LIDDELL

GLENCORE

Air Quality Management and Monitoring

Plan

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Owner: Environment & Community Officer
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1. Introduction

Liddell Coal Operations (LCO) is an open cut coal mine located approximately 25 kilometres north-west of Singleton, NSW, shown in ***Figure 3-1***Figure 3-1. Liddell is operated by Liddell Coal Operations Pty Ltd, a subsidiary of Glencore Coal Pty Limited (Glencore), on behalf of a joint venture between Glencore (67.5%) and Mitsui Matsushima Australia (MMA).

LCO operates under NSW development consent (DA 305-11-01 Modification 7) and Environmental Protection Licence (EPL No. 2094) administered under the Protection of the Environment Operations Act 1997. Mining operations at LCO are approved until 31 December 2028, with production of up to 8 million tonnes per annum (Mtpa) run-of-mine (ROM) coal from its open cut operations.

2. Purpose

The Air Quality Management and Monitoring Plan (hereafter "AQMMP") is intended to meet statutory requirements, notably development consent conditions as documented in ***Appendix A -.***

The AQMMP has been prepared generally in accordance with ***GCAA HSEC Protocol 11.10 Air Quality Management*** and addresses the goals and objectives relating to air quality and greenhouse gas management contained within the Glencore HSEC Standards.

The AQMMP documents objectives and targets, roles and responsibilities, air pollution mitigation controls and systems, monitoring programs, training requirements and communication and reporting mechanisms required for the management of air quality and greenhouse gas impacts associated with activities at LCO. Reference is made to supporting documentation where necessary, which include operational procedures, in which more detailed work instructions are provided.

Through the implementation of its AQMMP, LCO aims to achieve the following objectives:

- Compliance with all air quality regulatory and permitting requirements at all times.
- Best practice environmental management air quality control measures are employed to reduce the potential for air quality impacts on sensitive receptors.
- LCO's contribution to local and regional dust levels is better understood and managed through the implementation of relocatable boundary monitors.

3. Scope

The AQMMP covers all mining operations undertaken at LCO and incorporates all relevant legislative and other corporate requirements pertaining to air emissions or air quality. It is applicable to all LCO employees and contractors in any capacity, and forms part of the LCO - Environmental Management System (EMS).

This AQMMP addresses primarily air emissions of interest in terms of air quality management, including particulate matter (dust) releases, blast fume and spontaneous combustion emissions. It also provides a description of the measures to be implemented by LCO to mitigate air quality and greenhouse gas (GHG) impacts and to detail air quality and GHG monitoring requirements associated with its operations;

This plan does not address occupational health and safety related monitoring and management.

In order to identify specific air quality and GHG requirements and where they are satisfied within this plan, the Plan has been separated into two parts:

Part 1 - provides the requirements and controls for air quality management at LCO; and

Part 2 - addresses the GHG management at LCO.

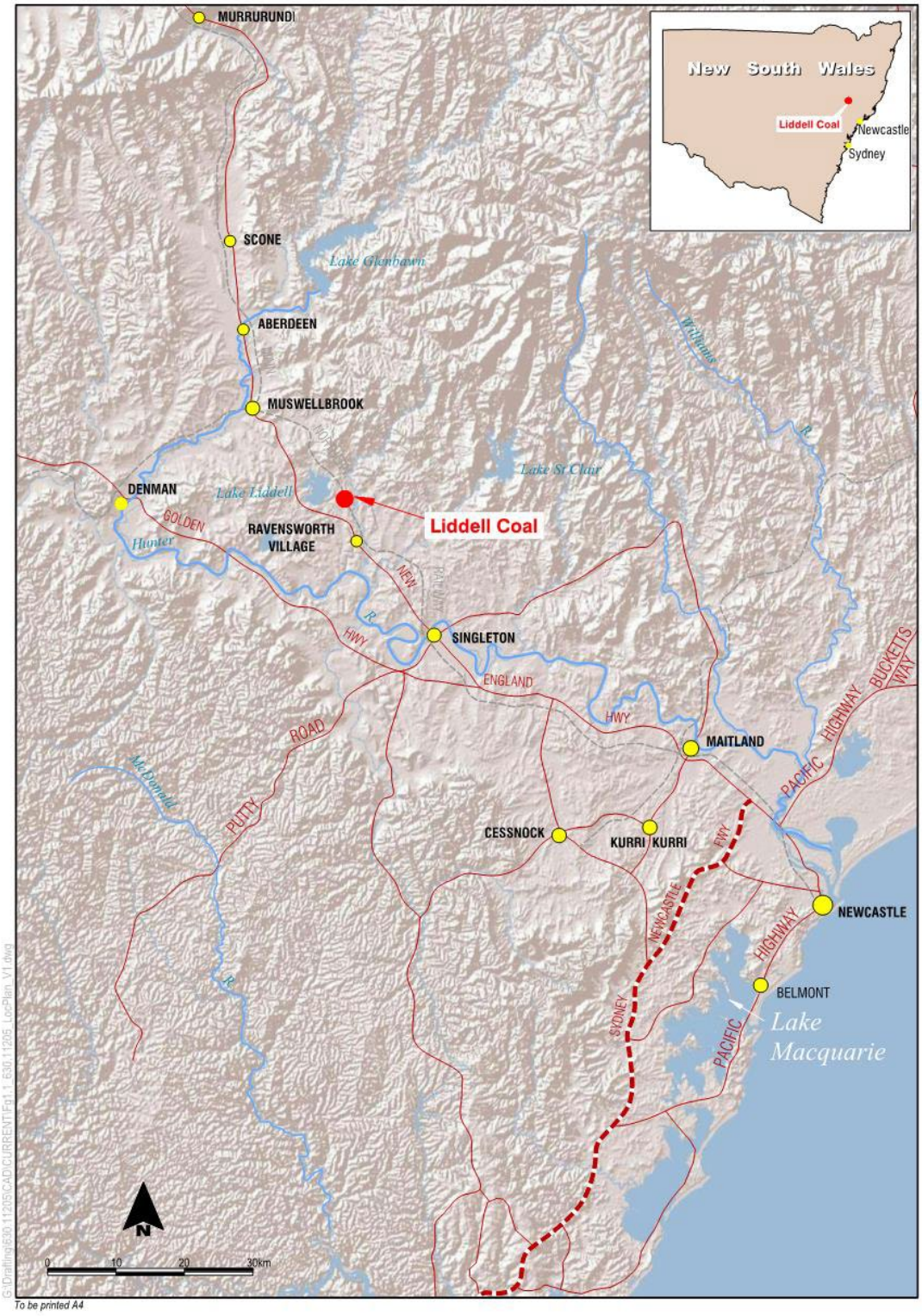

Figure 3-1 - LCO Locality Map

4. Part 1 – Air Quality

4.1 AQMMP Overview

An overview of the AQMMP is given in ***Figure 4-1***. Air Quality Risks related to LCO's operations have been identified based on the site's air emissions inventory documented within the LCO's ***Coal Mine Particulate Matter Control Best Management Practice Determination*** (LCO, 2012) (hereafter "***LCO Particulate Matter BMP Determination Report***").

Taking site-specific air quality risks into account, Objectives and Targets have been devised to address regulatory requirements and Glencore commitments, with due regard for community welfare and expectations.

Air Quality Management Measures include source-specific control measures, including contingency measures implementable in response to adverse conditions, and site-wide management and monitoring measures. Whereas all air quality management measures are listed within this AQMMP, detailed work instructions related to such measures are integrated within relevant site operating procedures, including LIDOC-90533967-2387 – Dust Management Trigger Action Response Plan, (hereafter "Dust Management TARP").

The Monitoring section in this AQMMP details air quality monitoring undertaken to satisfy Schedule 3, Condition 18 for compliance monitoring, in addition to the real-time monitoring system established to support on-going operational air quality management and the supplementary relocatable boundary monitors required under Schedule 3, Condition 19. The monitoring section of this AQMMP additionally details the requirements for Particulate Matter Monitoring as per M2.2 of Environmental Protection Licence 2094.

Supporting Systems and Procedures include a roles and responsibilities matrix, incident and complaint management systems, and awareness and training programs.

Air quality related reporting includes the compilation of monthly monitoring reports which are made available on the LCO website, air quality related inputs for the Annual Review, EPL Annual Return Report, and National Pollutant Inventory (NPI) reporting.

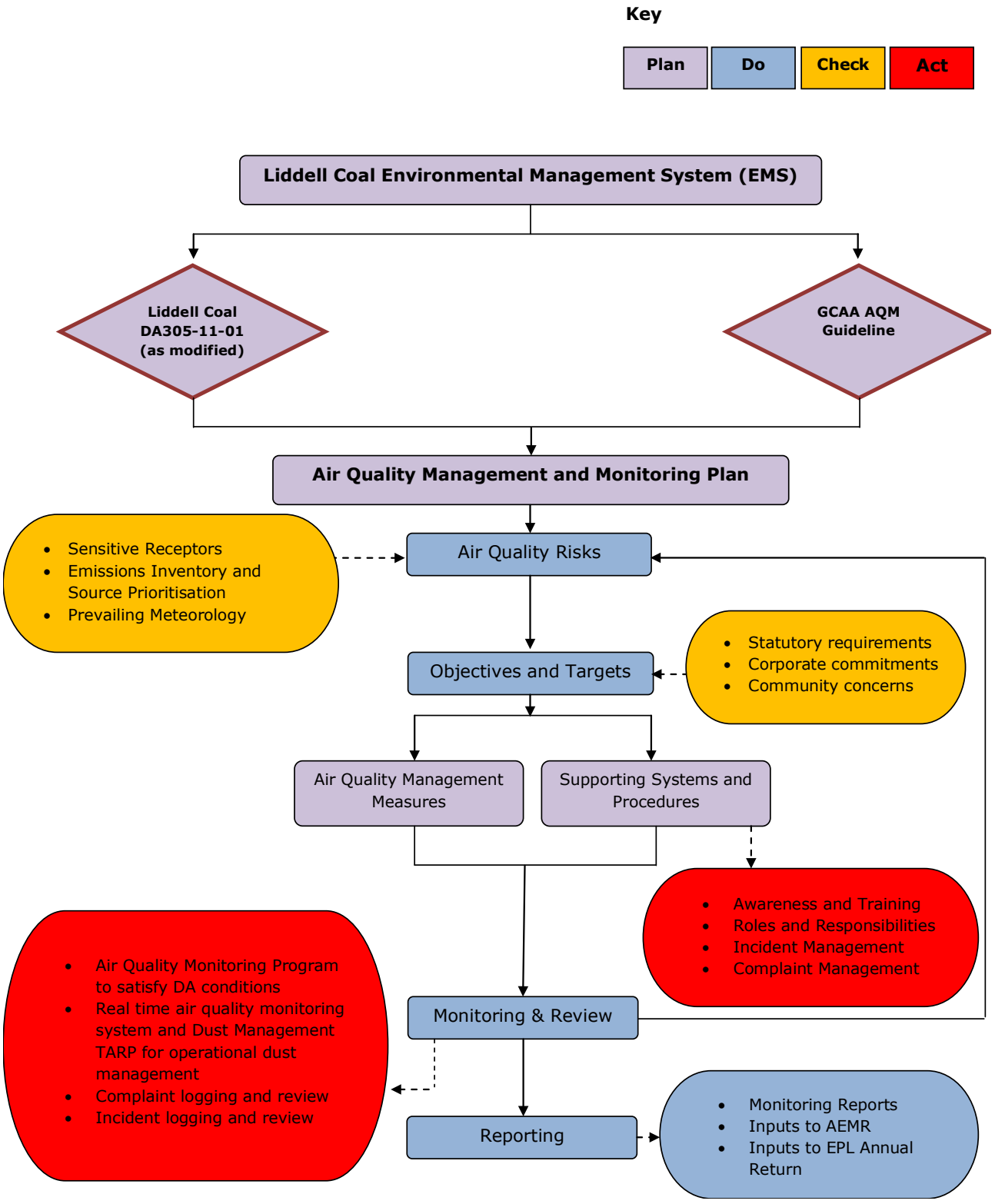

Figure 4-1 - Overview of LCO - Air Quality Management and Monitoring Plan

4.2 Commitments and Statutory Requirements

Key regulatory requirements and corporate commitments of relevance to air quality management at LCO are as follows:

Regulatory Requirements:

- ***LCO Development Approval (DA) 305-11-01 Modification 5*** issued under Part 3A of the ***Environmental Planning and Assessment Act 1979*** (EP & A Act) Sections 76(A) 9 & 80. Consent conditions specified in the DA pertaining to air quality and relevant sections of the AQMMP addressing those conditions are detailed in ***Appendix A -***.
- ***Environmental Protection Licence (EPL) No. 2094*** which specifies requirements for air quality monitoring.

Corporate Commitments:

- GCAA HSEC Standard ***GCAA-625378177-9978 – 11.0 Environment and GCAA-625378177-10324 – 11.10 Air Quality Management Protocol***. These outline source-specific and site-wide measures which are required to be implemented by LCO to meet corporate commitments.

4.3 Air Quality Criteria

As specified in Schedule 3, Condition 16 (***Appendix A -***) of the Development Consent (DA 305-11-01), LCO is required to ensure that dust emissions generated by the development do not exceed the impact assessment criteria listed in ***Table 4-1*** and ***Table 4-2*** at any residence on privately owned land.

Table 4-1 - Impact Assessment Criteria for Particulate Matter

Pollutant	Averaging Period	[d] Criterion (µg/m³)	Source
Total suspended particulate (TSP) matter	Annual	[a]90	Table 3 and 4, Condition 16 of Schedule 3, DA 305-11-01.
Particulate matter <10 µg (PM_{10})	24 hour	[b]50	
	Annual	[a]30	

Table 4-2 - Impact Assessment Criteria for Deposited Dust

Pollutant	Averaging Period	Maximum Increase in Dust Deposition	Maximum Total Deposited Dust Level	Source
Deposited dust	Annual	[b]2 g/m²/month	[a]4 g/m²/month	Table 5, Condition 16 of Schedule 3, DA 305-11-01.

Notes:

(a) Total impact (i.e. incremental increase in concentrations due to the development plus background concentrations due to all other sources;
(b) Incremental impact (i.e. incremental increase in concentrations due to the development on its own);
(c) Deposited dust is to be assessed as insoluble solids as defined by Standards Australia, *AS/NZ3580.10.2003: Methods for Sampling and Analysis of Ambient Air Determination of Particulate Matter – Deposited Matter – Gravimetric Method; and*
(d) Excludes extraordinary events such as bushfires, prescribed burning, dust storms, fire incidents or any other activity agreed by the Secretary.

4.4 Compliance and Implementation Targets

In implementing the AQMMP, LCO continues to work towards the following specific targets:

1. Meeting ambient TSP, PM10 and dust deposition criteria (***Section 4.3***) at compliance monitoring stations (***Section 4.11.3)***.
2. Achieve a 100% data completeness for compliance dust deposition and HVAS monitoring stations.
3. Achieve 90% data availability for real-time monitors (TEOMS and EBAMS).
4. On-going implementation of a Dust Management TARP, informed by real-time air quality and meteorological monitoring.
5. Achieve an average haul road dust control efficiency of >80 %. The method for measuring haul road dust control efficiency is specified in the EPL PRP Monitoring Plan 2013.
6. Reduce the overall site disturbance footprint through progressive rehabilitation, with a particular focus on reducing the overall area of site disturbance in the short to medium term.

4.5 Local Environment

Local environmental conditions with direct implications for air quality management include the prevailing meteorology, background air quality and location of sensitive receptors in relation to LCO activities.

4.5.1 Neighbouring Land Use and Sensitive Receptors

XThe area surrounding LCO is dominated by power generation and mining activities, with some agricultural activities and scattered residential settlement. Neighbouring operations include Ravensworth Surface Operations and Hunter Valley Operations to the south, Ravensworth Coal Terminal and Ravensworth Underground Mine to the south-west, the Mt. Owen Complex to the east, and Liddell and Bayswater power stations to the west. A number of other mining operations are situated in the Upper Hunter region.

There are fifteen nearby private dwellings, four of which are located to the north-west of LCO with the nearest dwelling situated about 1.8km from the boundary across Lake Liddell. The remaining private dwellings are situated within the Bowmans Creek valley to the north-east of LCO, with the nearest occupied dwelling located approximately 3.5km from LCO's closest mining and dump footprint.

Land ownership in the vicinity of LCO is shown in ***Figure 4-2***.

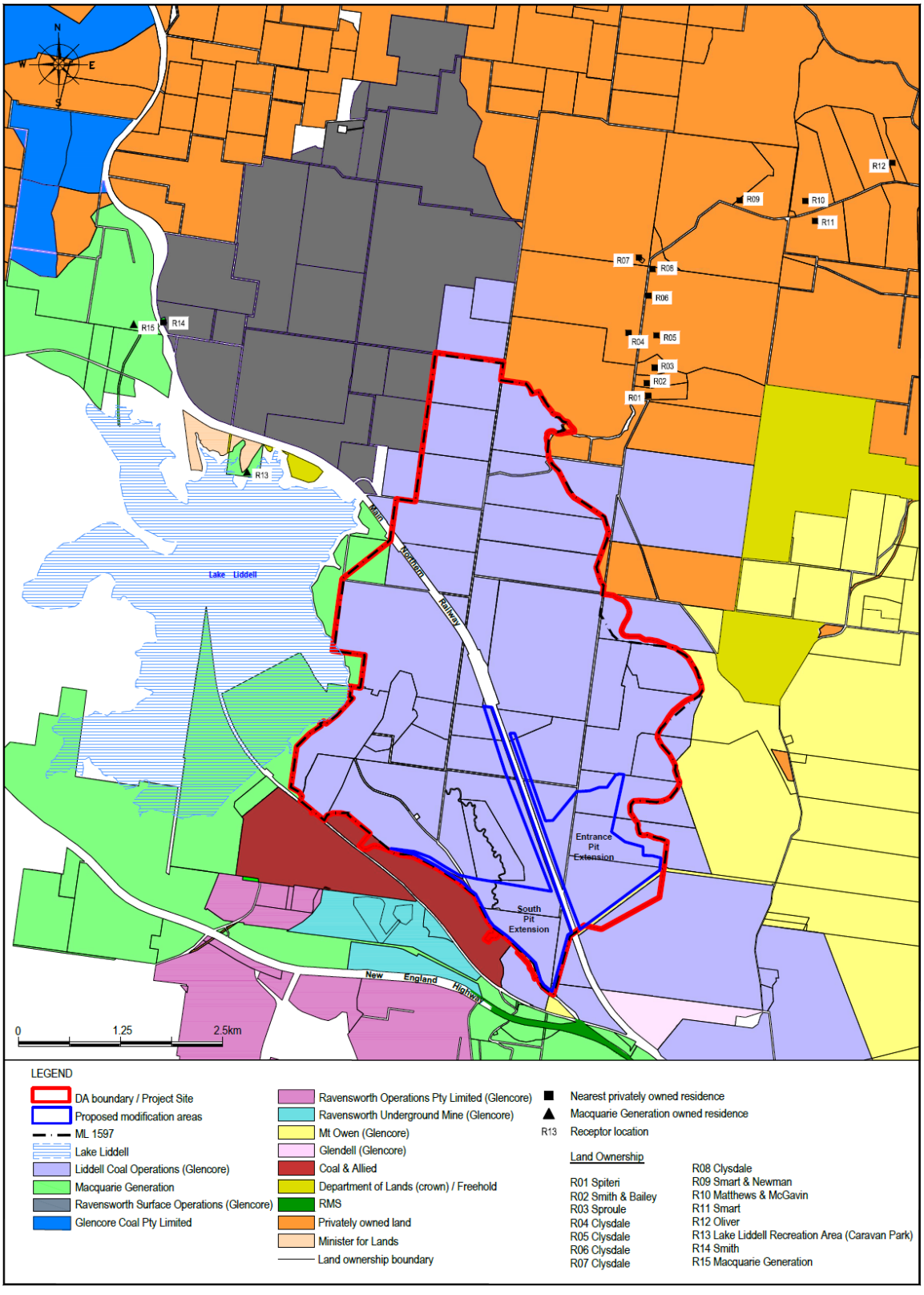

Figure 4-2 - Land ownership surrounding the LCO Development Consent Boundary

4.6 Adverse Meteorological Conditions

The generation, dispersion, transformation and eventual removal of pollutants from the atmosphere is dependent on the prevailing meteorology. Meteorological conditions identified as being conducive to increased air pollutant concentrations from site operations are termed 'adverse meteorological conditions'. Such conditions are more generally described in this section of the AQMMP, with a detailed description of site-specific adverse meteorological conditions being given within the Dust Management TARP.

Reference is made to climate records from the Bureau of Meteorology's Jerrys Plains Post Office Weather Station and to meteorological and air quality monitoring data from LCO and neighbouring Glencore mine site monitoring stations. Such stations include:

- LCO's Meteorological Station
- Two continuous PM_{10} and meteorological monitoring stations (SX38M1 and SX38M2)
- Mt Owen Complex's continuous PM_{10} and meteorological monitoring stations (SX8 Hebden Road; SX13 Glendell Reference Monitor)
- Ravensworth Operations' continuous PM_{10} and meteorological monitoring stations; and
- Ravensworth Operations' Narama Meteorological Station.

Further information on LCO's continuous monitoring stations is provided in ***Section 4.11.5***.

4.6.1 Dry, Windy Conditions

Dust generation rates are particularly dependent on wind energy and the moisture content, which is a function of rainfall and evaporation rates. Dry, high wind conditions are conducive to increased emissions and resultant elevated particulate matter concentrations at receptors located downwind of the mine site.

Wind speeds greater than about 5 m/s are indicative of periods with higher wind erosion potentials. Based on 5-minute average data from the LCO Meteorological Station recorded during 2011, wind speeds in excess of 5 m/s are recorded to occur approximately 16.7% of the time annually. Strong wind occurs more frequently during June, July, September and in Summer months (***Figure 4-3***).

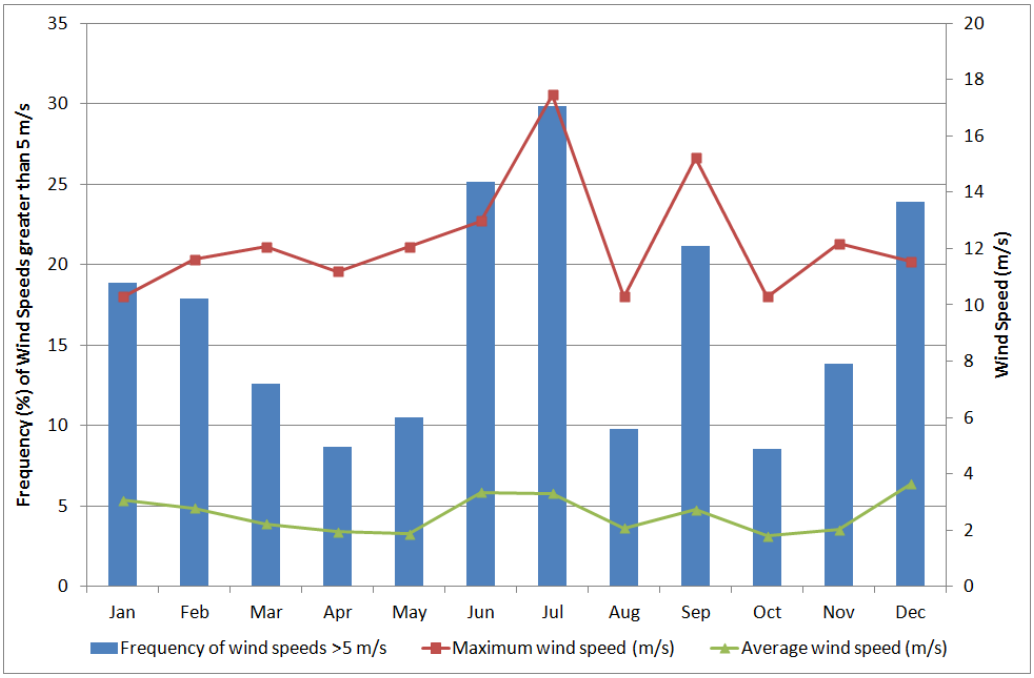

Figure 4-3. Frequency of Wind Speeds greater than 5 m/s and Maximum and Average Wind Speeds by Month for LCO Monitoring Station, 2011

Wind direction affects the path air pollutants will follow when dispersing from the site. Annual wind roses, depicting recorded wind speed and direction data at Glencore monitoring sites in the area for 2011, are presented in ***Figure 4-4***. Annual and seasonal wind roses for LCO monitoring stations are given in **Appendix B**.

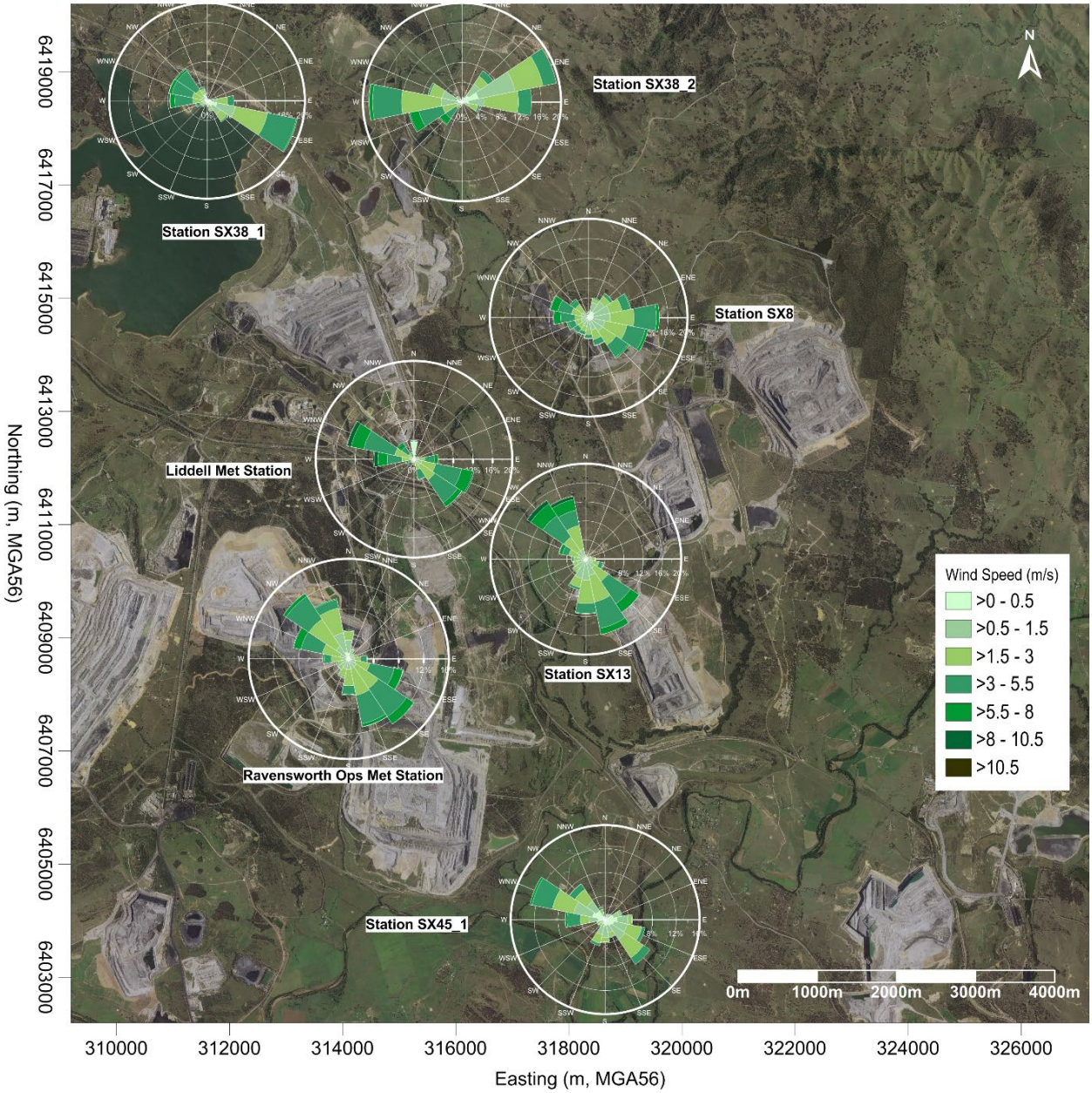

Figure 4-4: Annual wind roses for LCO and neighbouring monitoring stations - 2011

Influenced by regional airflows and the local terrain, airflow patterns in the region are generally dominated by winds from the south-eastern and north-western quadrants. Airflow from the south-eastern quadrant dominates during summer, with airflow from the north-western quadrant prevailing during the winter. More varied airflow patterns are characteristic of autumn and spring months with both flow components prevalent during these seasons.

Differences in the airflow measured across stations are due to local terrain features. The airflow at SX38M2 is notably different to other stations, likely due to the channelling effect of the river valley within which it is located.

The long term (1884-2012) annual average rainfall in the region is 644.3 mm, with an average of 67.7 rain days per year. Significant inter-annual variations in rainfall are apparent, with total annual rainfalls recorded to vary between about 230 mm and 1190 mm. Rainfall occurs throughout the year, with higher total rainfall amounts recorded during summer months, particularly during the December to February period, as shown in ***Figure 4-5.*** Despite recording similar numbers of rain days, lower monthly rainfall amounts occur during the winter.

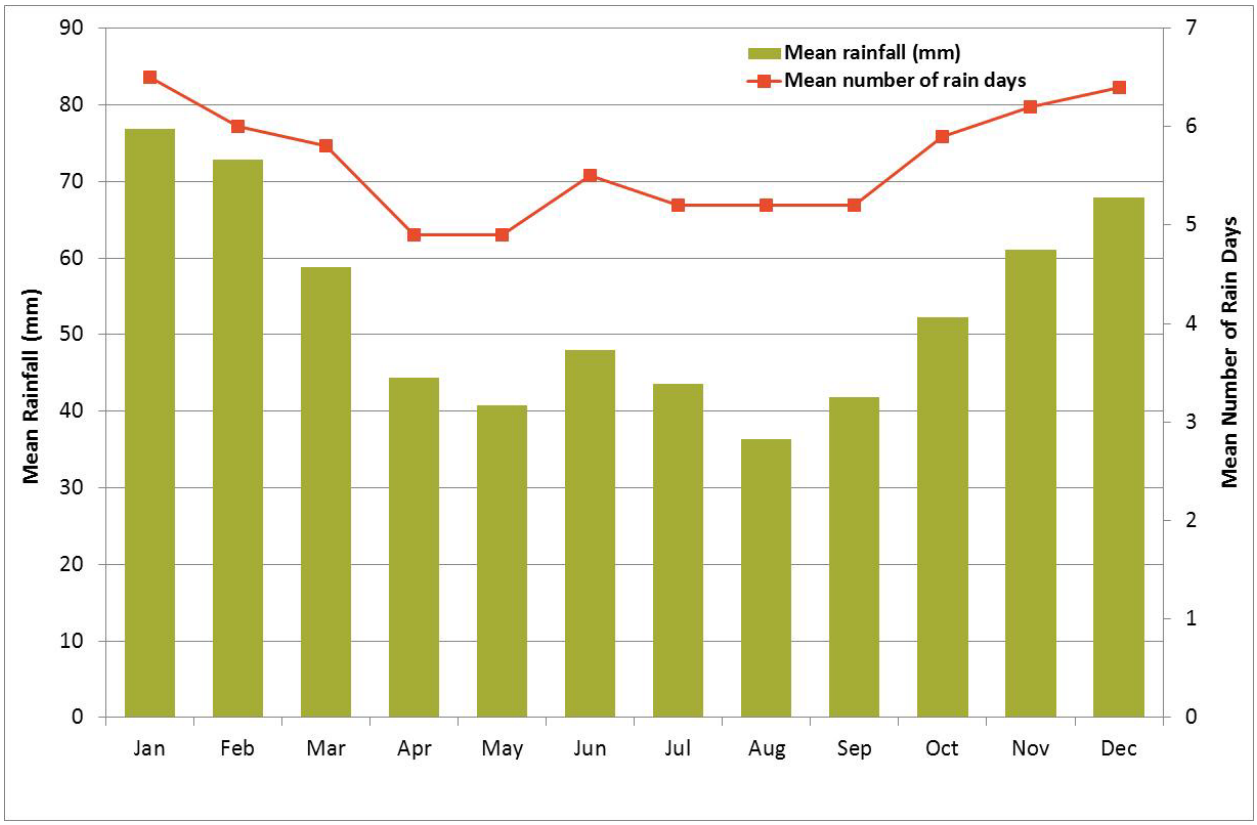

Figure 4-5 - Long term average (1884 – 2012) monthly variations in rainfall as recorded at the Bureau of Meteorology (BoM) Jerrys Plains Post Office Weather Station

Evaporation exceeds rainfall during all months of the year, with the greatest moisture deficit estimated to occur during summer, and in particular during the November to January period (***Figure 4-6***). The increase in rainfall during the summer is offset by increased evaporation rates due to greater levels of incoming solar radiation. The higher moisture deficit experienced during the summer is associated with greater dust erosion potentials and therefore holds relevance for fugitive dust control.

The effect of the increased frequency of high winds in June and July is partially offset by the lower moisture deficits characteristic of winter months.

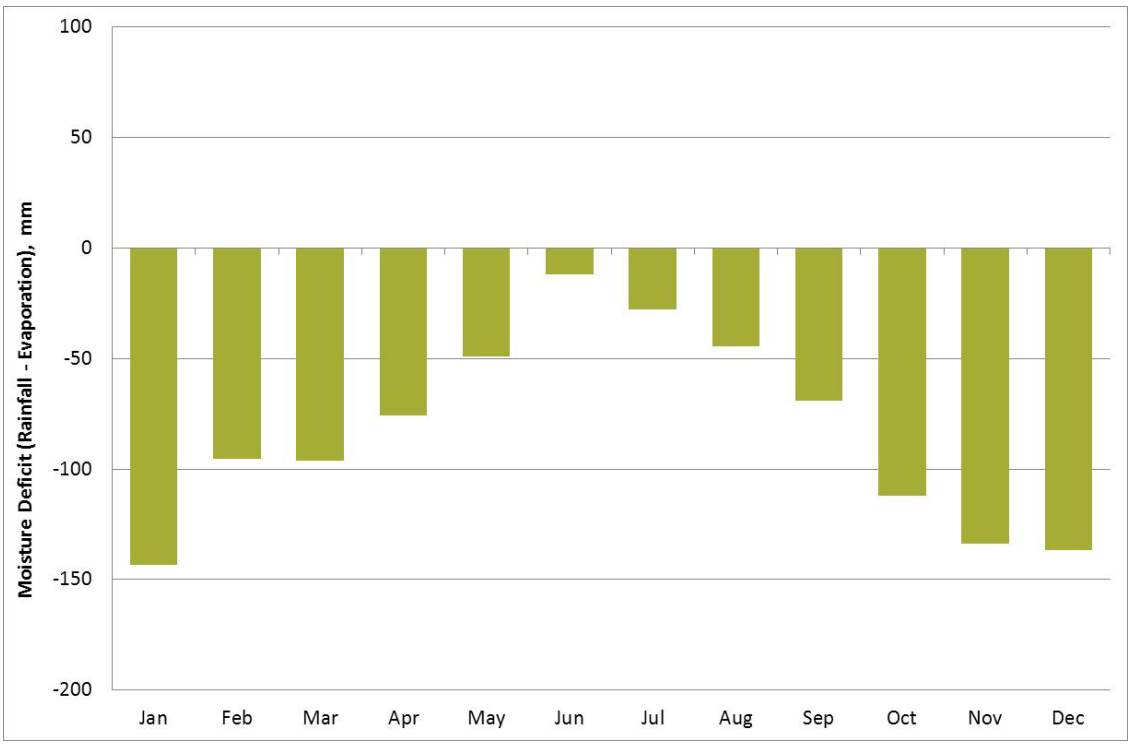

Figure 4-6 - Monthly moisture deficit based on long term average (1884–2012) rainfall and evaporation data from the Bureau of Meteorology Jerrys Plains Station

4.6.2 Low Winds and Mixing Depths

The potential for off-site air quality impacts due to mining sources is not limited to high wind conditions. Non-wind dependent emission from sources such as wheel generated dust and blasts may result in high particulate concentrations during low wind and stable atmospheric conditions, particularly when vertical mixing depths are restricted.

The mixing depth is a function of the vertical ambient temperature profile and occurrence of temperature inversion conditions. Mixing depths are more limited during the night-time and early morning, increasing during the day due to convective mixing driven by solar radiation.

4.7 Regional Air Quality

Air quality within the Hunter Valley region is affected by a wide range of local and geographically remote sources including:

- Coal mining activities;
- Coal fired power stations;
- Exhaust emissions from vehicles and locomotives;
- Fugitive dust emissions from agricultural activities;
- Vehicle entrained dust emissions from agricultural activities;
- Wind erosion of open areas, particularly during high winds;
- Domestic wood heating, principally during the winter months;

- Episodic emissions from vegetation fires;
- Biogenic sources (e.g. pollens and spores); and
- Long – range transport of pollutants from sources situated outside the region (bushfires, dust storms, large industrial sources, sea salt).

Particulate matter emitted is classified for air quality management purposes into the following particle sizes:

- TSP - total suspended particulates;
- PM_{10}- particulate matter with an equivalent aerodynamic diameter of less than 10 micrometres; and
- $PM_{2.5}$ - particulate matter with an equivalent aerodynamic diameter of less than 2.5 micrometres

NSW-OEH (now the Department of Planning, Industry and Environment – Biodiversity Conservation Division) prepared a compendium of air quality monitoring data from a number of industry monitoring sites for the period 2005-2009 to characterise the air quality within the Hunter Valley (OEH, 2011)[1]. Exceedances of ambient air quality criteria in the Hunter Valley are primarily associated with particulate matter (PM_{10}, $PM_{2.5}$) and sulphur dioxide. Sulphur dioxide incidents measured are typically restricted to exceedances of short-term (≤1-hour average) air quality criteria at sites impacted by power station stack emissions. Maximum daily average PM_{10} concentrations have typically been recorded in the range of 40 µg/m³ to 140 µg/m³, with exceedances of the 24-hour criterion of 50 µg/m³ recorded to be in the range of 0 to 10 days per year (OEH, 2011). Annual average PM_{10} concentrations have been recorded in the range of 15 µg/m³ to 35 µg/m³, with the annual air quality criterion of 30 µg/m³ marginally exceeded at some monitoring sites (OEH, 2011).

Annual average PM_{10} concentrations measured across LCO compliance monitoring stations (high volume PM_{10} sampling stations on privately owned land) for the period July 2010 to December 2014 were in the range of 11 µg/m³ to 19 µg/m³ as documented in the LCO 2014 AEMR. There were no exceedances of the 24-hour criterion of 50 µg/m³ during the 2014 reporting year.

4.8 Source Prioritisation

Source prioritisation has been undertaken for mining activities at LCO resulting in air emissions, and ranking the significance of such sources based on the extent of the emissions. In undertaking the source prioritisation, LCO commissioned ERM to undertake a review for the operation as mining progresses at LCO to determine emissions inventory. This ERM study estimated the TSP, PM_{10} and $PM_{2.5}$ emissions (kg/y) for 2021 mining operations at LCO (***Figure 4-7***) as the peak production year prior to decline towards planned closure in 2023.

Taking 2021 LCO mining operations and dust management measures into account, the top five sources of TSP, PM_{10} and $PM_{2.5}$ emissions were identified, as listed in ***Table 4-3***.

Table 4-3 - Top Five Particulate Matter Sources for 2021 Mining Operations at LCO

Source Ranking	Source Details
1	Wheel generated dust by haulage (for TSP, PM_{10} and $PM_{2.5}$ emissions)
2	Dozers on waste dumps (for TSP, PM_{10} and $PM_{2.5}$ emissions)

1 NSW OEH, *Compendium of Upper Hunter Ambient Air Quality Monitoring Data*, Review of Upper Hunter Air Quality Data, 2011

Source Ranking	Source Details
3	Loading / dumping of overburden (for TSP, PM_{10} and $PM_{2.5}$ emissions)
4	Loading / dumping coal (for TSP, PM_{10} and $PM_{2.5}$ emissions)
5	Dozers on ROM pad (for TSP, PM_{10} and $PM_{2.5}$ emissions)

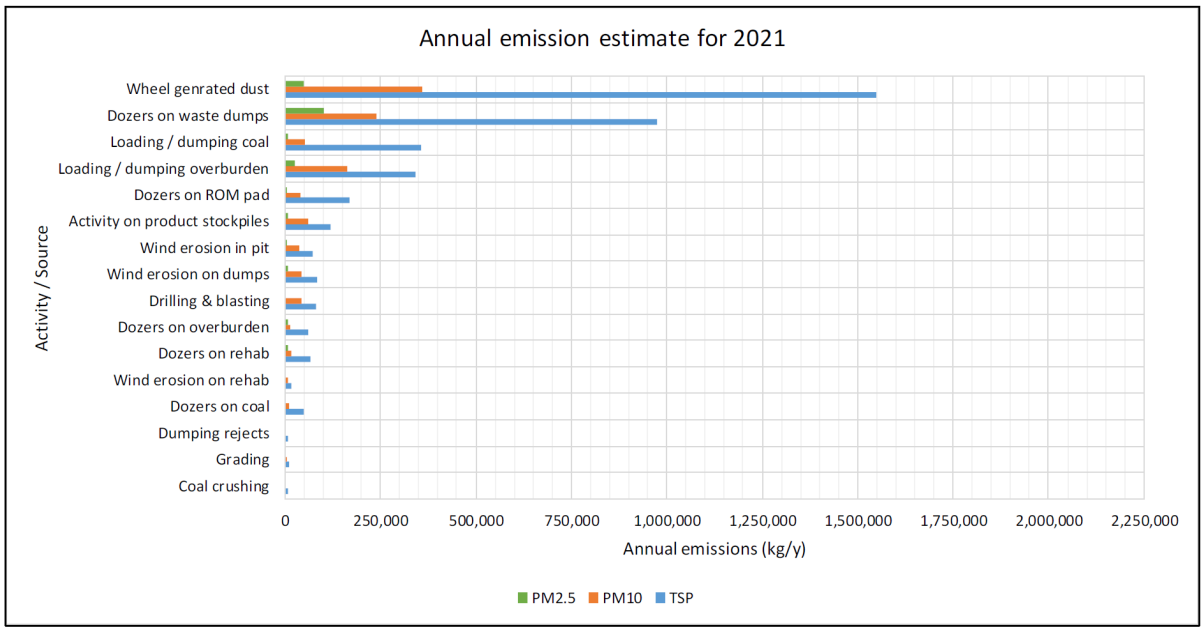

Figure 4-7: Annual TSP, PM_{10} and $PM_{2.5}$ controlled emissions estimated from 2021 mining activities at LCO

The ***ERM - Summary of estimated emissions for Liddell Coal Mine, 2021*** determined there to be a decrease in the 2021 emissions estimates when compared to those calculated in the Modification 5 EA.

Source rankings and emissions estimates inform revisions of the AQMMP, to ensure air quality management and monitoring continues to address significant sources of air emissions.

4.9 Air Quality Management Measures

4.9.1 Overview of Measures

Air quality management at LCO includes a combination of the following types of measures:

- Engineering Controls (e.g. enclosure of conveyors);
- Source specific control measures routinely implemented (e.g. road dust suppression); and
- Contingency measures implemented during periods of high particulate matter concentrations or adverse meteorological conditions, such as modification or ceasing of operations.

The need for contingency measures is triggered by visual monitoring and alerts from the real time operational monitoring and forecast systems as prescribed in the ***LCO Dust Management TARP (LIDOC-90533967-2387)***.

Source-specific measures, including contingency actions taken in response to adverse conditions, are documented in ***Section 4.9.2***. Site-wide management measures applicable across all operations at LCO are summarised in ***Section 4.10***.

4.9.2 Overview Source – Specific Air Pollution Control Measures

Source-specific air pollution control measures currently implemented at LCO are listed in ***Table 4-4*** by source type with reference made to procedural documents where applicable.

Table 4-4 - Source-specific air pollution management measures implemented at LCO

Activity / Source	Management Measures
Haulage Operations	Measures to control dust emissions from haulage are documented within: • LCO Particulate Matter BMP Determination Report • Dust Management TARP (LIDOC-90533967-2387) • Dust Suppression & Road Watering (LIDOC-90533967-2843) • Airborne Contaminants (LIDOC-90533967-1) Measures implemented are as follows: • Trafficable areas are clearly identified and kept to a minimum. • Obsolete roads are ripped and revegetated. • Permanent roads are constructed from hard non-friable material and have defined marker posts to prevent vehicle deviations. • Gravel surfacing is applied across all of the major haul roads on site during construction, with resurfacing as necessary. • Development of construction roads is limited and the locations of these clearly defined as required. • Major haul roads are maintained in a damp condition through sufficient watering to prevent dust generation, as specified in Dust Suppression & Road Watering (LIDOC-90533967-2843) • Application of a chemical surfactant on major haul roads (~32 km of haul road) and other ancillary roads as deemed appropriate during period of prolonged extreme weather conditions (hot dry, windy low rainfall periods). • Other trafficable areas that are in regular use during a shift are maintained in a damp condition through sufficient watering to prevent dust generation. This applies, in particular to: – the precinct of the ROM pad; – secondary ROM stockpiles; – maintenance areas; and – other major roads on site. • Vehicles are required to remain within identified trafficable areas unless there is a valid reason to travel outside of them. • Vehicles are required to operate at speeds which avoid the generation of excessive dust. • Any split coal is graded off the road surface as soon as possible, so as to minimise the chance of coal fines and dust being generated. Graded coal is pushed into a heap, where it is recovered before processing. • Tracks used by topsoil stripping equipment during their loading and unloading cycle are watered.

Activity / Source	Management Measures
	• Water cart operators are briefed on the main areas that require watering before each shift commences. If it becomes necessary to alter the watering program during a shift, instructions are provided by radio to the water cart operator. • Water cart filling stations with adequate water quantities and pumping facilities are established and maintained at locations convenient to the operations of the mine. • Haul activities are modified or ceased in response to visual triggers or measured/predicted adverse conditions, as specified within Dust Management TARP (LIDOC-90533967-2387). • . Actions that may be taken depending on the level of the trigger include: – Truck Operator to reduce speed and notify water cart operators for additional dust suppression. – Limit grading activities. – Reduce haul distance if possible. Shut non-essential roads. – Cease hauling operations until water cart operator has advised roadway is adequately watered. • All construction vehicle operators are made aware by signage (where practicable) and the induction process of speed limits that apply at LCO. • Excess mud is removed from vehicles before entering public roads from the site.
Topsoil Management and Stockpiles	Measures implemented to control dust emissions from topsoil handling and stockpiling are documented within: LCO Particulate Matter BMP Determination Report Land Clearing & Topsoil Stripping (LIDOC-90533967-506) Airborne Contaminants (LIDOC-90533967-1) Management measures include: *Topsoil Stripping*: Depth of stripping is determined in accordance with a soils distribution plan and specified in the land clearing plan. Topsoil stripping is limited where possible to 100 metres in advance of mining. *Loading Topsoil*: Loading of topsoil is carried out using small excavators or loaders. Haulage routes are identified and traffic control measure implemented. Loading areas are watered by water carts including piles of soil to minimise excessive dust. Clearing and loading of topsoil is minimised or ceased during adverse conditions, in response to visual triggers or alerts from real time and predictive monitoring systems, as provided for within the Dust Management TARP (LIDOC-90533967-2387). *Topsoil Stockpiling*: Topsoil stockpiles are located away from mining, traffic areas and watercourses so as to minimise disturbance.

Activity / Source	Management Measures
	Level or gently sloping areas are selected as stockpile sites to minimise erosion and potential soil loss. Drainage from higher areas is diverted around stockpiles and appropriate sediment controls installed at the base of stockpiles where required. Stockpiles are generally less than three metres high. Stockpiles to be kept for more than three months are sown with a suitable cover crop to minimise erosion. Stockpiles are appropriately sign-posted to identify the area and minimise the potential for unauthorised use or disturbance. Dust screens and stabilising agents are used on construction material stockpiles containing fine material as required.
Exposed Areas-General	Measures to control dust emissions from general exposed areas and overburden emplacement areas (OEAs) are documented within: • LCO Particulate Matter BMP Determination Report • Land Clearing & Topsoil Stripping (LIDOC-90533967-506) • Airborne Contaminants (LIDOC-90533967-1) Management measures include: • Minimising areas disturbed by mining activities. • Prompt, progressive rehabilitation of disturbed areas following completion of mining. • Temporary rehabilitation of cleared, unmined areas to assist in dust control. • Revegetation activities are generally undertaken in spring and autumn; however, opportunistic revegetation may be practised if areas become available for sowing in summer and winter. After surface soil amelioration and tillage is completed for any given area, revegetation commences as soon as possible. • Revegetation techniques are continually developed and refined over the life of the mine through a continual process of research, trialling, monitoring and improvement. • All rehabilitation campaigns are recorded using the Rehabilitation Establishment and Methodology Record. • Annual monitoring undertaken in line with the GCAA Rehabilitation Planning and Management guideline, utilising the Annual Rehabilitation Inspection (Walkover Form). • Periodic rehabilitation inspections and audits are undertaken by external, third parties, with progress against rehabilitation objectives assessed. • Establishment and implementation of a procedure for identifying areas for temporary (interim) stabilisation. Identification procedure along with rehabilitation techniques are annually reviewed within the LCO Annual Review.
Material Extraction and Dumping – General,	Management measures implemented at LCO to control dust emissions from material extraction and dumping are documented within: • LCO Particulate Matter BMP Determination Report

Activity / Source	Management Measures
Truck and Shovel,	• Dust Management TARP (LIDOC-90533967-2387) • Airborne Contaminants (LIDOC-90533967-1) Management measures include: • Provision of in-pit dumping locations for periods of high winds, where practicable. • Dust control measures including the use of water sprays, minimising drop heights when handling soil and overburden and avoiding double handling of materials are employed wherever practicable. • Modifying (e.g. sheltered dumping) or ceasing excavation and tipping activities if excessive dust is observed. Visual triggers and corresponding actions/responses for dumping activities have been defined in the Dust Management TARP (LIDOC-90533967-2387). • Contingency measures implemented in response to alerts from the real time and predictive monitoring systems, as provided for within the Dust Management TARP (LIDOC-90533967-2387).
Coal Handling Stockpiling and Load out	Management measures implemented to control dust emissions from coal handling are documented within: • LCO Particulate Matter BMP Determination Report • Dust Management TARP (LIDOC-90533967-2387) • Airborne Contaminants (LIDOC-90533967-1) Management measures include: • Water sprays are applied at the ROM coal stockpile area. Sprinkler systems operated so as to ensure dust is suppressed during adverse meteorological conditions. Excessive watering of stockpiles is however avoided to minimise the potential for contaminated runoff. • Areas around the ROM coal stockpile area are maintained in a damp condition, particularly during dry and windy weather. • Particular attention is paid to dust suppression during stockpiling of dry, dust ROM coal. • Water sprays are applied at the ROM coal hopper. Hopper is level with the ground. • ROM coal conveyors and transfers are enclosed. Shielding on conveyors and other coal handling equipment is maintained in good condition to contain dust generated during coal handling. • Product coal conveyors and transfer points are equipped with water sprays and enclosed. • Conveyors are cleaned and inspected regularly to such that dust is not being generated by spillage, particularly at transfer stations between conveyors. • Spillage from conveyors is cleaned up promptly. • Train loading is partially enclosed with water sprays in operation. • Regular dust inspections are carried out and coal excavation and tipping activities may be ceased or modified if excessive dust is observed. • Contingency measures are implemented in response to visual triggers or alerts from the real time and predictive monitoring systems, as provided for within the Dust Management TARP (LIDOC-90533967-2387).

Activity / Source	Management Measures
Material Crushing and Screening	Dust controls for material crushing and screening are documented within: • LCO Development Application Consent Conditions • Coal Mine Particulate Matter-BMP Determination Study. • Dust Management TARP (LIDOC-90533967-2387) • Airborne Contaminants (LIDOC-90533967-1) Management measures include: • Coal crushing operations are enclosed with water sprays implemented. Crusher sprays are activated when the crushers are in operation. • In-pit mobile gravel crushing units operate water sprays during operation. • In-pit crushing activities are modified or ceased in response to visual triggers or measured/predicted adverse conditions, as specified within the Dust Management TARP. Actions that may be taken depending on the level of the trigger include: – Additional water suppression. – Change material type. – Checking dust suppression system for operational issues and maintenance requirements. – Ceasing of operations until the dust suppression system is operable and weather conditions permit.
Reject Handling	Management measures implemented at LCO to control dust emissions from reject handling are documented within: • LCO Particulate Matter BMP Determination Report • Airborne Contaminants (LIDOC-90533967-1) Management measures include: • Reject conveyors and transfer points are partially enclosed (roof and one side). • By its nature, Reject material is wet as a result of the coal washing process.
Dozer Operations on Coal and Overburden	Management measures implemented at LCO to control dust emissions from dozer operations on coal and overburden are documented within: • LCO Particulate Matter BMP Determination Report. • Dust Management TARP (LIDOC-90533967-2387) Management measures include: • Contingency actions are implemented in response to visual triggers or alerts from the real time and predictive monitoring systems, as provided for within the Dust Management TARP (LIDOC-90533967-2387). Depending on the level triggered, actions may include: – Limiting dozer operations to the leeward side of areas – Reducing material drop height – Ceasing non-essential activities – Limiting travel speeds – Watering of work areas where practical – Ceasing operations

Activity / Source	Management Measures
Blasting	Management measures to reduce air quality impacts from blasting are documented within: • Blast Management (LIDOC-90533967-3742) • Dust Management TARP (LIDOC-90533967-2387) Management measures include: • Permissible blast times are restricted to Monday-Saturday (inclusive) between 9am and 5pm (EST). No blasting takes place on Sundays or Public Holidays unless in accordance with written approval from the Secretary (NSW DP&E). • The Dust Risk Forecast Model[2] is used during blast planning. The prevailing wind field and occurrence of temperature inversions are considered. • Blasting activities are delayed, where safe to do so, when adverse conditions are measured or predicted based on LCO's real time air quality and meteorological monitoring or by the Dust Risk Forecast Model, as provided for within the Dust Management TARP (LIDOC-90533967-2387).
Drilling Of Blast Holes	Dust management measures for drilling operations are documented within: • LCO Particulate Matter BMP Determination Report • Dust Management TARP (LIDOC-90533967-2387) • Airborne Contaminants (LIDOC-90533967-1) Management measures include: • All drill rigs are fitted with dust suppression systems. • Drill operations are ceased when dust suppression systems are not operating. • Dust aprons are lowered during drilling. • Drill cuttings, including dust cones, are wetted down to prevent dust generation. • During hot, dry or windy conditions drill patterns are watered as required. • Care is taken when moving drilling equipment so as not to disturb drill cuttings. • Adequate stemming is used at all times. • Drill patterns are watered during drilling and before loading as required to manage dust generation. • Contingency actions are implemented in response to visual triggers or alerts from the real time and predictive monitoring systems, as provided for within the Dust Management TARP (LIDOC-90533967-2387). Depending on the level triggered, actions may include: – Checks on the dust suppression system for operational issues and maintenance requirements. – Ceasing of operations, with work recommencing only if the dust suppression system is operable, site preparation is adequate and weather conditions permit.
Spontaneous Combustion Management	Management measures for the prevention and reducing the incidence and impacts of spontaneous combustion are documented in the Spontaneous Combustion Management Plan (LIDOC-90533967-84). This plan has been developed addressing the development consent conditions (**Appendix A**).

2 Dust Risk Forecast Model, Jacobs Pty. Ltd. (*http://envforecasting.com/index*)

Activity / Source	Management Measures
	The Spontaneous Combustion Management Plan outlines standards to be maintained, and the monitoring system and procedures to be followed in the case of a spontaneous combustion incident. A procedure has been developed for managing drill and blast operation of areas suspected to be liable to spontaneous combustion. The mine design incorporates the use of benches for sealing off the highwall to minimise the ingress of oxygen, and the flooding of heated areas prior to mining with recycled mine water. Every effort is made in managing heat affected overburden or coal which is cooled and saturated with water where practicable prior to mining to minimise dust generation.
Exhaust fumes from Mine Plant	As per LCO development consent conditions (**Appendix A**), all mining equipment is maintained in a good working order to limit exhaust fumes. Engines used in essential mining equipment such as drill rigs, excavators, graders, off-road haul trucks, loaders and dozers are either US-Tier 1 or US-Tier 2 compliant.

4.10 Site-Wide Management Measures

Site-wide air quality management measures implemented by LCO are documented in the Dust Management TARP (LIDOC-90533967-2387).

The Dust Management TARP is designed to provide a guideline as to the acceptable standards at LCO to reduce the likelihood of non-compliance with air quality criteria and community complaints, and to protect employees and equipment on site.

The Dust Management TARP is essentially a reactive / predictive air quality control system which draws on visual monitoring, real time air quality and meteorological monitoring and forecast meteorological and dust risks as summarised in ***Figure 4-8***.

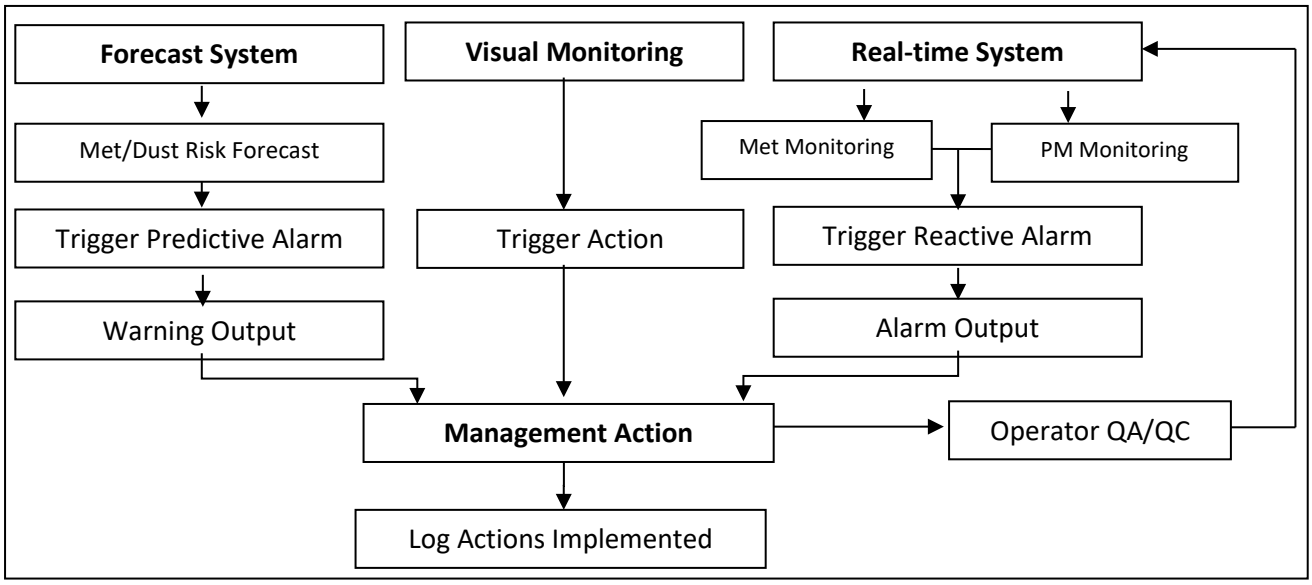

Figure 4-8 - Overview of the Operational Dust Management System at LCO

Provision is made for the following trigger types and monitoring methods within the Dust Management TARP:

Trigger Type	Monitoring Method
Visual triggers	Visual monitoring of dust levels by LCO personnel, enhanced through the dust management camera network.
Adverse meteorological conditions (conducive to dust events)	Real-time meteorological monitoring.
Peaks in PM_{10} concentrations	Real-time PM_{10} monitoring.
Forecast dust risk	Dust Risk Forecast Model[3]

The Dust Management TARP makes provision for the following Trigger Level classifications:

Normal State	Reasonably expected conditions in day to day operations No cause for review or action, but routine dust management to be continued
Level 1 Triggers	Change from normal indicating a potential risk Not of a serious nature, but acts as an alert and requires monitoring to detect further trends
Level 2 Triggers	Moderate risk of dust related impacts occurring Remedial action needs to be planned and executed
Level 3 Triggers	High risk of dust related impacts occurring A situation has occurred that poses an immediate risk and remedial action is undertaken

Site-wide Triggers and Associated Actions and Mine-activity specific Triggers and Associated Actions are documented within the Dust Management TARP (LIDOC-90533967-2387).

A description of the real time air quality and meteorological monitoring system which informs the Dust Management TARP is provided in ***Section 4.11.5***.

4.11 Air Quality Monitoring

4.11.1 Overview of Monitoring

Three types of air quality monitoring are undertaken at LCO, namely:

1. **Compliance Monitoring:** Air Quality and Meteorological Monitoring undertaken at privately owned residence, in accordance with development consent conditions (***Appendix A*** -) To demonstrate compliance, monitoring is undertaken at these locations to satisfy legislative requirements as specified in ***Section 4.2*** and ***4.3*** of this AQMMP.
2. **Management Monitoring:** This primarily refers to real-time Air Quality and Meteorological Monitoring for reactive dust management. This monitoring is used to inform operational dust management at LCO, as provided for in the ***Dust Management TARP (LIDOC-90533967-2387)***.

3 Dust Risk Forecast Model, Jacobs Pty. Ltd. (*http://envforecasting.com/index*)

This monitoring is not intended for use in assessing compliance with ambient air quality criteria to meet regulatory requirements.

3. **Supplementary Boundary Monitoring:** This refers to supplementary relocatable boundary monitors, as required by Schedule 3, Condition 19. The supplementary real-time boundary monitoring serves two purposes: 1) aid determination of LCO's contribution to local dust concentrations when investigating exceedances of air quality criterion and 2) to supplement the reactive dust management system.

In addition to LCO monitoring, the OEH operate the Upper Hunter Air Quality Monitoring Network (UHAQMN), with 14 sites measuring PM_{10} continuously and three sites measuring $PM_{2.5}$ continuously. The relevant sites are those located in a direct upwind and downwind direction of LCO operations, including:

- Muswellbrook - located ~17 km northwest of LCO.
- Camberwell located ~10 km southeast of LCO.
- Singleton NW located ~18 km southeast of LCO.
- Singleton - located ~21 km southeast of LCO).

The data recorded at the UHAQMN may be used by LCO in conjunction with their compliance, management and boundary monitoring to better inform LCO contribution to regional dust levels as required.

The monitoring equipment, frequency, purpose and relevant monitoring standards utilised at LCO to manage air quality are summarised in ***Table 4-5***.

Table 4-5 - Air quality and meteorological monitoring

Monitoring site(s)	Parameters Monitored	Units of Measure	Averaging Period	Frequency	Sampling Method	Purpose
D55 and D62	Deposited dust (Insoluble Solids) and Ash Content	g/m^2/month percent	Month, Annual	Monthly	DDG, AM-19, AS580.10.1-2003	Compliance
HVAS11 and HVAS20	TSP	$\mu g/m^3$	24 hour, Annual	24 hours, every 6 days*	HVAS-TSP, AM-15, AS3580.9.3-2003	Compliance
HVAS12 and HVAS21	PM_{10}	$\mu g/m^3$	24 hour, Annual	24 hours, every 6 days*	HVAS- PM_{10}, AM-15, AS580.9.6-2003	Compliance
SX38-D1 and SX38-D2	PM_{10}	$\mu g/m^3$	24 hour, Annual	24 hours	TEOM-PM_{10}, AM-22, AS 3580.9.8-2001	Compliance and Management
SX13-D1**	PM_{10}	$\mu g/m^3$	24 hour, Annual	24 hours	AS/NZS 3580.9.8:2008	Management
SX38-D3, SX38-D4, SX38-D5 and SX38-D6	PM_{10}	$\mu g/m^3$	24 hour	Continuous	Special Method 1***	Supplementary Boundary

Monitoring site(s)	Parameters Monitored	Units of Measure	Averaging Period	Frequency	Sampling Method	Purpose
						Monitoring - Management
Meteorological Station	Rainfall	Millimetres	1 hour	Continuous	AM-2 and AM-4 Approved Methods for the Sampling and Analysis of Air Pollutants in	Compliance
	Sigma Theta	Degrees	15 minutes			
	Temperature at 2 metres	Celsius	15 minutes			
	Temperature at 10 metres	Celsius	15 minutes			
	Total Solar Radiation	Watts per square metre	15 minutes			
	Wind Direction at 10 metres	Degrees	15 minutes			
	Wind Speed at 10 metres	Metres per second	15 minutes			

DDG - Dust Deposition Gauges

HVAS-TSP - High Volume Air Samplers (HVAS) measuring Total Suspended Particulates

HVAS-PM_{10} - High Volume Air Samplers (HVAS) measuring PM_{10}

* In the event a HVAS unit may not operate at the specified frequency, the adjacent 24 hour TEOM data will be utilised for reporting. This may include maintenance and calibration requirements, power outages, no access due to safety concerns of personnel and other external events outside the control of Liddell Coal. ** Mt Owen Complex's TEOM monitoring station

***Special Method 1 requires the monitoring of PM10 concentration to occur in strict accordance with the manufacturer's operating manual titled "E-BAM Rapid Deployment Particulate Monitor – Operational Manual for PM10 or PM2.5 Continuous Monitoring E-Bam-9800 REV L" dated 2008.

4.11.2 Monitoring Methods

Monitoring for compliance purpose is undertaken in accordance with relevant Australian Standards, legislation and the *Approved Methods for the Sampling and Analysis of Air Pollutants in New South Wales* (DEC, 2007)[4]. Relevant methods implemented are as follows:

- Dust deposition gauges are sampled monthly for insoluble solids in accordance with AS 3580.10.1 (2003) ***Methods for sampling and analysis of ambient air – determination of particulate matter – deposited matter – gravimetric methods; as per AM-19*** *(DEC, 2007).*
    - High Volume Air Samplers (HVAS) measure and analyse TSP in accordance with the guidelines specified in AS3580.9.3 (R2014) "***Methods for the Sampling and Analysis of Ambient Air – Determination of Suspended Particular Matter – Total Suspended***

4 Department of Environment and Conservation NSW, *Approved Methods for the Sampling and Analysis of Air Pollutants in New South Wales*, 2007

Particulate Matter (TSP) – High Volume Air Sampler Gravimetric Method"; as per AM-15 (DEC, 2007).

- High Volume Air Samplers (HVAS) measure and analyse PM10 in accordance with the guidelines specified in AS3580.9.6 (R2014) *"**Methods for sampling and analysis of ambient air. Determination of Suspended Particulates – PM10 High Volume Air Sampler with size selective inlet – Gravimetric method**"; as per EPA AM-18*.
- PM10 concentrations are continuously measured and analysed through the use of Tapered Element Oscillating Microbalances (TEOMs) in accordance with the guidelines specified in AS3580.9.8-2008 ***Methods for sampling and analysis of ambient air -Determination of suspended particulate matter - PM10 continuous direct mass method using a tapered element oscillating microbalance analyser.***
- Siting and operation of air monitoring equipment reflects the guidance in AS3580.1.1:2007 ***Guide to siting air monitoring equipment;*** as per AM-1 (DEC, 2007); and AS3580.14.1:2011 ***Methods for sampling and analysis of ambient air***.
- Meteorological monitoring in undertaken in accordance with AS3580.14.1- 2011 ***Methods for sampling and analysis of ambient air Part 14: Meteorological monitoring for ambient air quality monitoring applications.***
- Environmental Beta Attenuation Monitors (E-BAMs) are used to continuously measured and analysed as supplementary boundary monitors as required by Environmental Protection Licence 2094. E-BAMs are operated in accordance with the manufacturers operating manual titled "***E-BAM Rapid Deployment Particulate Monitor – Operation Manual for PM10 or PM2.5 Continuous Monitoring E-Bam-9800 REV L***" dated 2008.

Air quality and meteorological monitoring, including monitoring site selection, station commissioning and maintenance, transfer of filters and samples to and from the field, and instrument calibration is undertaken in accordance with appropriate monitoring standards as listed above. All preparatory laboratory work (e.g. filter preparation) and post-monitoring laboratory analysis is conducted by a NATA certified laboratory.

The locations of compliance air quality monitoring stations and LCO Meteorological Monitoring Station are shown in ***Figure 4-9***. The locations of the management and supplementary boundary monitoring stations are shown in ***Figure 4-10***.

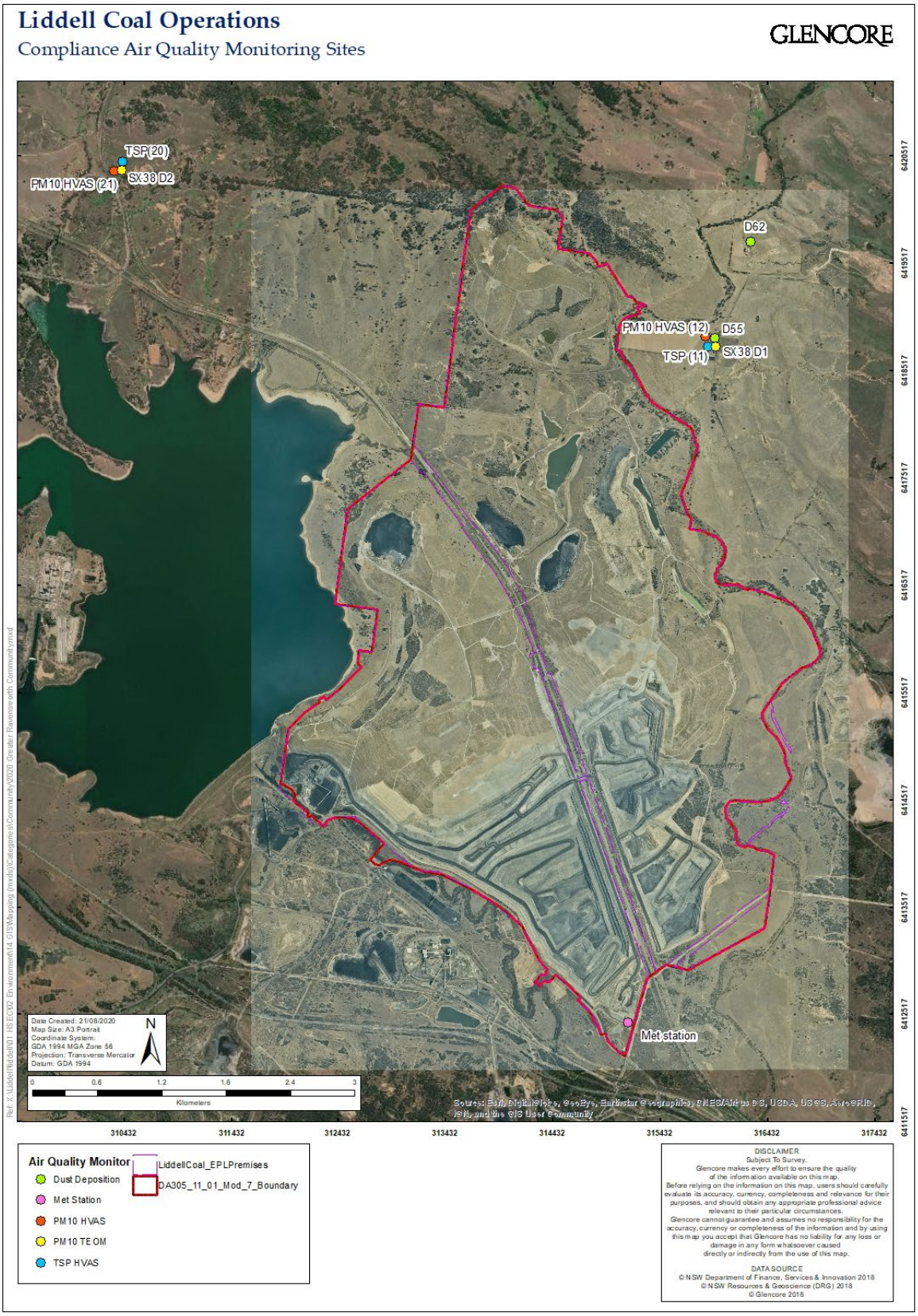

Figure 4-9 - Compliance Air Quality Monitoring Stations at LCO

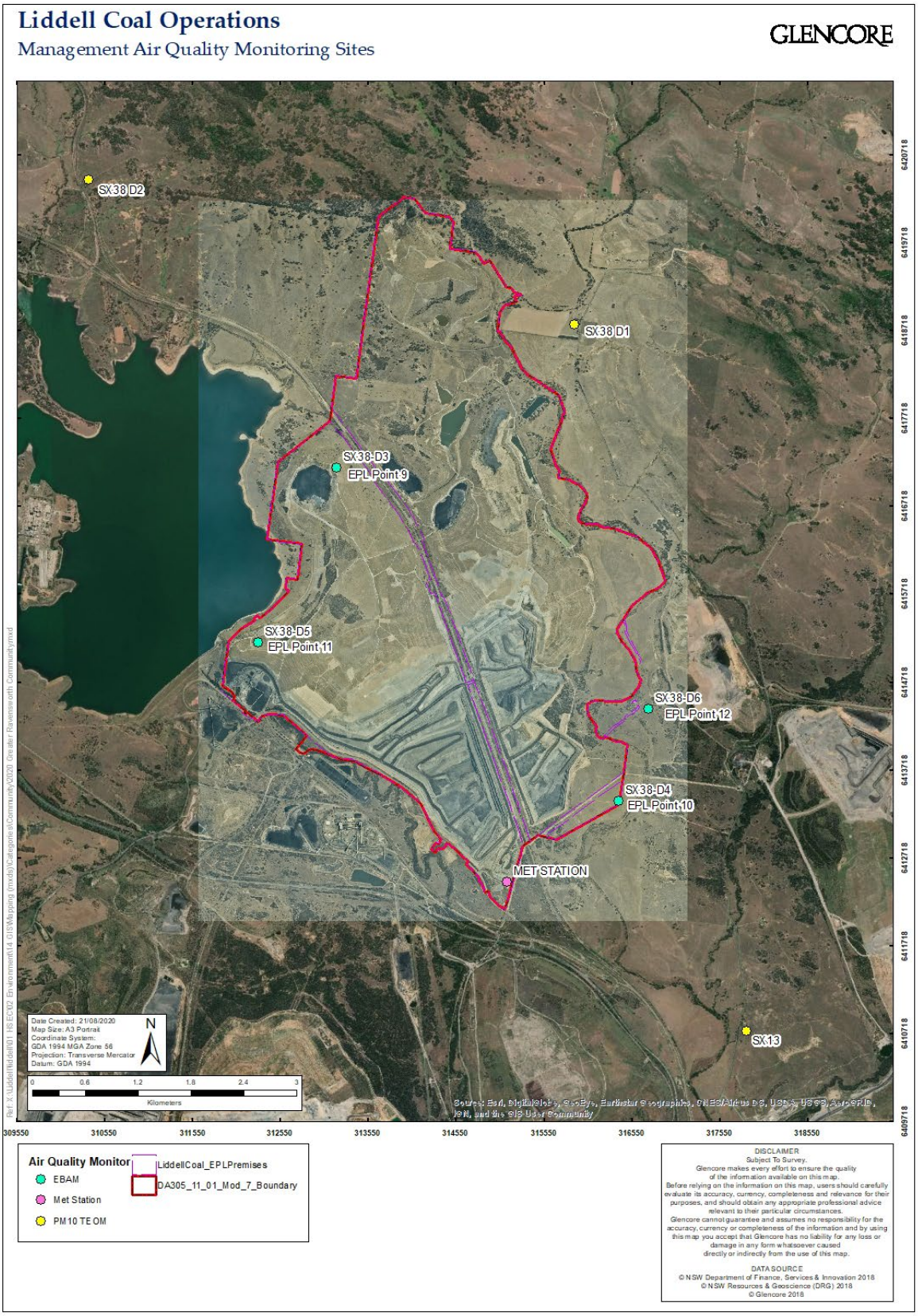

Figure 4-10 - Management Monitoring Network at LCO

4.11.3 Compliance Air Quality Monitoring

4.11.3.1 Dust Deposition Sampling and Analysis

Dust deposition gauges measure the dust deposition rate and involve the passive deposition and capture of dust within a funnel and bottle arrangement. Data is collected over a period of 30 days (±2 days), following which samples are sent to a NATA certified laboratory for gravimetric and other analyses. Dust deposition rates are expressed in g/m^2/month (i.e. mass of dust deposited per m^2 per month). Laboratory analysis undertaken is as follows:

- Insoluble solids – matter that does not dissolve in water
- Ash content – matter that remains after the sample has been combusted in the laboratory.

In assessing compliance with dust deposition objectives, reference is made to the total insoluble solids fraction, as defined in AS3580.10.1-2003.

Ash content is a useful indicator in dust deposition samples as it provides the percentage of non-combustible material in a sample, i.e. the portion that is mineral content (or soil dust). The mineral content may be attributable to mining, but may also be attributable to other sources such as public and private unsealed roads and agriculture. The material making up the insoluble solids that has been combusted will not be attributable to mining or other sources since this is mostly organic matter.

4.11.3.2 HVAS Sampling and Analysis

High volume air samplers (HVAS) determine airborne particulate matter concentrations, and comprise the collection of particulate matter by drawing a constant flow rate of ambient air through a prepared filter. The samplers draw air in via a TSP inlet which acts as a hood to prevent precipitation and debris from falling onto the filter. The sample of TSP is collected on a pre-weighed filter mounted in the HVAS filter holder and subsequently weighed after exposure (gravimetric method). The sample volume is calculated from the average flow rate and sample duration. Based on the gravimetric mass collected and the sampled volume, the TSP concentrations in $\mu g/m^3$ can be derived. The HVAS-PM_{10} samplers similarly measure gravimetric PM_{10} concentrations by using a specific PM_{10} inlet.

HVAS sample airborne particulates over a 24-hour (±1 hour) period. The HVAS operates on a 1 in 6 day schedule in accordance with the Australian Standard with filters collected and sent to a NATA certified laboratory for gravimetric analysis, providing results as 24-hour average concentrations in $\mu g/m^3$.

4.11.3.3 TEOM Sampling and Analysis

Air quality and meteorological monitoring is undertaken in accordance with the following Australian Standards:

The standard TEOM method involves drawing ambient air through a PM_{10} size selective inlet at a constant flow rate. The main flow passes through an exchangeable sample filter placed at the tip of a hollow tapered glass element, then passes to the mass flow controller that maintains constant flow. The filter accumulates suspended particulate matter. The increase in mass on the filter reduces the resonant frequency at which the hollow tapered element oscillates. By frequently measuring the variation in frequency, the analyser is able to calculate a continuous measurement of the accumulated particle mass. The total particle mass is then converted to the particle mass concentration in micrograms per cubic metre ($\mu g/m^3$) using the flow rate of the sampled air stream (corrected for standard temperature and pressure). In this way, a real-time, continuous measurement of ambient PM_{10} concentration is provided. TEOM dichotomous monitors operate in a similar manner but include a virtual impactor that splits the airflow and allows multiple particle size fractions to be measured continuously.

Parameters measured by these real-time monitoring stations specified in ***Table 4-6***.

Table 4-6 - Parameters Measured by Real-time Monitoring Stations

Parameter	Tapered Element Oscillating Microbalance (TEOM) Stations	
	SX 38-D1	SX38-D2
PM_{10} Concentration	✓	✓
Wind Speed	✓	✓
Wind Direction	✓	✓
Air Temperature @ 2m	✓	✓
Relative Humidity	✓	✓
Rainfall	✓	✓
Barometric Pressure	✓	✓
Solar Radiation	✓	✓
Dew Point Temperature	✓	✓
Wind Chill	✓	✓

TEOM data is screened to check the operating state of the instrument and the validity of air quality and meteorological monitoring data through:

- Checks on instrument status codes,
- Comparison of measured values to upper and lower limits (range check),
- Rate of change checks to identify data that change too rapidly or not at all (stuck signal), and
- Physical principle assessments relating two or more variables (e.g. dew point should never exceed the dry-bulb temperature).

4.11.3.4 Meteorological Monitoring

Continuous meteorological monitoring is undertaken at the LCO Meteorological Station as per ***Section 4.11.3.1.*** Meteorological parameters recorded are as follows: wind speed, wind direction, air temperature, relative humidity, rainfall, barometric pressure, solar radiation and Sigma Theta (measure of wind direction variations).

4.11.3.5 Data Availability Objective

The compliance monitoring program with regards to dust gauges and HVAS will be operated with the objective of achieving a valid dust deposition and airborne particulate matter concentration data availability target of 100% for each year of monitoring. A data availability target of 90% is specified for the continuously recorded meteorological data.

For the TEOMs, the air quality and meteorological monitoring program will be operated with the objective of achieving a valid data availability target of 90% for all critical air quality and meteorological parameters for each year of monitoring.

4.11.3.6 Data Completeness Criteria for Period Averaging

With regards to the dust gauges and HVAS, the data completeness criterion for the purpose of calculating period averages is 75%. That is, valid data are required for 75% of a period on which to basis the calculation of the average value for that period. The data completeness criterion for TEOMs for the purpose of calculating period averages is also 75%. That is, valid data are required for 75% of a period on which to basis the calculation of the average value for that period. Implications of this data completeness criterion for different averaging periods are as follows:

- The calculation of hourly averages are based on at least 45 minutes of valid data.
- The calculation of 24-hour averages are based on at least 18 hours of valid data.
- The calculation of quarterly averages necessitate 75% data completeness.
- Annual averages are calculated on the basis of available valid data, and only if the overall data availability is 75% and there is sufficient data to facilitate the calculation of all four quarterly averages.

4.11.3.7 Maintaining of Monitoring Records

All monitoring records required to be kept by LCO will be:

- In a legible form, or in a form that can readily be reduced to a legible form;
- Kept at least for four years; and
- Produced in a legible form to any authorised officer of OEH who asks to see them.

The following records will also be kept in respect of air quality monitoring undertaken:

- The dates on which the monitoring was undertaken;
- The times at which the monitoring was undertaken;
- The point at which the monitoring was undertaken; and
- The name of the person who undertook the monitoring.

4.11.4 Management Monitoring

Real-time air quality and meteorological monitoring is undertaken to inform reactive operational dust management at LCO, as provided for in the Dust Management TARP (LIDOC-90533967-2387). This monitoring is not intended for use in assessing compliance with ambient air quality criteria to meet regulatory requirements.

Real-time air quality and meteorological monitoring data is evaluated against site-specific weather assessment criteria to identify whether adverse meteorological conditions or elevated PM_{10} concentrations are occurring. Depending on the severity of the conditions occurring, contingency dust control measures are triggered to reduce the potential for air quality impacts as described in ***Section 4.9***. Site-wide Triggers and Associated Actions and Mine-activity specific Triggers and Associated Actions are documented within the Dust Management TARP (LIDOC-90533967-2387).

LCO's main Meteorological Station is situated on-site.

LCO utilises the capability of the two compliance monitoring stations (TEOMS) which measure continuous PM_{10} and meteorology:

- SX38-D1 – located north-north east of LCO
- SX38-D2 – located northwest of LCO

Additionally, LCO makes reference to measurements made at one of Mt Owen Complex's TEOM monitoring stations:

- SX13 - located to the southeast of LCO.

Supplementary boundary monitors listed in ***Section 4.11.5*** are additionally utilised to assist in managing operations in accordance with the Dust Management TARP (LIDOC-90533967-2387).

Locations of the management monitoring stations used to inform the Dust Management TARP are shown in ***Figure 4-10***. Parameters measured by these real-time monitoring stations are specified in ***Table 4-7.*** .

Table 4-7 – Parameters Measured by Compliance TEOM Real-time Monitoring Stations

Parameter	LCO Met. Station	Tapered Element Oscillating Microbalance (TEOM) Stations		
		SX 38-D1	SX38-D2	SX13-D1
PM_{10} Concentration		✓(b)	✓(b)	✓(b)
Wind Speed	✓	✓	✓	✓
Wind Direction	✓	✓	✓	✓
Air Temperature	✓(a)	✓	✓	✓
Relative Humidity	✓	✓	✓	✓
Rainfall	✓	✓	✓	✓
Barometric Pressure	✓	✓	✓	✓
Solar Radiation	✓	✓	✓	✓
Dew Point Temperature		✓	✓	✓
Wind Chill		✓	✓	✓
Sigma Theta	✓			

(a) Air temperature measured at 2m and 10m above ground, with difference in concurrent temperatures logged as "Delta T".

(b) Continuous PM10 concentration measurement using Tapered Element Oscillating Microbalances (TEOMs)

4.11.5 Supplementary Boundary Monitoring

In accordance with ***Schedule 3, Condition 19*** and ***Environmental Protection Licence 2094 Condition M2.2***, LCO will operate relocatable boundary monitors with the following purpose:

- To assist with determination of LCO's contribution to local dust levels when investigating potential exceedances of criterion at privately owned residences, based on their upwind and downwind positioning relative to the location of LCO mining activity.
- To supplement the reactive operational dust management at LCO, as provided for in the Dust Management TARP (LIDOC-90533967-2387).

LCO have installed four solar-powered E-BAM 9800 units for continuous monitoring of PM10 levels. Each unit also includes an on-board weather station, processor and telecommunications and are trailer mounted to allow easy relocation as the mine progresses. The units will be run in accordance with the current manufacturer guidance "***E-BAM 9800 REV L Operating Manual***" or subsequent relevant revisions (Met One Instruments; 2008).

The four E-BAM units are installed in an upwind and downwind location, relative to location of mining activity at LCO. This location is determined by the general northwest-southeast alignment and consistency of the winds in the Hunter Valley.

4.11.5.1 E-BAM Sampling and Analysis

E-BAMs measure and record airborne PM10 particulate concentration levels using the principle beta ray attenuation. This method provides a simple determination of concentration in units of milligrams of particulate per cubic meter. A small ^{14}C element emits a constant source of high-energy electrons known as beta particles. These beta particles are detected and counted. A vacuum pump pulls a measured amount of dust-laden air through filter tape, which is positioned between the source and the detector thereby causing an attenuation of the beta particle signal. The degree of attenuation of the beta particle signal is used to determine the mass concentration of particulate matter on the filter tape, and the volumetric concentration of particulate matter in ambient air.

Figure 4-10 also shows the locations of the E-BAM units, determined in consultation with the NSW EPA. The monitoring units are located to capture the upwind and downwind PM_{10} emissions from site, whilst excluding contribution from neighbouring operations as reasonably practical. Parameters measured by E-BAM real-time monitoring stations are specified in ***Table 4-8***.

Table 4-8 - Parameters Measured by Boundary EBAM Real-time Monitoring Stations informing the Dust Management TARP

Parameter	Unit Reference			
	SX 38-D3 (EPL Point 9)	**SX 38-D4 (EPL Point 10)**	**SX38-D5 (EPL Point 11)**	**SX 38-D6 (EPL Point 12)**
PM_{10} Concentration	✓	✓	✓	✓
Wind Speed	✓	✓	✓	✓
Wind Direction	✓	✓	✓	✓

Parameter	Unit Reference			
	SX 38-D3 (EPL Point 9)	**SX 38-D4 (EPL Point 10)**	**SX38-D5 (EPL Point 11)**	**SX 38-D6 (EPL Point 12)**
Air Temperature	✓	✓	✓	✓
Relative Humidity	✓	✓	✓	✓
Rainfall	✓	✓	✓	✓
Barometric Pressure	✓	✓	✓	✓
Solar Radiation	✓	✓	✓	✓
Dew Point Temperature	✓	✓	✓	✓
Wind Chill	✓	✓	✓	✓

4.11.5.2 Data Availability Objective

The supplementary boundary monitoring program with regards to E-BAMs will be operated with the objective of achieving a valid data availability target of 90% for each year of monitoring.

4.11.5.3 Data Completeness Criteria for Period Averaging

The data completeness criterion for EBAM's for the purpose of calculating period averages is 75%. That is, valid data is required for 75% of a period on which to basis the calculation of the average value for that period. Implications of this data completeness criterion for different averaging periods are as follows:

- The calculation of hourly averages are based on at least 45 minutes of valid data.
- The calculation of 24-hour averages are based on at least 18 hours of valid data.
- The calculation of quarterly averages necessitate 75% data completeness.
- Annual averages are calculated on the basis of available valid data, and only if the overall data availability is 75% and there is sufficient data to facilitate the calculation of all four quarterly averages.

The data completeness criterion is integrated into the automated data screening and averaging protocols incorporated within the Dust Management TARP.

4.11.5.4 LCO's Contribution Analysis

LCO's contribution to ambient PM_{10} concentrations is determined as follows:

- The upwind and downwind monitoring locations are reviewed at least annually, taking into consideration the location of planned LCO mining operations.

- Real time monitoring data are collected and screening level data validation is preformed to remove outliers, negatives and periods of instrument faults (see Section 2.11.5.5).This is automated through the existing data management and reporting system.
- LCO contribution is calculated based on the difference between the concurrent hourly PM10 concentrations recorded at the downwind and upwind monitoring location, determined according to wind direction recorded for greater than 50% of the 24hr monitoring period.
- LCO's contribution would be determined as a percentage increase / contribution. This contribution can then be applied to monitors further downwind to determine an absolute concentration contribution.

4.11.5.5 Role in Reactive Dust Management

The relocatable boundary monitoring will also help inform reactive operational dust management at LCO by supporting the role of the management monitoring described in Section 2.11.4. It is proposed that the relocatable boundary monitoring will act as an early warning alert Level 1 Trigger.

The relationship between the onsite early warning alert triggers and offsite triggers has been determined by comparing PM10 concentration at the boundary monitors against concentrations recorded further from site at the TEOM locations for the period October 2015 till October 2016. This analysis has determined the level of dust dispersion/dilution achieved between the site boundary and offsite receptors and thereby informs the relationship between the early warning alert (at the boundary) and the existing trigger level at the TEOM. The early waring triggers will be implemented in the Dust Management TARP, with performance reviewed and adjusted as required.

4.11.5.6 E-BAM Data Screening and Storage

The data screening, completeness and data availability objectives for the relocatable boundary monitoring are the same as those described for management monitoring, with flexibility allowed for periods when instruments are relocated and require a period of conditioning.

4.12 Reporting

Environmental monitoring result summaries, compliance with Consent and Licence conditions and any required modifications to the air quality monitoring will be reported in the Annual Review and Annual Return. Summaries will also be made available to the public via the LCO website in accordance with the EPA requirements for publishing monitoring data.

Air quality monitoring results will also be presented at Community Consultative Committee (CCC) meetings.

4.12.1 Incident Reporting and Compliance Evaluation

If monitoring results identify an exceedance of the criterion outline in ***Table 4-1*** or ***Table 4-2,*** LCO will notify DP&E in accordance with Schedule 5 Condition 11 and 12. A formal incident report must be provided to this Department within 7 days of the exceedance. Air quality monitoring results and compliance with Consent and Licence conditions will be reported in the Annual Return to the EPA and in the Annual Review, including those that were found to be a result of non-mine contributions.

Compliance with the criteria in ***Table 4-1*** or ***Table 4-2*** will be demonstrated where the measured level is below the criteria. Measured levels above the criteria do not necessarily constitute non-compliance. In these circumstances additional investigations will be carried out to determined compliance. The specific investigations to be carried out to determine if a non-compliance has occurred are outlined in ***Table 4-9***.

Table 4-9 - Methods for determining compliance against Impact Assessment Criteria

Pollutant	Averaging Period	Methods for determining compliance
Long Term Impact Assessment Criteria for Particulate Matter		
Total Suspended Particulate (TSP) matter	Annual	Assessed annually. Compliance will be determined by direct comparison of the measured annual average (calendar year) against the relevant criterion in ***Table 4-1***. Results will be reported in the Annual Review. Non-compliances will be accompanied by actions for improvement and, in these circumstances, this AQMMP will be updated, as appropriate, in accordance with ***Section 7.***
Particulate Matter < 10 µm (PM10)	Annual	Assessed annually. Compliance will be determined by direct comparison of the measured annual average (calendar year) against the relevant criterion in ***Table 4-1***. Results will be reported in the Annual Review. Non-compliances will be accompanied by actions for improvement and, in these circumstances, this AQMMP will be updated, as appropriate, in accordance with ***Section 7.***
Deposited Dust (maximum increase)	Annual	Assessed annually. Compliance will be determined by direct comparison of the measured annual average (calendar year, excluding contaminated samples) against the relevant criterion. Results will be reported in the Annual Review. Non-compliances will be accompanied by actions for improvement and, in these circumstances, this AQMMP will be updated, as appropriate, in accordance with ***Section 7.***
Deposited Dust (annual average)	Annual	Assessed annually. Compliance will be determined by direct comparison of the measured annual average (calendar year, excluding contaminated samples) against the relevant criterion. Results will be reported in the Annual Review. Non-compliances will be accompanied by actions for improvement and, in these circumstances, this AQMMP will be updated, as appropriate, in accordance with ***Section 7.***
Short Term Impact Assessment Criteria for Particulate Matter		
Particulate Matter < 10 µm (PM10)	24 hour	Assessed in the event of an exceedance of the 24-hour average criterion at the two TEOM PM10 monitors, SX38-D1 and SX38-D2 (i.e. greater than 50µg/m3). Compliance will be determined by calculating the contribution from LCO to the measured 24-hour average result at the monitor where the exceedance was recorded. The 24 hour average contribution of LCO will be calculated by firstly using an upwind/downwind approach. If this value exceeds the 24 hour average criterion, LCO will further investigate the background PM10 concentration, prevailing wind speed and direction measurements of the previous 24 hour period.

Pollutant	Averaging Period	Methods for determining compliance
		In the instance where there is a measured exceedance of the Short Term Impact Assessment Criteria for Particulate Matter, an investigation will be triggered to estimate LCO contribution and determined whether significant contribution has occurred (i.e. an estimated contribution of >75%). In accordance with Schedule 5 Condition 12 of DA 305-11-01, the Department will be notified immediately where LCO has estimated to have significantly contributed to greater than 50µg/m3 of the 24 hour average result as per Schedule 3 Condition 16. A report detailing the event will be provided to the Department within 7 days of the event occurring. Recorded exceedances will also be reported in the Annual Review. Non-compliances will be accompanied by actions for improvement and, where appropriate, this AQMMP will be updated in accordance with ***Section 7.*** If investigation determines LCO is estimated to significantly contributed to the exceedance of the Short Term Impact Assessment Criteria for Particulate Matter, notification to affected landholders is required to be completed in accordance with Schedule 4 Condition 2.

4.13 Compliant Management

4.13.1 Complaint Mangement

Community Complaints at LCO are managed in accordance with CAA HSEC PCL Community Complaint Management and LCO SD PRO 0017 - Complaints Management.

LCO implements a complaints hotline (1800 037 317) for handling the conflict resolution process. The conflict resolution process includes:

- Acknowledging all complaints, responding to the complainant within 24 hours, where practicable;
- Registering all complaints in CMO;
- Investigating complaints impartially giving proper consideration to the facts and the circumstances prevailing at the time;
- Implementing corrective actions if required;
- Reporting to relevant stakeholders of investigation outcomes and corrective actions taken.

Complaint handling requirements, in terms of development consent conditions are provided in Appendix A.

4.13.2 Air Quality Specific Complaint Management

When a complaint is received by LCO regarding air quality at a particular receiver location, in addition to the compliance monitoring outlined in ***Section 4.11***, specific monitoring may be undertaken at that particular location to demonstrate compliance with air quality criteria outlined in ***Section 4.3*** or to investigate possible sources.

In accordance with Schedule 4, Condition 4 of the Development Consent conditions (***Appendix A*** -), if a landowner considers the development to be exceeding the air quality criteria (***Section 4.3***), except where predicted in the Environmental Assessment (SLR,2013) then he/she may request an independent review of the impacts of LCO on his/her land. Should this occur, LCO will undertake the process in accordance with Schedule 4, Conditions 4 to 8 of the Development Consent conditions (***Appendix A*** -).

4.13.3 External Communication and Reporting

A summary of air quality related external communication, reporting and notification is provided in ***Table 4-10.***

Table 4-10 - External Communication and Reporting Requirements

Stakeholder / Regulatory Authority	Reporting Requirement	Description of Report Content	Delivery Schedule
NSW EPA	Annual Return	Annual Returns Reporting is a requirement of EPL No. 2094 for LCO. The Annual Returns statement comprises a statement of compliance, monitoring and complaints summary.	Annually
Dept. of Planning, Industry and Environment (DPIE), NSW Resources Regulator Dept. Primary Industries - Water, NSW Office of Environment and Heritage, Singleton Council, Muswellbrook Shire Council, LCO Community Consultative Committee, NSW EPA	LCO - Annual Review	Each year LCO will prepare an Annual Review including: comprehensive review of monitoring results and complaints against performance measures/criteria and statutory requirements; non-compliances and corrective actions; comparison of predicted and actual impacts; and any measure to be implemented to improve performance.	Annually
NSW EPA / DPIE / Public	Environmental Monitoring Reports	• Air quality monitoring results are reported on a monthly basis to LCO management; • Environmental monitoring results are updated on the LCO website on a monthly basis.	Monthly delivery schedule to LCO Management / Monthly Reports uploaded onto website
NSW EPA / Public	Publication of air pollution monitoring data as required by the Protection of the Environment Legislation	Air Pollution monitoring data that has been collected as result of a licence condition, in accordance with section 66(6) of the POEO Act and written requirements issued by the EPA are	Within 14 days of obtaining the data and/or receiving a

Stakeholder / Regulatory Authority	Reporting Requirement	Description of Report Content	Delivery Schedule
	Amendment Act 2011 (1 July 2012 onwards). The requirement for publication applies to monitoring conducted after 31 March 2012. Data must be made available, in a prominent position, on LCO website.	required to be published. This data is to be provided in a table format and may be illustrated by a graph or chart. Accompanying information: • A meaningful summary of the monitoring data on at least a monthly basis as outlined in the EPA requirements; and • Information regarding when and to what extent the performance limits specified within the licence were not met and why, when the monitoring data indicates that a limit has been exceeded	written request from the EPA
DPIE	Notification of air quality non-compliance	Provide notification of non-compliance with air quality criteria, plus quarterly monitoring results until the results show that the development is complying with the criteria in Section 4.3.	Within 7 days of becoming aware of the non-compliance, notification via DPIE Major Projects Planning Portal. Alternatively via email to *compliance@planning.nsw.gov.au* (if required)
Affected landholders	Notification of air quality exceedance at residences	Provide notification of exceedance, plus quarterly monitoring results to each party until the results show that the development is complying with the criteria in Section 4.3.	Notification via letter/email, , phone call or face-to-face meeting following exceedance (stakeholder preferred method).
Community Consultative Committee (CCC)	Provision of information to the CCC as per development consent conditions.	Provide the CCC with regular information on mine operations and future developments, environmental performance and actions taken to improve environmental performance.	Regularly, as agreed by the CCC

5. Part 2 – Greenhouse Gas Emissions

5.1 Baseline Data – GHG Emissions

GHG emissions associated with LCO have been categorised into Scope 1, 2 and 3 emissions. The three 'scope' categories can be defined as:

- **Scope 1** - covers *direct emissions* from the combustion of fuels (e.g. diesel) and industrial processes within the boundary of the operation;
- **Scope 2** - covers *indirect emissions* from the operation's consumption of purchased electricity produced by another organization; and
- **Scope 3 -** includes *other indirect emissions* as a result of the operation's activities that are not from sources owned or controlled by the organisation (e.g. product transport by rail).

Direct emissions are produced from sources within the boundary of an operation as a direct result of its activities (e.g. combustion of diesel fuels in coal production).

Indirect emissions are produced outside the boundary of the operation by other organisations but are directly linked to the operation's onsite activities. Indirect emissions mainly result from the generation of electricity consumed by the operation.

This Plan will focus on Scope 1 and 2 emissions, consistent with requirements of DA305-11-01 condition 18 (b) of Schedule 3, which states:

> *18. The Applicant shall:…*
>
> *(b) implement all reasonable and feasible measures to minimise the release of greenhouse gas emissions from the site.*

The total direct (Scope 1) GHG emissions associated with LCO are estimated at 4.4Mt $CO2_{-e}$. Approximately 0.16Mt of indirect (Scope 2) $CO2_{-e}$ emissions associated with on-site electricity consumption and 113Mt of indirect (Scope 3) $CO2_{-e}$ emissions associated with the transport of product coal to Newcastle, diesel and electricity use and the use of the product, would also be generated over the life of the operation. Total direct GHG emissions therefore only represent approximately 4% of the overall emissions associated with the operation of the mine, with being indirect emissions from third parties. (SLR, 2013).

The largest source of Scope 1 GHG emissions is fugitive methane emissions, which accounts for 72% of all direct GHG emissions form the site. Diesel usage accounts for approximately 27%, with blasting contributing less than 1%. (SLR, 2013).

5.2 Compliance Reporting Criteria

5.2.1 National Greenhouse and Energy Reporting System

The National Greenhouse and Energy Reporting (Measurement) Determination 2008 (Cth) provides methods and criteria for calculating greenhouse gas (GHG) emissions and energy data under the NGER Act. Each reporting year technical guidelines based on the Determination are developed; reflecting improvements in estimation methods and in response to industry feedback. LCO through GCAA uses an online reporting tool known as SAP ERS, which calculates energy consumption and GHG emissions for every site in accordance with the technical guidelines.

Roles and accountabilities for NGERS management are divided between GCAA and LCO. NGERS data collection requirements for GCAA are prescribed in a series of protocol documents that outline the obligations of all facilities within GCAA. Each department's function may include energy and emissions data collection systems, carbon management assurance processes, internal and external reporting requirements and sign off responsibilities.

5.3 GHG Management Controls

LCO implements all reasonable and feasible management controls to mitigate Scope 1 and 2 GHG emissions associated with the site. The primary sources of GHG at the LCO are:

- Electricity consumption;
- Fuel combustion;
- Fugitive emissions;
- Waste water emissions; and
- Gas insulated switch gear (SF6 production).

GHG emissions can be managed through project design, procurement processes and project operation. The management controls implemented at the LCO will be initiated at both corporate and site levels. The following sections include a combination of corporate and site based GHG management controls.

5.3.1 Design Controls

The LCO pit design has been selected based on operational efficiency and development costs, as well as environmental factors. The concept mine plan that formed the basis of the Project Approval was based on a design that reduced impact, provided the most cost effective design and shortened overburden haulage distances.

The conceptual design process included specific consideration of energy efficiency and GHG emissions. The mine planning process considered issues such as selecting fleet vehicles, truck haul routes, waste removal placement and rehandling material to optimise diesel use efficiency.

5.3.1.1 Fleet Selection

Equipment is selected according to a set of guidelines that involve being fit for task, maintainability, reliability, performance, safety and environment. GCAA has general rules governing the numbers of a particular type of equipment required for a particular project. The guidelines assist in optimising the number of ancillary equipment required. .

The design process confirms that loading units are matched to truck capacity, to eliminate suboptimal loader movements (digging and moving part bucket volumes).

5.3.1.2 Haul Routes

Out of pit dumps have been designed to optimise impacts to external parties and haul route distances. Where practical, ramp placement and ramp grades have been designed to maximise haulage efficiency. Rehandling material and energy use can be reduced by optimising removal and placement schedules. The LCO design has been developed to minimise the rehandling of waste and coal materials.

5.3.2 Procurement

Site procurement processes require all procurements to be approved via an Application for Expenditure (AFE). An AFE specifically requires energy efficiency be considered to demonstrate how new procurement will impact environmental factors.

5.3.3 Corporate Controls

GCAA has developed protocols that are regularly reviewed to promote continuous improvement. GCAA protocols focus on improving the greenhouse and energy reporting performance at each site. GCAA also use the SAP ERS platform for reporting that refines measurements and estimations of fugitive emissions on an annual basis.

5.3.4 Site Controls

GCAA require all sites to review their Life of Mine (LOM) planning on an annual basis. As part of this process, sites are required to reforecast future GHG emissions and review GHG and energy reduction opportunities.

5.3.5 Fugitive Emissions

Management controls to address fugitive emissions are evaluated by GCAA as part of an annual process for allocating capital expenditure across the NSW Division.

The LCO open cut coal seams do not require pre-drainage to manage safety risks. Initial investigations into methane drainage requirements have indicated it is not feasible to flare methane and/or capture methane for energy production prior to mining the coal seams present at the LCO.

The NGERS Technical Guidelines outline how to calculate and report fugitive emissions. There are 2 mothods:

1. *Method 1* - The default method (Method 1) for estimating fugitive emissions from an open cut coal mine is to multiply ROM tonnes by a state based methane emissions factor. In non-gassy mines such as the LCO, the NSW methane emissions factor can overstate the expected generation of fugitive emissions during the mining process.
2. *Method 2* - GCAA has developed a Method 2 approach (as described in the NGERS Technical Guidelines) for estimating fugitive emissions from open cut mining and this is now implemented for LCO. This method significantly reduces reported open cut fugitive emissions

Energy Use

5.3.6 Energy Use

Managing energy use is an important GHG management control option and LCO and as such LCO has completed a number of energy efficiency projects including:

- Sensors on various fixed lighting area across the MIA and CHPP;
- Power factor correction installed at the CHPP;
- Reduction of machinery idle times;
- Upgrade to energy efficient conveyor drive for train loading system.

Energy usage is reported on an annual basis and is captured via NGERs reporting process and the Annual Review.

5.3.7 Waste

General waste produced at LCO is managed and processed at the local council area landfill. The LCO Waste Management System requires its operations to recycle paper, cardboard and timber. Recycling paper, cardboard and timber will divert organic material from being disposed of to landfill and reduce potential methane emissions. LCO operates two managed aerobic waste water management treatment plant, which is the most cost effective way to manage GHG emissions from waste water.

5.3.8 Industrial

A very small proportion of GHG emissions are generated by gas (SF_6) insulated switch gear installed at LCO. Installing SF_6-free switch gear is the only option for controlling SF_6 emissions from switch gear. The installation of SF_6-free switch gear is considered in line with GCAA's procurement process as new switch gear is installed and/or replaced.

5.3.9 GHG Monitoring

LCO monitor GHG emissions, energy use and energy production by the direct measurement of energy use and modelling emissions based on measured activity data. The GHG monitoring program will require the collation of activity data such as energy use, coal production and waste disposal.

5.3.10 Monitoring Standards

The GCAA Protocols provide specific monitoring standards for monitoring GHG emissions, energy use and energy production. GCAA Protocols are based on the monitoring standards specified in the legislative Measurement Technical Guidelines. LCO will utilise relevant GCAA Protocols when monitoring greenhouse emissions and activity data.

5.3.11 Monitoring Program

The LCO GHG and energy use monitoring program is undertaken across a number of business systems. All GHG emissions and activity use data are monitored for multiple purposes through established systems. ***Table 5-1*** outlines how GHG and energy use monitoring is achieved across multiple systems. ***Table 5-2*** outlines how energy production will be monitored across multiple systems.

Table 5-1 - GHG and energy use monitoring systems

Emission/Energy Source	Activity Data/Direct Measurement	Monitoring System
Fuel Combustion	Diesel (Stationary & transport) Petrol (Stationary) Oils and Greases (Stationary) Oils and Greases (Transport) Oils and Greases (Recycled)	Invoices & tank dip levels Monthly fuel reconciliation return Invoices SAP report JR Richards monthly waste report
Industrial processes	SF6 from gas insulated switch gear	Circuit breaker specifications
Waste	Solid waste to landfill	JR Richards Monthly waste report
	Waste water handling	Laboratory Reports
Scope 2 emissions	Electricity use	Electricity Invoices

Table 5-2 - Energy Production Monitoring Systems

Energy source	Activity data/Direct measurement	Monitoring system
Fuel production	Washed coal	Weightometers

5.3.12 Monitoring Records

To comply with the legislation, all sites are required to retain records of energy consumption, energy production, emissions data and estimations for a minimum of seven years from the end of the reporting period in which the activities took place.

LCO has developed procedures for the collection and retention of data to ensure the site complies with the appropriate legislative requirements.

5.4 GHG Reporting and Review

LCO will report GHG emissions and energy use both internally and externally. Internal reporting systems allow divisional groups to evaluate the performance of energy efficiency programs and comply with corporate greenhouse reporting requirements (NGERS is reported at a corporate level). Internal reporting also allows Glencore Plc to evaluate SD programs and report SD performance externally in programs such as the Global Reporting Index (GRI).

Glencore Plc maintains a global internal reporting system called Glencore Corporate Practice (GCP). This is a web based system for collecting data and reporting sustainable development performance. As a subsidiary of Glencore Plc, GCAA must update GCP at prescribed intervals. LCO will report GHG activity data internally via GCP according to the schedule outlined in ***Table 5-3***.

Table 5-3 - GCP Reporting Intervals

Activity Data	Reporting Interval
SF6 emissions	Annually
CO2-e for stockpiled coal	Quarterly
Electricity purchased	Quarterly
Diesel non-transport	Quarterly
Diesel transport	Quarterly
Petrol / gasoline non-transport	Quarterly
Petrol / gasoline transport	Quarterly
Diesel for explosives	Quarterly
General waste to landfill	Quarterly

6. Accountabilities and Training

6.1 Roles and Responsibilities

Air quality management related roles and responsibilities at LCO are listed in ***Table 6-1***.

Table 6-1 - Roles and Responsibilities

Role	Accountabilities for this Role
Operations Manager	Provide sufficient resources to manage air quality related risks and progress opportunities for improvement. Identify and allocate sufficient resources to manage air quality related risks by supporting AQMMP implementation.
Manager Mining Engineering	Oversee the implementation of air quality management measures on all mining and related operations.
Coal Preparation Plant Manager	Oversee the implementation of air quality management measures at all CHPP locations.
Mining Superintendent	Oversee the implementation of air quality management measures listed in the AQMMP in their Department. Modify operations that are generating excessive air emissions. Report excessive dust emissions to the relevant Mining or CHPP Manager.
Mining Supervisor	Coordinate mining operations to minimise dust generation. Suspend or modify operations when dust suppression systems are not operational or effective. Implement appropriate contingency measures in the event of triggers activated as specified in the Dust Management TARP. Supervisor/OCE to notify Environment and Community Superintendent/Officer about operations that are creating excessive dust or if the measures listed in this AQMMP are not being implemented or if they are not effective in mitigating air emissions.
Environment & Community Manager	Have a sound understanding of mine-related air emission sources and controls. Oversee the implementation, monitoring and review of this AQMMP in accordance with applicable legal and other requirements pertaining to air quality. Record, investigate and respond to air quality related incidents and complaints in accordance with site complaint and incident management procedures. Periodically assess dust management performance and review the AQMMP to reduce the overall risk profile. Provide training to employees and contractors for the implementation of dust management related controls, systems and procedures. Provide induction programs for employees, contractors and visitors addressing relevant air quality management objectives, hazards, risks, controls, behaviours and consequences of inappropriate behaviour.

Role	Accountabilities for this Role
	Consult with affected stakeholders regarding air quality issues; maintaining records of consultation, personnel participating in the consultation and the issues discussed. Report air quality performance as per the Communications and Reporting Schedule outlined in the AQMMP.
Environment & Community Officer	Have a sound understanding of mine-related dust emission sources and controls. Implement, monitor and review programs, systems and procedures linked to the AQMMP, including the Dust Management TARP. Monitor and review the data that is being sent for compiling the Environmental Monitoring Reports and the AEMR. Monitor, document and communicate progress against dust management objectives and targets as per the Communication and Reporting Schedule. This includes the reporting of dust monitoring results in the AEMR and EPL Annual Return, and Quarterly Environmental Monitoring Reports. Review the monitoring reports provided by monitoring contractors to assess compliance with the limits. Report on any air quality related non-compliances and exceedance events.
All Persons	Demonstrate an awareness of dust emission sources and related risks, both generally and specifically in relation to their own site activities. Identify and report incidents involving excessive dust emissions. Consistently implement dust management measures integrated within site operating procedures.
Air Quality Monitoring Contractor	Collect, analyse and report air quality related data to LCO Environment and Community personnel in accordance with legislative requirements, Australian Standards and recognised Quality Control Procedures.

6.2 Awareness and Training

LCO provides training commensurate with the roles and responsibilities of personnel outlined above.

Training implemented at LCO with respect to air quality management includes the following:

- Site Familiarisation Inductions provided to all new employees and contractors;
- General Environmental Awareness provided to all existing employees and permanent contractors; and
- Issue specific training sessions provided to employees and contractors as required.

Other methods used to communicate the responsibilities of LCO employees and contractors relating to air quality management include:

- Communication sessions;
- Tool-Box Talks;
- Electronic site notice boards; and
- Site newsletters.

7. Auditing and Review Provisions

The AQMMP will be reviewed in accordance with Schedule 5, Condition 10 of DA 305-11-01, that is, within 3 months of:

- The submission of the Annual Review under Schedule 5 Condition 3;
- The submission of an incident report under Schedule 5 Condition 11;
- The submission of an audit under Schedule 5 Condition 4; or
- Any modification to the conditions of the consent.

. The objective of the scheduled review process being primarily to:

- Monitor and report on compliance with Objectives and Targets which cover statutory requirements and other commitments;
- Account for changes in environmental requirements, technology or operational procedures; and
- Identify opportunities to drive continuous improvement and to reduce the overall risk profile of the operation.

8. Definitions

Term	Definition
Adverse meteorological conditions	Weather conditions under which air quality impacts are likely to occur. Such conditions are source-specific, and may vary depending on whether emissions are wind dependent and the relative location of sensitive receptors. Windy, dry conditions typically represent adverse conditions for wind-dependent sources such as erosion of exposed surfaces, with impact potentials enhanced for downwind sensitive receptors. Calm wind periods, stable atmospheric conditions (i.e. limited air turbulence) and limited mixing heights potentially constitute adverse conditions for blasting emissions.
Ambient air	Air within the surrounding environment, not including air inside buildings
AQMMP	Air Quality Management and Monitoring Plan
BoM	Bureau of Meteorology
BMP	Best Management Practice
Chemical additives / chemical suppressants / chemical surfactants	Chemical additives are also known as dust palliatives, chemical suppressants and chemical surfactants. Categories of chemical suppressants include: hygroscopic salts; petroleum resins; bitumen, asphalt and tar; polymer emulsions; wetting agents; and lignosulphonates.
Chemical stabilisation / chemical suppression	Use of chemical additives in the water, to aide surface crusting and binding of dust particles thus reducing the potential for entrainment. Chemical suppressants with a dust control efficiency of at least 80% when effectively implemented are required.

Term	Definition
CCC	Community Consultative Committee
CHPP	Coal Handling and Preparation Plant
DA	Development Approval
DEC	Department of Environment and Conservation, currently the Environment Protection Authority
Disturbed areas	Areas disturbed during construction and mining activities and include any construction site, permanent and temporary access roads and mining areas
DP&E	Department of Planning and Environment
DRE	Department of Resources and Energy
Dust	Refers to any particulate matter that can be carried in the atmosphere
Dust control efficiency	Percentage reduction in dust emissions achieved by a measure as compared to dust emissions from uncontrolled operations.
EBAM	Portable continuous beta attenuation mass monitor
Entrainment	Process by which surface sediment is incorporated into an air flow. This process can result from wind erosion of exposed material, or by the suspension of surface material by vehicles.
EMS	Environmental Management System
EPL	Environmental Protection Licence
GCAA	Glencore Coal Assets Australia
LCO	Liddell Coal Operations
MMA	Mitsui Matsushima Australia Pty Ltd
Mtpa	Million ton per annum
NGERS	National Greenhouse and Energy Reporting System
NPI	National Pollutant Inventory
NSW EPA	New South Wales - Environmental Protection Agency
OEA	Overburden Emplacement Areas
OEH	NSW Office of Environment and Heritage
Other unsealed roads	All trafficked unsealed roads on-site which are not used as haul roads.
Permanent rehabilitation	Rehabilitation on land that will not be disturbed again and typically comprises topsoiling and planting with native species.

Term	Definition
PM	Particulate matter (general term)
PM_{10}	Particulate matter less than 10micrometres in aerodynamic equivalent diameter
$PM_{2.5}$	Particulate matter less than 2.5micrometres in aerodynamic equivalent diameter
PRP	Pollution Reduction Program
QA/QC	Quality Assurance / Quality Control
ROM	Run of Mine
Sensitive receptor	A location where people are likely to work or reside; this may include a dwelling, school, hospital, office or public recreational area.
TARP	Triggered Action Response Procedure
TEOM	Tapered Element Oscillating Microbalance
Temporary rehabilitation	Use of temporary cover crops to reduce dust prior to construction of the final landform.
Trafficable Areas	Areas where mobile machinery is permitted to travel
TSP	Total Suspended Particulates
Visible dust	Dust that is visible to the naked eye in normal light conditions

9. Document Information

Relevant legislation, standards and other reference information must be regularly reviewed and monitored for updates and should be included in the site management system. Related documents and reference information in this section provides the linkage and source to develop and maintain site compliance information.

9.1 Related Documents

Related documents, listed in ***Table 9-1***, are *documents* directly related to or referenced from within this document.

Table 9-1 - Related documents

Number	Title
LIDOC-90533967-1642	Coal Particulate Matter Control Best Management Practice Determination

Number	Title
	Pacific Environment Operations Pty Ltd – Summary of estimated emissions for Liddell Coal Mine, October 2017
	Liddell Colliery – Environmental Assessment for the Liddell Colliery Modification to Development Consent, Umwelt Australia Pty. Ltd, 2006
	Liddell Coal Operations – Preliminary Environmental Assessment, Proposed Modification to DA 305-11-01, GSS Environmental, September 2011
	SLR Consulting Pty Ltd, Proposed Modification to DA 305-11-01. Environmental Assessment September 2013, Prepared on behalf of Liddell Coal Operations
	Hansen Bailey, Environmental Assessment, Modification 7 to DA 301-11-01, August 2018, Prepared on behalf of Liddell Coal Operations
	Liddell 2014 Annual Environmental Management Report (AEMR). Final. 30/03/2015
	Liddell Coal –Annual Environmental Management Report (AEMR), July 2010 – December 2011
LIDOC-90533967-797	Environmental Management Strategy
LIDOC-90533967-2387	Liddell Dust Management TARP
LIDOC-90533967-2843	Dust Suppression & Road Watering
LIDOC-90533967-2877	Meteorological Assessment, Blast Monitoring and Reporting
LIDOC-90533967-84	Spontaneous Combustion Management Plan
LIDOC-90533967-955	Airborne Dust
LIDOC-90533967-506	Land Clearing & Topsoil Stripping

9.2 Reference Information

Reference information, listed in ***Table 9-2***, is *information* that is directly referred to for the development of this document.

Table 9-2 - Reference information

Reference	Title
Legislation	Environmental Planning and Assessment Act 1979 (NSW).
	Environmental Planning and Assessment Regulation 2000 (NSW).
	Environment Protection and Biodiversity Conservation Act 1999.

Reference	Title
	National Parks and Wildlife Act 1974.
	NSW Department of Trade & Investment – Resources & Energy – Guidelines To The Mining, Rehabilitation and Environmental Management Process.
	Protection of the Environment and Operations Act 1997.
	Protection of the Environment Legislation Amendment Act 2011.
	Approved Methods for the Sampling and Analysis of Air Pollutants in New South Wales, December 2007.
	Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales, August 2005.
Australian Standards	AS/NZS 3580.1.1:2007 Guide to siting air monitoring equipment.
	AS 3580.10.1-2003 Methods for Sampling and Analysis of Ambient Air - Determination of Particulates - Deposited Matter - Gravimetric Method.
	AS/NZS 3580.9.3-R2014 Methods for the Sampling and Analysis of Ambient Air – Determination of Suspended Particular Matter – Total Suspended Particulate Matter (TSP) – High Volume Air Sampler Gravimetric Method.
	AS 3580.9.6-R2014 Methods for sampling and analysis of ambient air – Determination of suspended Particulate Matter - PM_{10} - high volume sampler with size-selective inlet – Gravimetric Method.
	AS 3580.9.8-2008 Methods for sampling and analysis of ambient air - Determination of suspended particulate matter - PM_{10} continuous direct mass method using a tapered element oscillating microbalance analyser.
	AS3580.14.1:2011 Methods for sampling and analysis of ambient air.
Glencore Coal Assets Australia	GCAA-625378177-9978 HSEC STD 11.0 Environment
	GCAA-625378177-10324 HSEC Protocol11.10 Air Quality Management
	GCAA-625378177-10301 HSEC Protocol 11.01 Environmental Compliance Management
	GCAA-625378177-9974 HSEC Protocol 11.13 Carbon Management
	GCAA-625378177-10245 HSEC Procedure 11.10 Mobile Crushing Unit Dust Management
	GCAA-625378177-10246 HSEC Procedure 11.10 Drill Dust Management
	GCAA-625378177-10263 HSEC Procedure 11.01 Real Time Monitoring
	GCAA-625378177-10274 HSEC Procedure Environmental Data Collection and Reporting

Reference	Title
Other	Air Quality Improvement Project – Review of Best Practice and XCN Dust Management Guideline Development, Report compiled by ENVIRON Australia Pty Ltd on behalf of XCN, March 2011.
	Air Quality Improvement Project – Dust Management Benchmarking of Xstrata Coal NSW Operations, Report compiled by ENVIRON Australia Pty Ltd on behalf of XCN, November 2010.
	Air Quality Improvement Project – Dust Management Perceptions of Xstrata Coal NSW Personnel, Report compiled by ENVIRON Australia Pty Ltd on behalf of XCN, September 2010.

9.3 Change Information

Full details of the document history are recorded in the document control register, by version. A summary of the current change is provided in ***Table 9-3***.

Table 9-3 - Change information

Version	Date	Review team (consultation)	Change Summary
1.0	18/3/2013	B de Somer, Colin Davies (Carbon Based)	This document supersedes LCO SD EXT 0071 Air Quality Monitoring Program. Prepared as per 2012 Independent Environmental Audit Recommendations
2.0	14/5/2015	B de Somer, Environ Australia Pty Ltd	General updates to reflect revised consent conditions for DA305-11-01 Modification 5, primarily Section 2.3 Air Quality Criteria and Section 2.11 Air Quality Monitoring, and Section 3 Greenhouse Gas Management to reflect new requirements. Updated to Glencore document template.
	15/7/2015	J Young, L Barben, B de Somer, Environ Australia Pty Ltd	Updated in accordance with comments from DP&E.
	13/8/2015	L Barben	Append DPE approval letter
3.0	October 2016		Document migration to new Sharepoint.
4.0	30/05/2017	B de Somer, J Young	Update Compliance Monitoring Section 2.11.2 – 2.11.11 Removal of Section 2.11.14 Historical Monitoring Location Update Supplementary Boundary Monitoring component (Section 2.11016 – 2.11.20 Update internal document links/references.

Version	Date	Review team (consultation)	Change Summary
			Addition of Section 2.12.3 Notification of exceedance Approved by DPE 30/5/2017, letter added to Appendix C.
5.0	11/10/2018	B de Somer, M Henderson	Update Figure 10 and 11. Delete Figure 12. New Table 8. Minor textual updates throughout. Add DPE Approval letter in Appendix C. H Simms, B De Somer - Transferred to current template, doc owner to E&C Officer.
6.0	26/06/2019	M Henderson, B de Somer	Full review Updated Figure 11 Updated Section 2.3 Air Quality Criteria, Section 2.11 Air Quality Monitoring and Section 5 Auditing and Review Provisions. Updated Section 2.8 Source Prioritisation with Pacific Environment estimated emissions summary Updated Appendix A with Modification 7.
7.0	20/08/2020	L Depczynski, B de Somer	Full review. Update to new template. Update Figures 5-9 & 5-10 with new DA and EPL boundary. Minor updates to sections 4.11.3.3, 4.11.4, 4.11.5.1, 5.2.1, 5.3.3, 5.3.5, 5.3.6. Updates approved by DPIE 29/1/21.
8.0	23/08/2022	L Ingram B de Somer	Full review. Update Section 4.8 source prioritisation rankings Update Table 4-5 to include reference to SX38-D5

Appendix A - LCO Development Consent Conditions – Air Quality

Table A 1: LCO Development Consent (DA 305-11-01) Requirements for Air Quality

Approval Schedule / Sections	Approval Condition	Relevant Section of AQMMP
DA 305-11-01 Schedule 3, Condition 16	**Impact Assessment Criteria** The Applicant shall ensure that all reasonable and feasible avoidance and mitigation measures are employed so that particulate emissions generated by the development do not exceed the air quality impact assessment criteria listed in Tables 3, 4, and 5 at any residence on privately-owned land.	*Section 4.3*

Table 3: Long term impact assessment criteria for particulate matter

Pollutant	Averaging Period	[a]Criterion
Total Suspended Particulate (TSP) matter	Annual	[a]90 µg/m^3
Particulate Matter < 10 µm (PM_{10})	Annual	[a]30 µg/m^3

Table 4:Short term impact assessment criteria for particulate matter

Pollutant	Averaging Period	[d]Criterion
Particulate Matter < 10 µm (PM_{10})	24 hour	[b]50 µg/m^3

Table 5: Long term impact assessment criteria for deposited dust

Pollutant	Averaging Period	Maximum increase in deposited dust level	Maximum total deposited dust level
[c]Deposited Dust	Annual	[b]2 g/m^2/month	[a]4 g/m^2/month (a)

Notes to Tables 3-5:

a Total impact (i.e. incremental increase in concentrations due to the development plus background concentrations due to all other sources;

b Incremental impact (i.e. incremental increase in concentrations due to the development on its own);

c Deposited dust is to be assessed as insoluble solids as defined by Standards Australia, AS/NZS3580.10:2003: Methods for Sampling and Analysis of Ambient Air Determination of Particulate Matter – Deposited Matter – Gravimetric Method; and

d Excludes extraordinary events such as bushfires, prescribed burning, dust storms, fire incidents or any other activity agreed by the Secretary.

Table A 1: LCO Development Consent (DA 305-11-01) Requirements for Air Quality

Approval Schedule / Sections	Approval Condition	Relevant Section of AQMMP
DA 305-11-01 Schedule 3, Condition 18	**Operating Conditions** The Applicant must: (a) implement all reasonable and feasible air quality management measures to minimise odour, fume and dust emissions from the development; (b) implement all reasonable and feasible measures to minimise the release of greenhouse gas emissions from the site; (c) minimise any visible air pollution generated by development; (d) minimise surface disturbance on the site; (e) operate an air quality management system that uses a combination of high volume samplers and dust deposition gauges to ensure compliance with the relevant conditions of consent; and (f) minimise the air quality impacts of the development during adverse meteorological conditions and extraordinary events to the satisfaction of the Secretary.	*Section 4.9*
DA 305-11-01 Schedule 3, Condition 19	**Monitoring** The Applicant must update and subsequently implement the Air Quality Monitoring Program for the development to the satisfaction of the Secretary. This program must be submitted to the Secretary by the end of May 2015, and must include a combination of real-time air quality monitors and supplementary monitors to monitor the dust emissions of the development; and an air quality monitoring protocol for evaluating compliance with the air quality impact assessment criteria in this consent.	*Section 4.11*
DA 305-11-01 Schedule 3, Condition 20	**Meteorological Monitoring** The Applicant must ensure that there is a suitable meteorological station operating in the vicinity of the development in accordance with the requirements in Approved Methods for Sampling of Air Pollutants in New South Wales; and to the satisfaction of the EPA and Secretary.	*Section 4.11*
DA 305-11-01 Schedule 4, Conditions 1-3	**Notification of Landowners** 1. By 31 October 2007, the Applicant must notify the landowners of the land listed in Table 1 that they have the right to an independent review in accordance with Condition 4 of Schedule 4 if they consider that the development is exceeding the relevant impact assessment criteria at any stage during the life of the development. 2. If the results of monitoring required in Schedule 3 identify that impacts generated by the development are greater than the impact assessment criteria, except where this is predicted in the EA, and except where a negotiated agreement has been entered into in relation to that impact, then the Applicant must notify the Secretary and the affected landowners and/or existing or future tenants (including tenants of mine owned properties) accordingly, and provide quarterly monitoring results to each of these parties until the results show that the development is complying with the criteria in Schedule 3. 3. The Applicant must send a copy of the NSW Health fact sheet entitled 'Mine Dust and You' (as may be updated from time to time) to advise landowners and/or existing or future tenants (including tenants of mine owned properties) of the possible health and amenity impacts associated with exposure to particulate matter, to the satisfaction of the Secretary where the predictions in the EA identify that the dust emissions generated by the development are likely to be greater than the air	*Section 4.13.2* *Section 4.13.3*

Table A 1: LCO Development Consent (DA 305-11-01) Requirements for Air Quality

Approval Schedule / Sections	Approval Condition	Relevant Section of AQMMP
DA 305-11-01 Schedule 4, Conditions 4-6	**INDEPENDENT REVIEW** 4. If a landowner of privately-owned land considers the development to be exceeding the impact assessment criteria in Schedule 3, then he/she may ask the Secretary in writing for an independent review of the impacts of the development on his/her land. If the Secretary is satisfied that an independent review is warranted, the Applicant must within 2 months of the Secretary decision: (a) commission a suitably qualified, experienced and independent expert, whose appointment has been approved by the Secretary, to: • consult with the landowner to determine his/her concerns; • conduct monitoring on the land, to determine whether the development is complying with the relevant impact assessment criteria in Schedule 3; and • if the development is not complying with these criteria then: – determine if more than one mine is responsible for the exceedances; and if so the relevant share of each mine regarding the impact of the land; – identify measures that could be implemented to ensure compliance with the relevant criteria; (b) give the Secretary and landowner a copy of the independent review. 5. If the independent review determines that the development is complying with the relevant impact assessment criteria in Schedule 3, then the Applicant may discontinue the independent review with the approval of the Secretary. 6. If the independent review determines that the development is not complying with the relevant impact assessment criteria in Schedule 3, and that the development is primarily responsible for this noncompliance, then the Applicant must: (a) take all reasonable and feasible measures, in consultation with the landowner and appointed independent expert to ensure that the development complies with the relevant criteria; or (b) secure a written agreement with the landowner to allow exceedances of the criteria in Schedule to the satisfaction of the Secretary. If the additional monitoring referred to above subsequently determines that the development is complying with the relevant criteria in Schedule 3, then the Applicant may discontinue the independent review with the approval of the Secretary. If measures referred to in (a) do not achieve compliance with the criteria in Schedule 3, and the Applicant cannot secure a written agreement with the landowner to allow these exceedances within 3 months, then upon receiving a written request from the landowner, then the Applicant or landowner may refer the matter to the Secretary for resolution. If the matter cannot be resolved within 21 days, the Secretary shall refer the matter to an Independent Dispute Resolution Process (see Appendix 4).	*Section 4.13.2*

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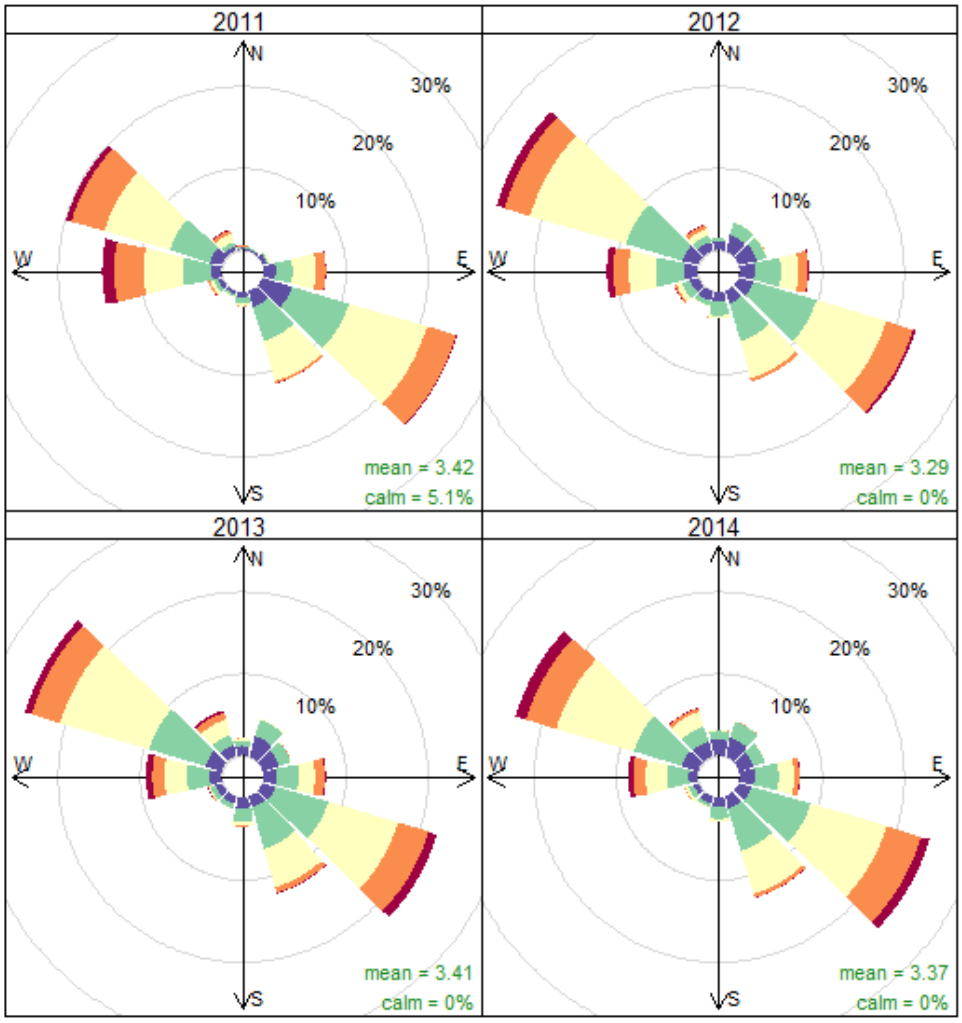
Approval Schedule / Sections	Approval Condition	Relevant Section of AQMMP
DA 305-11-01 Schedule 5, Condition 3	**Annual Review** 3. Each year, the Applicant must prepare an Annual Review to the satisfaction of the Secretary. This review must: (a) identify the standards and performance measures that apply to the development; (b) describe the works carried out in the last 12 months; (c) describe the works that will be carried out in the next 12 months; (d) include a comprehensive review of monitoring results and complaints received during the past year, and compare the results against: – limits/criteria in this consent, statutory requirements and performance – measures/criteria; – monitoring results from previous years; and (e) predictions in the latest EA; (f) identify any trends in the monitoring over the life of the development; (g) identify and discuss any non-compliance during the previous year and describe what actions were (or are being) taken to ensure compliance; (h) identify any discrepancies between the predicted and actual impacts of the development, and analyse the potential cause of any significant discrepancies; and (i) describe what measures will be implemented over the next year to improve the environmental performance of the development.	*Section 4.13.3*
DA 305-11-01 Schedule 5, Condition 7	**Community Consultative Committee** The Applicant must maintain a Community Consultative Committee for the development to the satisfaction of the Secretary. The CCC must be operated in accordance with the *Department's Community Consultative Committee Guidelines: State Significant Projects (2016).*	*Section 4.13.3*

Appendix B - Annual & Seasonal Average Wind Roses

B.1 Annual Wind Roses – Liddell Met Station



B.2 Seasonal and Monthly Wind Roses – Liddell Met Station