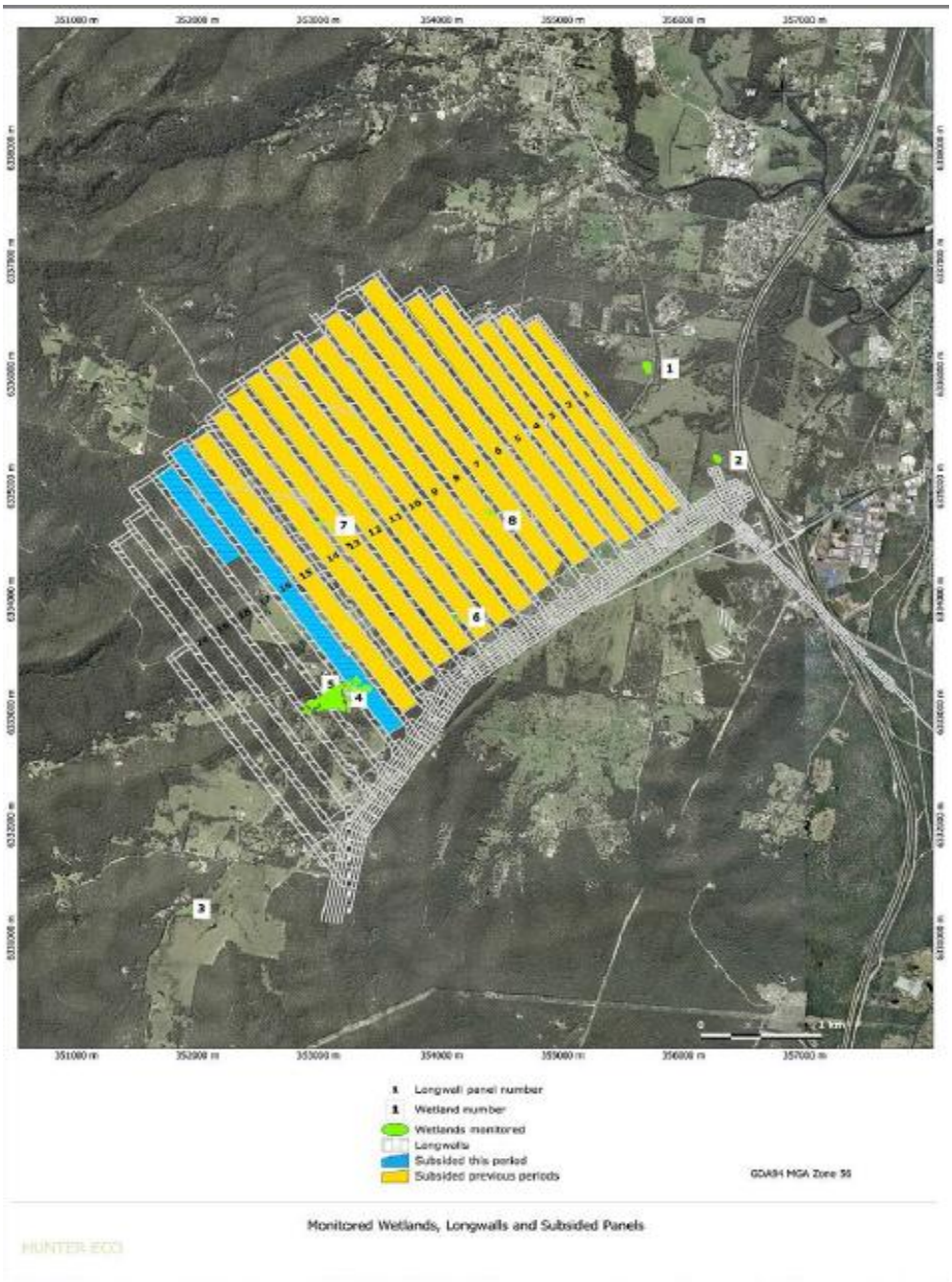


Figure 12: Wetland Monitoring Locations and underground workings.

The purpose of this monitoring program, as prescribed in the conditions of consent, is to determine what, if any, changes in the monitored wetlands in the Mandalong floodplain can be attributed to subsidence.

Monitoring of these eight wetlands commenced in April 2009 so as at January 2015 the total monitoring period has been over five years, twelve monitoring occasions. All wetlands started out with water then began to dry until May 2010 when only Wetlands 1 and 3 had water. Section 5.2 of the Hunter Eco (2015) report shows an increasing rainfall trend over the entire monitoring program with short-term fluctuations. Prior to January 2015 there has been lower than average rainfall resulting in lower water levels.

Clearly these wetlands are dynamic ecosystems with species composition and diversity varying with the amount of available water and seasons. Variable land-use activities also have an influence on the state of the wetlands. Water analysis results continue to be highly variable, showing no trends over time or within or among wetlands.

Wetland 6 is located over a pillar between panels 11 and 12, both panels having been subsided. The most noticeable change at this wetland is the change from dry to margin habitat at the beginning of the transect. This change appears to now be a feature of this transect. Wetland 8 has been subject to subsidence for over four years and there is no change in the wetland vegetation and water levels that can clearly be assigned to being an impact of subsidence.

Wetland 7 which is located over a pillar between panels 13 and 14, both of which have been subsided. There is no subsidence monitoring through this wetland, however this wetland was in a healthy condition in January 2015. Wetlands 4 and 5 are part of a larger wetland that has drained as a consequence of subsidence in panel 16 which has temporarily lowered the wetland overflow point. The wetland capacity will be restored following the subsidence from panel 17 in mid-2015, and following sufficient rainfall runoff.

When reading the Hunter Eco (2015) report regarding the plant species it is important to be aware of the distinction between occurrence and abundance. The species lists, as in Section 5.1 (**Appendix 12**), only provide occurrence information and say nothing about how many of any one species is present. Abundance information is contained in Section 6.3. (**Appendix 12**). The data show that species composition across all wetlands is relatively consistent over time. Few new species were added on this monitoring occasion suggesting that the majority of likely species has been recorded.

Weeds are primarily confined to the surrounding dry grassland with no invasion into the aquatic ecosystem (except *Isolepis prolifera* in Wetland 5 which declined in the period from November 2012 to April 2014, and has since remained steady). Section 5.1 of **Appendix 12** shows that the proportion of weeds to native species over time has reduced significantly for Wetlands 6, 7 and 8 but has remained unchanged for the others.

Changes in the amount of the threatened *Maundia triglochinoides* are interesting with whole local populations disappearing by April 2011 (Wetlands 2 & 6) or substantially reducing in numbers (Wetlands 1 & 4). Since then the species has not been present in Wetlands 1, 2, and 4. Since November 2011 a large area of the species at the south eastern end of Wetland 6 had recovered by November 2012 but had declined in April 2013, November 2013, was longer present in April 2014 and has recovered in January 2015.

Wetlands 4 and 5 had been fenced from stock since November 2012 however the property tenant reported seeing deer inside the fence and deer droppings were present along Wetland 4 transect in January 2015.

Herbivory and environmental degradation caused by feral deer is listed as a Key Threatening Process in the NSW Threatened Species Conservation Act 1955. The impact of deer on wetlands could arise from direct grazing of wetland plants and indirectly by destroying underwater regrowth with continual trampling. Depending on severity, this type of disturbance will add a confounding factor to comparison between wetlands.

Table 21: Wetland Trigger Action Response Plan and Assessment

Trigger	Result at January 2015	Response
A steady trend in the decline of water level observed in more than one round for monitoring at monitored wetlands that cannot be explained by rainfall data or upstream agricultural activity.	Water levels were low in W1, W2, W3 and W7 and W8 was dry, all as a consequence of below average rainfall. W4 and W5 were dry as a short-term consequence of subsidence (see section 7.1).	No further action needed.
A significant increase in the trend of EC levels observed over greater than one monitoring round. AGEC	EC levels were all within an acceptable range.	No further action needed.

(2008) describe the alluvial aquifer as having substantially elevated EC levels. Any increase in EC in a wetland could be the result of the alluvial aquifer coming into contact with surface water.		
Substantial physical erosion or damage to the wetland soil that cannot be explained by natural or man-made erosion process and is caused subsidence cracking (>200 mm in width).	No erosion or cracking was found.	No further action needed.
A significant increase in water nutrient levels, particularly N and P that cannot be explained by natural variations in nutrient levels or manmade influences.	Nutrient levels were acceptable.	No further action needed.
A steady trend in declining biodiversity observed over a period greater than one monitoring round.	Six wetlands have shown statistically significant declining diversity indices.	Not related to subsidence (see discussion in Section 6.2 of Appendix 12) .
A landholder submits a complaint that a wetland has changed as a result of subsidence.	No landholder reports had been received.	No landholder reports had been received.

Source: (Hunter Eco, 2015)

5.8.2 VAM-RAB Rehabilitation Off-Set Monitoring

Centennial received approval in 2011 (DA97/800 Modification 8) for the trial installation of a ventilation air methane regenerative afterburner unit (VAM-RAB) that would remove and breakdown the exhaust methane.

Installation of the VAM-RAB unit necessitated clearing of some native vegetation. Two endangered ecological communities (EEC) listed in Schedule 3 of the NSW Threatened Species Conservation Act 1995 were included in the areas to be cleared. These were: Swamp Sclerophyll Forest (SSF) on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions; and River-Flat Eucalypt Forest (RFEF) on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions.

Consent condition 76A included a requirement for a 1.25 hectare rehabilitation off-set area to be established on cleared land adjoining the VAM-RAB construction site. These EEC were represented by communities described in the regional vegetation mapping and classification (NPWS 2000) as: MU37 Swamp Mahogany Paperbark Forest (SSF); and MU38 Redgum – Rough-barked Apple Swamp Forest (RFEF).

An ecology survey (Hunter Eco, 2011) prepared for the VAM-RAB project application described the area to be rehabilitated as mostly dominated by weeds. This being the case, active regeneration was required and this was commenced in January 2012 and completed in March 2012.

Further to the requirement to rehabilitate, the consent condition 76A also requires that the progress of the rehabilitation be monitored annually for five years. Hunter Eco commenced baseline monitoring in October and November of 2012, with the first annual monitoring completed in October 2013 and the second annual round of monitoring completed in December 2014 (Hunter Eco, 2014b). Refer to **Appendix 14** for the 2014 monitoring report.

The aim of the monitoring program conducted by Hunter Eco was to collect data that would enable a quantitative comparison between the relatively undisturbed communities and the areas being rehabilitated. This is achieved through the collection of floristic data from 400 m^2 permanently established plots. The normal plot size is 20 m x 20 m but the dimension can vary depending on the configuration of the available space. Two plots were established in each of the two undisturbed communities and two in each of the two areas being rehabilitated to these communities; eight plots in all.

All plots were permanently established with star pickets at each corner in 2012, and floristic data were collected on 8 December 2014.

Hunter Eco have found that rehabilitation areas remain substantially different to that in the reference areas. However, as time goes by the cover contribution of the planted species will increase and should contribute to improved similarity. Hunter Eco have recommended that *Kunzea ambigua* and Blackberry regrowth are controlled and that the annual planting program is maintained, particularly replacing any losses. This will ensure canopy density is maintained and will result in a spread of age classes. *Melaleuca nodosa* paperbark and the sedge *Carex appressa* should be planted in Plots P3 and P4 as that species is a significant component of the two reference plots (P1, P2). Further additional plantings will be undertaken in March / April of 2015.

Overall Hunter Eco (2014b) have concluded that the results to date are encouraging suggesting that the measures taken should result in successful rehabilitation, although over a longer period than the required five year monitoring program.

Source (Hunter Eco, 2014b)

Figure 13: Location of Floristic Sample Plots

5.8.3 Cultural Heritage & Archaeology

Aboriginal Archaeology

No archaeological sites were recorded in the Cooranbong Colliery Life Extension Project EIS within Areas 1 (longwall mining area) and 2 (Umwelt, 1997). The EIS identified a number of landforms and features within Areas 1 and 2 which are potentially archaeologically sensitive including;

- Stream channels and banks;
- Ridge and hill crests;
- Sandstone outcrops on any landform.

The EIS identified that the most likely impact to archeological sites from underground mining will be through inundation and / or fracturing of sandstone strata.

RPS was commissioned to prepare Cultural Heritage Assessments for the SMP LW15-17 and LW18-21 applications. The Cultural Heritage Assessment considered the environmental and archaeological context of the LW 15-17 and LW18-21 SMP Areas, developed a predictive model, reported on the results of an archaeological survey for Aboriginal and non-Aboriginal cultural heritage and provided an impact assessment for the proposed development based on field survey results.

A survey of the LW 15-17 SMP Area was undertaken by RPS archaeologist Laraine Nelson accompanied by Aboriginal Registered Stakeholders from Awabakal Local Aboriginal Land Council, Awabakal Descendants Traditional Owners Aboriginal Corporation and Awabakal Traditional Owners Aboriginal Corporation. The field survey was undertaken between 13 to 15 December 2011 and 11 and 12 January 2012. This report has been prepared in accordance with the NSW Department of Energy and Minerals SMP approval guidelines (RPS, 2012).

Based on the area surveyed during the field trip, a total of six Aboriginal cultural heritage sites inside the Project Application Area were identified. These comprised three isolated artefacts, two artefact scatters and one set of grinding grooves. If subsidence remains inside the range proposed for the area it is considered unlikely there will be impact on the isolated artefact and artefact scatter sites. The grinding grooves have a greater potential to be adversely affected by subsidence (RPS, 2012). A further four Aboriginal cultural heritage sites were identified outside the Project Application Area. No historical sites were identified in the areas surveyed.

RPS Mand Nth 9 (Grinding Grooves) were considered more susceptible to damage than the other recorded sites. The grinding grooves located in the RPS (2012) survey are located over the three heading Maingate 14. The impact of any increased subsidence over the long-term stable maingate pillars is expected to be minimal. The site was included in the subsidence monitoring programme. Subsidence over Maingate 14 was within predicted levels and there was no observed impact to the grinding groove site as shown in **Figure 14**.

Figure 14: Post Mining Photographs of RPS Mand Nth 9 Site

RPS Mand Nth 1 & 2 (Artefact Scatters) and RPS Mand Nth 7, 8 & 10 (Isolated Artefacts) are not expected to be impacted by subsidence mining activities at the predicted levels. RPS Mand Nth 1 and 2 have been affected by subsidence within the predicted values as shown in **Table 22**.

The majority of the SMP LW18-21 application area was covered by the survey for SMP LW 15-17, undertaken by RPS (2012) archaeologist Laraine Nelson accompanied by Aboriginal Registered Stakeholders from Awabakal Local Aboriginal Land Council, Awabakal Descendants Traditional Owners Aboriginal Corporation and Awabakal Traditional Owners Aboriginal Corporation. The field survey was undertaken between 13 to 15 December 2011 and 11 and 12 January 2012. A Heritage Due Diligence Assessment was also undertaken by RPS (2013b) to provide full coverage of the SMP LW18-21 area. A visual inspection of this area was conducted on 8 July 2013 and undertaken by RPS Cultural Heritage Consultants, Jeremy Hill and Philippa Sokol.

Based on the areas surveyed, a total of 10 Aboriginal cultural heritage sites were located inside the Project Area. These comprised:

- Five isolated artefacts (#45-3-3538; #45-3-3452; #45-3-3451; #45-3-3456; #45-3-3455);
- Four artefact scatters (#45-3-3446; #45-3-3458; #45-3-3457; #45-3-3453); and
- One set of grinding grooves (#45-3-3454).

RPS (2013a) assessed that if subsidence remains inside the range proposed for the area it is considered unlikely there will be impact to the eight sites in the subsidence zones. Two sites (#45-3-3446; and #45-3-3558) are outside of the predicted subsidence zones but are located close to access tracks so there remains a remote chance of surface impact if not managed correctly.

The current mine plan ensures Grinding Groove AHIMS Site #45-3-3454 will not be undermined and as such no harm will occur. The grinding grooves located in the RPS (2013a) survey are located outside of the extraction void and will be exposed to subsidence less than 20mm.

Table 22: Subsidence on Aboriginal Cultural Heritage Sites

AHIMS Number	Artefact No.	Aboriginal Cultural Heritage Site	Mining Location	Predicted Subsidence	Actual Subsidence	Comment
45-3-3458	RPS MAND Nth 1	Artefact Scatter	Maingate 17	0.25m	0.13m	
45-3-3457	RPS MAND Nth 2	Artefact Scatter	Longwall 18	0.70m		
45-3-3456	RPS MAND Nth 3	Isolated Find	Maingate 18	0.50m		
45-3-3455	RPS MAND Nth 4	Isolated Find	Maingate 18	0.60m		
45-3-3454	RPS MAND Nth 5	Grinding Groove	Angle of Draw Longwall 20	0.02m		
45-3-3453	RPS MAND Nth 6	Artefact Scatter	Bleeder pillar Longwall 20	0.10m		
45-3-3452	RPS MAND Nth 7	Isolated Find	Maingate 18	0.35m		

AHIMS Number	Artefact No.	Aboriginal Cultural Heritage Site	Mining Location	Predicted Subsidence	Actual Subsidence	Comment
45-3-3451	RPS MAND Nth 8	Isolated Find	Abutment Pillar Longwall 14	0.05m	0.01m	
45-3-3450	RPS MAND Nth 9	Grinding Groove	Maingate 14	0.15m Strain <1m/m Tilt <1mmm	0.15m Strain 1mm/m Tilt 1mm/m	No visible impact to grinding groove or rockshelf/boulders following subsidence.
45-3-3449	RPS MAND Nth 10	Isolated Find	Longwall 17	0.85m	0.35m	

European Heritage

Subsidence on the section of Convict Road (Brisbane Waters to Wallis Plains Road) above Longwall panels 1 and 2 was last recorded at 320mm in 2012. No observed subsidence damage was identified to the road which is in accordance with the predictions in the EIS. Subsidence monitoring was completed in 2012 as approved by the DRE.

5.9 COMMUNITY COMPLAINTS

One complaint was received by Centennial Mandalong from the community during the period January 2014 to December 2014, as described in **Table 23**.

Table 23: Community Enquiries / Complaints Summary

Mandalong Complaint Log Number	Date Complaint Logged	Type of Complaint	Comments
4/2014/ccapp1000115	5/2/2014	A Mandalong resident called the Mandalong Mine Control Room to record a complaint on 5/2/14 stating that their emails of 6/1/14 and 23/1/14 to a Mandalong staff member regarding a Property Subsidence Management Plan (PSMP) had not been responded to within an adequate time frame.	The Mandalong staff member was on annual leave in early January 2014 and at the time of the complaint a response was being prepared with assistance from James Marshall. A meeting was held with the Mandalong resident in February 2014 to discuss their PSMP.

5.10 SUBSIDENCE MONITORING

In accordance with the conditions of the development consent Mandalong Mine is to undertake a subsidence monitoring program. These are reported in the AEMR as detailed in **Table 24**.

Table 24: Summary of Consent Conditions

Consent Condition	AEMR Section
19. Summary, analysis and discussion on subsidence monitoring, effects, impacts and environmental consequences.	Section 5.10.2
63 & 65. Six monthly inspection of floodpaths:	Section 5.10.1 & Appendix 9
63. Monitoring of groundwater level and quality	Section 5.2, Section 8.1.3 & Appendix 5
65. Consideration and monitoring of remedial works	Section 7 & Section 9.

5.10.1 Stream Channel

The condition of floodpaths and stream channels are discussed in the Mandalong Mine "*Floodpath Condition Report 2014*" (2015) in **Appendix 9** and should be referred to for further details. The Mine's development consent requires the condition of major floodpaths be inspected every six months or following a flood event in an area subject to a Subsidence Management Plan (SMP) application. This Floodpath Condition Report for 2014 has been developed to compile survey and photographic records of subsidence induced changes to Stockton Creek and Morans Creek as per the assessment methodology in Section 1.2 (refer to **Appendix 9**).

Appendix 9 assesses the changes to the condition of floodpaths along stream reaches undermined by longwall 15, 16 and 17 in 2014 and previously subsided longwall panels 1 to 14, identifying the effects of subsidence on the floodpaths. The pre-mining condition of the floodpaths above longwall panels 17 and 18 is also documented in this report.

On the basis of the information obtained from field surveys, the pre mining characteristics of Morans Creek can be described as having a generally poorly defined channel system, in which creek lines give way to undefined overland flow paths in several areas. The levels of predicted subsidence and associated grade changes along Morans Creek over proposed Longwalls 17 and 18 are of a similar order of magnitude to the existing creek bed slopes. The levels of predicted subsidence along Morans Creek are relatively small over proposed Longwalls 17 and 18 and it is therefore considered that these will not significantly alter the flow conveyance capacity of the existing channels. The associated impacts on the maximum flood depths and flood hazards that have been modelled are not considered to be significant.

The subsidence levels above longwall panel's 3 to 6 remained unchanged in 2014. The stream condition (Stockton Creek) in 2014 above longwall panels 1 to 3 and 6, where stock have been excluded, were in a similar condition to that recorded pre mining. No changes to the well established riparian vegetation was found on stream banks and with no further bank erosion.

The bank widening and erosion process above longwall panels 4 and 5 in Stockton Creek has been occurring prior to mining and for a considerable length of time prior to mining given the large difference in stream widths compared to other stream sections. This erosion process is unlikely to have been caused by subsidence as, the areas of erosion identified prior to mining, were observed in June 2008 to be a result of the concentrated flows on the opposing bank causing further erosion.

As described in Section 7.3 of this AEMR, remnant ponding was observed in limited areas above longwall panel 7 and 8 situated on an existing low lying area of Centennial's properties. The area

consists of exotic pasture species primarily used for horse grazing. Centennial Mandalong has completed a survey design to construct a drain to remediate the longwall 7 ponding and the project is currently under the tender process. The drainage of the area above longwall 8 area is impractical with little fall available from the ponded area into the nearest creek, over 300 m to the east. This ponded area will be fenced from stock and allowed to develop into a freshwater wetland and will be incorporated into the bi-annual wetlands monitoring program. These works will be completed in 2015.

Ponding above longwalls 9 – 11 occurs in woodland/forest vegetation and these areas have not been remediated because it has been judged that damage by machinery to habitat, particularly the threatened *Melaleuca biconvexa*, would be unacceptable. These areas will be monitored at least annually to determine whether increased inundation is having a net detrimental impact on the habitat.

5.10.2 Subsidence Results

Subsidence performance and management has been undertaken and reported in accordance with Subsidence Management Approval requirements of SMP LW15-17. Condition 12 requires the approval of a Subsidence Monitoring Programme by the Principal Subsidence Engineer (PSE). The current Subsidence Monitoring Programme Rev. 16 was approved by the PSE in August 2014. A total of 36 subsidence surveys were conducted during 2014 with the results provided to DRE and all relevant stakeholders. The monitoring included longwall centrelines, crosslines, public roads, Telstra infrastructure, dwellings and wetlands.

Condition 17 requires Subsidence Management Status Reports to be prepared on a fortnightly basis as well as submitting four monthly reports to the Director, Environmental Sustainability (DRE) and relevant stakeholders, including the Department of Planning & Environment. Condition 18 requires an end of panel report to be provided to DRE within four months of extraction being completed for each longwall panel. Mandalong Mine Development Consent, Condition 18 also requires an end of panel report to be provided to DPE, Mandalong Mine CCC, DRE, EPA, NOW and any other relevant agency.

During 2014 the end of panel report for Longwall 15 was completed and the required three Subsidence Management Status Reports were provided as outlined in **Table 25.**

Table 25: Subsidence Reports 2014

Report	Report Period	Date Issued
End of Panel Report Longwall 15	Completion of Longwall 15	July 2014
Subsidence Management Status Report No. 31	1 January 2014 to 30 April 2014	May 2014
Subsidence Management Status Report No. 32	1 May 2014 to 31 August 2014	September 2014
Subsidence Management Status Report No. 33	1 September 2014 to 31 December 2014	January 2015

During 2014, Longwall 15 and Longwall 16 completed extraction, while Longwall 17 had extracted approximately 800m of its total length of 3035m. The three longwalls continued on the same orientation and face width as previous 10 longwall panels. **Table 26** summarises the mining parameters for Longwalls 15, 16 and 17.

Table 26: Longwall Mining Parameters

Mining Parameters	Longwall 15	Longwall 16	Longwall 17
Length	2934m	3025m	3035m
Face Width	150m	150m	150m
Void	160m	160m	160m
Extraction Height	3.4m to 4.8m	3.4m to 4.8m	3.4m to 4.8m
Chain Pillar Width (coal)	46m	46m	46m
Cover Range	230m to 260m	240m to 270m	240m to 280m
Commenced	24 September 2013	12 May 2014	6 November 2014
Completed	22 April 2014	13 October 2014	
Coal Extracted	3.0 M tonnes	3.04 M tonnes	

5.10.2.1 Description of impact

The area affected by Longwalls 15 and 16 covered properties both above and within the Mandalong floodplain. A total of 12 properties and three dwellings were exposed to subsidence from the extraction of Longwall 15, while 17 properties and 10 dwellings were affected by subsidence from Longwall 16. A number of these properties were above both the longwall panels. Surface features included Stockton Creek, Morans Creek, Mandalong Rd, Browns Rd, Telstra communications network and the Ausgrid network. By the end of 2014, Longwall 17 had extracted approximately 800 m and mined beneath four properties including one private and two Centennial dwellings.

Following the completion of Longwall 15, there have been no reports of subsidence damage to any of the 12 properties or three private dwellings impacted by subsidence. There have been no observed or reports of damage to infrastructure during the extraction of Longwall 15 other than a minor compression hump (10mm) that developed into small potholes on the Mandalong Rd pavement. The potholes have been repaired by LMCC during routine road maintenance.

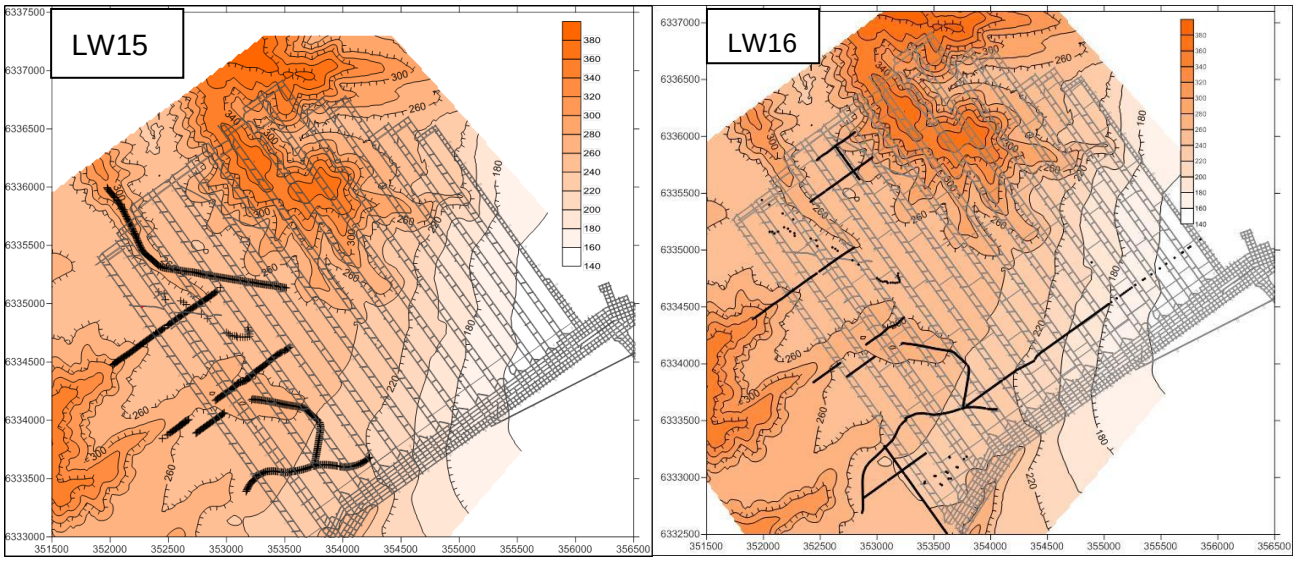
During the extraction of Longwall 16, one private dwelling was exposed to tilts approaching the maximum safe, serviceable and repairable (SSR) value of 7mm/m. The Property Subsidence Management Plan (PSMP) process was followed and with agreement of the landowner's, the property has been purchased by Centennial. The dwelling remains SSR, with landowners continuing to live in the dwelling. There were no reports of damage to any of the other 16 properties or five dwellings impacted by subsidence. There were no observed or reports of damage to infrastructure including Mandalong Rd and Telstra communications.

While only 800m of Longwall 17 had been extracted by the end of 2014, there were no reports of damage to property or infrastructure. The private dwelling located at the start of the panel was exposed to low levels of subsidence, being less than 50mm, with tilts and strains less than 1mm/m and no visible damage to the dwelling or property.

5.10.2.2 Monitoring Results

Subsidence monitoring was completed in accordance with the approved subsidence monitoring programme which included subsidence monitoring along 19 survey lines as well as monitoring a number of private dwellings and dams. The monitoring was primarily conducted for subsidence over

Longwalls 15 and 16, with a number of annual surveys over the previously mine area as shown on **Figure 15.**



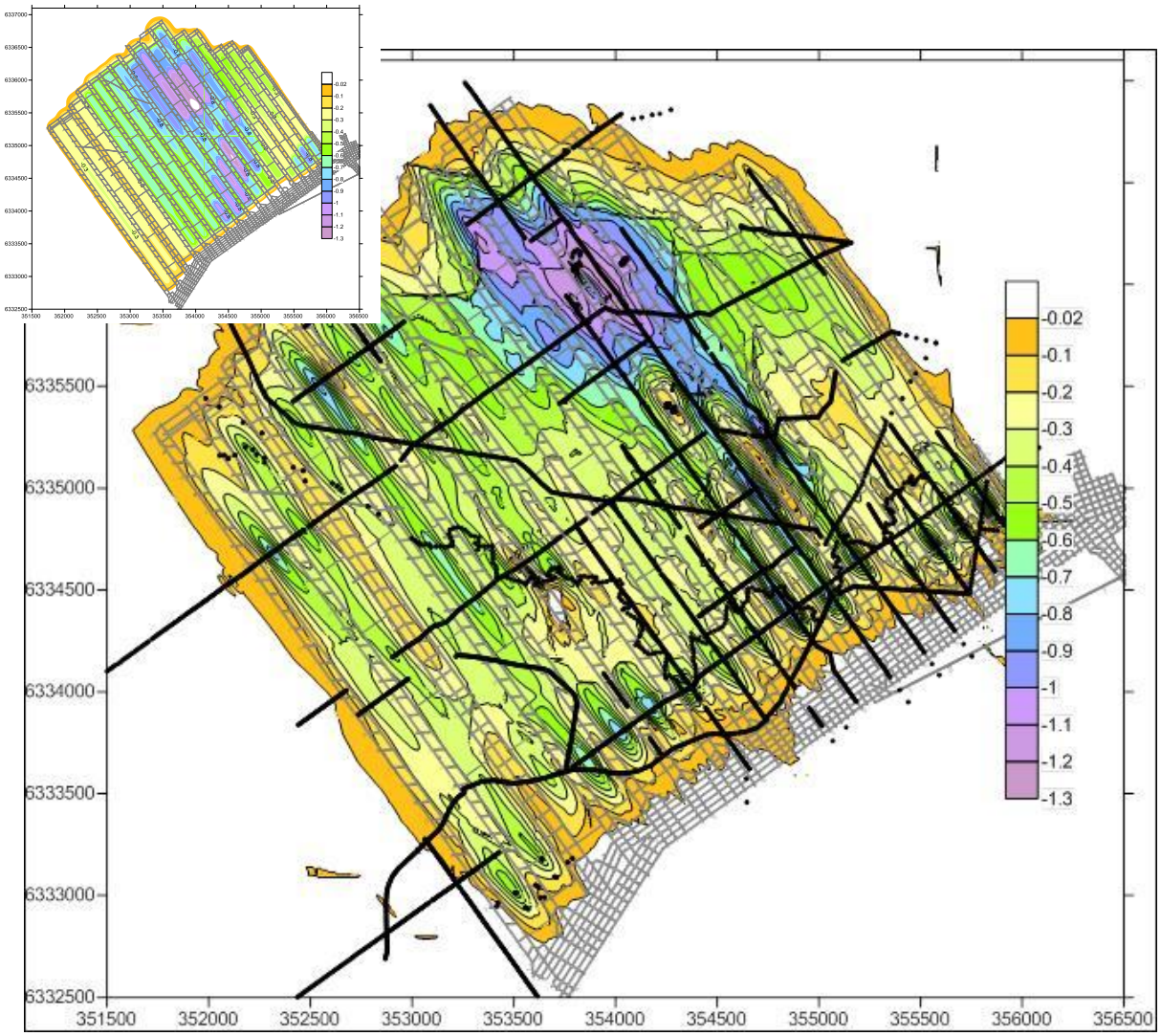
Source: (Seedsman Geotechnics, 2014) and (Seedsman Geotechnics, 2015)

Figure 15: Subsidence Monitoring Lines occupied for LW15 and LW16.

The largest vertical subsidence recorded during the retreat of Longwall 15 was 0.47m measured on Crossline 2, with maximum subsidence over the majority of the panel typically 0.3m. The largest vertical subsidence recorded over Longwall 16 was 0.78m. The subsidence outcomes for Longwall 16 have been generally within the anticipated range but there was one notable case of higher than anticipated subsidence. One dwelling was subjected to tilts approaching the SSR criterion of 7 mm/m and the property was purchased by Centennial.

A review of subsidence was also undertaken by Seedsman Geotechnics for both Longwalls 15 (Seedsman Geotechnics, 2014) and Longwall 16 (Seedsman Geotechnics, 2015).

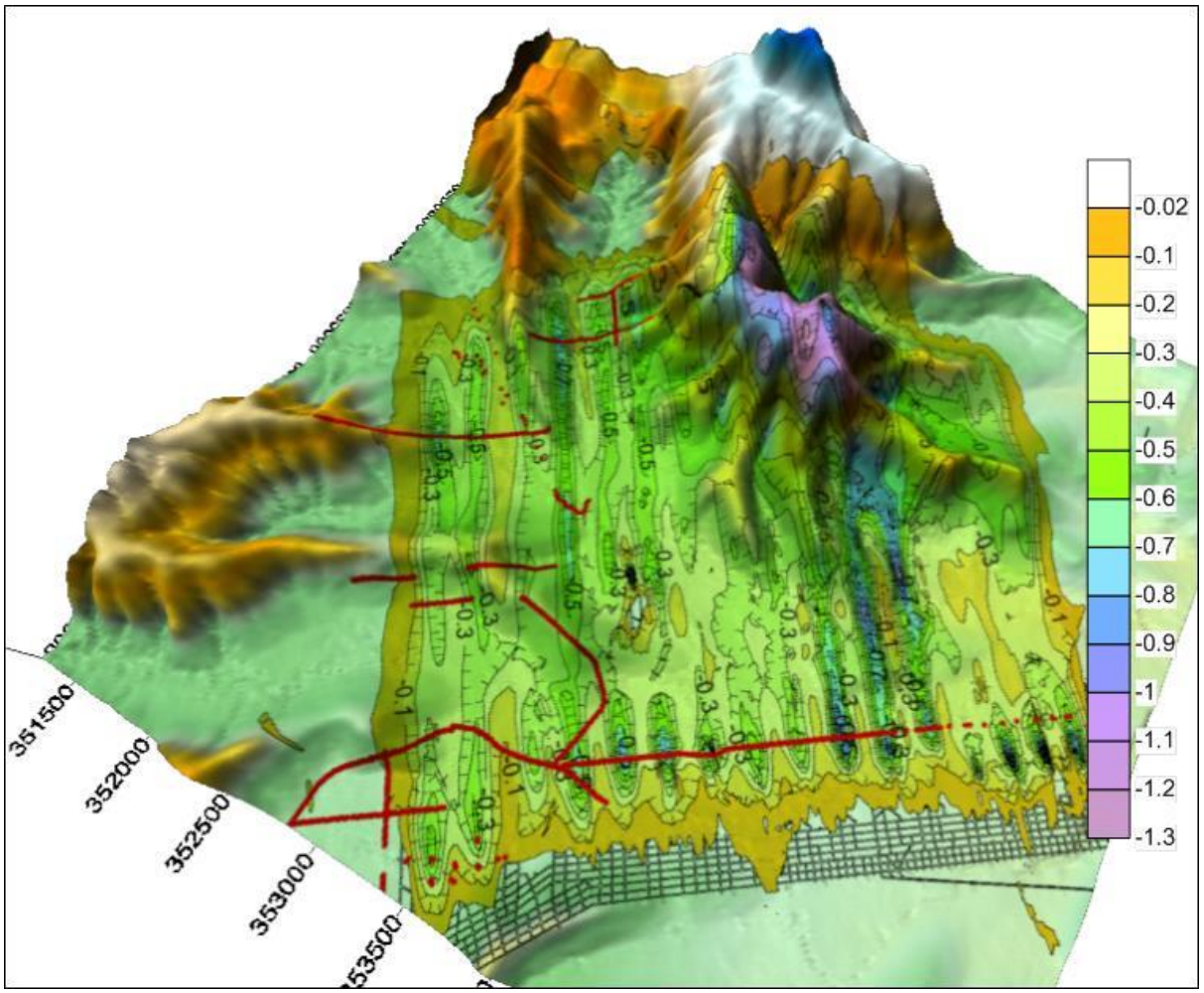
Figure 16 presents a visualisation of the vertical subsidence over the whole area based on interpolation of survey data from the significant number of subsidence lines over the mining area. The predicted subsidence is also shown on the top right of the figure.



Source: (Seedsman Geotechnics, 2015)

Figure 16: Visualisation of Subsidence to LW16 and Prediction

Figure 17 shows the subsidence visualisation overlayed on the topography and includes the subsidence lines occupied during the extraction of Longwall 16



Source: (Seedsman Geotechnics, 2015)

Figure 17: Visualisation of Subsidence up to LW16 Projected onto the Topography

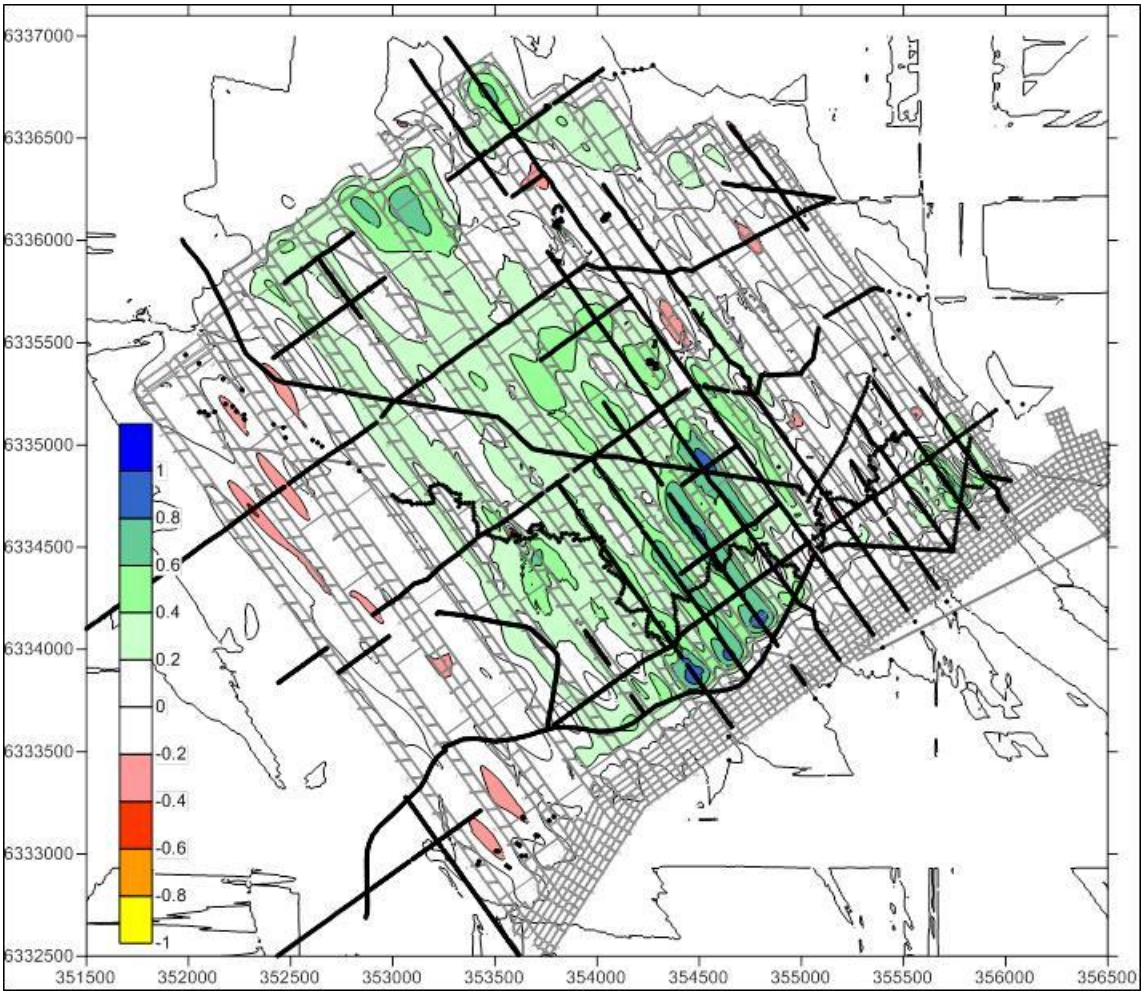
5.10.2.3 Performance against Prediction

The depth of cover for both Longwalls 15 and 16 were similar, ranging from 230m to 270m and primarily driven by the surface topography over the longwall panels as illustrated by **Figure 17.**

The subsidence results above Longwall 15 were generally within anticipated levels, with maximum vertical subsidence over the majority of the panel typically up to 0.3m, apart from two areas at the start and ends for the panel, where maximum subsidence was up to 0.47m. Following the extraction of Longwall 16, additional settlement of around 0.15m occurred as expected on Longwall 15 with the settlement of the intervening chain pillar.

Subsidence over Longwall 16 was also generally within the anticipated levels, with the exception of two areas in similar locations to the higher than predicted subsidence on Longwall 15.

Figure 18 below, shows the difference between actual and predicted subsidence, where green shading is where actual subsidence is less than predicted and red shading is where actual subsidence greater than predicted. The figure shows that subsidence predictions were greater than predicted in a number of locations over Longwall 15 and 16, typically by 0.2m to 0.4m. The majority of the longwall panels remained within the predicted range.



Source: (Seedsman Geotechnics, 2015)

Figure 18: Difference between Predicted and Actual Subsidence

The Seedsman Geotechnics review of Longwall 16 (2015), indicates that there have been some under-predictions of vertical subsidence, in particular the sag between the chain pillars in a zone close to and parallel to the Main Headings and also to the north-west on survey line Crossline 2. This trend is clearer if the measured sag (difference between the subsidence at the centreline and the subsidence on the adjacent pillars) is compared with the predicted deflection of the voussoir beam formed in the Mandalong Conglomerate. These exceedances have not resulted in adverse outcomes due to the conservativeness in the overall design. A review of the under prediction of subsidence in these areas is ongoing.

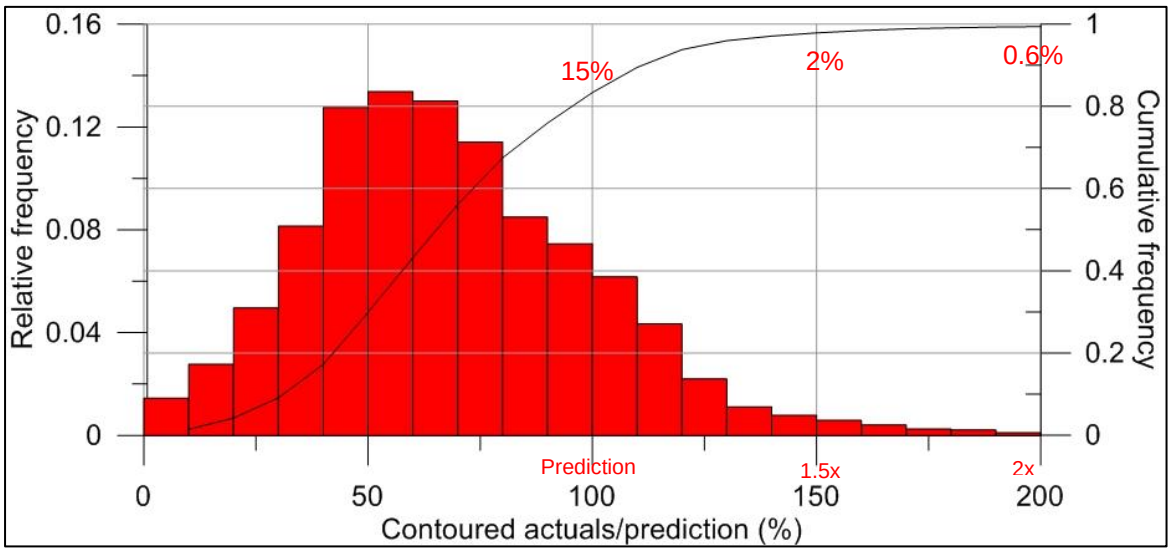
Following the extraction of each longwall panel and in preparation for End of Panel Reports, frequency histograms are produced to compare subsidence results against Safe, Serviceable and Repairable (SSR) criteria for dwellings. SSR values for dwellings are defined as being less than 5mm/m for tensile and compressive strains and less than 7mm/m for tilt. **Table 27** summarises the results from all monitoring points affected by subsidence from Longwalls 6 to 16. The results a confirm the high level of confidence in the mine design achieving low levels of subsidence with greater than 97% of all results below SSR values.

Table 27: Frequency Histogram Summary Longwalls 6 to 16

Frequency Histogram Summary for Longwalls 6 to 16 Compared Against SSR Criteria for Dwellings			
Longwall Panel	**Tilt Less that 7mm/m**	**Tensile Strain Less than 5mm/m**	**Compressive Strain Less than 5mm/m**
LW6	97.7%	99.8%	97.4%
LW7	97.6%	100%	97.8%
LW8	100%	100%	99.4%
LW9	100%	100%	100%
LW10	98.8%	100%	98.5%
LW11	96.5%	100%	100%
LW12	96.4%	100%	93.3%
LW13	95.6%	100%	95.6%
LW14	100%	100%	100%
LW15	96.9%	100%	100%
LW16	90.9%	100%	96.7%
Average	**97.3%**	**99.9%**	**98.0%**

The Mandalong Mine SMP risk assessment process looks at the likelihood of maximum predicted subsidence being exceeded by a factor of one and a half times (1.5x) and two times (2x) the maximum predicted subsidence. To review the performance of subsidence against these sensitivities, Seedsman Geotechnics (2014) produced frequency graphs comparing the ratio of the predicted contour data against measured contour data, similar to that shown in **Figure 16**. The plots were based a 10m grid and consisted over 83,000 data points.

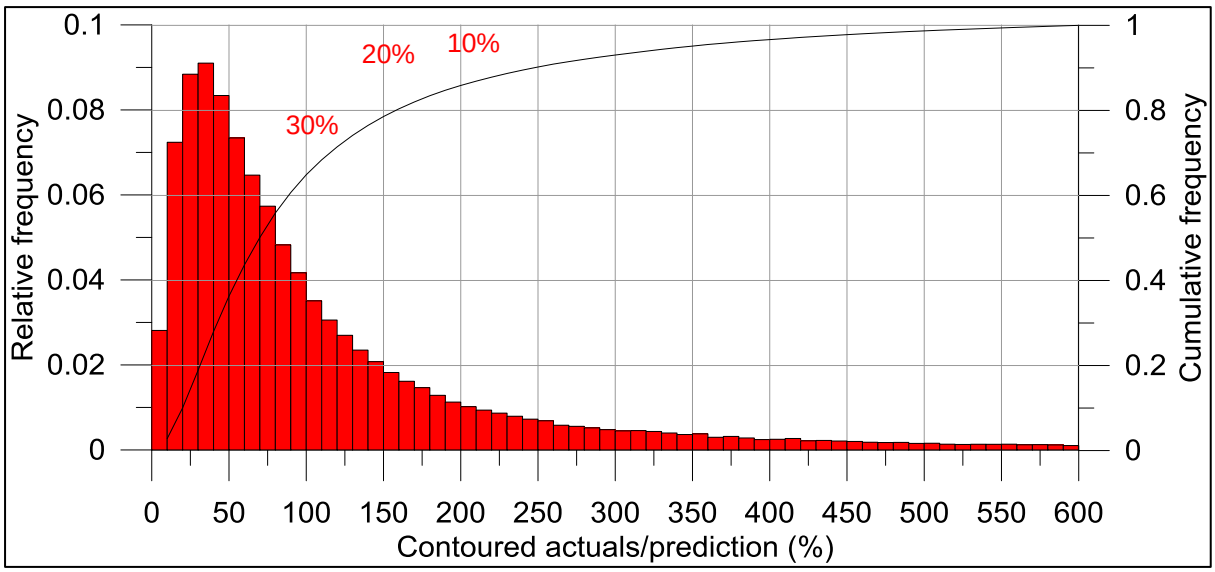
Using **Figure 19** it can be seen the majority of the actual subsidence measurements are below prediction, while 15% of the database measurements were greater than predicted. Only 2% of measurements have exceeded the prediction by 1.5 times (150%) and 0.6% of measurements exceeded the predictions by two times (200%). These high percentage exceedances occur at low levels of vertical movement.



Source: (Seedsman Geotechnics, 2014)

Figure 19: Relative and Cumulative Frequency Graph of Measured and Predicted Vertical Movements

The predicted vertical subsidence grids have also been generated to produce grids of the associated tilts and frequency graphs produced. Because the first derivative of the vertical subsidence is being examined, the comparison of tilts is not as good. The measured tilt is less than or equal to the prediction about 70 % of the time. The measured tilt is 1.5 times higher (150%) than the prediction about 20% of the time and the measured tilt is twice as high about 10% of the time. These exceedences typically develop at tilts less than the SSR value of 7 mm/m the vast majority of the time (97%) as detailed in **Table 27**.



Source: (Seedsman Geotechnics, 2014)

Figure 20: Relative and Cumulative Frequency Graph of Measured and Predicted Tilts

5.11 NATURAL FEATURES SUBSIDENCE IMPACTS AND PERFORMANCE AGAINST PREDICTED IMPACTS

Natural features are monitored in accordance with the LW15-17 **Environmental Monitoring Program (EMP)**. This monitoring included subsidence levels on Stockton and Morans Creeks, groundwater, floodpath inspections, and native habitat (wetland) areas. **Table 28** below summarises the predicted impacts with the observed impacts on natural features in 2014.

Table 28: Summary of Predicted and Observed Subsidence Impacts Natural Features

Predicted Subsidence Impact LW 15, 16 & 17	Observed Subsidence Impact LW 15, 16 & 17
Predicted minor increase in ponding as a result of subsidence in areas of existing ponding on the floodplain.	**Impact as predicted.** There has been no observed or reported impacts to natural features affected by LW15, LW16 and the partly extracted LW17.
Predicted no adverse subsidence related impacts on alluvium groundwater levels.	**Impact as predicted (refer to Appendix 5)**. The monitoring data indicates that although mining has impacted groundwater levels in overburden rocks, there has been no long-term impact, even in faulted areas, on groundwater levels in the alluvial aquifers.
Minimal changes to creek channel flows or alignment.	**Impact as predicted (refer to Appendix 9)**. Minimal changes to creek channel grades resulting in a negligible change to stream flows. No mining induced erosion or deterioration in stream bank condition.
Predicted no surface cracking on floodplain and some minor cracking in rock head areas in high depth of cover.	**Impact as predicted**. No subsidence related soil cracking was observed in 2014 in areas with higher depth of cover or alluvial flood plain area above LW15, LW16 and LW17.
Predicted no net loss of native flora and fauna habitat.	**Impact as predicted**. There has been no observed or reported impacts to flora and fauna affected by LW16, LW16 and the partly extracted LW17.

6 COMMUNITY LIAISON

6.1 COMMUNITY CONSULTATION

Mandalong Mine consults with the community through forums such as, the Mandalong Mine Community Consultative Committee and community organised events.

Meetings of the Mandalong Mine Community Consultative Committee (CCC) were held in February, June and October 2014. Representatives of the Mandalong community, a Dora Creek community representative, appointed community representatives; relevant government organisations and company representatives attended the meetings. A detailed presentation was provided to attendees at each CCC meeting on the Mine's production, geological update, subsidence results, environmental monitoring, SMP update and sponsorship. Additional agenda items discussed in 2014 included the Mandalong South Extension Project, the Mine's exploration drilling, approvals status, VAM RAB project, and Centennial's land management. A site inspection was also undertaken by the CCC at Cooranbong in April 2014.

6.2 SMP CONSULTATION

Extensive community consultation with landowners in the Mandalong mining area is undertaken for the purpose of monitoring and assessing subsidence effects on private properties. The existing community consultation process that is established under the Mandalong Mine Development Consent provides a good foundation to address the requirements under the SMP process. In general, the Mandalong Mine community consultation has included:-

- Community consultation in line with the Landowner Communication and Consultation Plan (LCCP).
- Individual landowner consultation associated with the development of SMP application for Longwalls 18 to 21 and their PSMP's.
- Consultation and general communication with all relevant government agencies and infrastructure owners during the development and subsequent approval of SMP for Longwalls 18 to 21.
- Individual landowner consultation and implementation of PSMPs during mining of Longwall 15, 16 and 17.
- Notification of SMP approval for LW18-21 to landowners and stakeholders.
- Four meetings of the Mandalong Mine Community Consultative Committee (MMCCC) chaired by Margaret MacDonald-Hill delivered updates on the status of SMP approvals, subsidence monitoring and management, including a site visit to the Cooranbong Site Services Site to inspect coal handling and water management facilities.
- Ongoing consultation with relevant stakeholders on the development and implementation of infrastructure Management Plans including Public Roads and Telstra.
- One month mining notifications were provided to landowners prior to mining beneath their property, with follow-up meetings undertaken where requested.
- Subsidence Management Status reports were completed on a four monthly basis and the End of Panel Report for Longwall 15 was prepared and provided to DRE, DPE, CCC and stakeholders.

6.3 COMMUNITY SPONSORSHIP

The Mandalong Mine continues to support the local community through various sponsorship avenues such as:

- Sponsorship of the 2014 LMCC School Environment Awards;
- Morisset Agricultural Show (February 2014);
- Sponsorship of the Morisset Country Club "Morisset Pro Am Event 2014";
- Bahtabah LALC NAIDOC family fun day (July 2014);

- Morisset Public School;
- Cooranbong Public School end of year presentation;
- Sponsorship of the Morisset St. John Vianney Primary School “swale” (drain) landscaping project and end of year presentation;
- Sponsorship of the Southlakes Carers Community Christmas Lunch;
- Sponsorship of the Morisset Peninsula Rural Fire Brigade for the purchase of an automatic hose winder for their fire truck;
- Funding provided to Southlakes Community Service to assist with their relocation to the Morisset Industrial Park;
- Sponsorship provided to the Morisset High School to assist with the purchase of football and netball uniforms;
- Funding provided to the Morisset Masonic Centre to assist with their hall upgrade works;
- Funding provided to the Cooranbong Rural Fire Brigade;
- Sponsorship provided to the Cooranbong Community Pre-school in May 2014;
- Sponsorship provided to the Morisset & District Children’s Centre;
- Sponsorship of Morisset Community Festival held on 19 May 2014; and
- Sponsorship provided to the Yula-Punaal Education & Healing Aboriginal Corporation for 10 students to complete their Certificate II in Conservation Land Management at the Yula-Punaal Trade Training Centre at Mandalong.

7 AGRICULTURAL LAND SUITABILITY

This section details the assessment of changes to agricultural land suitability resulting from the mining operations, including cumulative changes, at the Mandalong Site as required by condition 105(iv) of the Mandalong Consent.

7.1 AGRICULTURAL SUITABILITY CLASSIFICATION

The agricultural suitability and land capability of the Mandalong area was classified in the Environmental Impact Statement titled *"Cooranbong Colliery Life Extension Project"* (Umwelt, 1997). As stated in the EIS the land areas range from fairly level country in which the majority of the areas have been cleared, to steep heavily timbered country which is not capable of sustaining economically viable agricultural operations. Agricultural land suitability classification is mapped using the definitions in the Department of Urban Affairs and Planning *"Rural Land Evaluation Manual",* which classifies land into five different classes, based on the potential productivity of the land in the relevant social and economic context. The agricultural suitability system classifies land in terms of suitability for general agricultural use, including both cropping and pastoral purposes.

The Agricultural Suitability of the land in the Mandalong area was assessed in the EIS (Umwelt, 1997) to range from class 3 to 5. The majority of the level land at Mandalong has an Agricultural Suitability of 3, suited to grazing and limited cultivation in rotation pasture. The timbered area on level ground and timbered areas on sloping foothills were classified in the EIS with an Agricultural Suitability of 4 and 5 respectively. Agricultural Suitability with a classification of 4 is not suitable for cultivation but is suitable for grazing. These areas tend to be prone to water logging and production of these areas is constrained by the land size. Timbered land with an Agricultural Suitability of 5 in the Mandalong area is not suitable for agricultural production due to major constraints by native vegetation regulation and the costs associated with improving this land to a productive level.

To update information in the EIS (Umwelt, 1997) 19 agricultural assessments have been completed on properties during the development of Private Property Subsidence Management Plans (PSMP's). In 2009 an additional five agricultural surveys were undertaken on private properties located above longwall panels 11 to 14 for PSMP's. No further agricultural assessments were required in 2014.

The agricultural assessments completed in 2009 concurred with the agricultural suitability classes described in the EIS. Monitoring has confirmed that Longwalls 1 to 12 are stable. Tilts and strains have also remained unchanged over these twelve longwall panels. Agricultural assessments for the properties above these panels are unchanged from previous AEMR's and as such are removed from **Table 29.** The properties situated above the current zone of subsidence in 2014 above Longwall 15-17 are highlighted in **Table 29** and have an agricultural classification ranging from three to five as defined above.

Table 29: Agricultural Suitability Classification and Land Use

Property Reference (Number)	Agricultural Suitability Class 3	Agricultural Suitability Class 4	Agricultural Suitability Class 5	Current Agricultural Land use
34	**x**	**x**	**x**	Nil
35		**x**	**x**	Nil
38		**x**	**x**	Nil
Centennial 49	**x**			Horses & Beef Cattle
67	**x**	**x**		Nil
Centennial 40	**x**	**x**		Beef Cattle
Centennial 48			**x**	Beef Cattle
47	**x**			Nil
Centennial 21	**x**	**x**		Horses
69		**x**	**x**	Nil
20	**x**	**x**	**x**	Nil
Centennial 33		**x**	**x**	Nil
39		**x**		Nil
Centennial 32		**x**	**x**	Nil
Centennial 37	**x**	**x**		Horses & Beef Cattle
68	**x**	**x**	**x**	Horses
91		**x**	**x**	Nil
Centennial 70	**x**	**x**		Horses

7.2 ASSESSMENT OF AGRICULTURAL SUITABILITY

Since commencing longwall mining operations, Mandalong Mine has fully extracted Longwalls 1 to 16. No additional subsidence was recorded above Longwalls 1 to 12 (refer to Section 5.10.2) in 2014. As such the agricultural suitability following mining is as reported in previous AEMRs. In 2014, 18 properties were influenced by subsidence movements on Longwalls 15 to 17. Of these 18, as highlighted in **Table 29**, seven currently use land for agricultural purposes and typically have agricultural land suitability of class 3 or 4. The predominant land use on these properties is recreational/lifestyle, horse breeding and agistment and cattle/horse grazing.

7.3 AGRICULTURAL SUITABILITY IMPACT ASSESSMENT

Vertical subsidence levels on Longwalls 15 to 17 are generally within predicted maximums. The distribution of subsidence above Longwalls 15 to 17, shown in **Figure 18** indicates subsidence on the

floodplain, where the majority of pasture areas are found, typically ranges up to 0.60 m. There is little evidence that these relatively low levels of subsidence have impacted on pasture condition, as further discussed below.

A number of private and Centennial owned properties as described in **Table 29** were noted as undertaking cattle and horse enterprises. Inspections of these properties were undertaken during surveys to assess the level of subsidence related changes. No significant changes to stock levels were reported as a result of subsidence following the extraction of Longwalls 15 and 16 in 2014.

The area disturbed during the construction of subsurface drainage, installed to alleviate remnant ponding above Longwall 6 on a Centennial owned property (56) was rehabilitated in October 2009. The area was inspected in 2014 following rainfall events. This confirmed the drains take up to seven days to remove ponded water from the paddock and varies depending on the amount of rainfall and the water level in Stockton Creek. Horses are able to use paddocks and are rotated out in wet conditions similar to other ponded areas of floodplain. This drying period is consistent with other areas of the flood plain which drain or dry out over a similar period.

In 2013, Hunter Eco completed a report titled "*Monitoring the Impact of Subsidence on Wetlands of the Mandalong Floodplain - Detection and Management of Surface Ponding*" (Hunter Eco, 2013e). LiDAR surface data and high resolution aerial photography (time series) were used to detect surface ponding.

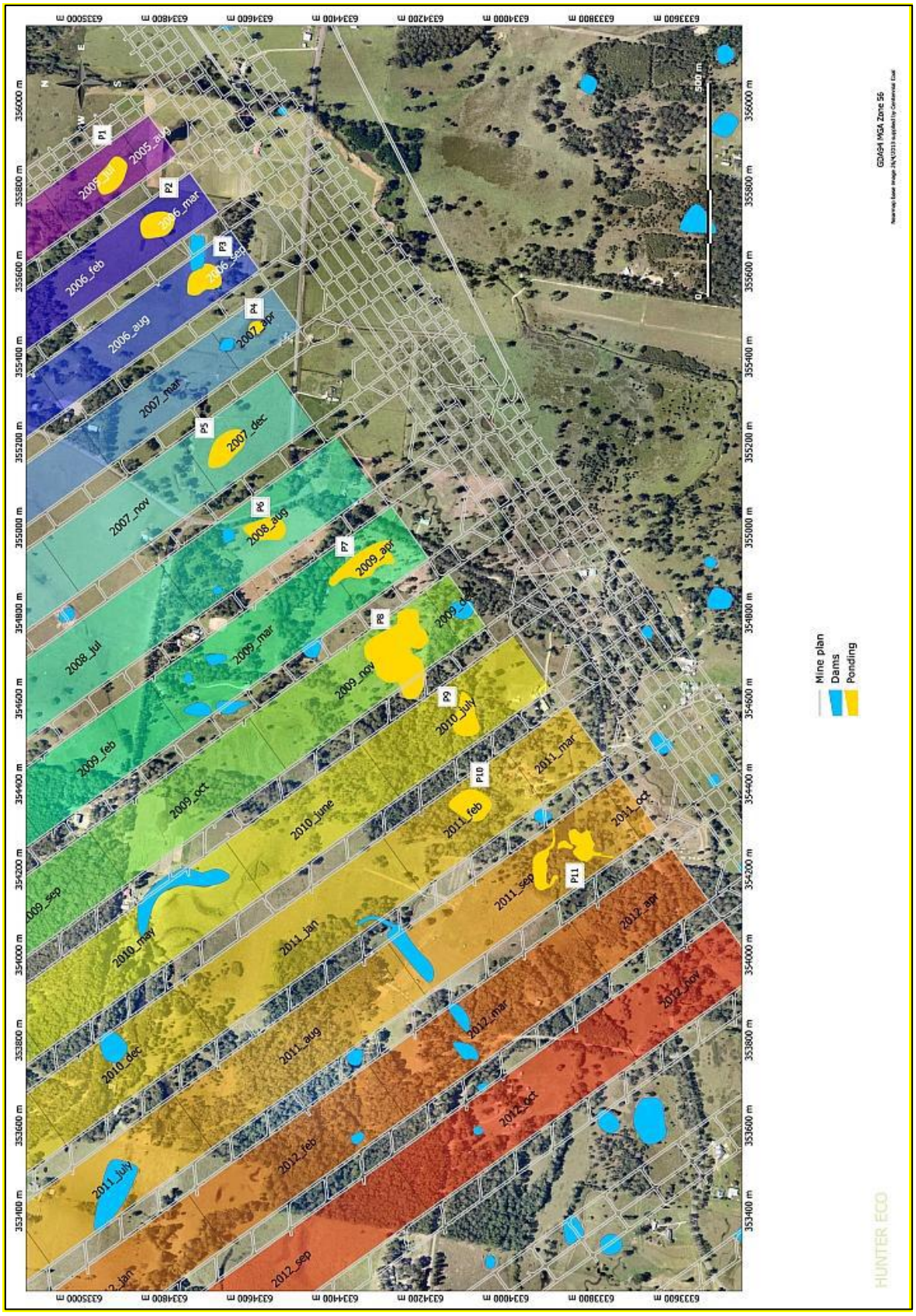
The analysis completed by Hunter Eco has shown that remote LiDAR data and aerial imagery can be useful in detecting areas of ponding resulting from mine subsidence. Fifteen ponding locations were identified by Hunter Eco and Centennial Mandalong at the southern end of the longwalls as per the predictions in the flood modelling assessments (**Figure 21**), most of which were in open grassland and had been drained. **Table 30** provides a description of each ponding instance and what if any remediation was undertaken.

Table 30: Details of Ponding & Remedial Action

Remnant Ponding Remediation					
Location	**Description**	**Remediation**	**Remediation Comments**	**Ponding Predicted**	**Property Reference Lot & DP**
Longwall 1 (P1)	Open grassland	Proposed new dam and area levelled as per PSMP	Continuing negotiations with landowner.	No	Ref. 6 2//557230
Longwall 2 (P2)	Open grassland	Drained	Constructed open drain and connected to nearby water course.	Yes	Ref. 7, 8 1//557230 3//557230
Longwall 3 (P3)	Open grassland	Drained	Constructed open drain and connected to nearby water course.	Yes	Ref. 7 1//557230
Longwall 4 (P4)	Open grassland	Allowed to remain as a source of water for stock.		Yes	Ref. 7, 59 1//557230 580//733227
Longwall 5 (P5)	Open grassland	Drained	Constructed open drain and connected to nearby water course.	No	Ref. 59 580//733227
Longwall 6 (P6)	Open grassland	Drained	Installed sub-surface drainage and drainage to Stockton Creek.	Yes	Ref. 56 12//582283
Longwall 6 (P6A)	Open grassland	Drained	Improved existing open drainage to ponded area.	No	Ref. 61 903//54230

Remnant Ponding Remediation					
Location	**Description**	**Remediation**	**Remediation Comments**	**Ponding Predicted**	**Property Reference Lot & DP**
					6
Longwall 7 (P7)	Open grassland fringed with Cabbage Gums and Melaleuca biconvexa.	Design survey completed to construct drain into Stockton Creek.	Project under tender process	Yes	Ref. 56 12//582283
Longwall 7 (P7A)	Open grassland	Allowed to remain as extension of existing dam.	Extension of existing dam	Yes	Ref.
Longwall 8 (P8)	Expansion of an already wet area having scattered Swamp Mahogany and Melaleuca biconvexa.	Remain as expansion of existing freshwater wetland.	Drainage of this area is impractical with little fall available from the ponded area into the nearest creek, over 300 m to the east. This ponded area will be fenced from stock and allowed to develop into a freshwater wetland.	Yes	Ref. 55 11/582283
Longwall 8 (P8A)	Open grassland and Melaleuca biconvexa Existing wetland	Expansion of existing Wetland 8.	Continue to monitor and report on Wetland 8 as per Wetland Management Plan.	No	Ref.42 25//755238
Longwall 9 (P9)	Mixed Cabbage Gum and paperbark forest.	Remain as extension of existing freshwater wetland.	Several threatened Melaleuca biconvexa paperbarks are present and remediation would involve losses of these through gaining access by machinery. Consequently remediation was not undertaken.	Yes	Ref. 57 180//859434
Longwall 10 (P10)	Mixed Cabbage Gum and paperbark forest.	Remain as freshwater wetland.	Several threatened paperbarks Melaleuca biconvexa are present and remediation would involve losses of these through gaining access by machinery. Consequently remediation was not undertaken.	No	Ref. 57 180//859434
Longwall 11 (P11)	Mixed paperbark woodland in an already periodically inundated area. Contains threatened Melaleuca biconvexa paperbarks. Ponding has extended an	Currently monitoring the impact of extending the existing wetland.	Will be monitored periodically to determine whether increased inundation is having a net detrimental impact on the habitat.	Yes	Ref. 44 9//800491

Remnant Ponding Remediation					
Location	**Description**	**Remediation**	**Remediation Comments**	**Ponding Predicted**	**Property Reference Lot & DP**
	existing wetland.				
Longwall 13 (P13)	Open grassland and Redgum Rough-barked Apple Forest	Currently being assessed by Ecologist		Yes	Ref. 44 , 50 9//800491 10//800491
Longwall 13 (P13A)	Open grassland	Minor increase in low lying area. No permanent ponding.	No impact on grazing area.	Yes	Ref. 26 10//650914
Longwall 15 (P15)	Alluvial Tall Moist Forest and Redgum Rough-barked Apple Forest.	Currently monitoring area and waiting on subsidence to be completed on LW17.	Conceptual design works to remediate potential ponding completed by GHD. Access agreement with landowner to monitoring and undertake remediation.	Yes	Ref. 67, 69 16//813385 61/755238
Longwall 16 (P16)	Redgum Rough-barked Apple Forest and Coastal Foothill Spotted Gum-Ironbark Forest.	Currently monitoring area and waiting on subsidence to be completed on LW17.	Conceptual design works to remediate potential ponding completed by GHD. Access agreement with landowner to monitoring and undertake remediation.	Yes	Ref. 69 61/755238



Source (Hunter Eco, 2013e)

Figure 21: Estimated Ponding Locations.

8 WATER BUDGET

This section summaries the water balance analysis prepared by GHD (2015) in the report titled *"2014 Water Balance"*. In accordance with condition 105 (vi) of the consent the quantity of water used from water storages and details of water discharges from the Mine are discussed below. The Mandalong, Cooranbong and Delta site water management plans can be viewed on plan references **MG10131**, **MG10069** and **MG10722B**.

8.1 WATER MANAGEMENT

8.1.1 Water Supply and Use

Mandalong is connected to town water and sewer. Potable water for underground use is currently supplied by Hunter Water Corporation (HWC) via a pipeline to the Cooranbong Services Site and to the Mandalong Mine. The total potable water used in 2014 was 443.3 ML. A total of 392.5 ML was supplied via the Cooranbong Services Site & Mandalong Mine Site to underground equipment. A total of 5 ML was used on the surface within the Cooranbong CHP and bathhouse, 35.8 ML in the Mandalong Mine bathhouse and a further 10 ML in the Mandalong Mine Washbay.

The total potable water usage (443.8 ML) for 2014 is above the water usage in 2013 (415.8 ML). Potable water was primarily supplied to the longwall and underground equipment (longwall, continuous miners and conveyors) for coolant on motor transmissions and dust suppression.

Mandalong Mine

Managing runoff from rainfall events is the only surface water management required at the Mandalong Mine Pit-Top. Clean water is diverted around the western area of the site. A dam has been constructed to capture this water. Clean water runoff from Mandalong Road, the Freeway on-ramps and the car park has been diverted around the eastern perimeter of the site.

Water from all other areas of the surface is considered 'dirty' and is directed to sediment control systems. Surface and subsurface drainage directs dirty water to the sediment control system. This system comprises of a Gross Pollutant Trap (GPT), a Sediment Control Dam and a polishing lagoon. Water from the Sediment Control Dam is used for irrigation of surrounding grassed areas as required. An oil water separator at the GPT removes hydrocarbons from potentially contaminated runoff from the refuelling bay, oil store, workshop, washdown bay and equipment yard.

Cooranbong Services Site

Clean and dirty water systems at the Cooranbong site direct surface runoff as, shown in plan **MG10722B** to sediment control structures. Water from the hardstand area is directed to the 5 ML dam for treatment before discharge by an overflow culvert at LDP002. A dewatering pump installed in the 5 ML Dam allows low water levels in the dam to be maintained. Contaminated water from the workshop, equipment storage and washdown bay areas drain to an oil water separator used to remove hydrocarbons from waste water.

Dirty water contaminated with coal fines from the CHP, conveyor gantries and ROM stockpile is directed to dedicated sediment control sumps to remove course fines material. Dirty water is then directed to the large GPT shown on plan **MG10722B** for further settlement of fines. Treated water from the GPT is then pumped to Settlement Dam 1 or directly underground. Settlement Dams 1 and 2 have a capacity of 7.6 ML.

A sediment control dam (ROM Stockpile Dam) and GPT were constructed in 2010 to capture and treat contaminated surface water runoff from the 100 000 T ROM coal stockpile. Sediment is captured in the ROM Stockpile Dam prior to flowing via pipeline into Settlement Dam 1 (via the Export Bin Sump).

Delta Entry Site

Clean and dirty water systems have been constructed at the Delta site. Site runoff also utilises the existing stormwater infrastructure at the Wyee Coal Unloader, which includes clean water diversion drainage and two large dirty water settling ponds (9ML capacity) sufficient to treat contaminated water prior to discharge.

Another settling pond was constructed down slope of the decline portal for the pre-treatment of dirty water from the Delta Site. Sediment in runoff is settled out in the dam prior to discharge into the large 9 ML settlings ponds.

Mandalong Haul Road

Clean and dirty water are separated along the haul road. Clean water is diverted by drains away from the haul road. Dirty water from the haul road and batters, is captured and treated within 6 sediment basins constructed along the haul road. Dirty water contained within the sediment basins is required to meet specific water quality criteria prior to discharge as discussed in Section 5.3.2.

8.1.2 Mine Water Management

Mandalong Mine

Water from the active mining area is pumped to a temporary settling area to reduce suspended solids. All water is then pumped to a goaf (Cooranbong underground longwall void) area in the north-west of the Cooranbong Entry Site. This void area has a significant storage capacity, and also acts as a primary settlement area for the removal of suspended solids. Dirty water from the Cooranbong Settlement Dams is also pumped or decanted via the existing infrastructure to the Cooranbong void to maintain low water levels in the surface dams.

Water in the Cooranbong void is then pumped to the surface through a borehole pump and overland to the Borehole Dam at the Cooranbong Services Site. Water discharges via a surface pipeline directly to LDP001.

Delta Site

No mine water is discharged from the Delta entry site, as inseam water from the Delta underground headings and decline tunnel is pumped to the existing Mandalong Mine water system.

8.1.3 Groundwater Management

8.1.3.1 Groundwater System

Mandalong Mine

This section summaries the groundwater monitoring results presented in **Appendix 5** as provided in the review undertaken by AGE Consulting Pty Ltd tilted *"Mandalong Longwall Mine Groundwater Monitoring Review for AEMR 2014"* (2015) .This report should be referred to for further detailed information on groundwater monitoring results.

An extensive groundwater monitoring network has been developed at Mandalong Mine with monitoring undertaken on many of the bores since August 1997. This program has been established to provide timely warnings of deviations from natural or background levels, so that if necessary, remedial measures and/or management strategies can be put in place.

The current monitoring network consists of 45 bores; 20 alluvial monitoring bores, 23 overburden monitoring bores and 2 coal seam monitoring bores. The bores consist of 12 nests of 2 or 3 bores monitoring strata at increasing depth at the same site, and 13 single bore sites. The bores are monitored every month with the water level, EC and pH being measured.

Table 31 provides a summary of the establishment timeframe and purpose of the network. The bore locations are shown on Drawing No.1 in **Appendix 5.** Drawing No.1 in the AGE (2015) report illustrates the groundwater monitoring boreholes location in relation to the underground mining areas.

Table 31: Summary of Monitoring Bore Network Establishment

Bores	Established	Location	Purpose
BH1 – 14	June 1997	Mandalong Valley alluvial	To monitor groundwater levels and quality in the alluvium.
BH15 – 16	February 1998	Private property 1 km south-east of mine	To monitor water levels and the impact of mining on the coal seam.
BH17 – 19	Sept-Oct 2002	Over longwall panels LW4 and LW5	To monitor water levels and the impact of mining on the overburden aquifers.
BH20, 20A, 20B BH21, 21A	October 2003	Nested bores over longwall panels LW1 and LW2	To monitor the impact of mining LW1 and LW2 on the alluvial and overburden aquifers.
BH2A, 2B, 2C BH3A, BH3B BH6A, BH6B BH7A, BH7B, BH17A1 BH22, BH22A, BH22B BH23, 23A, 23B	Sept – Oct 2005	Nested monitoring bores over longwall panels	To provide a broader coverage of monitoring of the impact of longwall mining on the alluvial and overburden aquifers.
BH9A, BH9B, BH10A, BH10B, BH24A, BH24B, BH24C & BH25A, BH25B, BH25C.	May 2010	Nested monitoring bores over longwall panels	To provide a broader coverage of monitoring of the impact of longwall mining on the alluvial and overburden aquifers.
BH26A, BH26B, BH26C, BH27A, BH267B & BH27C.	September 2011	Nested monitoring bores.	To provide a broader coverage of monitoring of the impact of longwall mining on the alluvial and overburden aquifers.

Source (AGE, 2015)

There are essentially three groundwater systems in the Mandalong Valley (mine lease area) – alluvial groundwater, bedrock groundwater and overburden/interburden.

The alluvial groundwater is the most important as a usable resource, however there are not many licensed extraction bores within the Valley. The alluvial groundwater is typically recharged from surface infiltration through the sands and upstream recharge.

The bedrock groundwater is less important as a usable resource. The permeability of the Narrabeen Group rocks is generally very low, with little groundwater yield. Any water that is localised in joints or fractures is typically of poor quality.

In the coal seam itself, the bulk permeability is low with some occasional high permeability zones associated with joints, fracture zones or faults, which results in the seam being a confined aquifer relative to the surrounding strata.

Delta Site

Groundwater encountered at Delta underground headings is essentially the same as that found in the coal seam at Mandalong Mine and is managed by pumping this water through the existing inseam water management system at Mandalong Mine. Groundwater make at Delta is low to nil given the relatively low permeability of overlying strata and limited opening created by the decline tunnel and main headings in the coal seam.

8.1.3.2 Groundwater Effects

Cooranbong and Delta Sites

Water make in the Delta underground workings and decline tunnel was monitored during construction of the Delta Decline tunnel and was finalised at the completion of construction works. Groundwater produced from the Delta Decline tunnel is considered to be low to nil and is pumped via the underground water management system where it is discharged to the Cooranbong Services Site at LDP001.

Mandalong Mine

The review of groundwater results by AGE *(2015)* presented in **Appendix 5** provides the following conclusions:

- *2014 groundwater level data indicates that there has been no impact to alluvial groundwater levels from mining. Also, all alluvial bores correlated closely with the CRD, indicating recharge is primarily related to rainfall.*
- *The shallow overburden has been impacted on various levels by mining at most monitoring sites due to bedding parting. Water levels, however, generally stabilised or recovered, especially in bores away from active mining, and there was no change in 2014 compared to previous years.*
- *Mining of the longwall panels generally results in depressurisation of the deeper overburden.*
- *The data also indicates that the Great Northern Seam to the south of the Mandalong Mine may have been depressurised as a result of mining in the area, but that the deeper Fassifern Seam has not been impacted.*
- *The monitoring data has confirmed the Kendorski (1993) model and previous assessments of the potential impact of goafing associated with longwall mining on the overlying aquifers, viz:*
  - *water levels in the alluvium and shallow overburden do not appear greatly impacted by mining.;*
  - *water bearing overburden strata at depths of greater than 90 m below ground level are depressurised/dewatered as a result of hydraulic connection with the longwall panel; and*
  - *the coal seam aquifer that is being mined is locally depressurised/dewatered.*
  -
- *Based on the analysis of the groundwater monitoring data, there has been no adverse long term impact on the alluvial aquifers or shallow overburden from longwall mining of panels LW1 to LW17. However, it is acknowledged that dewatering of the goafed zones in addition to the depressurisation of the deeper overburden has occurred due to mining.*

In summary, the monitoring data indicates that although mining has impacted groundwater levels in overburden rocks, there has been no long-term impact, even in faulted areas, on groundwater levels in the alluvial aquifers. Generally groundwater quality does not appear to be impacted long-term.

The approved Water Management Plan (WMP) specifies that if the alluvial groundwater data indicate anomalous groundwater behaviour, an assessment of the changes against climatic conditions and further investigation into the occurrence will be undertaken. As stated above the alluvium groundwater boreholes indicate groundwater water levels trend with CRD and there has been no permanent adverse impact recorded in alluvial groundwater monitoring boreholes as a result of mining. Therefore, no anomalous alluvial groundwater results have occurred requiring a groundwater investigation program and routine monitoring will continue as per the management plan.

8.1.3.3 Groundwater Licensing

A review of the groundwater licences held by Mandalong Mine under *Part 5A Water Act 1912* assessed the compliance licence conditions and the results are contained within **Appendix 10.** Groundwater monitoring licences are held for the purpose of monitoring groundwater levels in the Mandalong Mine lease area. The Mine's 2014 underground operations water cycle as shown in **Figure 18.**

Mandalong Mine also holds a licence permitting the extraction of groundwater water from the coal measures encountered during the process of mining. This extraction licence permits the Mine to dewater the underground coal measures via a submersible dewatering pump located at Cooranbong. The extraction bore entitles the Mine to extract an annual entitlement of 1825 ML of groundwater for the period. This mine water is subsequently discharged at LDP001 and is monitored as discussed in Section 5.3.1.

In 2014, 253.6 ML was pumped by the dewatering borehole to the surface at the Cooranbong Services Site. Potable water usage in 2014 was 443.8 ML (imported process water).

8.2 WATER BALANCE – MANDALONG SITE

The 2014 water balance diagram (GHD, 2015) for Mandalong Mine is shown in **Figure 22.** The water balance for 2014 is presented in **Table 32**. The primary inputs for the water budget are potable water, groundwater, and surface run off as described below. The primary outputs from the water budget are discharged water, water loss in product coal and water to sewer.

Potable water is supplied by the HWC to the Cooranbong Services Site and the Mandalong Mine via overland pipes and is consumed underground by the mine equipment. Potable quality water is used underground in mining equipment as; uncontaminated water is required for cooling systems on drive motors, in dust suppression sprays on miners and transfer points. In 2014, 392.5 ML or 1.07 ML per day was supplied underground for use on mining equipment. It is estimated a minor amount of potable water (5 ML) was used on the surface at the Cooranbong Services Site for surface facilities.

GHD's (2015) water balance model indicates 376.1 ML was discharged in 2014 from the Mandalong Mine, Cooranbong and Delta Services Sites. As shown in **Table 32** and **Figure 22** this consisted of 25.9 ML from the Mandalong Mine Sediment Control Dam. A total of 296.9 ML was discharged from the Cooranbong Services Site, with 254.1 ML from LDP001, 11.4 ML from LDP002 (5 ML Dam) and 31.4 ML from the Construction Dam (clean water dam). 53.3 ML of surface water run off water was discharged from Delta Entry Site dams.

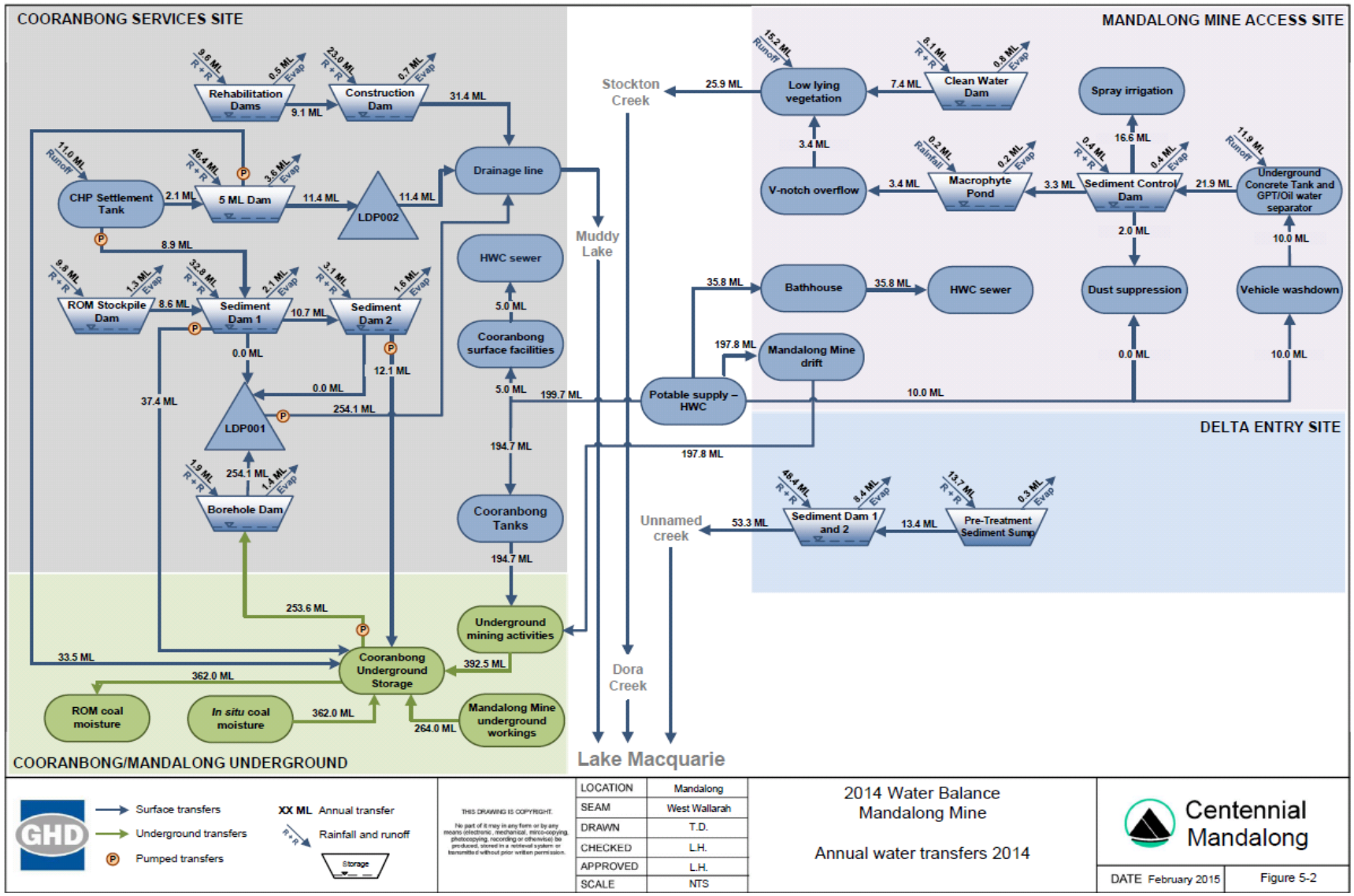
The majority of discharged water from the sites is generated from surface water run-off as, shown in **Figure 22**. The exception being LDP001 at the Cooranbong Services Site. It is estimated 264.0 ML was pumped from the Cooranbong Settlement Dams to the underground to provide sufficient surface water storage during rainfall events.

Table 32: 2014 Water Balance Model

	Transfer in 2014 (ML/yr)	Source
INPUTS		
Direct Rainfall and Runoff	235.5	Water Balance Model
Potable Water Supply	443.3	Provided by Centennial
In Situ Coal Moisture	362.0	Water Balance Model
Transfer from active underground workings to Cooranbong Underground Storage	264.0	Water Balance Model
TOTAL INPUTS	**1305**	

	Transfer in 2014 (ML/yr)	Source
OUTPUTS		
Evaporation	21.3	Water Balance Model
Dust Suppression	2.0	Provided by Centennial
Spray Irrigation	16.6	Water Balance Model
Sewage to HWC	40.8	Water Balance Model
Discharge through LDP001 (Cooranbong)	254.1	Water Balance Model
Discharge through LDP002 (Cooranbong)	11.4	Water Balance Model
Discharge from Construction Dam (Cooranbong)	31.4	Water Balance Model
Discharge from Mandalong Mine Access Site	25.9	Water Balance Model
Discharge from Delta Entry Site	53.3	Water Balance Model
ROM coal moisture	362.0	Water Balance Model
TOTAL OUTPUTS	**819**	
CHANGE IN STORAGE		
Cooranbong Underground Storage	485.9	Water Balance Model
Surface Water Storages	0.1	Water Balance Model
TOTAL CHANGE IN STORAGE	**486**	
BALANCE		
Inputs – Outputs – Change in Storage	**0**	

Source (GHD, 2015)



Source (GHD, 2015)

Figure 22: GHD Water Balance Model 2014

9 REHABILITATION

9.1 BUILDINGS

Mandalong Mine

Construction of infrastructure is discussed in Section 1.1 including the construction of the VAM-RAB facility and the Gas Flares which were completed in 2013 as shown in plan **MG 10069**. No buildings or infrastructure were removed or decommissioned in 2014.

Delta Entry Site

All buildings at the Delta Entry Site are associated with the coal conveying system and as such are a permanent fixture. The buildings associated with the construction of the site were decommissioned and removed prior to the site being rehabilitated in 2006. No construction or decommissioning of buildings occurred at the Delta Entry Site in 2014 and as such no rehabilitation of buildings was undertaken.

Cooranbong Services Site

To ensure continuation of coal handling operations and mine support infrastructure, surface buildings and mine related infrastructure have been retained at the Cooranbong Services Site. The Cooranbong Services Site, CHP and supporting infrastructure were used in 2014 to supply coal to the Eraring Power Station and to Newstan Colliery for export. In 2014, the Cooranbong ROM Bin Stanchion was decommissioned. No other buildings or infrastructure at the Cooranbong Services Site were removed or decommissioned in 2014.

9.2 REHABILITATION OF DISTURBED LAND

Mandalong Mine

The majority of Mandalong Mine site has been rehabilitated following the completion of construction activities in 2005. Rehabilitated sections of the Mine's surface area are well established and have provided vegetation cover to effectively minimise the potential for erosion. Disturbance activities from the construction described in Section 1.3 were largely within the Mine's existing operating footprint.

Water drainage from the new car park and demountable buildings has been connected into the existing surface water drains. The surface water structures at the Mandalong Mine have previously been rehabilitated to prevent erosion and are stable.

Centennial Mandalong received approval in 2011 (DA97/800 Modification 8) for the trial installation of a ventilation air methane regenerative afterburner unit (VAM-RAB) that would remove and breakdown the exhaust methane.

Installation of the VAM-RAB unit in 2012 necessitated clearing of some native vegetation. Two endangered ecological communities (EEC) listed in Schedule 3 of the NSW Threatened Species Conservation Act 1995 were included in the areas to be cleared. These were: Swamp Sclerophyll Forest (SSF) on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions; and River-Flat Eucalypt Forest (RFEF) on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions.

Consent condition 76A included a requirement for a 1.25 hectare rehabilitation off-set area to be established on cleared land adjoining the VAM-RAB construction site. These EEC were represented by communities described in the regional vegetation mapping and classification (NPWS 2000) as: MU37 Swamp Mahogany Paperbark Forest (SSF); and MU38 Redgum – Rough-barked Apple Swamp Forest (RFEF).

An ecology survey (Hunter Eco, 2011) prepared for the VAM-RAB project application described the area to be rehabilitated as mostly dominated by weeds. This being the case, active regeneration was required and this was commenced in January 2012.

Further to the requirement to rehabilitate, the consent condition 76A also requires that the progress of the rehabilitation be monitored annually for five years. This monitoring was conducted by Hunter Eco in December 2014 and is described in Section 5.8.2 of this document.

Longwall Mining Area

The surface areas above the completed longwall mining panels are inspected as per the schedules prescribed in the approved LW15-17 Environmental Monitoring Plan and Subsidence Management Plan (SMP). The EMP requires the floodpaths to be inspected every six months or after a flood event (refer to **Appendix 9**) and the SMP requires surface inspections during surveying of monitoring lines. During the course of these inspections observations are made on the progress of remedial measures implemented to minimise subsidence related effects.

The area disturbed during the construction of subsurface drainage, installed to alleviate remnant ponding above Longwall 6 on a Centennial owned property (56) was rehabilitated in October 2009. The area was inspected in 2014 following rainfall events. This confirmed the drains take up to seven days to remove ponded water from the paddock which can vary depending on the amount of rainfall and the water level in Stockton Creek. Horses are able to use the paddock and are rotated out in wet conditions similar to other ponded areas of floodplain. This drying period is consistent with other areas of the flood plain which drain or dry out over a similar period.

The remanent ponding on Centennial's properties 59 & 61 above Longwalls 5 and 6 are now free draining following works to re-instate and extend existing surface drainage. Land use by the tenants for cattle and other activities are now occurring as they did prior to mining.

Remnant ponding was observed in limited areas above longwall panel 7 and 8 situated on an existing low lying area of Centennial's properties. The area consists of exotic pasture species primarily used for horse grazing. Centennial Mandalong has completed a survey design to construct a drain to remediate the longwall 7 ponding and the project is currently under the tender process. The drainage of the area above longwall 8 area is impractical with little fall available from the ponded area into the nearest creek, over 300 m to the east. This ponded area will be fenced from stock and allowed to develop into a freshwater wetland and will be incorporated into the bi-annual wetlands monitoring program. These works will be completed in 2015.

Exploration Sites

Three surface exploration drill sites were prepared in 2014 (CM121 to 123). These three sites required minor clearing only and all three drill sites were located within the Olney State Forest. These sites were rehabilitated following the sealing of the boreholes. Existing tracks were utilised to again access to these exploration drill sites where possible and required limited vegetation clearing.

Above ground 20,000 litre drill sumps were used during the drilling process with only a small 500 litre tank dug into ground level. These sumps minimise the drilling fluids interaction with ground and greatly reduce the risk of drill sumps overflowing. The drill sumps where pumped out to remove and dispose of waste water and drill tailings then backfilled to re-instate the natural surface levels.

Sites CM 121, 122 and 123 were seeded with sterile grass species to stabilise the drill site following the re-instatement of the land surface. The sites were lightly scarified to de-compact the soils using hand tools, and cleared vegetation laid on the disturbed area to further stabilise the ground.

Forests NSW were consulted prior to commencing these works, so that the rehabilitation meet with their land use requirements. All rehabilitation works were completed by November 2014 and inspected by a Forests NSW representative on 20/11/14. Forests were satisfied with the standard of the rehabilitation which had been achieved. Ongoing monitoring and maintenance of rehabilitated sites will be conducted in 2015 and reported in the AEMR.

Delta

Construction of the Delta coal clearance system was largely completed in 2005 and rehabilitation of the site was completed in 2006. Construction works were separated into two areas (refer to Plan **MG10131**). Stage one, located west of the existing Delta diversion drain consists of the portal, conveyor and fire fighting tanks. Stage two to the east of this drain consists of a transfer tower, crusher building and conveyors and the temporary topsoil stockpile located near the Delta 9 ML dams.

Rehabilitation at the Delta entry site was inspected in 2014 to assess the effectiveness of the works to stabilise disturbed areas onsite. The direct seeding rehabilitation methods used have been successful in establishing a substantial area of the site with pasture and tree groundcover. Ground cover on the direct tree seeded areas is approximately ninety percent similar to those recorded in 2013. Ninety-five percent ground cover has been achieved in rehabilitated pasture seeded areas. The area is slashed to maintain access to infrastructure and as part of the asset protection zone.

The rehabilitation methods used on drainage lines have been successful as these are stable and are effective in directing surface runoff to sediment control structures.

Cooranbong Services Site

A total of 3.9 hectares have been disturbed from the construction of the upgrades to the CHP and haul road as described in Section 1.3 at the Cooranbong Services Site in 2009. Construction activities were completed in May 2010 with all disturbed areas rehabilitated by the contractor (Leighton) shortly after. No further rehabilitation works were undertaken in 2014.

Mandalong Haul Road

The haul road construction resulted in approximately 18 ha of disturbance. Of this 3.9 hectares of disturbed land associated with the CHP upgrades (stockpile and conveyor) and haul road are located on Mandalong Mine's Mining Lease as shown in plan **MG11217**. 1.25 hectares of disturbed area not occupied with haul road and CHP infrastructure was rehabilitated in 2010. The remaining areas are located on the Awaba Colliery Mining Lease. Of this, nine hectares along the haul road was rehabilitated in 2009 as described in the 2009 AEMR. Six hectares of land will not be rehabilitated as it is occupied by the haul road infrastructure.

As per the requirement of the Mandalong Haul Road Landscape and Rehabilitation Plan, Jeff Dunwoodie (Environment & Community Coordinator) audited the rehabilitation on the haul road in September 2014. The audit assessment required the following issues be addressed: -

- An *assessment of surface and slope stability.*
- *Properties of the soil or root zone media (such as chemistry, fertility and water relations).*
- *Plant community structural attributes (such as cover, woody species, density and height).*
- *Plant community composition (such as presence of desirable species, weeds).*
- *Selected indicators of ecosystem functioning analysis (such as soil microbial biomass).*

The 2014 audit focused on identifying sites where remedial action or maintenance is required to bring sites to an acceptable standard. The inspection strategy involved one person inspecting the full length of the Haul Road to access 100% of the disturbed area.

In total nine sites were inspected and recorded an action priority from highest to lowest. The highest priorities included maintenance of sediment and erosion controls along the Haul Road drains.

The audit provides a useful assessment of baseline rehabilitation completed to date on the haul road following the completion of all construction activities in 2011. In general rehabilitated sections of the haul road are well established and continued growth occurred in 2014. Maintenance and effectiveness of the haul road rehabilitation will be assessed in 2015 and reported in the next AEMR.

9.3 OTHER INFRASTRUCTURE

No other infrastructure was rehabilitated during the reporting period.

9.4 REHABILITATION TRIALS AND RESEARCH

Moran's Creek Rehabilitation Trials

During consultation with local Mandalong landowners, concerns were raised regarding historical land management practices which have resulted in extensive clearing of native vegetation and severe erosion of creek banks and drainage lines across the valley. The Moran's Creek Rehabilitation trial was initiated in 2007 to respond to local landowner concerns in particular the historical erosion on Moran's Creek caused by flood flows and stock accessing creek areas. Local landowner's sited evidence that excavation of the creek in the 1950's caused the creek to widen as a result of the creek banks eroding. In November 2007 a trial commenced to rehabilitate a section of Moran's Creek on a Centennial owned property. The objective of the trial is to assess the effectiveness of direct seeding and tube stock planting to re-establish a native vegetation community on a degraded section of Moran's Creek.

Direct seeding of the trial area commenced in January 2008 with inspections in 2011, 2012, 2013 and 2014 concluding that the direct seeding method has been successful in establishing tree cover over the majority of the area. Juvenile species including *Eucalyptus Tereticornis, E. robusta* and *Casuarina Glauca* have successfully established on the trial area. The trial direct seeding area has been largely successful in re-establishing the native vegetation found along Moran's Creek. Weed spraying was conducted in 2014 to control Tobacco, Scotch Thistle and Blackberry.

The 2000 tube stock planted in November 2008 along the fenced Moran's Creek rehabilitation corridor are now established along Moran's Creek with trees heights of up to 5 m. The rehabilitation site is a reference site for the Catchment Management Authority (CMA) vegetation monitoring report. The monitoring has recorded the baseline vegetation conditions and will evaluate the rehabilitation measures implemented at Moran's Creek.

A Macquarie University Research Project was completed in November 2013 titled "*How has the Water Quality of Morans Creek Changed Since Rehabilitation?"* A variety of methods were employed in order to answer the questions regarding the health of Morans Creek, including water quality sampling and counting of macroinvertebrates. The study concluded that:

- Riparian vegetation and bank stability had increased at the rehabilitation site; and
- Banks remain unstable and riparian zones small if they exist at all within the fences area beyond the rehabilitation site.

Translocation Research Program

Field investigations for the haul road project had established that the local populations of *Grevillea parviflora subsp. parviflora* and *Tetratheca juncea* were so extensive that it would not be possible to avoid the loss of some plants of these species no matter where the haul road was located. Consequently a translocation research programme was developed in consultation with the EPA for the translocation and ongoing monitoring and reporting for the threatened flora species *Tetratheca juncea* and *Grevillea parviflora* that would have otherwise been lost as a result of the haul road construction. The main aim of this translocation project was to implement an experimental model that would add to the knowledge base regarding the translocation of these species, building on available information from any previous attempts. The overall experiment ran for 5 years with interim reports prepared at the end of each year and a final report after the 5th year. Hunter Eco produced the final Centennial Coal Cooranbong-Awaba Haul Road Threatened Flora Translocation Monitoring Report for Centennial Coal in November 2013 (Hunter Eco, 2013a).

In January 2010 the first detailed monitoring report was completed by inspection of all sites containing the translocated threatened plant species within and around the haul road. The current report by Hunter Eco *"Cooranbong-Awaba Haul Road Threatened Flora Translocation Report"* (2013a), has established the extensive presence of *Grevillea parviflora* subsp. *pariflora* and *Tetratheca juncea* that has undergone a threatened flora translocation research programme between 27 April 2009 and 6 May 2009.

One recipient site for *Grevillea parviflora* subsp *parviflora* and three sites for *Tetrathea juncea* were established which were translocated by methods of an excavator and individual clumping.

Grevillea parviflora* subsp. *parviflora

Translocation of this taxon appears to have been a success with the population established, consisting of robust mature plants along with a range of early successional plants. There was no evidence of fruit production despite consistent flowering so it is likely that the smaller plants are clones sprouting from underground rhizomes.

Tetratheca juncea

There were three aims of this translocation experiment:
1. To compare translocating individual clumps (Site 2) with using an excavator to move large groups of clumps (Sites 3 and 4);
2. At Site 2, to determine whether loosening of soil around the recipient hole facilitated vegetative spread compared with unloosened soil;
3. At Site 3, to determine whether translocating *Tetratheca juncea* using an excavator could assist in rehabilitating a highly disturbed area.

Unfortunately these aims were thwarted by heavy grazing of the translocated *Tetratheca juncea* by herbivores at all three sites. Grazing pressure was such that the translocated clumps were not able to establish themselves. In this regard, comparison can be made with the *Tetratheca juncea* translocation experiment conducted at Gwandalan (Driscoll and Bell 2008 in (Hunter Eco, 2013a)) where herbivory was not a problem. That experiment was subdivided into ten groups of ten clumps each, all located in a variety of habitat types. In favourable habitat survival was as high as 90% after five years.

Nest Box Research Program

Habitat hollows are an important resource utilised by a variety of forest fauna. The abundance of hollow bearing trees in the Australian context is important for the survival of many endemic species. Many threatened species are obligate users that require the presence of hollows to survive and reproduce.

Nest boxes have been installed within the surrounding haul road vegetation communities as part of the offset strategy for the clearing of vegetation and hollow bearing trees required for the construction of the haul road. A research based approach to the installation and monitoring of nest boxes has been developed to more effectively offset the loss of hollow bearing limbs caused by the construction of the private haul road. The Mandalong haul road nest box research program will investigate factors that influence the use of nest boxes and the value that such nest box programs provide as an offset/management tool. Several research questions will be examined experimentally as part of the nest box research programme. These are:

- The impact of micro-climate on nest box use and the effect of nest box design (experiment 1). In particular, this will look at the temperature extremes and fluctuations experienced in standard nest box design versus naturally occurring hollows, and examine the effects of varying wall thickness (insulation) on reducing unfavourable microclimatic conditions within the nest boxes.
- The effect of nest box placement: does aspect matter (experiment 2). This involves examining the effect of differing aspects on nest box inhabitation. This will also be linked to microclimate within the nest boxes.
- Examining utilisation rates of nest boxes in areas of varying natural hollow density (experiment 3). This will involve an examination of the density of naturally occurring habitat hollows each experimental quadrat and correlating this to the rate of nest box use.

In January 2010 Ecobiological installed 150 nest boxes distributed across 15 quadrats (10 in each) located alongside the western perimeter of the haul road. The experimental design adopted, allowed each quadrat having four of each single walled nest box type (bat and glider) and one of each double-walled nest box type (bat and gilder). The two double-walled boxes were placed at a northern aspect in all quadrats, and the remaining eight, one of each design, at each aspect.

The inspection of all 150 nest boxes was undertaken by Kleinfelder on the 10th and 11th of July 2014. A summary of the report is provided as follows.

Nest box usage is recorded in two ways:

a) actual use, animal sighted in the nest box; and
b) evidence of use which includes relatively recent nests or scats.

A total of 16 (12.7%) nest boxes were found to contain evidence of recent use during the winter 2014 surveys. This is an increase in recent usage from the 2014 summer survey (60% i.e. 10 recently utilised boxes recorded for summer 2014 against 16 for winter 2014) which is in accordance with the evident trend of nest box usage being significantly higher during the winter months. However, this was also a considerable reduction in usage from the winter surveys of 2012 where 48 nest boxes were recently used (-66%) and winter 2013 where 37 nest boxes were recently used (-56%).

The number of nest boxes that have contained any signs of use or an animal present over the last four years is 87 nest boxes out of the 150 nest boxes on site (58%). This is an increase from the last survey with three previously unused nest boxes having been used. The total usage of boxes recorded has however, decreased slightly as not all evidence of usage is permanent, and therefore not necessarily recorded in every year.

Since the 2010 surveys, the thickness of nest box wall has been shown to have a marked effect on their use between seasons. In winter 2013, the single walled boxes displayed a significant spike in use and for the first time had a higher usage rate than double walled boxes (26.5% and 22.2% respectively). The summer 2014 survey showed that even with a drop in usage, single walled nest box usage remained above double walled nest boxes. This trend has not continued in the winter 2014 survey with a return to a higher percentage of double walled nest boxes (17.39%) being used as compared with 11.65% of single walled nest boxes.

Several species of live mammal were recorded in the nest boxes (Brown Antechinus Antechinus stuartii (35 individuals), Squirrel Glider Petaurus norfolcensis (four individuals) and Sugar Glider P. breviceps (five individuals). This is a considerable increase from the previous survey where no live gliders of either species were observed and only two A. stuarii were recorded. Squirrel Gliders are listed as Vulnerable under the Threatened Species Act 1995 (NSW) have been recorded occasionally since 2011 with generally only one nest box occupied. In the winter 2013 and winter 2014 survey however, individuals were recorded at Q2 (both surveys), Q14 (this survey only) and Q15 (both surveys). This is an important and encouraging sign for this species and the overall ecosystem health in the offset area.

The ninth nest box inspection was completed successfully and the subsequent data analysis has provided some interesting results. The key findings of the 2014 winter surveys and analysis included:

- Recent usage of nest boxes recorded a moderate rebound compared to the dramatic decline seen in summer 2014; however, recent usage rates are still considerably lower than surveys between winter 2012 – winter 2013;
- West facing nest boxes continued to show the lowest evidence of recent usage and east facing nest boxes the highest;
- Double walled nest boxes had a higher usage rate than single walled boxes (returning to the previous trend between 2010 – 2013); and
- Both Petaurid glider species were recorded as live animals occupying six different nest boxes (an encouraging result as neither species was recorded in summer 2014) and 35 Brown Antechinus were also recorded from five different boxes.

10 ENVIRONMENTAL MANAGEMENT TARGETS AND STRATEGIES

This section details the environmental management targets and strategies for the reporting period in accordance with condition 105(viii) of the consent. Targets and strategies for the Delta Entry Site are also provided in this section as part of the overall management of the Mandalong Mine, although this is not specifically required by any condition of consent.

10.1 SUMMARY OF PREVIOUS TARGETS

Several actions were committed for completion during this reporting period. A summary of actions completed during the 2014 period is shown in **Table 33**.

Table 33: Summary of Targets completed during 2014

Mandalong Mine Site – Planned Action	Status
▪ Continue VAM-RAB demonstration trial.	▪ Simulated trial to begin in 2015.
Delta Entry – Planned Action	
▪ Complete installation of final sediment sump.	▪ Installation of the sump completed in 2014.
▪ Complete de-silting of 9ML Dam	▪ De-silting completed with a long-reach excavator in 2014.
Cooranbong Site – Planned Action	
▪ Complete cladding upgrades to CHP and rotary breaker building for noise mitigation.	▪ The cladding upgrade to the CHP and rotary breaker buildings was completed in June 2014.

10.2 TARGETS FOR 2015

The environmental targets associated with the Mandalong Mine during the next twelve-month reporting period are summarised in **Table 34**. Some actions were derived from the risk assessment document completed for the DRE Annual Environmental Risk Assessment.

Table 34: Summary of Targets for the period January 2015 to December 2015

Mandalong Mine
▪ Continue VAM-RAB demonstration trial.
Cooranbong Services Site
▪ Complete LDP001 monitoring upgrade. ▪ Complete de-silting of Settlement Dam 2. ▪ Complete de-silting of Mandalong Haul Road Dams.
Delta Entry Site
▪ Nil major targets for 2015.

10.3 MINE WATER REDUCTION TARGETS

Consent Condition 66 requires the mine to investigate opportunities to reduce mine water discharge at Mandalong and report on such in the AEMR. The GHD (2015) water balance model estimated 254.1 ML of water from the underground mine and surface water discharge from LDP001 in 2014 (see Section 8.2 for further details) which is slightly higher than the water volume discharged in 2013 (596.5 ML).

Investigations into reducing the mine water discharge by recycling underground mine water were undertaken in 2009 and 2010. These included a water treatment options study and engineering design & feasibility assessments. The preferred option, recycling the underground mine water by treatment in a Reverse Osmosis (RO) plant, was assessed as not feasible for the Mine. The feasibility of the RO plant was limited due to the inability to discharge waste brine generated by the RO plant to receiving waters. Disposal methods, other than the discharge of waste brine, were cost prohibitive and not feasible at this stage. In addition the RO treatment plant was not capable of supplying mining equipment with potable water for 100% of the time as required by operations, due to equipment malfunction and routine maintenance requirements. Given the currently limited options for waste brine disposal and RO treatment plant availability the investigations conclude recycling of underground mine water by an RO treatment, does not at this time, provide a feasible business option to reduce mine water discharges from the Mine.

Centennial Coal continues investigations into conventional water treatment and reuse options on a regional basis by undertaking initial collating of water quality and discharge requirements for the Centennial mines in the region.

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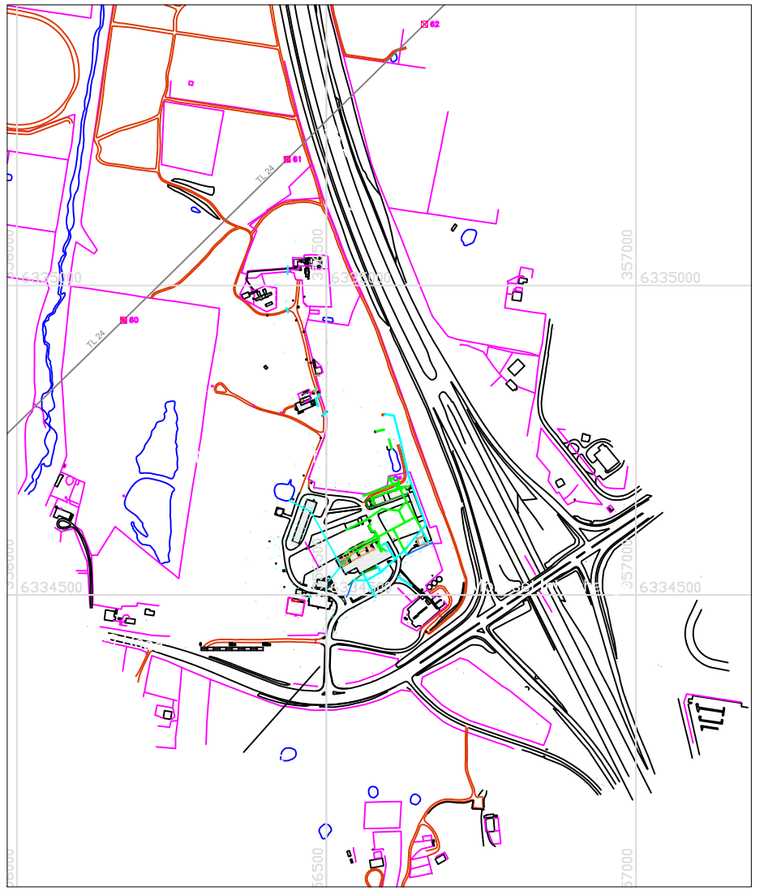
PLANS

Location Plan 1:10000



Mandalong Fan Location Plan 1:2000

Site Plan 1:2000

LEGEND

- Location of Spill Kits
- Surface Flow
- Surface Drainage to Settling Dam
- Clean Water Drainage
- 2014 Rehabilitation
- Concreted Areas

LOCATION	MANDALONG
SEAM	WEST WALLARAH
DRAWN	MB 23.02.05
CHECKED	
APPROVED	
SCALE	as shown

Centennial Coal

Mandalong Mine - Surface Facilities - Water Management & Rehabilitation

CONTRACT No.	
PLOTFILE No.	MG10069_rev17.pdf
A3	MG 10069
DRAWING REVISION	17 - 25.02.2015

LEGEND

- Clean water drainage
- Dirty water drainage
- Clean water surface drainage
- Dirty water surface drainage

LOCATION	MANDALONG
SEAM	N/A
DRAWN	PCD 22-02-05
CHECKED	
APPROVED	

SCALE 1:1500

Centennial Mandalong

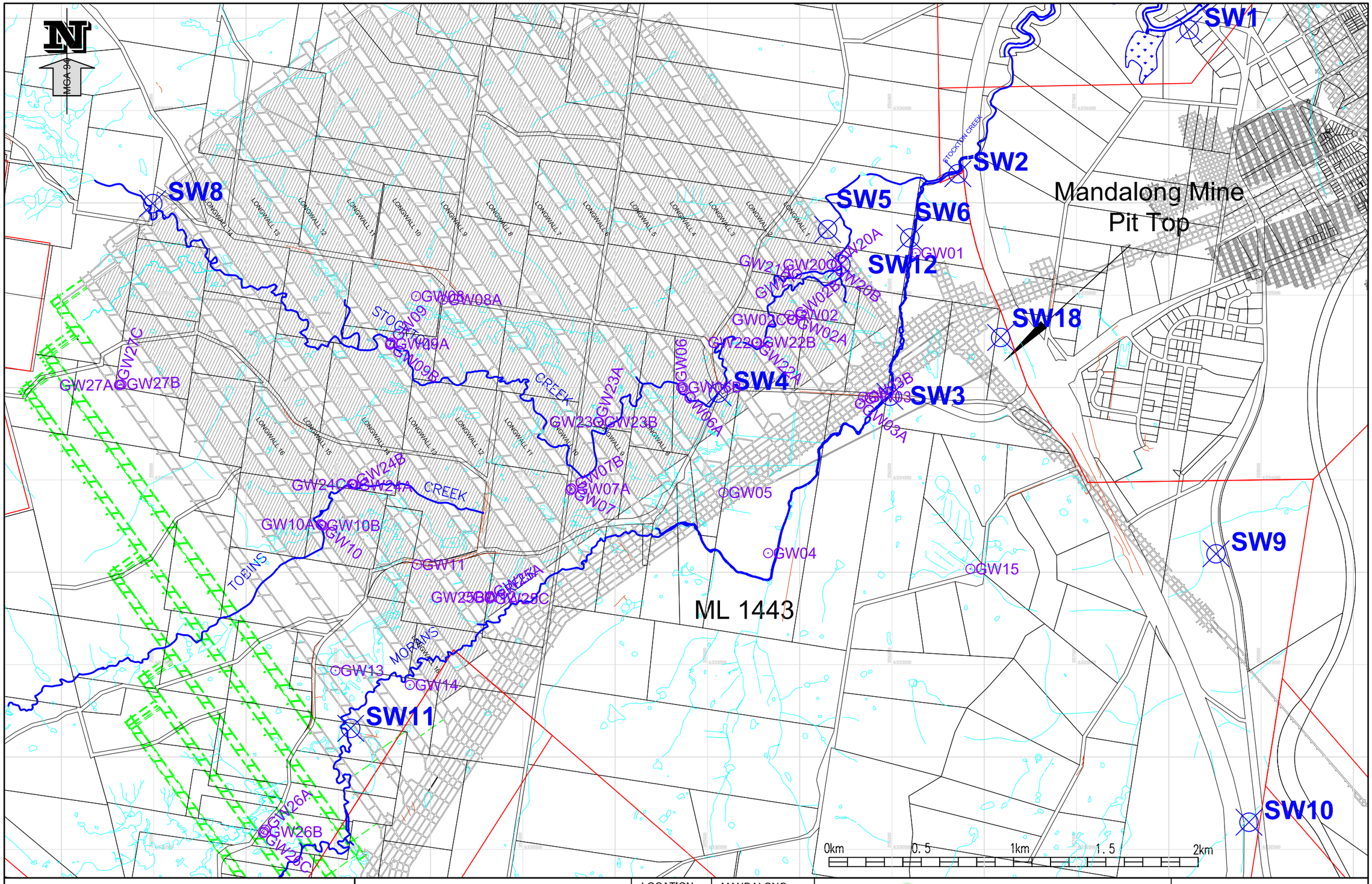
Delta Entry Site Surface Facilities
Water Management &Rehabilitation Plan

CONTRACT

PLOTFILE: MG10131_rev14.pdf

A3 **MG10131**

DRAWING REVISION 14 - 25.02.2015



LEGEND

- ⊙ Groundwater Monitoring Bore
- ⊗ Surface Monitoring Point

LOCATION	MANDALONG
SEAM	WEST WALLARAH
DRAWN	PJS 20/10/06
CHECKED	
APPROVED	
SCALE	1: 20 000

Centennial Mandalong

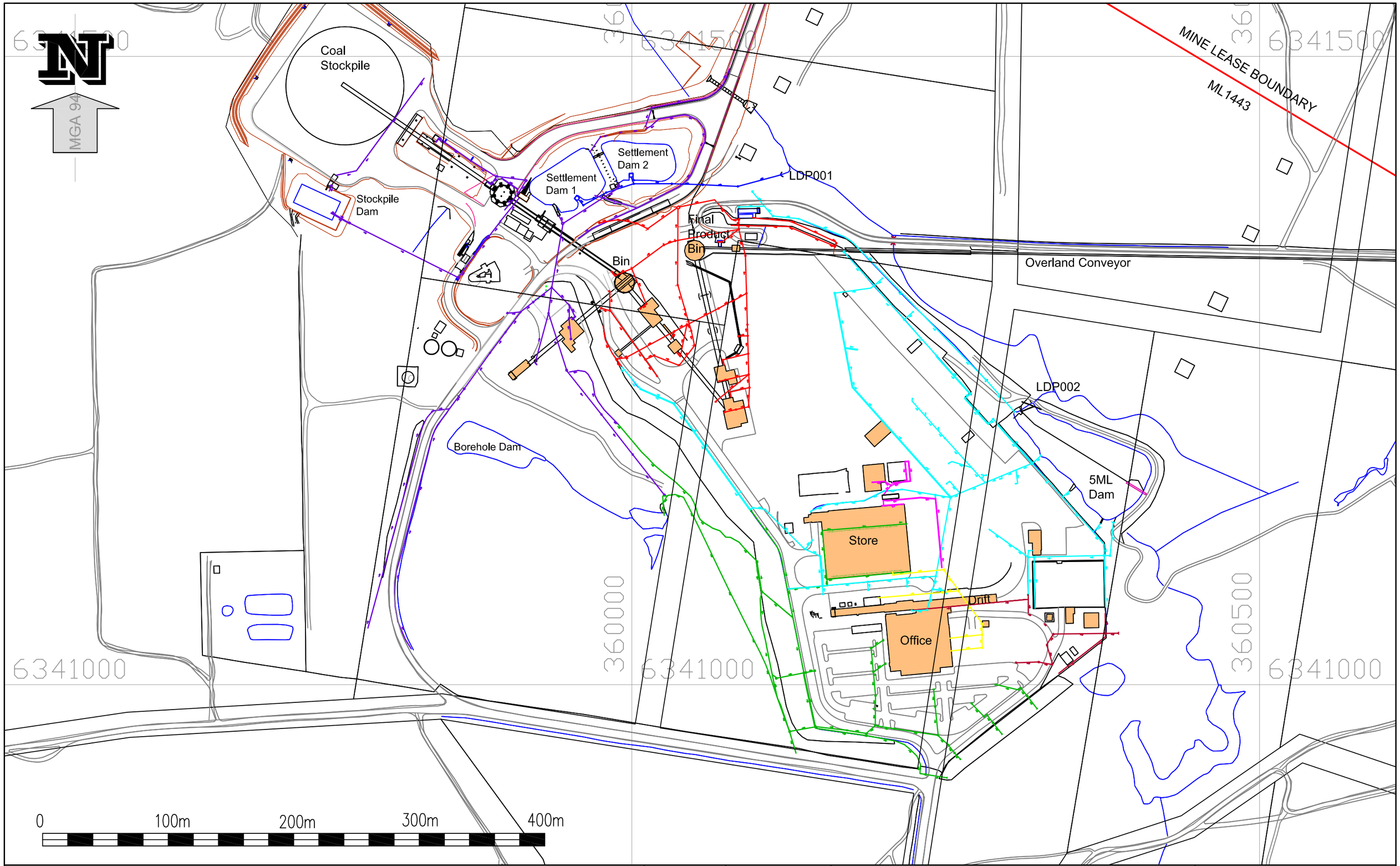
Location of Ground Water and Surface Monitoring Points - Mandalong Mine

CONTRACT

PLOTFILE: MG10502_rev13.pdf

A3 **MG10502**

DRAWING REV. 13 - 25.02.2015



LEGEND

- Dam
- Stockpile
- Surface drainage to Settlement Ponds
- Surface drainage to 5ML Dam
- Surface drainage to Construction Dam
- Raw sewage flow to sewage surge tank
- Surface Drainage to Oil Seperator
- Surface Drainage to gross pollutant trap
- Surface drainage to creek
- Surface drainage to LDP1

LOCATION	MANDALONG
SEAM	WEST WALLARAH
DRAWN	PJS 08/10/07
CHECKED	
APPROVED	

SCALE 1: 3000

Centennial Mandalong

Cooranbong Services Site - Surface Water Management

CONTRACT

PLOTFILE: MG10722b_rev9.pdf

A3 **MG10722b**

DRAWING REV. 9 - 25.02.2015

DELTA ENTRY SITE

VALES POINT RAIL LOOP

MAIN NORTHERN RAILWAY

RUTLEYS ROAD

DDG1

DDG2

DDG3

N

MGA 94

359000

359500

360000

360500

6331000

6330500

0 100m 200m 300m 400m

LEGEND

Dust Monitoring Point

LOCATION	MANDALONG
SEAM	WEST WALLARAH
DRAWN	PJS 08/10/07
CHECKED	
APPROVED	
SCALE	1: 5000

Centennial Mandalong

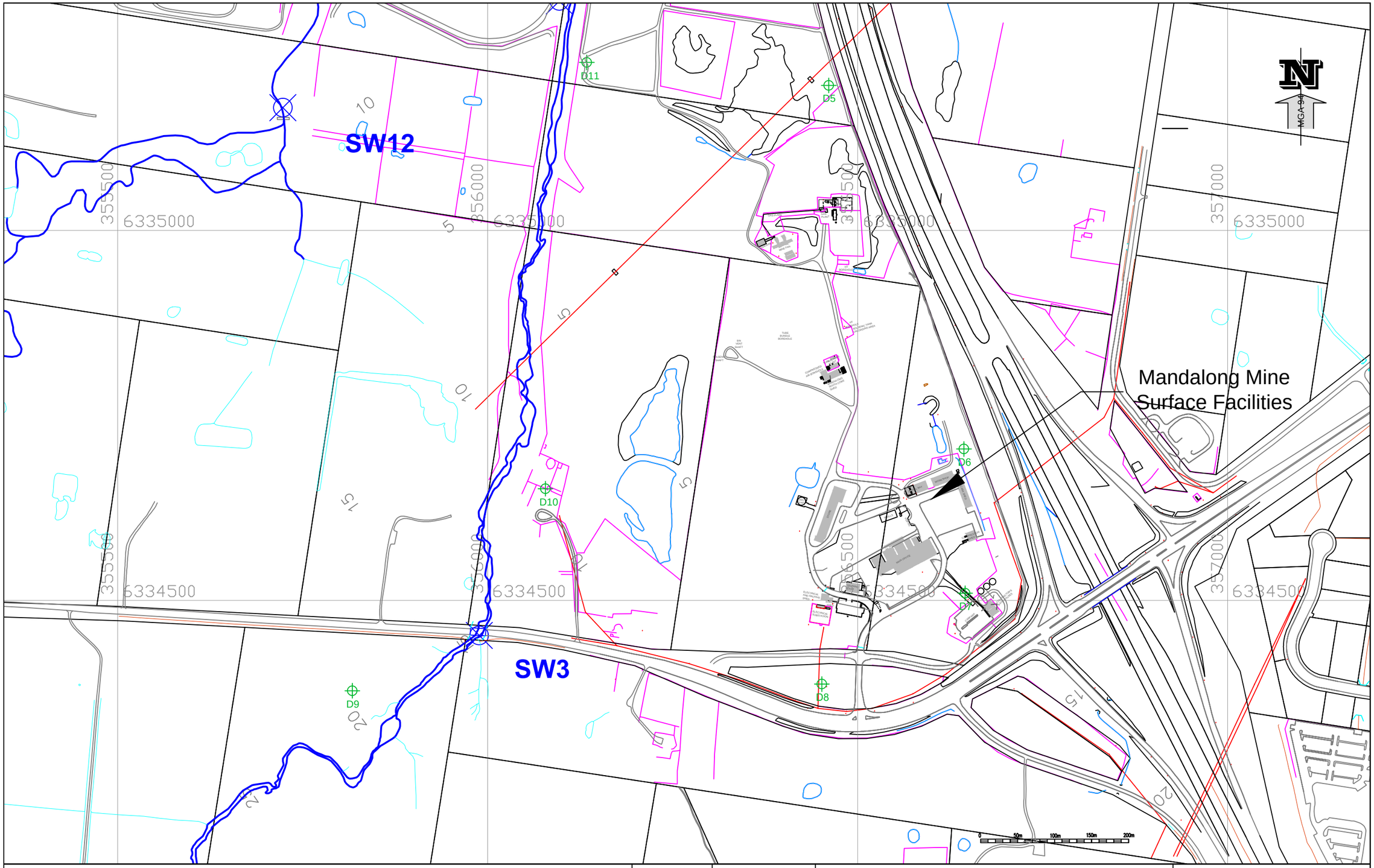
Delta Entry Site -
Location of Environmental Monitoring Points

CONTRACT

PLOTFILE: MG10722c_rev7.pdf

A3 **MG10722c**

DRAWING REV. 7 - 25.02.2015



LEGEND

- Dust Monitoring Point
- Surface Water Monitoring Point

LOCATION	MANDALONG
SEAM	WEST WALLARAH
DRAWN	PJS 08/10/07
CHECKED	
APPROVED	
SCALE	1: 5000

Centennial Mandalong

Mandalong Mine -
Location of Environmental Monitoring Points

CONTRACT

PLOTFILE: MG10722d_rev10.pdf

A3 **MG10722d**

DRAWING REV. 10 - 25.02.2015

SW15

SW14

D1

BW01

LDP001

LDP002

SW13

Dam0

CC

MINE LEASE BOUNDARY

ML1443

MGA 94

D4

SW16

PIPELINE

SW17

LEGEND

- Dust Monitoring Point
- Surface Water Monitoring Point
- Licenced Discharge Point

LOCATION	MANDALONG
SEAM	WEST WALLARAH
DRAWN	JS 13/03/12
CHECKED	
APPROVED	
SCALE	1: 15000

Centennial Mandalong

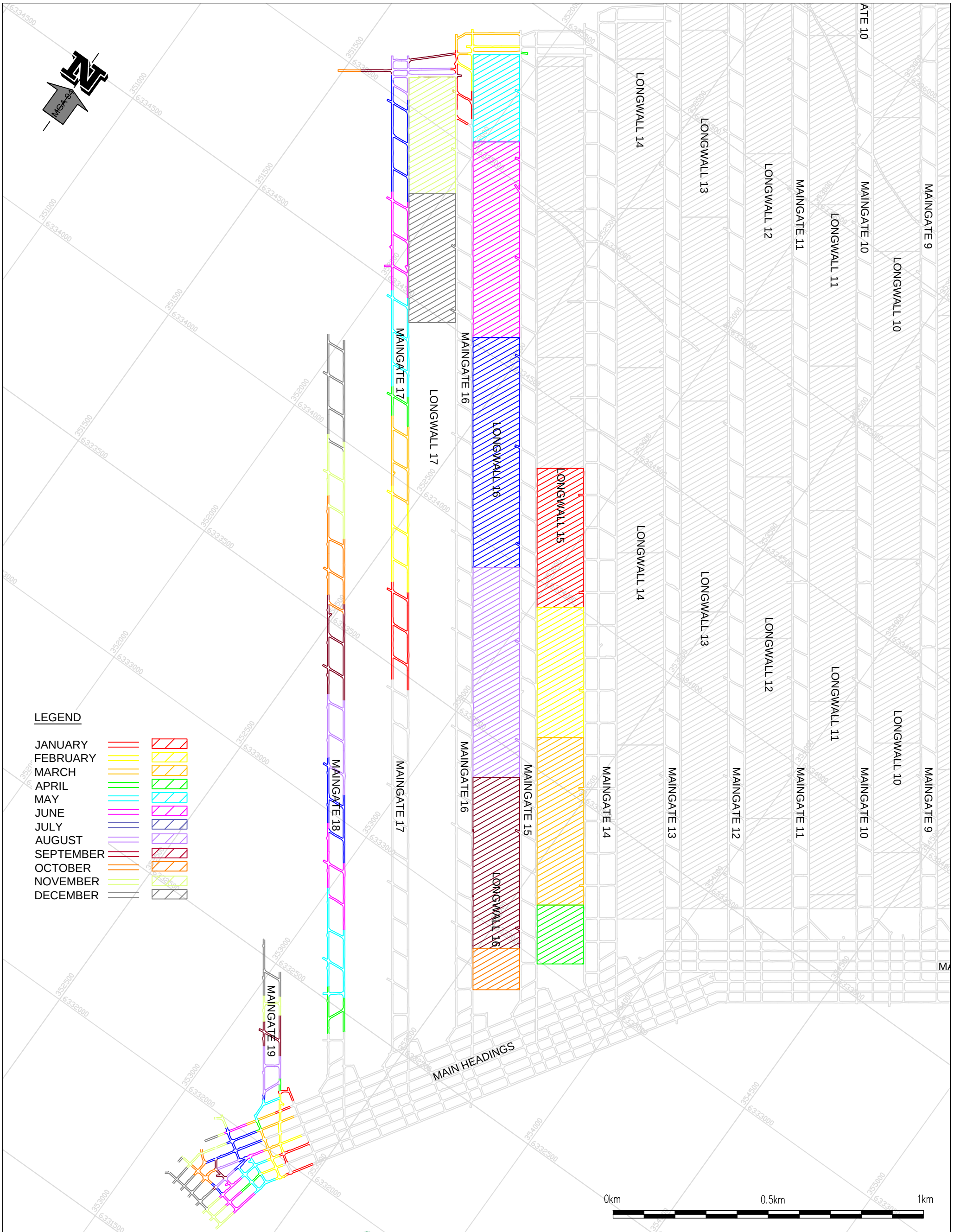
Cooranbong Services Site -
Location of Environmental Monitoring Points

CONTRACT

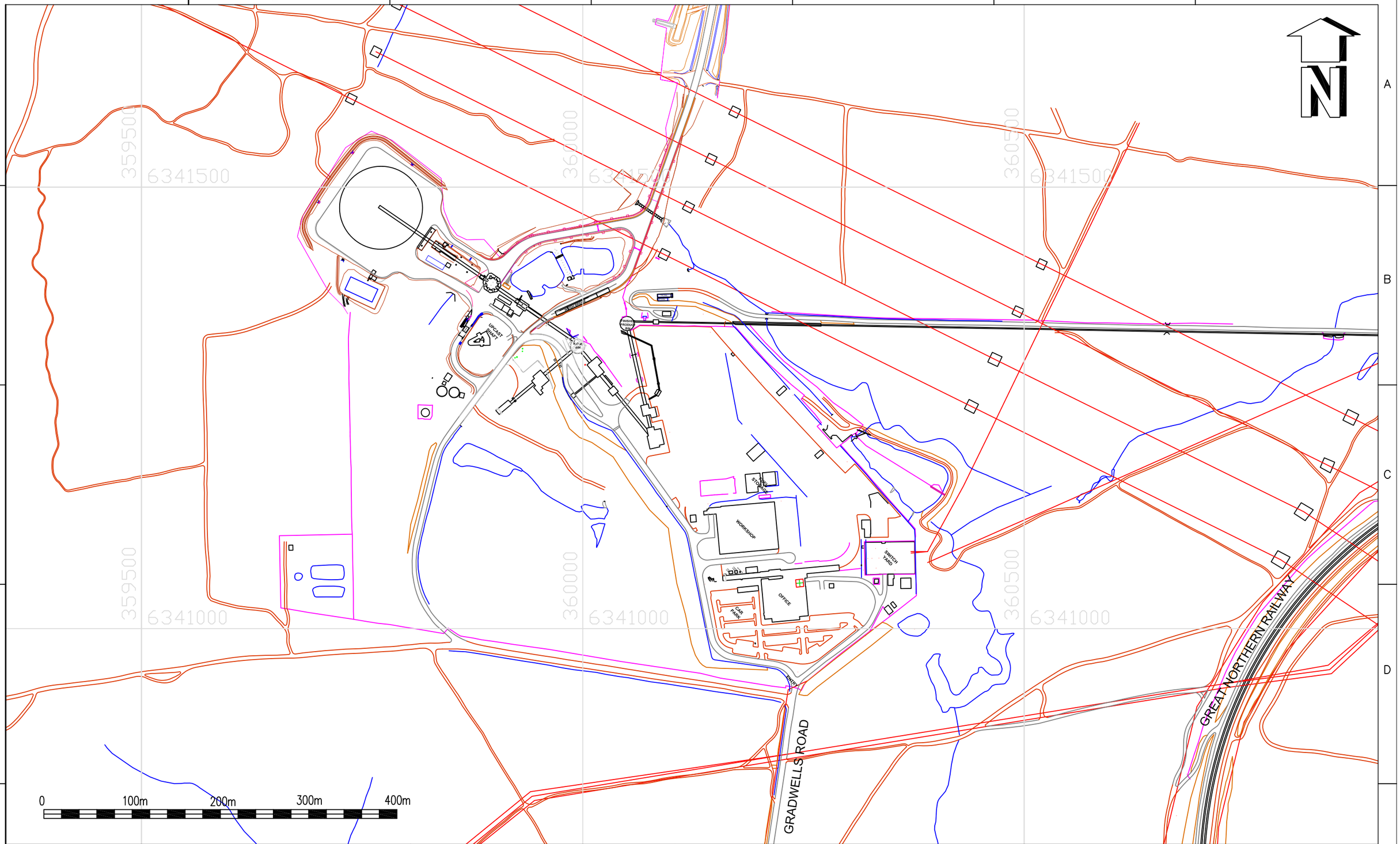
PLOTFILE: MG10722e_rev6.pdf

A3 **MG10722e**

DRAWING REV. 6 - 25.02.2015



	LOCATION	MANDALONG	Centennial Coal Mandalong	CONTRACT No.	
	SEAM	WEST WALLARAH		PLOTFILE No.	MG10815_rev9.pdf
	DRAWN	DH 23.01.2008		A3	MG 10815
	CHECKED		MONTHLY PRODUCTION 2014		
	APPROVED			DRAWING REVISION	9 - 23.01.2015
	SCALE	N.T.S.			



LEGEND

REHABILITATION 2013

REHABILITATION 2014

LOCATION	MANDALONG
SEAM	WEST WALLARAH
DRAWN	JDS 27.02.2014
CHECKED	
APPROVED	

SCALE 1:4000

Centennial Coal
Mandalong

COORANBONG SERVICES SITE - REHABILITATION

CONTRACT

PLOTFILE MG11217_Rev6.pdf

A3 MG11217

DRAWING REV. 7 JDS 25.02.15

APPENDICES