Appendix O – Air quality and greenhouse gas impact assessment

NEWSTAN MINE EXTENSION PROJECT

Air Quality Impact Assessment and Greenhouse Gas Assessment

Prepared for:

Centennial Newstan Pty Ltd

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BASIS OF REPORT

This report has been prepared by SLR Consulting Australia Pty Ltd (SLR) with all reasonable skill, care and diligence, and taking account of the timescale and resources allocated to it by agreement with Centennial Newstan Pty Ltd (the Client). Information reported herein is based on the interpretation of data collected, which has been accepted in good faith as being accurate and valid.

This report is for the exclusive use of the Client. No warranties or guarantees are expressed or should be inferred by any third parties. This report may not be relied upon by other parties without written consent from SLR.

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DOCUMENT CONTROL

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1 Introduction

SLR Consulting Australia Pty Ltd (SLR) has been commissioned by Centennial Newstan Pty Limited (Centennial Newstan) to conduct an Air Quality Impact Assessment (AQIA) and Greenhouse Gas (GHG) Assessment for the Newstan Mine Extension Project (hereafter 'the project').

The Extension Project proposes to extract up to 4 Million tonnes per annum (Mtpa) of Run-of-Mine (ROM) coal and a total of 25.9 Mt over a fifteen year mine life from the West Borehole seam.

The aim of this AQIA and GHG Assessment is to assess the incremental and cumulative impacts from the relevant construction and operational activities associated with the project.

1.1 Secretary's Environmental Assessment Requirements

The scope of this AQIA has been designed to address the Secretary's Environmental Assessment Requirements (SEARs) with regard to the assessment of air pollutant emissions. The comments provided by other government agencies have also been reviewed with regard to their relevance to the assessment of air quality and greenhouse gas impacts. Where relevant, these have also been addressed within the AQIA and GHG Assessment. A summary of the SEARs and relevant regulatory comments is provided in **Table 1** together with the associated section of this report addressing the particular SEAR/regulatory comment.

Table 1 Secretary's Environmental Assessment Requirements and Government Agency Comments

Requirement	Relevant Section of AQIA Report
SEARs	
A detailed assessment of potential construction and operational air quality impacts, in accordance with the Approved Methods for the Modelling and Assessment of Air Pollutants in NSW, and with a particular focus on dust emissions including $PM_{2.5}$ and PM_{10}, and having regard to the Voluntary Land Acquisition and Mitigation Policy; and	**Section 8** **Section 4.1**; and **Section 10.2**
An assessment of the likely greenhouse gas impacts of the development.	**Section 11**
EPA Comments	
The EIS should include a detailed AQIA. The AQIA should cover both the construction and operational phases of the development. The AQIA should: Demonstrate the proposed project will incorporate and apply best management practice emission controls	Entire AQIA
Demonstrate that the project will not cause violation of the project adopted air quality impact assessment criteria at any residential dwelling or other sensitive receptor.	**Section 8**
Demonstrate the proposal's ability to comply with the relevant regulatory framework, specifically the *Protection of the Environment Operations Act 1997* (POEO Act) and the POEO (Clean Air) Regulation (2010)	**Section 9**
Provide a detailed description of the existing environment within the assessment domain, including: o geophysical form and land-uses;	**Section 3.1**

Requirement	Relevant Section of AQIA Report
o location of all sensitive receptors; o local and regional prevailing meteorology.	**Section 3.2** **Section 6.3**
Provide a detailed description of the project and identify the key stages with regards to the potential for air emissions and impacts on the surrounding environment.	**Section 2.2**; and **Section 5.1**
Identify all sources of air emissions, including mechanically generated, combustion and transport related emissions likely to be associated with the proposed development.	**Section 2.2**
Provide a detailed discussion of all proposed air quality emission control measures, including details of a reactive/predictive management system.	**Section 10**
The information provided must include: o explicit linkage of proposed emission controls to the site specific best practice determination assessment o timeframe for implementation of all identified emission controls o key performance indicators for emission controls o response mechanisms o responsibilities for demonstrating and reporting achievement of KPIs o record keeping and complaints response register	**Section 10**
Lake Macquarie City Council Comments	
The applicant is to prepare an Air Quality Impact Assessment to assess potential air impacts on nearby sensitive receptors. The Air Quality Impact Assessment is to be prepared in accordance with the NSW EPA Approved Methods for the Modelling and Assessment of Air Pollutants in NSW (2016).	Refer to entire AQIA
Greenhouse gas emissions attributable to the project should be assessed in the context of the City of Lake Macquarie emission targets.	**Section 11.8**
Consideration must be given to evaluating the feasibility of achieving for net zero carbon emissions from the project, and the options and consequences of this and alternative low carbon emission scenarios.	**Section 11.10**

The SEARs also require that the assessment be performed in accordance with relevant policies, guidelines and plans including:

- Approved Methods and Guidance for the Modelling and Assessment of Air Pollutants in NSW (EPA);
- Approved Methods for the Sampling and Analysis of Air Pollutants in NSW (EPA);
- Coal Mine Particulate Matter Control Best Practice – Site Specific Determination Guideline (EPA);
- Generic Guidance and Optimum Model Settings for the CALPUFF Modelling System for Inclusion in the Approved Methods for the Modelling and Assessment of Air Pollutants in NSW (EPA);
- National Greenhouse Accounts Factors (Commonwealth); and
- Voluntary Acquisition and Mitigation Policy for State Significant Mining, Petroleum and Extractive Industry Developments (DP&E).

This assessment addresses the key issues raised within the SEARs and is performed in accordance with the relevant policies and guidelines.

2 Project Overview

Newstan Colliery is an existing underground coal mine located in the Lake Macquarie Local Government Area (LGA), approximately 25 kilometres south west of Newcastle and 140 kilometres north of Sydney, NSW. It is owned and operated by Centennial Newstan.

Mining operations at Newstan Colliery began in 1887 and upon the introduction of the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act) operated pursuant to continuing use rights in accordance with Part 4, Division 10 of the EP&A Act (continuing use rights).

Newstan Colliery has at various times mined the upper coal seams (Great Northern and Fassifern seams) and lower coal seams (West Borehole, Borehole, Young Wallsend and Yard seams) and produced both semi-soft coking coal and thermal coal for the domestic and export markets. In the lower seams, workings to date have been concentrated to the west of the seam split, which is a defining geological feature of the mine. Historically, mining has been undertaken using a combination of bord and pillar and longwall mining.

In August 2014, the underground operations at Newstan Colliery were placed onto care and maintenance due to poor market conditions. In recent years, Centennial Newstan has commenced feasibility investigations into the recommencement of mining at Newstan Colliery. The most recent modification to DA 73-11-98 (MOD 8) in January 2019, permits first workings mining within the West Borehole seam in the southern portion of the Newstan Colliery mining lease area. The first workings aim to improve Centennial Newstan's understanding of the geology within the West Borehole seam, including the presence, throw and strike of a major fault zone projected from the historic Newstan workings.

Centennial Newstan is now seeking approval for an extension of mining within the West Borehole seam. The Newstan Mine Extension Project proposes to extract up to 25.9 million tonnes (Mt) over a fifteen year period at a maximum production rate of 4 million tonnes per annum (Mtpa) of ROM coal. Bord and pillar mining is proposed using continuous miner methods that will include areas of first workings, partial extraction and total extraction. A mix of metallurgical and thermal coal is proposed to be extracted. ROM coal will be delivered to the Newstan Colliery Surface Site via a series of existing underground conveyors. Once the coal reaches the Newstan Colliery Surface Site it will be handled in accordance with the approved operations for the Northern Coal Logistics Project (SSD-5145) [NCL Project], managed by Centennial Coal's Northern Coal Services business unit.

Other key features of the project include:

- Utilisation of the Newstan Colliery Surface Site to provide parking, bathhouse, administration and workshop facilities for the underground workforce. A small number of administrative, maintenance and monitoring personnel will also be located at Awaba Colliery Surface Site.
- Transportation of personnel and materials to and from the underground mining area via the existing men and materials drift at Newstan Colliery Surface Site.
- Continued operation of the two existing ventilation fans at Newstan Colliery Surface Site until the installation and operation of two new ventilation fans at the existing ventilation shaft at Awaba Colliery Surface Site. At this point the Newstan ventilation fans will be decommissioned.
- In-seam gas drainage, with gas transferred to a new gas flaring facility to be located within the existing disturbance footprint of Awaba Colliery Surface Site.

- Extraction of underground water via the existing Fassifern Pump Station at Newstan Colliery Surface Site and ongoing groundwater management in accordance with Centennial Coal's Northern Operations Water Management Plan.

The project is aligned with the broader Centennial Coal business strategy in that it facilitates the development of a new semi-soft coking coal product stream and a thermal coal product for both the domestic and export markets. The project will enable supply of export coal products while meeting contractual coal supplies to the domestic markets. Over time, the project can potentially replace the coal product currently supplied to the domestic market by other Centennial operations as these other resources become depleted. This will ensure ongoing security of supply for domestic electricity generation.

If approved, the project will allow for the optimisation of resource recovery from Newstan Colliery while providing ongoing direct and indirect employment opportunities. In addition, the project will provide a number of positive flow-on effects to the local, regional and state economies through additional wages and royalties.

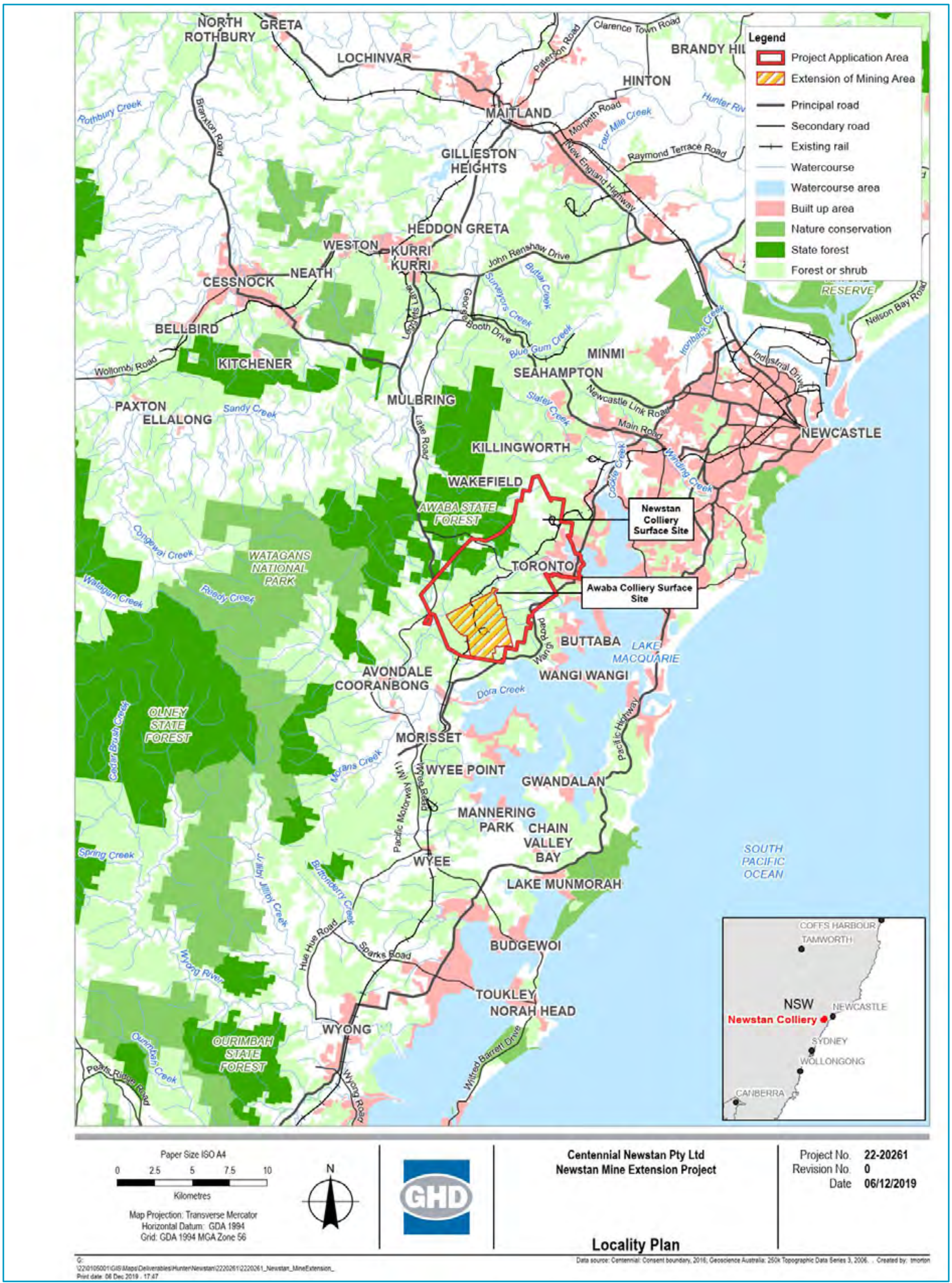
2.1 Project Application Area

The Project Application Area (PAA) is located on the western side of Lake Macquarie in the Lake Macquarie LGA. The Newstan Colliery Surface Site and Awaba Colliery Surface Site are located approximately 4 kilometres (km) north and 5.5 km south-west of Toronto respectively. The regional setting of the PAA is shown in **Figure 1**.

The indicative Project Layout is shown in **Figure 2**. It includes:

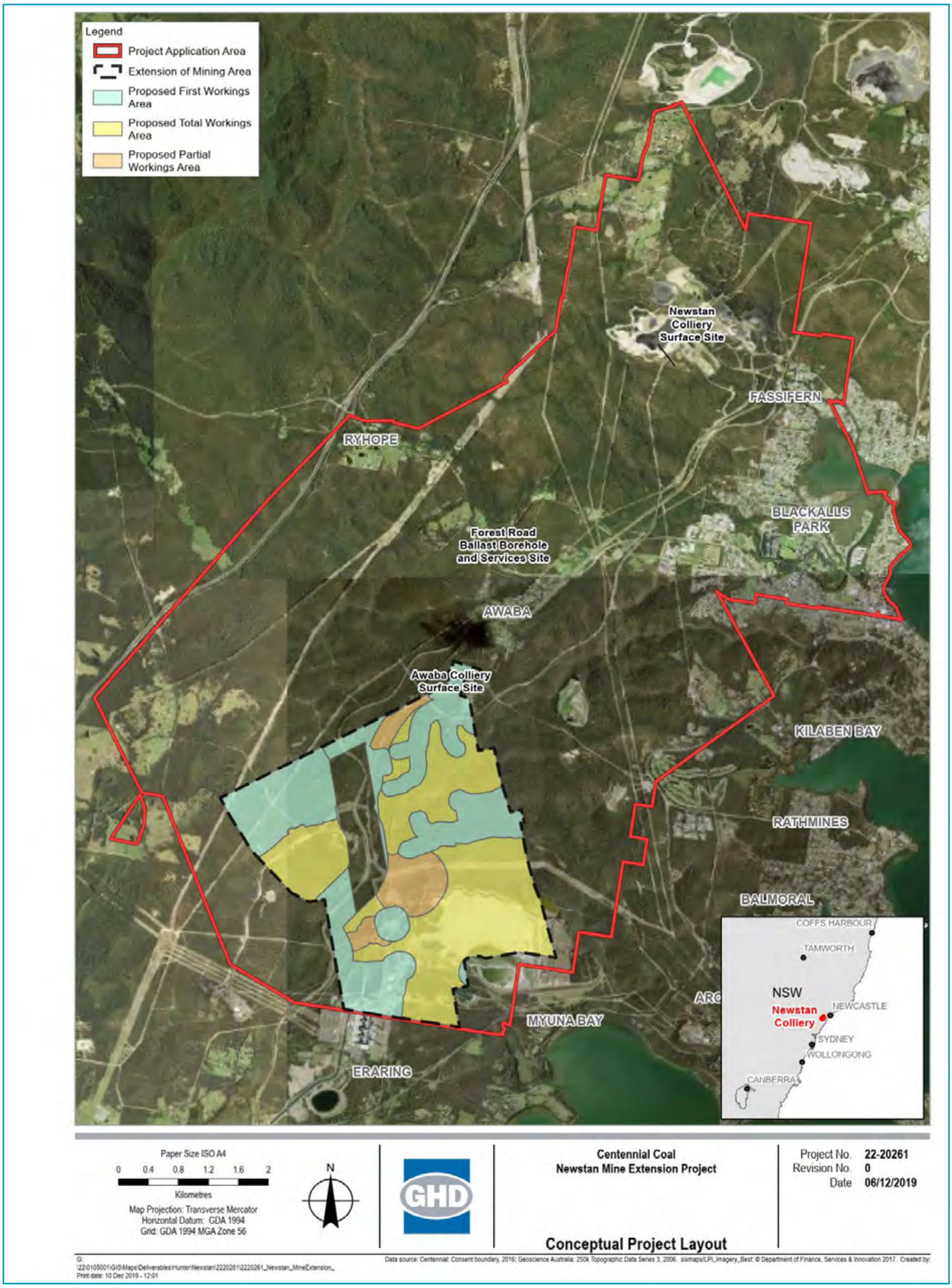
- proposed Newstan Extension of Mining area, including the extent of existing and approved mine workings for Newstan and Awaba;
- existing Newstan Colliery Surface Site; and
- existing Awaba Colliery Surface Site.

Figure 1 Regional Setting of the Project



Source: GHD 2019

Figure 2 Indicative Project Layout – Newstan Extension of Mining



Source: GHD 2019

2.2 Project Elements with Potential for Air Quality Impacts

The key air emissions from the project with potential for off-site impacts would occur during the construction activities at the Awaba Colliery Surface Site, and the operation of the ventilation fans at Newstan Colliery Surface Site and Awaba Colliery Surface Site and gas flares to be located at the Awaba Colliery Surface Site.

2.2.1 Construction Activities

This phase will involve the construction of the new and upgraded surface facilities at Awaba Colliery Surface Site. Key works will include drilling and construction of services and gas drainage boreholes, enlargement of the existing Pollution Control Dam, and construction of the gas flaring facility and ventilation fan site.

Construction is expected to take approximately ten months complete. Some construction works will occur concurrently with the mobilisation and site establishment phases.

In addition, minor decommissioning activities will occur at the Newstan Colliery Surface Site, when the mine ventilation fans are relocated to the Awaba Colliery Surface Site. However these decommissioning activities are likely to generate relatively insignificant emissions and are not considered any further in this assessment.

A range of plant and equipment will be used during construction. The construction contractor will determine the final equipment and plant requirements. An indicative list of construction equipment is provided in **Table 2**.

Table 2 An Indicative List of Construction Equipment for the project

Equipment	Equipment
Bulldozers	Hand tools (motorised and pneumatic)
Concrete pumps	Light vehicles
Concrete saws	Mulchers
Concrete trucks	Road trucks
Cranes	Roller/compacters
Drill rigs	Scrapers
Dump trucks	Telehandlers
Excavators	Water pumps
Generators	Water trucks

Source: Centennial 2019

Exhaust emissions will also occur as a result of the use of mobile plant and machinery and haul trucks. These emissions will be emitted over a relatively large area and will not have potential to give rise to off-site exceedances of relevant air quality guidelines. They have therefore not been considered further within the construction activities. The scope of this AQIA is limited to particulate matter emissions from the construction activities.

2.2.2 Operational Activities

The operational activities likely to give rise to air pollutant emissions as part of the project are shown in **Table 3**.

Table 3 Summary of Operational Activities within the project

Site	Operational Activities	Pollutant
Newstan ventilation shaft (Current ventilation fan site)	Current ventilation fans (x2) located at the Newstan Colliery Surface Site (during first workings only)	TSP, PM_{10}, $PM_{2.5}$, deposited dust and odour
Awaba ventilation shaft (Proposed ventilation fan site)	New main ventilation fans (x3) to be operated at the Awaba Colliery Surface Site	TSP, PM_{10}, $PM_{2.5}$, deposited dust and odour
Centralised gas drainage, abatement and utilisation plant	New gas flares (x2) to be operated at the Awaba Colliery Surface Site	CO, NO_X

The proposed conceptual layout of the surface facilities Awaba Colliery Surface Site is shown in **Figure 3**.

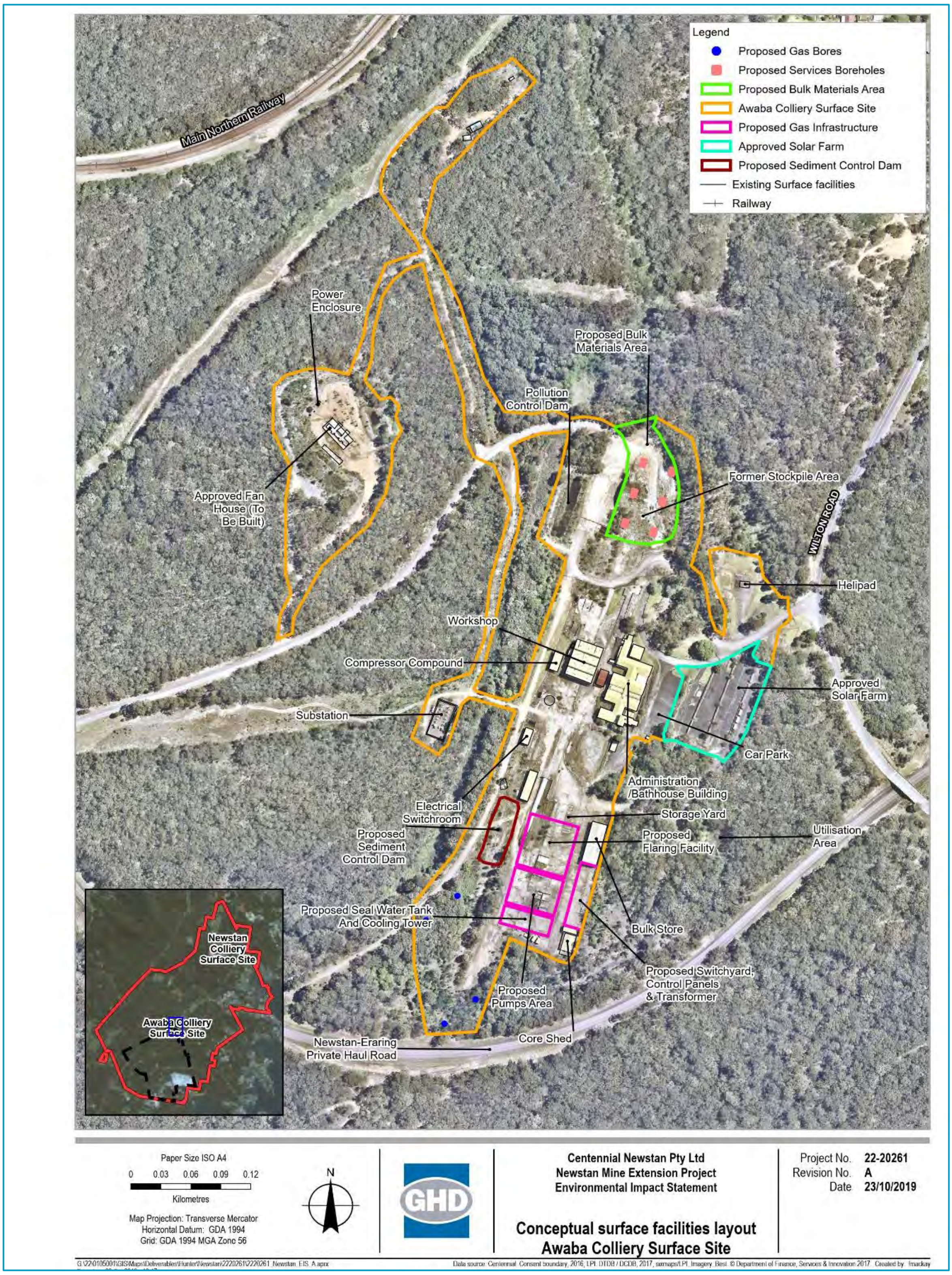
2.3 Hours of Operation

It is anticipated that construction will be largely carried out during the following hours:

- Monday to Friday: 7.00 am to 6.00 pm
- Saturday: 8.00 am to 6.00 pm
- Sundays and public holidays: no work

The project proposes to continue mining operations 24 hours a day, seven days a week. This is consistent with the current approvals at both the Newstan and Awaba operations.

Figure 3 Conceptual Surface Facilities Layout– Awaba Colliery Surface Site



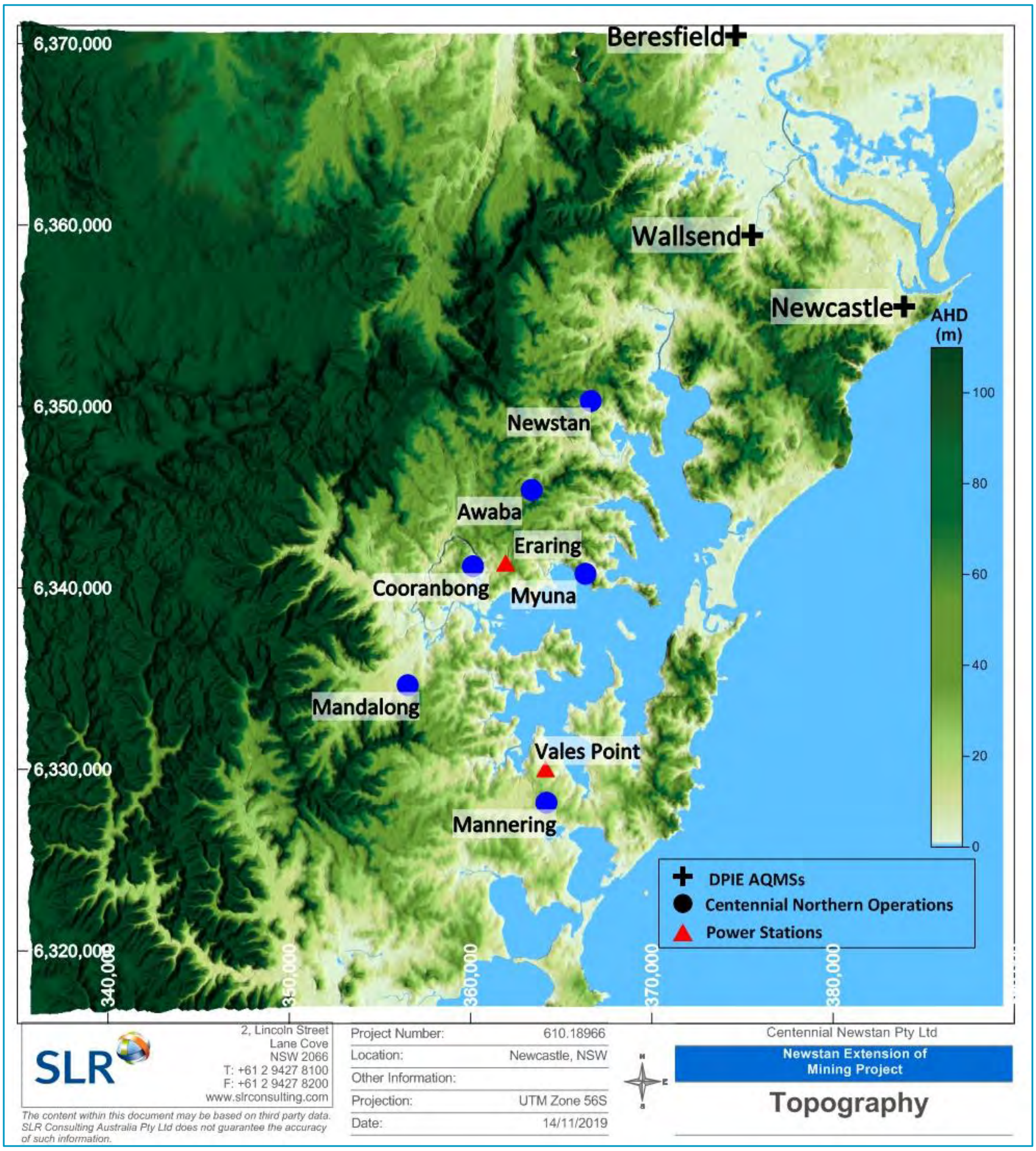
Source: GHD 2019

3 Study Area

3.1 Local Topography

The topographical data used in the meteorological and dispersion modelling was sourced from the United States Geological Service's Shuttle Radar Topography Mission database that has recorded topography across Australia with a 3 arc second (~90 m) spacing. The Newstan Colliery Surface Site and Awaba Colliery Surface Site are located west of Lake Macquarie within undulating terrain. The topography of the local region surrounding the PAA is presented in **Figure 4**.

Figure 4 Local and Regional Topography



3.2 Sensitive Receptors

Majority of the project activities are proposed to occur in the vicinity of Awaba Colliery Surface Site (such as the construction activities, operation of new mine ventilation fans etc). Some intermittent project activities are also proposed to occur in the vicinity of Newstan Colliery Surface Site, such as the continued operation of the existing mine ventilation fans currently approved under DA 73-11-98 Mod 8, demolition of the ventilation fans etc. The AQIA prepared for the NCL Project (SSD-5145) was prepared by SLR Consulting Pty Ltd (SLR) in April 2014. The AQIA concluded that the contribution of emissions from the Newstan ventilation fans to the total predicted incremental impacts, at the receptors around Newstan Colliery Surface Site was less than 0.4% (see **Section 7.4.1**).

As discussed in **Section 2**, the two existing ventilation fans at the Newstan Colliery Surface Site will be utilised during development of the first workings. During this development phase, the new fans will be installed at the existing ventilation shaft at the Awaba Colliery Surface Site. Once these new fans at the Awaba Colliery Surface Site become operational, the existing fans at Newstan Colliery Surface Site will be decommissioned.

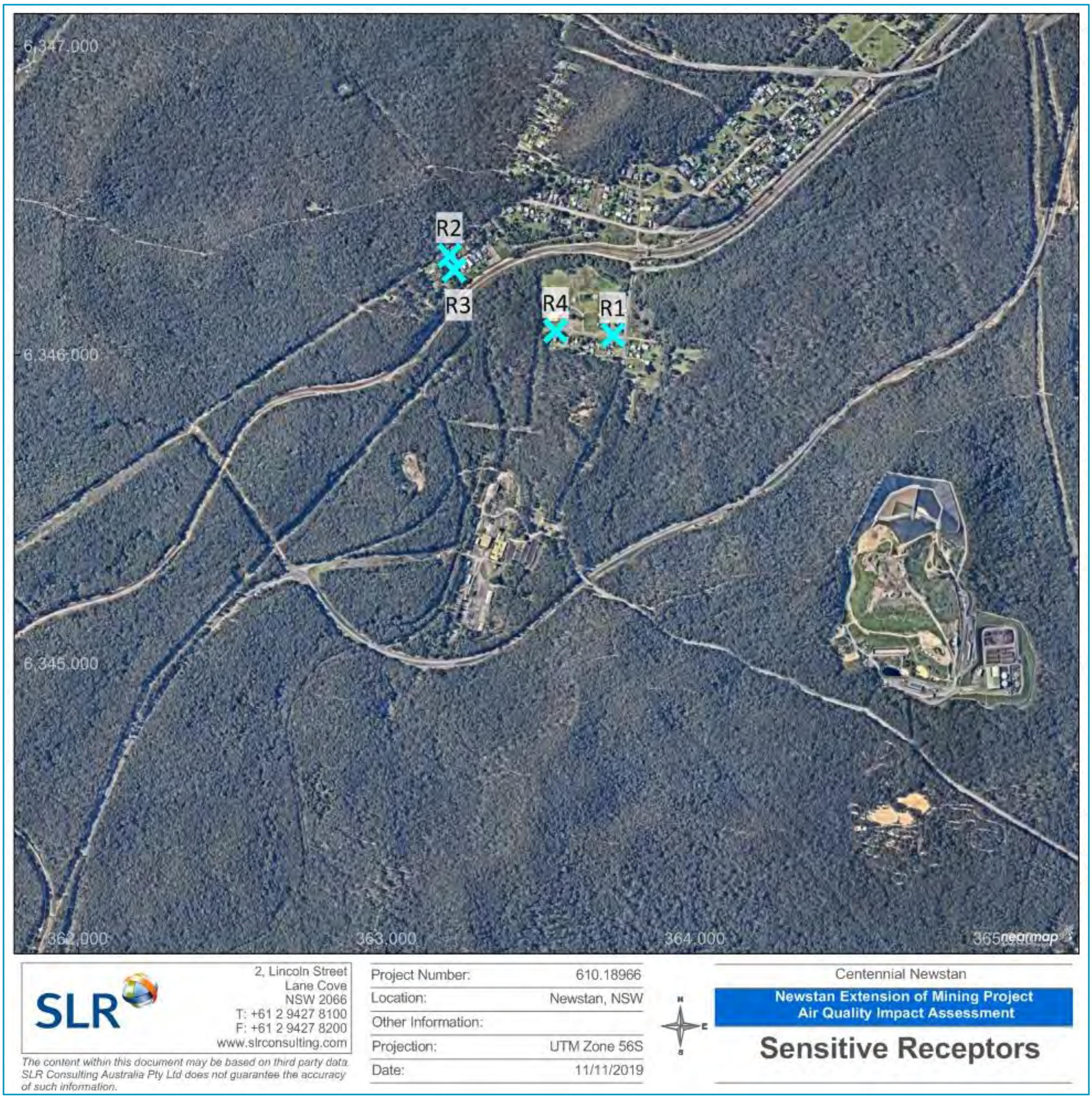
In this current assessment for the Newstan Mine Extension Project, dispersion modelling has only been conducted for the receptors around the Awaba Colliery Surface Site, as the activities around the Newstan Colliery Surface Site are only transitory in nature, and due to the large separation distance and the minimal contribution of ventilation fans to total emissions, are unlikely to have any cumulative impact at the receptors around the Awaba Colliery Surface Site.

Therefore only sensitive receptors in proximity to the Awaba Colliery Surface Site are assessed and presented for this project. A list of the identified sensitive receptors in the vicinity of the Awaba Colliery Surface Site are listed in **Table 4** and shown in **Figure 5**.

Table 4 Sensitive Receptor Locations – Newstan Mine Extension Project (Awaba)

Receptor ID	Location	Location (m, UTM)	
		Easting	Northing
R1	9 Olney Street, Awaba	363,733	6,346,064
R2	15 Evans Street, Awaba	363,203	6,346,323
R3	51 Puddy Lane, Awaba	363,220	6,346,274
R4	1A Olney Street, Awaba	363,547	6,346,080

Figure 5 Sensitive Receptor Locations –Newstan Mine Extension Project (Awaba)



4 Ambient Air Quality Criteria

4.1 Particulate Matter

The current air quality criteria for Newstan Colliery, as listed under Schedule 2, Condition 6.1C of Development Consent DA 73-11-98 (including MOD 8), are reproduced as follows:

> *The Applicant shall ensure that all reasonable and feasible avoidance and mitigation measures are employed so that particulate matter emissions generated by the development do not cause exceedances of the criteria listed in Table 1 at any residence on privately owned land.*

Pollutant	Averaging Period	Criterion	
Particulate matter <10 µm (PM_{10})	24 hours	[a]50 µg/m^3	
Particulate matter <10 µm (PM_{10})	Annual	[a,d]30 µg/m^3	
Total suspended particulates (TSP)	Annual	[a,d]90 µg/m^3	
[c]Deposited Dust	Annual	[b]2 g/m^2/month	[a,d]4 g/m^2/month

a Cumulative impact (ie increase in concentrations due to the development plus background concentrations due to all other sources).

b Incremental impact (ie increase in concentrations due to the development alone, with zero allowable exceedances of the criteria over the life of the development.

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

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

On 15 December 2015, the National Clean Air Agreement (NCAA) was endorsed by Commonwealth, State and Territory Environment Ministers. In this agreement, the Ministers agreed to strengthen national ambient air quality reporting standards for airborne fine particles. All jurisdictions have agreed to implement strengthened standards for particles, as well as move to even tighter standards for annual average and 24-hour $PM_{2.5}$ in 2025.

As such, in February 2016, a variation to the Ambient Air Quality National Environment Protection Measure (NEPM) was made to extend its coverage to $PM_{2.5}$, setting reporting standards for $PM_{2.5}$ with no allowable exceedances (NEPC 2016). In addition, the Ambient Air Quality NEPM revised the standard for annual average PM_{10} to be in line with the NCAA.

These standards have now been adopted by NSW Environment Protection Authority (EPA). The updated standards are outlined in the NSW EPA document '*Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales*' (EPA 2017) (hereafter 'the Approved Methods').

The updated standards for particles are reflected in the NCL (modified) consent SSD-5145 granted in December 2017, which included the Newstan Colliery ventilation fans, as shown below. In particular, the criterion for annual average PM_{10} is noted to be updated from 30 µg/m^3 to 25 µg/m^3.

Pollutant	Averaging Period	Criterion	
Particulate matter <10 µm (PM_{10})	Annual	[a,d]25 µg/m^3	
Particulate matter <10 µm (PM_{10})	24 hours	[b]50 µg/m^3	
Total suspended particulates (TSP)	Annual	[a,d]90 µg/m^3	
[c]Deposited Dust	Annual	[b]2 g/m^2/month	[a,d]4 g/m^2/month

a Cumulative impact (ie increase in concentrations due to the development plus background concentrations due to all other sources).

b Incremental impact (ie increase in concentrations due to the development alone, with zero allowable exceedances of the criteria over the life of the development.

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

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

In addition, the *Voluntary Land Acquisition and Mitigation Policy* of the NSW Government for State Significant Mining, Petroleum and Extractive Industry Developments (DPE 2018) stipulates assessment criteria consistent with those prescribed in Schedule 2, Condition 6.1C of Development Consent DA 73-11-98. It also states that:

> *"Applicants are required to assess the impacts of the development in accordance with the Approved Methods for the Modelling and Assessment of Air Pollutants in NSW (EPA 2005) (Approved Methods)"*

The air quality goals adopted for particulate matter in this study, which conform to current EPA and Federal air quality criteria, are summarised in **Table 5**.

Table 5 Adopted Project Air Quality Goals

Pollutant	Averaging Period	Criteria (µg/m^3)	Source
TSP	Annual	90	EPA 2017
PM_{10}	24 hours	50	EPA 2017
	Annual	25	EPA 2017
$PM_{2.5}$	24 hours	25	EPA 2017
	Annual	8	EPA 2017
		Criteria (g/m^2/month)	
Deposited dust	Annual	2 (maximum increase in deposited dust level) 4 (maximum total deposited dust level)	EPA 2017

4.2 Odour

The current condition for odour compliance for Newstan Colliery, as listed under Schedule 2, Condition 6.1A of Development Consent DA 73-11-98, is reproduced as follows:

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

The NSW EPA impact assessment criteria for complex mixtures of odours have been designed to consider the range of sensitivity to odours within the community and to provide additional protection for individuals with a heightened response to odours. Where a number of the factors simultaneously contribute to making an odour "offensive", an odour goal of 2 ou at the nearest residence (existing or any likely future residences) is appropriate.

Considering the small number of potentially affected residential residences around the Awaba Colliery Surface Site, it is considered appropriate to adopt a conservative odour criterion of 4 ou for the receptors around Awaba Colliery Surface Site.

4.3 Nitrogen Dioxide

The Approved Methods outlines the criteria applicable to nitrogen dioxide (NO_2). These criteria were adopted from National Environment Protection Measure (NEPC 1998) and are outlined in **Table 6**.

Table 6 EPA Criteria for Nitrogen Dioxide

Pollutant	Averaging Time	Maximum Allowable Concentration ($\mu g/m^3$)[1]
Nitrogen Dioxide	1 hour	246
	Annual	62

Note 1 Gravimetric concentrations have been derived at 25°C and 1 atmosphere pressure.

4.4 Carbon Monoxide

The Approved Methods outlines the criteria applicable to carbon monoxide (CO). These criteria are adopted from World Health Organisation (2000) and NEPC (1998) criteria and are summarised in **Table 7**.

Table 7 EPA Criteria for Carbon Monoxide

Pollutant	Averaging Time	Maximum Allowable Concentration (mg/m^3)[1]
Carbon monoxide	15 minutes	100
	1 hour	30
	8 hours	10

Note 1 Gravimetric concentrations have been derived at 25°C and 1 atmosphere pressure.

5 Emissions Estimation

This section describes the various scenarios assessed as part of the project (**Section 5.1**), the methodology used to estimate emissions (**Section 5.2**), the activity data used in the emissions estimation and the respective emissions inventory (**Section 5.3**).

5.1 Scenarios Assessed

To quantify the predicted air quality impacts due to the project, emission estimates are required for the construction and operational activities at various sites within the PAA.

Two scenarios are quantified to assess the pollutant emissions due to construction and operations of the project. A summary of the emission sources assessed in the two scenarios is shown in **Table 8**.

Table 8 Summary of the Scenarios Assessed – Newstan Mine Extension Project

Scenario	Site	Pollutants
Construction (Scenario 1)	Construction activities at the Awaba Colliery Surface Site (includes construction of proposed ventilation fans and gas flares)	TSP, PM_{10}, $PM_{2.5}$ and deposited dust
Operations (Scenario 2)	Awaba surface facilities	No operational emissions
	Awaba ventilation shaft (proposed ventilation fan site)	TSP, PM_{10}, $PM_{2.5}$, deposited dust and odour
	Centralised gas drainage (x2 gas flares)	CO, NO_X

5.1.1 Scenario 1 (Construction)

This scenario assesses the emissions due to construction activities associated with establishment of surface infrastructure at the Awaba Colliery Surface Site. The construction activities are proposed to be conducted in phases with the overall time for the construction estimated to be approximately ten months.

Specifically, the activities associated with the construction activities that are likely to generate dust emissions include:

- Site preparation (compounds and roadways);
- Wind erosion of exposed areas; and
- Construction of associated infrastructure.

Particulate emissions from these activities have been estimated and discussed in **Section 5.2.1**.

5.1.2 Scenario 2 (Operations)

This scenario assesses the impacts from gas flares in conjunction with the operations of mine ventilation fans at the Awaba Colliery Surface Site.

5.2 Methodology

5.2.1 Scenario 1 (Construction)

Construction activities are likely to start in Quarter 1 2021. Particulate emissions from the construction activities have been calculated using default emission factors, sourced from the US EPA AP-42 Emission Factor Handbook (USEPA 1995) for *Heavy Construction Industries*.

It is noted that the emission factor prescribed by the USEPA is most applicable to construction operations with:

- medium activity level;
- moderate silt contents; and
- semi-arid climate.

It is understood that the construction will take approximately 10 months. However for the purposes of the modelling assessment, it has been assumed that the construction will go on for 12 months, to assess the worst case impacts due to seasonal variations over a full year.

The emission factors used for the estimation of TSP, PM_{10} and $PM_{2.5}$ emissions from the construction activities are:

- TSP – 2.69 tonnes/ha/month
- PM_{10} – 0.942 tonnes/ha/month
- $PM_{2.5}$ – 0.141 tonnes/ha/month

5.2.2 Scenario 2 (Operations)

Gas Flares

The emissions from the gas flaring units have been estimated using emission factors from the NPI EET Manual, *Oil and Gas Exploration and Production* (DEWHA 2010) as shown in **Table 9**.

Table 9 Emission Factors for Emission Estimation from Flares

Gas Flares	Emission Factor (kg emissions/ tonnes throughput)
CO	8.7
NO_X	1.5

Source: DEWHA 2010

Coal seam gas is generally relatively pure with negligible sulfur content (DEWHA 2008). It has therefore been assumed that no SO_2 is formed when the drainage gas is flared.

Oxides of nitrogen (NO_X), comprised of nitric oxide (NO) and nitrogen dioxide (NO_2), is formed in most combustion processes. NO will dominate the emissions but will eventually react in the presence of ozone and volatile organic compounds into NO_2. NO_2 is considered to have the largest impact on human health. The rate of transformation depends on a number of factors. It has been conservatively assumed that 100% of emitted NO_X will form NO_2 by the time it reaches sensitive receptors. This is in accordance with Method 1 prescribed by the Approved Methods.

The stack parameters used in the modelling study for the proposed flare systems at the Awaba Colliery Surface Site are derived in accordance with the Ohio EPA's Division of Air Pollution Control *Air Quality Modelling and Planning Section Engineering Guide #69 Air Dispersion Modelling Guidance* (OEPA 2003) as follows:

- Compute the adjustment to stack height as a function of heat release Q in MMBtu/hr (where H has units of meters):

  $H_{equiv.} = H_{actual} + 0.944(Q)^{0.478}$

- Compute an equivalent stack diameter $d_{equiv.} = 0.1755(Q)^{0.5}$
- assume exit temperature of 1,273 K
- assume exit velocity of 20 m/s
- Heating value of Methane (Q) is assumed to be 1,011 BTU/ft^3

The flare system has been designed for a total gas drainage flowrate of 2,500 L/s. Using the above methodology and maximum flaring capacity of 1,250 L/s per flare gives the equivalent diameters and release heights shown in **Table 10**, which have been used as input parameters in the modelling.

Table 10 Stack Parameters of Gas Flaring Units – Newstan Mine Extension Project

Source	Easting (m E)	Northing (m S)	Height[1] (m)	Height[2] (m)	Diameter (m)	Velocity (m/s)	Temperature (°C)
Gas Flare Unit 1	363,298	6,345,238	10	20.7	2.2	20.0	1,000
Gas Flare Unit 2	363,293	6,345,221	10	20.7	2.2	20.0	1,000

1 Actual proposed height of the flare unit
2 Equivalent height of the flare unit, calculated using the method prescribed by OEPA 2003.

The gas flaring units are assumed to operate 24 hours a day, 7 days a week. The location of the gas flaring units will be within the proposed gas flaring facility shown in **Figure 3**.

Ventilation Fans

To calculate the pollutant emission rates from the proposed ventilation fans, reference is made to the actual measurements of the particulate and odour emissions from the existing ventilation fans located at the Mandalong Mine.

The monitoring of particulate and odour emissions was undertaken during a period of normal underground mining operations. The results of the monitoring of the ventilation fans at the Mandalong Mine have been adopted to assess potential impacts from the proposed new ventilation fans at the Awaba Colliery Surface Site, which will be operating under similar geological conditions.

Specifically, to estimate emissions from the gas ventilation fans, a monitoring program was conducted by SLR at the existing Mandalong Mine in June 2012 and August 2012 (SLR 2012a and SLR 2012b respectively). The pollutant emissions that were monitored were:

- TSP;
- PM_{10};
- $PM_{2.5}$; and
- Odour.

The ventilation fan parameter data is sourced from the *Newstan Coal Mine – Main Vet Fans Project* report prepared by Howden (Howden 2019). The parameters adopted are shown in **Table 11**.

Table 11 Source Parameter Data for Main Ventilation Fans - Awaba Colliery Surface Site

Source	Easting (m E)	Northing (m S)	Height (m)	Diameter[1] (m)	Velocity[2] (m/s)
Ventilation fan 1	363,081	6,345,651	20.0	4.2	12.1
Ventilation fan 2	363,091	6,345,636	20.0	4.2	12.1
Ventilation fan 3	363,100	6,345,620	20.0	4.2	12.1

1 Diameter calculated based on evase area of 13.8 m^2.

2 Exit velocity calculated based on total exit flow rate of 500 m^3/s.

5.3 Emissions Inventory

5.3.1 Scenario 1 (Construction)

The total area of disturbance at the Awaba Colliery Surface Site is estimated to be approximately 1.3 hectares (ha), which includes areas for fan house, proposed services boreholes, and proposed gas bores. Using the emission factors listed in **Section 5.2.1**, the emissions for construction of the project have been calculated as shown in **Table 12**.

Table 12 Estimated Emissions from Construction of the project

Activity	TSP (kg/month)	PM_{10} (kg/month)	$PM_{2.5}$ (kg/ month)
Construction	41,964	14,695	2,200

It is noted that in order to predict the impacts due to construction of the project, the dispersion modelling was conducted over a full year using the emissions rates calculated in **Table 12**. This is considered to be conservative as in reality the construction is likely to finish in approximately 10 months.

5.3.2 Scenario 2 (Operations)

Gas Flares

To calculate the pollutant emissions, it has been conservatively assumed that the drainage gas will contain 100% methane. Using the design gas flowrate (1,250 L/s) gas density of 0.717 kg/m^3 and the emission rates presented in **Table 9**, the total pollutant emissions from individual flares are shown in **Table 13**.

Table 13 Calculated Pollutant Emissions – Gas Flares

Pollutant	Emissions per gas flare (g/s)
NO_X	1.3
CO	7.8

Ventilation Fans

No site specific ventilation fan emissions data is available. For the proposed ventilation fans at the Awaba Colliery Surface Site, it is estimated (from preliminary design studies) that the total exit flow rate will be approximately 500 m^3/s.

For the purposes of the project, the particulate and odour emission rate has been calculated using the same pollutant concentrations as were monitored at Centennial Mandalong (refer **Section 5.2.2**). The calculated emissions from ventilation fans are shown in **Table 14**.

Table 14 Pollutant Emissions from the Proposed Ventilation Fans - Awaba Colliery Surface Site

Pollutant	Emission Rate	Units
TSP[1]	1.20	g/s
PM_{10}[1]	0.20	g/s
$PM_{2.5}$[1]	0.20	g/s
Odour[2]	38,500	OU.m^3/s

1 Source: SLR 2012b

2 Source: SLR 2012a, the average of three samples is adopted as the odour emission rate.

6 Air Dispersion Modelling Methodology

6.1 Model Selection

Emissions from the project have been modelled using the CALPUFF (Version 6.267) modelling system. CALPUFF is one of the air dispersion modelling tools accepted by the NSW EPA. It is a transport and dispersion model that breaks emission plumes into 'puffs' of material emitted from modelled sources. The model predicts the trajectory of these puffs, simulating dispersion and transformation processes along the way.

In order to model the trajectory and dispersion / transformation of these puffs, the model requires input data on the emissions themselves (location, release times / frequencies, type and strength of the releases), the terrain over which the puffs travel and the meteorological conditions that occur at the location and in the time period under consideration. Both the terrain and meteorological data are in incorporated in three dimensions.

For the meteorological data, CALPUFF typically uses wind field data generated by the meteorological pre-processor CALMET, discussed further below. Temporal and spatial variations in the meteorological fields selected are explicitly incorporated in the resulting distribution of puffs throughout a simulation period.

The primary output files from CALPUFF contain either hourly concentrations or hourly deposition fluxes calculated at selected receptor locations. The CALPOST post-processor is then used to process these files, producing tabulations that summarise results of the simulation for user-selected averaging periods.

6.2 Meteorological Modelling Methodology

Meteorological mechanisms govern the dispersion, transformation and eventual removal of pollutants from the atmosphere. The extent to which pollution will accumulate or disperse in the atmosphere is dependent on the degree of thermal and mechanical turbulence within the Earth's boundary layer (that layer of the atmosphere closest to the surface of the Earth. Dispersion comprises vertical and horizontal components of motion. The stability of the atmosphere and the depth of the surface-mixing layer define the vertical component. The horizontal dispersion of pollution in the boundary layer is primarily a function of the wind field. The wind speed determines both the distance of downwind transport and the rate of dilution as a result of plume 'stretching'. The generation of mechanical turbulence is similarly a function of the wind speed, in combination with the surface roughness. The wind direction, and the variability in wind direction, determines the general path pollutants will follow, and the extent of crosswind spreading.

Pollution concentration levels therefore fluctuate in response to changes in atmospheric stability, to concurrent variations in the mixing depth, and to shifts in the wind field (Oke 2004). To adequately characterise the dispersion meteorology of the study site, information is needed on the prevailing wind regime, mixing depth and atmospheric stability and other parameters such as ambient temperature, rainfall and relative humidity.

To adequately characterise the dispersion meteorology of the region covered by the Awaba Colliery Surface Site, information is needed on the prevailing wind regime, ambient temperature, rainfall, relative humidity, mixing depth and atmospheric stability. The meteorology of the region was characterised based on a 3-dimensional prognostic meteorological dataset.

The advanced Weather Research and Forecast (WRF) model was used to produce the meteorological field required as an input to the CALMET meteorological model (see **Section 6.2.1**). The modelled year was selected to be 2018 calendar year, based on the most recent completed year.

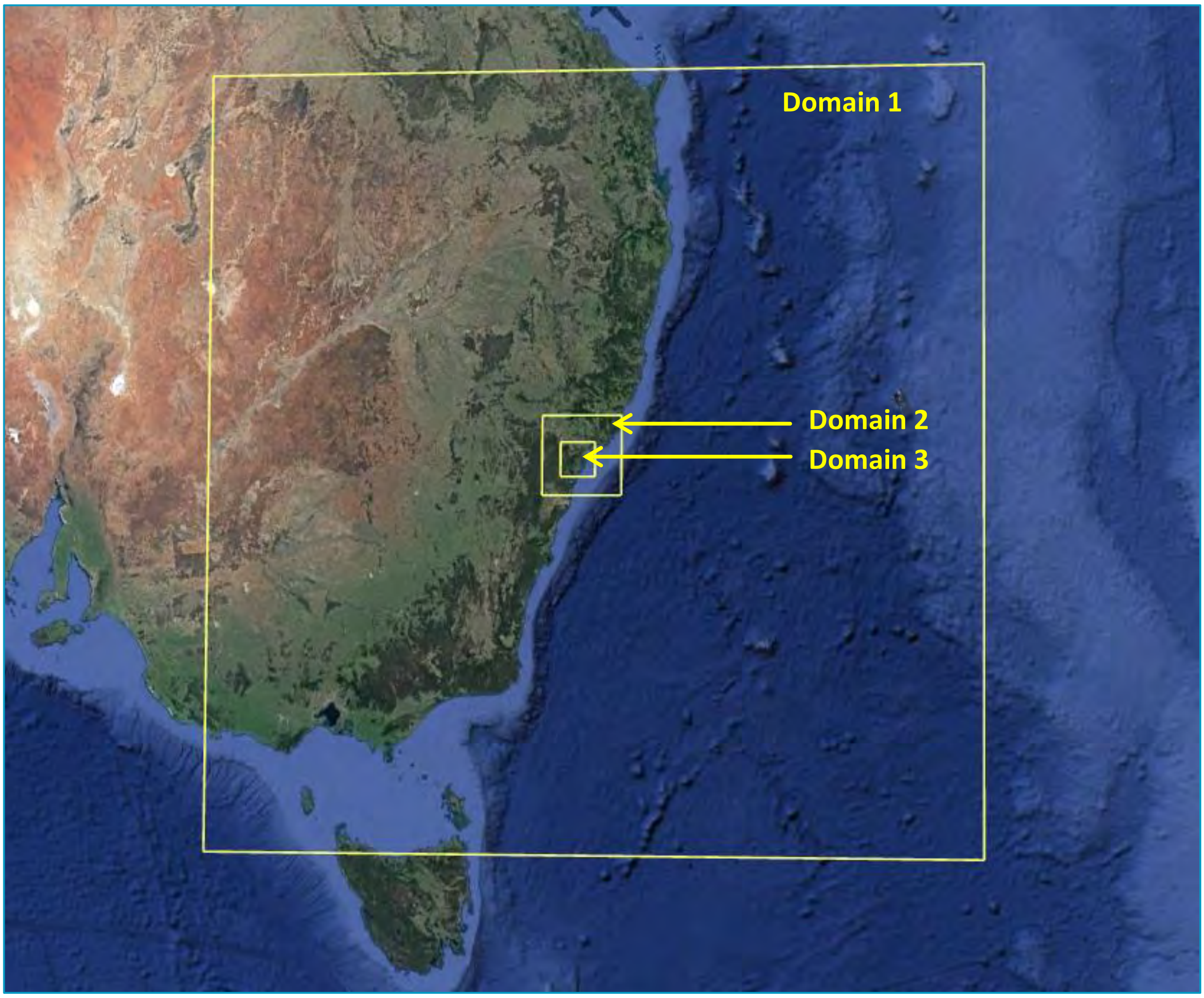
The Approved Methods prescribe the use of the same background data year to that used for modelled year for contemporaneous analysis. Therefore, the background data used for this assessment is also based on monitoring data from 2018 (see **Section 7**).

6.2.1 Weather Research and Forecast Model

The WRF model is a next generation mesoscale numerical weather prediction system designed for both atmospheric research and operational forecasting needs. It features two dynamical cores; a data assimilation system and a software architecture facilitating parallel computation and system extensibility. The model serves a wide range of meteorological applications across scales from tens of metres to thousands of kilometres.

For this assessment, the WRF modelling system was used to produce the meteorological field required as an input to the CALMET meteorological model over the domains shown in **Figure 6**.

Figure 6 WRF Modelling Domains



Parameters used in the WRF model for this assessment are presented in **Table 15**. Modelling was performed for 2018 calendar year.

Table 15 Meteorological Parameters used for this Study (WRF)

Parameter	Domain 1	Domain 2	Domain 3
Modelling domain	1,890 km × 1,890 km	198 km × 198 km	84 km x 84 km
Grid resolution	27 km	9 km	3 km
Number of vertical levels	30	30	30

6.2.2 CALMET

In the simplest terms, CALMET is a meteorological model that develops wind and temperature fields on a three-dimensional gridded modelling domain. Associated two-dimensional fields such as mixing height, surface characteristics and dispersion properties are also included in the file produced by CALMET. The interpolated wind field is then modified within the model to account for the influences of topography, as well as differential heating and surface roughness associated with different land uses across the modelling domain. These modifications are applied to the winds at each grid point to develop a final wind field. The final wind field thus reflects the influences of local topography and land uses.

CALMET modelling was conducted using the nested CALMET approach, where the results from a coarse-grid run were used as the initial 'guess' of a fine-grid run. This has the advantage that off-domain terrain features including slope flows and blocking effects can be allowed to take effect and the larger scale wind flow provides a better start in the fine-grid run.

The outer domain (50 km × 50 km) was modelled with a resolution of 1 km. WRF-generated 3-dimensional meteorological data was used as the initial guess wind field and the local topography and available surface weather observations in the area were used to refine the wind field predetermined by WRF.

The output from the outer domain CALMET modelling was then used as the initial guess field for the inner domain CALMET modelling. The inner domain encompasses an area of 40 km × 40 km. A horizontal grid spacing of 300 m was used to adequately represent the important local terrain features and land use. The fine scale local topography and land use information were used in this run to refine the wind field parameters predetermined by the coarse CALMET run.

Table 16 details the parameters used in the CALMET modelling. The CALMET modelling approach used in this assessment is identified in the *Generic Guidance and Optimum Model Settings for the CALPUFF Modelling System* prepared for NSW Office of Environment and Heritage (TRC 2011) as the CALMET Hybrid Mode and is considered to be an 'advanced model simulation'.

Table 16 Meteorological Parameters used in this Assessment (CALMET v 6.42)

Outer Domain	
Meteorological grid	50 km × 50 km
Meteorological grid resolution	1 km
Initial guess filed	3D output from WRF model
Inner Domain	
Meteorological grid	40 km × 40 km
Meteorological grid resolution	0.3 km
Initial guess field	3D output from 'outer' domain model run

6.3 Meteorological Data Used in Modelling

To provide a summary of the meteorological conditions predicted at the Awaba Colliery Surface Site area using the methodology described in **Section 6.2**, a single-point, ground-level meteorological dataset was extracted from the 3-dimensional dataset and is presented in this section. It is noted that wind conditions used in the modelling at other locations within the modelling domain may be different to those predicted at the Awaba Colliery Surface Site area.

6.3.1 Wind Speed and Direction

A summary of the annual wind behaviour predicted by CALMET at the Awaba Colliery Surface Site for the year 2018 is presented as wind speed frequency chart in **Figure 7** and wind roses in **Figure 8**.

Wind roses show the frequency of occurrence of winds by direction and strength. The bars correspond to the 16 compass points (degrees from north). The bar at the top of each wind rose diagram represents winds blowing from the north (i.e. northerly winds), and so on. The length of the bar represents the frequency of occurrence of winds from that direction, and the widths of the bar sections correspond to wind speed categories, the narrowest representing the lightest winds. Thus it is possible to visualise how often winds of a certain direction and strength occur over a long period, either for all hours of the day, or for particular periods during the day.

The following description of wind speeds references the Beaufort Wind Scale, as outlined in **Table 17**. Use of the Beaufort Wind Scale is consistent with terminology used by the BoM.

Table 17 Beaufort Wind Scale

Beaufort Scale #	Description	Wind Speed (m/s)	Description on Land
0	Calm	0-0.5	Smoke rises vertically
1	Light air	0.5-1.5	Smoke drift indicates wind direction
2-3	Light/gentle breeze	1.5-5.3	Wind felt on face, leaves rustle, light flags extended, ordinary vanes moved by wind
4	Moderate winds	5.3-8.0	Raises dust and loose paper, small branches are moved
5	Fresh winds	8.0-10.8	Small trees in leaf begin to sway, crested wavelets form on inland waters
6	Strong winds	>10.8	Large branches in motion, whistling heard in telephone wires; umbrellas used with difficulty

Source: http://www.bom.gov.au/lam/glossary/beaufort.shtml

Figure 7 and **Figure 8** indicate that winds experienced at the Awaba Colliery Surface Site predominantly range between a gentle breeze and strong winds (between 1.5 m/s and 11.5 m/s) with a small percentage of strong winds (>10.8 m/s) that mainly blow from the southwest. Calm wind conditions (wind speed less than 0.5 m/s) were predicted to occur approximately 9% of the time during a year.

The predominant wind direction is seasonally dependent, with the seasonal wind roses indicating that:

- In summer, wind speeds range from light to fresh winds (between 0.5 m/s and 9.5 m/s) but are typically less than 5.3 m/s. Most winds blow from the east-northeast and east, with very few winds from the west. The strongest winds blow from the south. Calm wind conditions were predicted to occur approximately 8% of the time during summer.

- In autumn, wind speeds ranged from light to fresh winds (between 0.5 m/s and 9.2 m/s), with the strongest winds blowing from the southwest. Most winds blow from the southwest, with very few winds from the north. Calm wind conditions were predicted to occur approximately 11% of the time during autumn.
- In winter, wind speeds ranged light to fresh winds (between 0.5 m/s and 9.5 m/s). Most winds blow from the southwest, with very few winds from the north and east. Calm wind conditions were predicted to occur approximately 8% of the time during winter.
- In spring, wind speeds ranged from light to strong winds (between 0.5 m/s and 11.5 m/s). Most winds blow from southwest and east-northeast directions, with very few winds from the north. Calm wind conditions were predicted to occur approximately 8% of the time during spring.

Figure 7 Wind Speed Frequency Chart for the Awaba Colliery Surface Site (CALMET predictions, 2018)

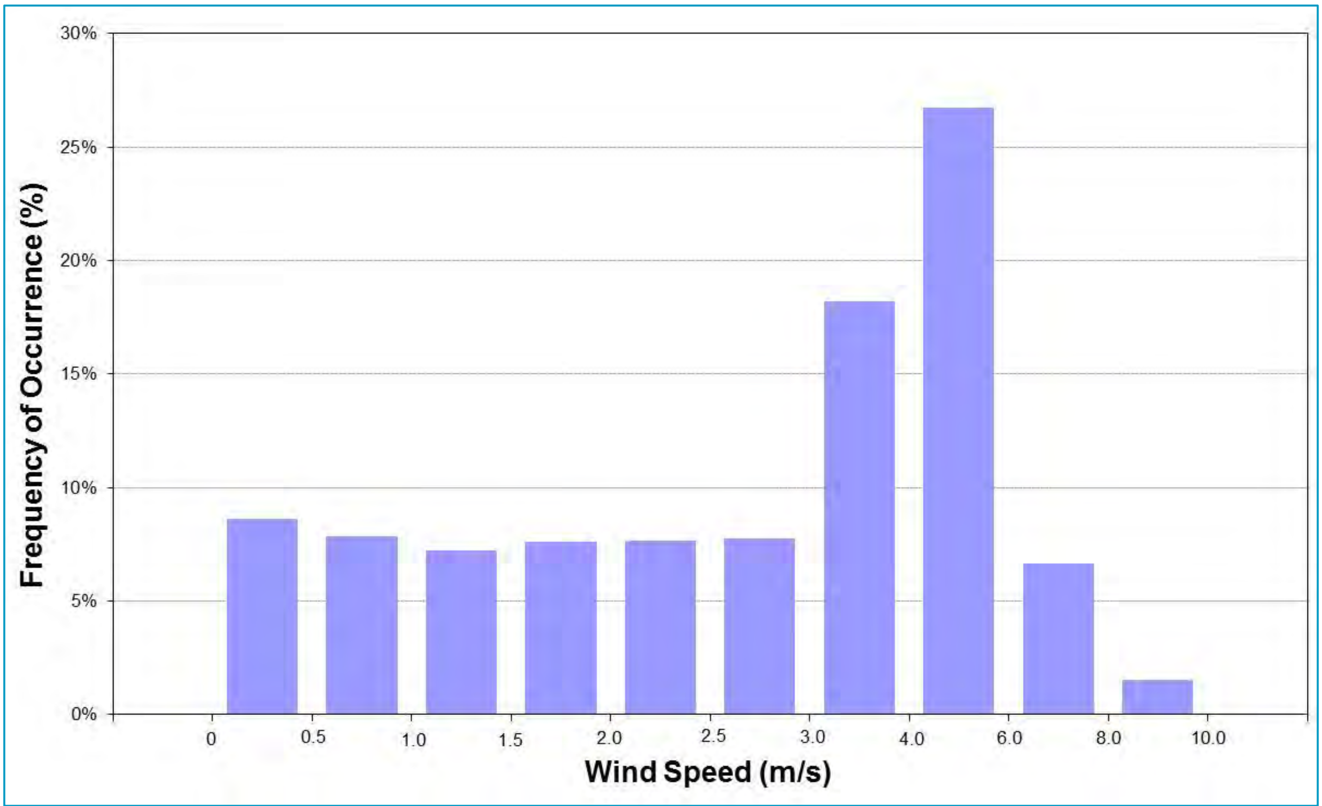
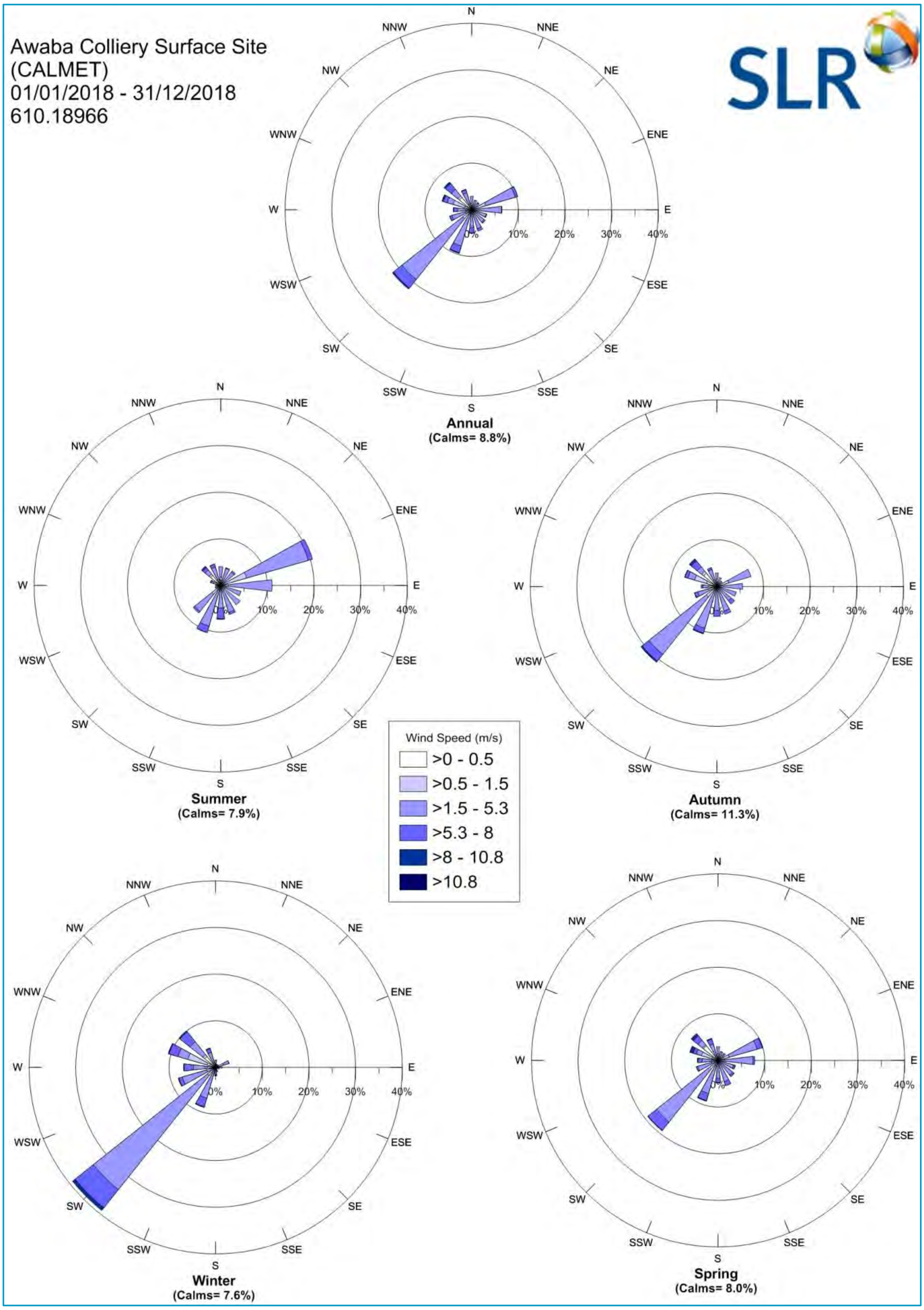


Figure 8 Annual Wind Roses for the Awaba Colliery Surface Site (CALMET predictions, 2018)



6.3.2 Atmospheric Stability

Atmospheric stability refers to the tendency of the atmosphere to resist or enhance vertical motion. The Pasquill-Gifford-Turner (PGT) assignment scheme identifies six Stability Classes, A to F, to categorize the degree of atmospheric stability as follows:

- A = Extremely unstable conditions
- B = Moderately unstable conditions
- C = Slightly unstable conditions
- D = Neutral conditions
- E = Slightly stable conditions
- F = Moderately stable conditions

The meteorological conditions defining each PGT stability class are shown in **Table 18**.

Table 18 Meteorological Conditions Defining PGT Classes

Surface wind speed (m/s)	Daytime insolation			Night-time conditions	
	Strong	Moderate	Slight	Thin overcast or > 4/8 low cloud	≤ 4/8 cloudiness
< 2	A	A - B	B	E	F
2 - 3	A - B	B	C	E	F
3 - 5	B	B - C	C	D	E
5 - 6	C	C - D	D	D	D
> 6	C	D	D	D	D

Source: NOAA 2018

Notes:

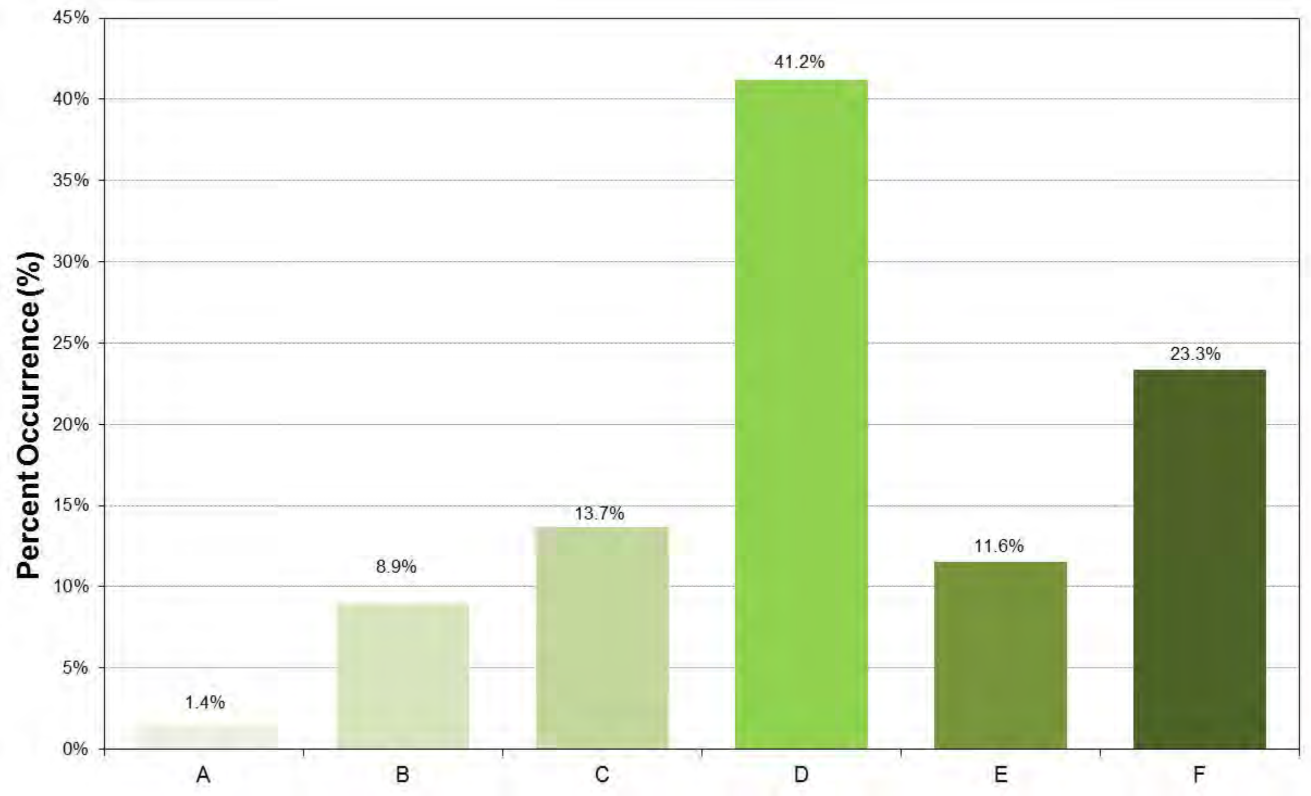
[1] Strong insolation corresponds to sunny midday in midsummer in England; slight insolation to similar conditions in midwinter.

[2] Night refers to the period from 1 hour before sunset to 1 hour after sunrise.

[3] The neutral category D should also be used, regardless of wind speed, for overcast conditions during day or night and for any sky conditions during the hour preceding or following night as defined above.

The frequency of each stability class predicted by CALMET, extracted at Awaba Colliery Surface Site, during the modelling period is presented in **Figure 9**. The results indicate a very high frequency of conditions typical to Stability Class D. Stability Class D is indicative of neutral conditions, conducive to a medium level of pollutant dispersion due to mechanical mixing resulting in relatively lower pollutant concentrations.

Figure 9 Stability Class Frequencies at the Awaba Colliery Surface Site (CALMET predictions, 2018)

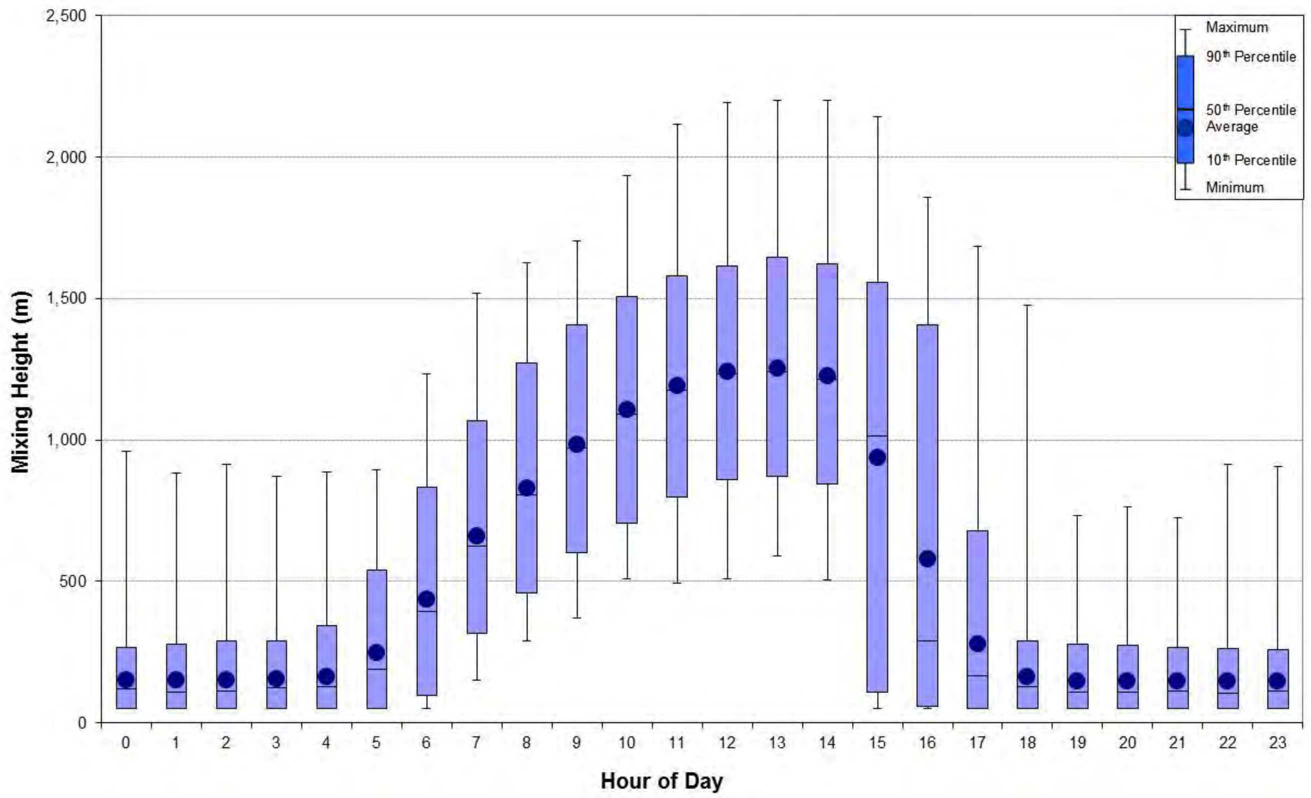


6.3.3 Mixing Heights

Diurnal variations in maximum and average mixing depths predicted by CALMET at Awaba Colliery Surface Site during 2018 are illustrated in **Figure 10**.

As would be expected, an increase in the mixing depth during the morning is apparent, arising due to the onset of vertical mixing following sunrise. Maximum mixing heights occur in the mid to late afternoon, due to the dissipation of ground-based temperature inversions and the growth of the convective mixing layer.

Figure 10 Mixing Heights at the Awaba Colliery Surface Site (CALMET predictions, 2018)



6.4 Dispersion Model Configuration

As discussed in **Section 6.1**, dispersion modelling was conducted using the CALPUFF dispersion model and three-dimensional meteorological data output from CALMET.

The estimated particulate emissions were modelled as:

- Fine particulates (FP < 2.5 µm);
- Coarse matter (2.5 µm<CM<10 µm); and
- Rest of the particulates (RE>10 µm).

These parameters were then grouped using CALPOST to predict $PM_{2.5}$, PM_{10} and TSP concentrations at surrounding receptor locations. This approach provides the most realistic treatment of the differing size fractions, with the lighter, finer particulate matter being dispersed further than the heavier size fraction which settles out of the air more rapidly.

6.5 Accuracy of Air Dispersion Modelling

Atmospheric dispersion models represent a simplification of the many complex processes involved in the dispersion of pollutants in the atmosphere. To obtain good quality results it is important that the most appropriate model is used and the quality of the input data (meteorological, terrain, source characteristics) is adequate.

The main sources of uncertainty in dispersion models, and their effects, are discussed below.

- **Oversimplification of physics**: This can lead to both under-prediction and over-prediction of ground level pollutant concentrations. Errors are greater in Gaussian plume models as they do not include the effects of non-steady-state meteorology (i.e., spatially- and temporally-varying meteorology).
- **Errors in emission rates**: Ground level concentrations are proportional to the pollutant emission rate. In addition, most modelling studies assume constant worst case emission levels or are based on the results of a small number of stack tests, however operations (and thus emissions) are often quite variable. This is particularly the case for fugitive dust emission sources such as those modelled in this assessment.
- **Errors in source parameters**: Plume rise is affected by source dimensions, temperature and exit velocity. Inaccuracies in these values will contribute to errors in the predicted height of the plume centreline and thus ground level pollutant concentrations. As this study involves emissions of particulate from non-buoyant ground level sources, plume buoyancy factors will be negligible. However, inaccuracies in source location etc can potentially impact on the results of the modelling.
- **Errors in wind direction and wind speed**: Wind direction affects the direction of plume travel, while wind speed affects plume rise and dilution of plume. Errors in these parameters can result in errors in the predicted distance from the source of the plume impact, and magnitude of that impact. In addition, aloft wind directions commonly differ from surface wind directions. The preference to use rugged meteorological instruments to reduce maintenance requirements also means that light winds are often not well characterised.
- **Errors in mixing height**: If the plume elevation reaches 80% or more of the mixing height, more interaction will occur, and it becomes increasingly important to properly characterise the depth of the mixed layer as well as the strength of the upper air inversion. As this study involves emissions of particulate from non-buoyant ground level sources, mixing height errors would not have a significant impact on the accuracy of the results.
- **Errors in temperature**: Ambient temperature affects plume buoyancy, so inaccuracies in the temperature data can result in potential errors in the predicted distance from the source of the plume impact, and magnitude of that impact. As this study involves emissions of particulate from non-buoyant ground level sources, ambient temperature errors would not have a significant impact on the accuracy of the results.
- **Errors in stability estimates**: Gaussian plume models use estimates of stability class, and 3D models use explicit vertical profiles of temperature and wind (which are used directly or indirectly to estimate stability class for Gaussian models). In either case, errors in these parameters can cause either under-prediction or over-prediction of ground level concentrations. For example, if an error is made of one stability class, then the computed concentrations can be off by 50% or more.

The US EPA makes the following statement in its Modelling Guideline (TRC 2011) on the relative accuracy of models:

> *"Models are more reliable for estimating longer time-averaged concentrations than for estimating short-term concentrations at specific locations; and the models are reasonably reliable in estimating the magnitude of highest concentrations occurring sometime, somewhere within an area. For example, errors in highest estimated concentrations of ±10 to 40% are found to be typical, i.e., certainly well within the often quoted factor-of-two accuracy that has long been recognised for these models. However estimates of concentrations that occur at a specific time and site, are poorly correlated with actually observed concentrations and are much less reliable."*

This study utilises the CALPUFF dispersion model in full 3D mode, incorporating the 3D meteorological output from CALMET. The meteorological dataset developed for use in this assessment has been compiled to provide a robust and conservative assessment of potential downwind impacts due to particulate emissions from the project construction and operations.

7 Existing Air Quality

For the purposes of assessing potential cumulative off-site air quality impacts, an estimation of ambient air quality concentrations is required. The methodology to estimate site-specific background ambient air quality concentrations adopted for this assessment is consistent with that used in air quality assessment prepared for the NCL AQIA (SLR 2014), however the data have been updated to the 2018 calendar year consistent with the meteorological year used in the modelling.

This section outlines the methodology used to generate the background particulate dataset used in this assessment. It involved the following steps:

- Assessment of suitability of site-specific air quality monitoring to assess the pollutant levels in the immediate vicinity of the Project (**Section 7.1**).
- Selection of an appropriate background dataset representative of regional air quality without the influence of major industrial sources in the local area (ie other local emissions sources and Project-related emissions) (**Section 7.2**).
- Addition of an appropriate incremental contribution to ambient particulate levels due to controlled process and fugitive emissions from power stations in the local area, such as Eraring and Vales Point power stations (**Section 7.3**); and
- Assessment of an appropriate incremental contribution (if any) to ambient particulate levels due to controlled process and fugitive emissions from other mining and ancillary operations in the local area (such as Teralba Quarry), other activities related to forestry recreation and agriculture (**Section 7.4**).

7.1 Ambient Air Quality Monitoring Programme – Awaba Colliery Surface Site

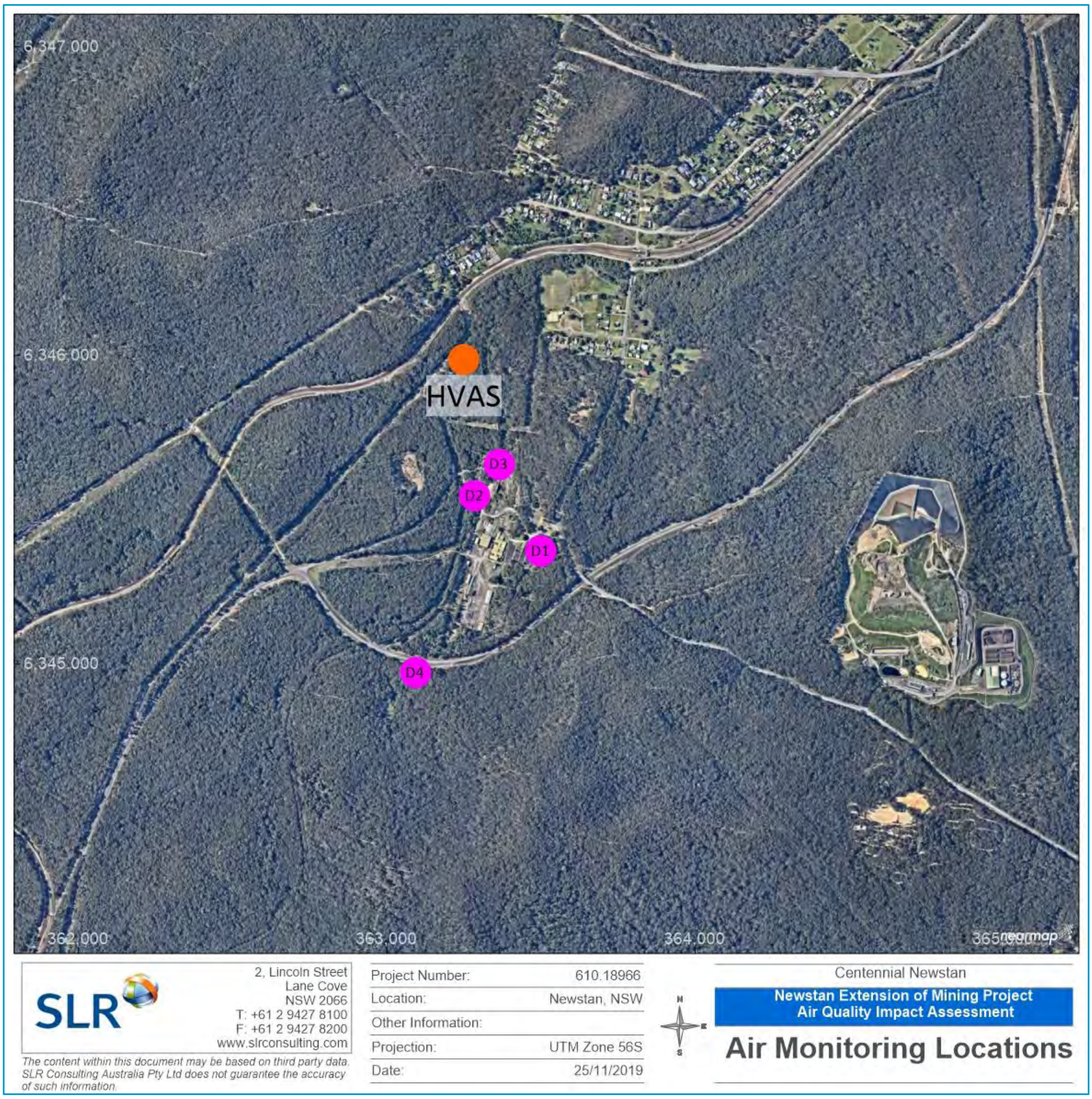
On-site ambient monitoring has been performed at the Awaba Colliery Surface Site for TSP and PM_{10}. A summary of the onsite monitoring program at Awaba Colliery Surface Site is shown in **Table 19**. The locations of these monitors are shown in **Figure 11**.

Table 19 Summary of On-Site Monitoring Program at Awaba Colliery Surface Site

Pollutant	Equipment Used
TSP	HVAS
PM_{10}	HVAS
Dust Gauges	DG1 to DG4

Note: HVAS = High Volume Air Sampler, TEOM = Tapered Element Oscillating Microbalance, DG = Dust Gauge

Figure 11 Locations of Dust Gauges – Awaba Colliery Surface Site



7.1.1 TSP and PM_{10} - HVAS

On-site ambient TSP and PM_{10} monitoring has been performed at the Awaba Colliery Surface Site since March 2015 using a High Volume Air Sampler (HVAS). The measured 24-hour average TSP and PM_{10} concentrations at the HVAS are presented graphically in **Figure 12** and **Figure 13**.

Of note, the ratio of mean TSP to PM_{10} measurements at the HVAS is of the order of 1.6 to 1. However as the monitoring data was measured on a 1-in-6-day cycle, it is not suitable for use in a contemporaneous cumulative impact analysis.

Figure 12 24-Hour Average PM_{10} Concentrations Monitored at HVAS - Awaba

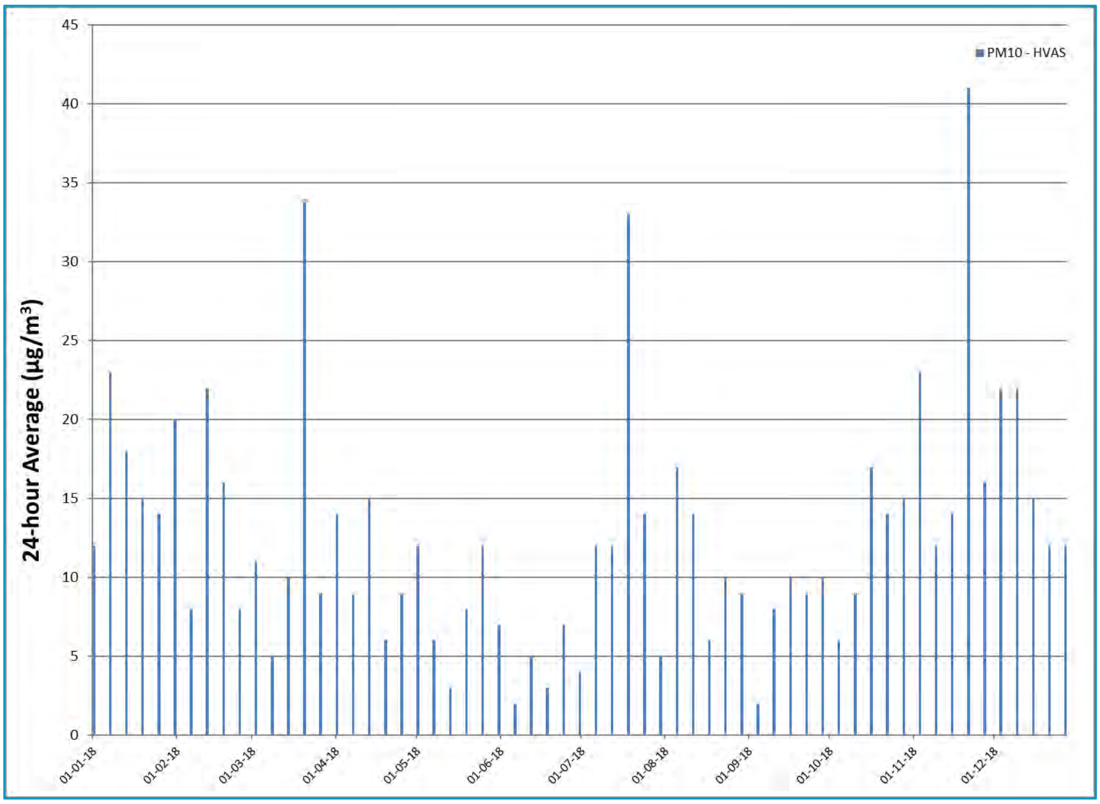
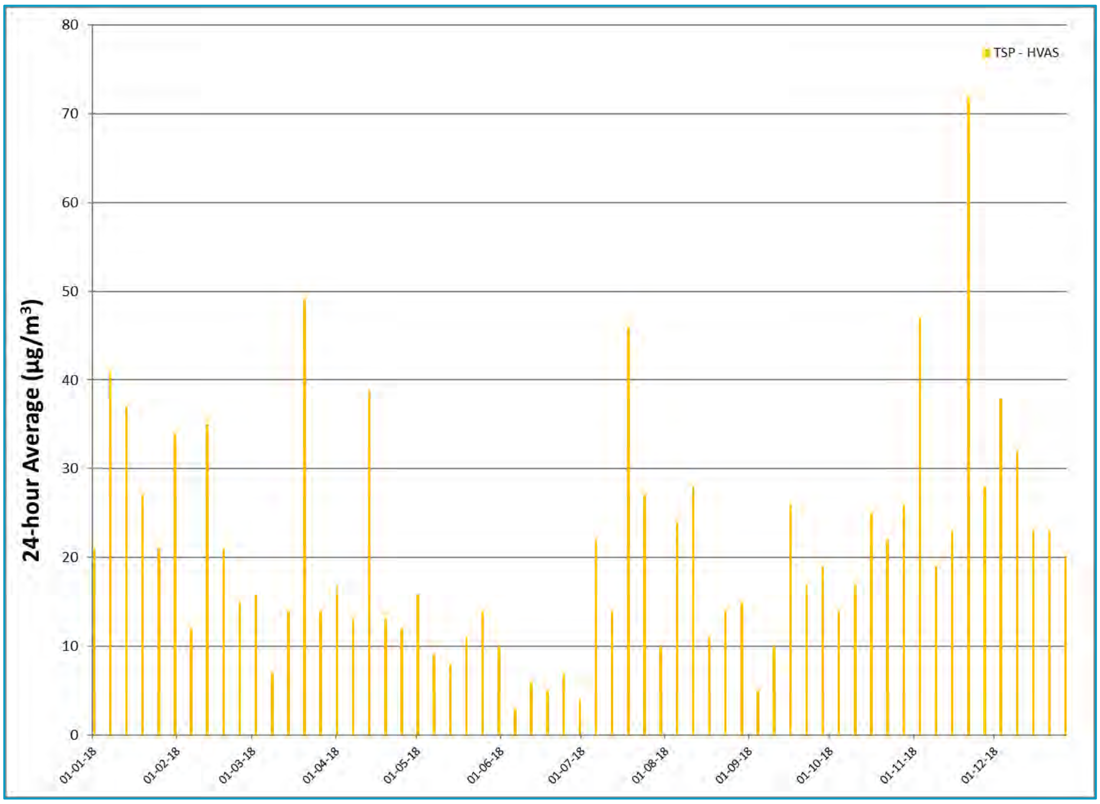


Figure 13 24-Hour Average TSP Concentrations Monitored at HVAS - Awaba



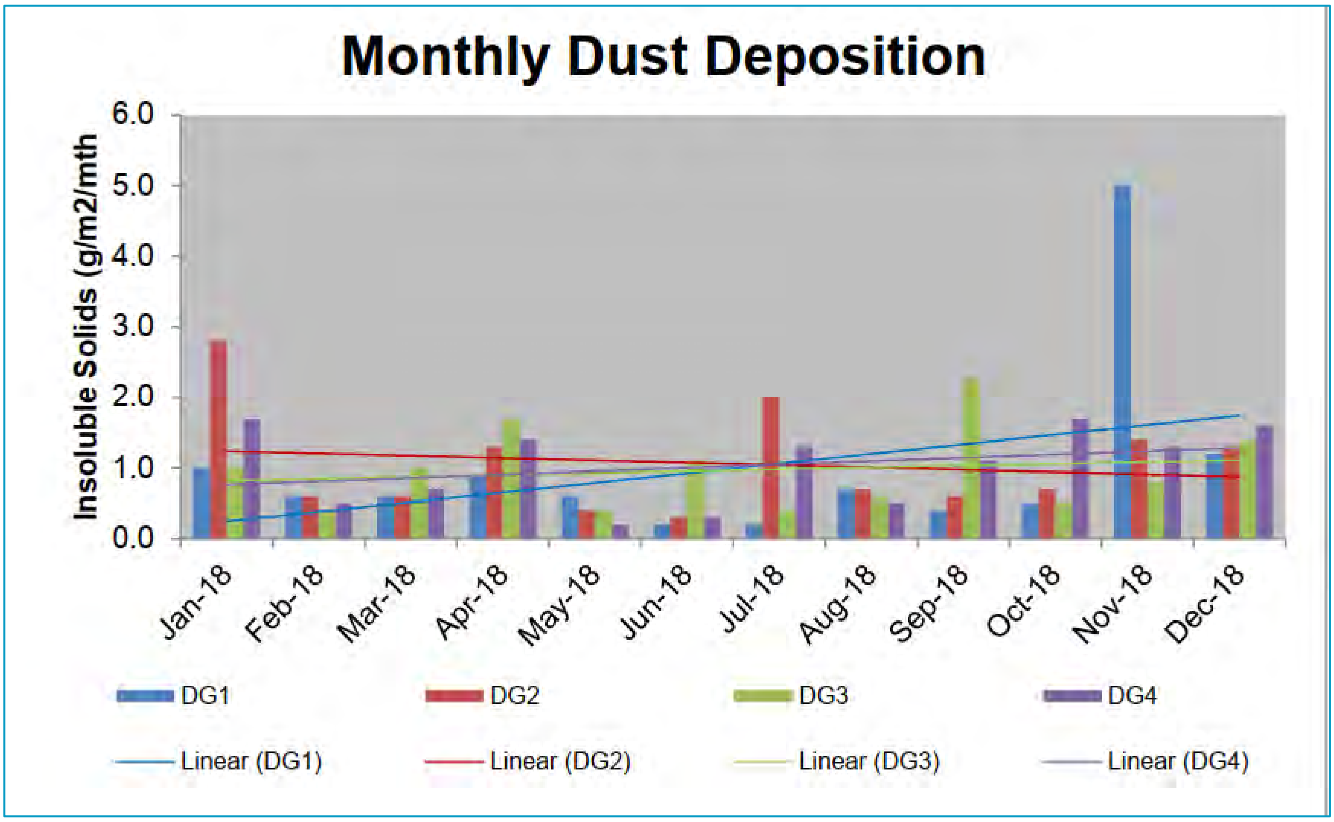
7.1.2 Dust

Awaba Colliery has had a dust monitoring program in place since March 2015. The locations of the dust monitoring sites are shown in **Figure 11**. A summary of the dust deposition monitoring results for the year 2018 is listed in **Table 20** and shown in **Figure 14**.

Table 20 Summary of the Dust Deposition Monitoring Results at Awaba Colliery

Dust Gauge	Annual Average Dust Deposition ($g/m^2/month$)	Long Term Average ($g/m^2/month$)
	2018	
DG1	1.0	0.6
DG2	1.1	1.2
DG3	1.0	3.2
DG4	1.1	1.1
Overall Average	**1.05**	**1.3**

Figure 14 Summary of the Dust Deposition Monitoring Results at Awaba Colliery



The long term average dust deposition rates shown in **Table 20** include the contribution of operations at Awaba Colliery Surface Site and background dust levels.

Considering that the monitored dust deposition rates include the contribution of current mining operations as well as regional background dust levels, based on the data presented in **Table 20**, a conservative background dust deposition rate of 2 g/m^2/month has been adopted for use in this assessment.

7.2 Regional Background Air Quality

The nearest Air Quality Monitoring Station (AQMS) maintained by the Department of Planning, Industry and Environment (DPIE) measuring continuous PM_{10} and $PM_{2.5}$ concentrations is located in Wallsend, approximately 12 km northeast of Newstan Colliery Surface Site, and 18 km northeast of Awaba Colliery Surface Site. The area surrounding the Wallsend AQMS is predominantly urban/residential in nature and PM_{10} concentrations recorded by this station are likely to be influenced by vehicle exhaust emissions and residential activities (eg lawn-mowing, wood heaters). Given the much lower population density in the region surrounding Newstan Colliery Surface Site, emissions from these types of sources will be much less significant and the Wallsend measurements are likely to provide a conservative estimate of regional background particulate levels. Further details regarding the pollutant concentrations recorded at Wallsend AQMS are provided below.

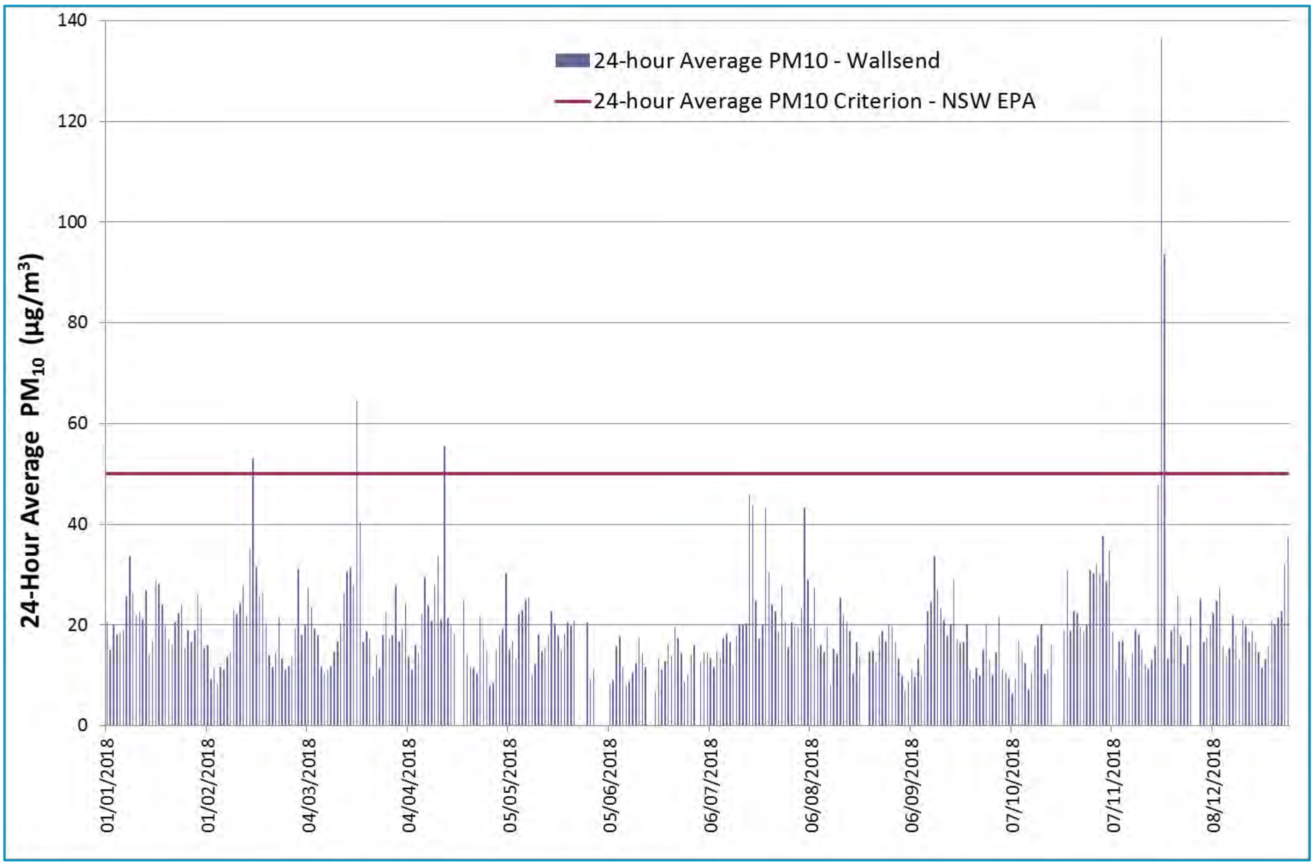
7.2.1 PM_{10}

A summary of the 24-hour average PM_{10} concentrations measured at the Wallsend AQMS during 2018 (contemporaneous with the meteorological data used in the modelling) is presented in **Figure 15** and **Table 21**.

Table 21 Statistical Summary of Measured 24-Hour Average PM_{10} Concentration at Wallsend during 2018

Parameter	Value
Data availability (data capture rate)	346 days (94.8%)
Annual Average	19.4 µg/m^3
1st highest 24-hour average	136.5 µg/m^3
2nd highest 24-hour average	93.6 µg/m^3
3rd highest 24-hour average	64.4 µg/m^3
4th highest 24-hour average	55.4 µg/m^3
5th highest 24-hour average	53.1 µg/m^3
6th highest 24-hour average	47.6 µg/m^3

Figure 15 24-Hour Average PM_{10} Data Monitored at Wallsend AQMS (2018)



The monitoring data for PM_{10} indicate that five exceedances of the 24-hour average criterion of 50 µg/m^3 were recorded during 2018. A summary of these exceedances is shown in **Table 22**.

Table 22 Summary of Exceedances of 24-hour Average PM_{10} Criterion – Wallsend AQMS

Date of Exceedance	Value (µg/m^3)	Comments
15/02/2018	53.1	Not identified
19/03/2018	64.4	Dust storms
15/04/2018	55.4	Likely agricultural activities
22/11/2018	136.5	Dust storms
23/11/2018	93.6	Dust storms

Source: OEH 2019

A review of the measured exceedances of the 24-hour average PM_{10} criterion indicates that four out of five exceedances were associated with exceptional events. On this basis, it is concluded that the air quality in the region is generally good, with intermittent elevations in 24-hour average PM_{10}, particularly in relation to dust storms and bushfires.

The daily-varying PM_{10} data for 2018 from Wallsend AQMS were used in the modelling to represent regional background levels.

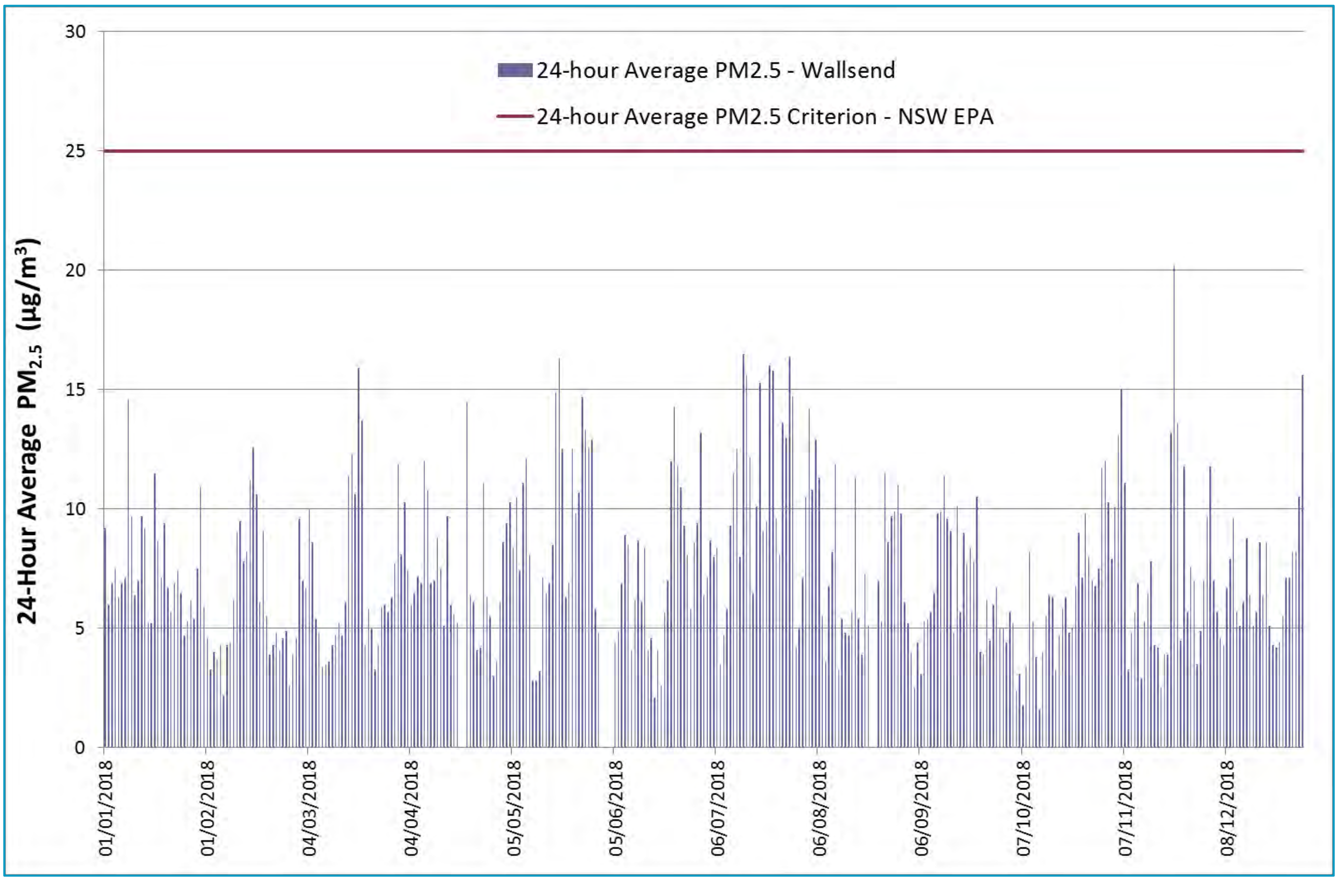
7.2.2 $PM_{2.5}$

A summary of the 24-hour average $PM_{2.5}$ concentrations measured at the Wallsend AQMS during 2018 (contemporaneous with the meteorological data used in the modelling) is presented in **Table 23** and **Figure 16**.

Table 23 Statistical Summary of Measured 24-Hour Average $PM_{2.5}$ Concentration at Wallsend during 2018

Parameter	Value
Data availability (data capture rate)	357 days (97.8%)
Annual Average	7.5 µg/m^3
1st highest 24-hour average	20.2 µg/m^3
2nd highest 24-hour average	16.5 µg/m^3
3rd highest 24-hour average	16.4 µg/m^3
4th highest 24-hour average	16.3 µg/m^3
5th highest 24-hour average	16.0 µg/m^3

Figure 16 24-Hour Average $PM_{2.5}$ Data Monitored at Wallsend AQMS (2018)



The daily-varying $PM_{2.5}$ data for 2018 from Wallsend were used in the modelling to represent regional background levels.

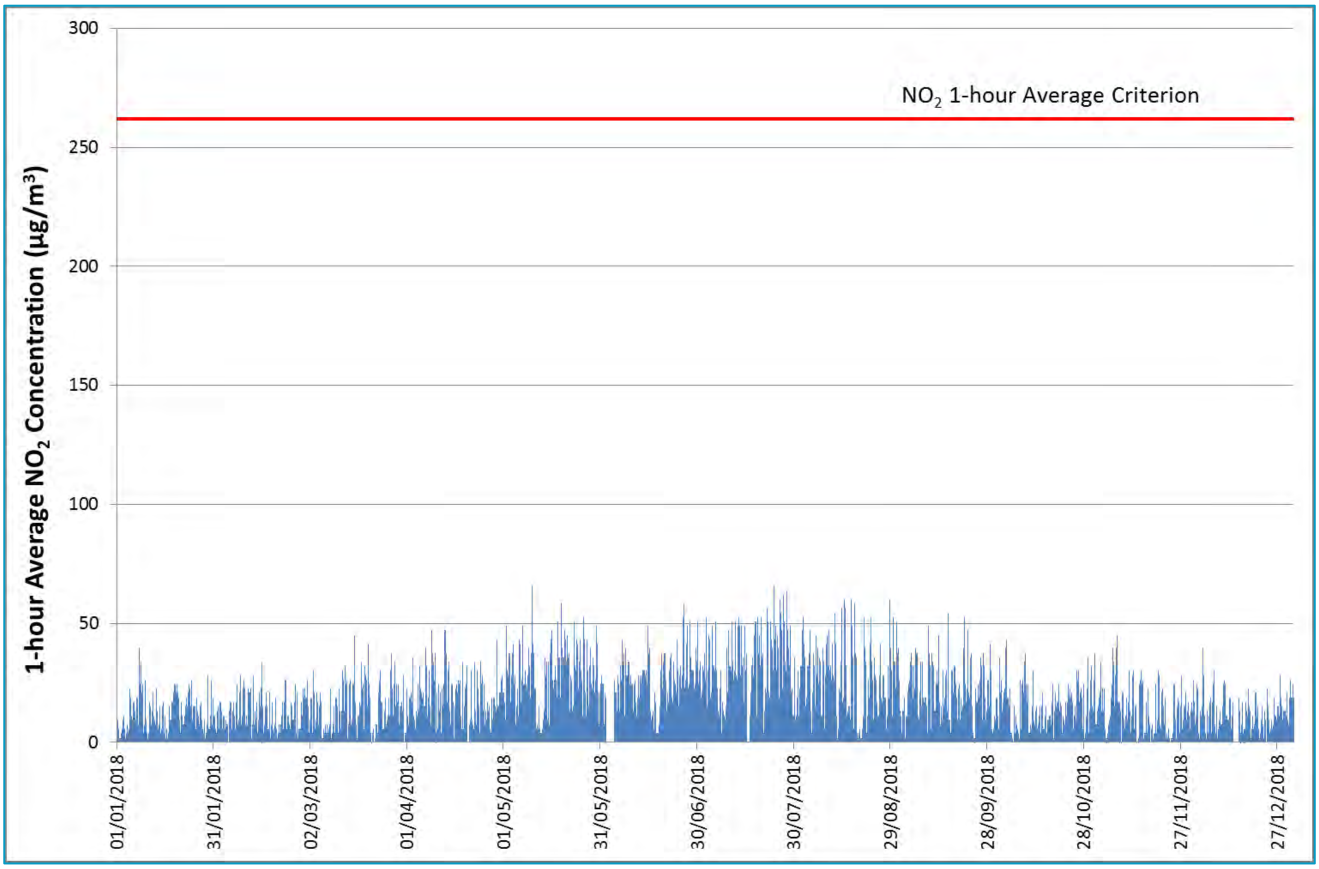
7.2.3 TSP

No TSP monitoring is conducted at the Wallsend AQMS. In the absence of any monitoring data for TSP, daily-varying ambient TSP concentrations have been estimated from the monitored PM_{10} concentrations from the Wallsend AQMS using a PM_{10}/TSP ratio of 0.5, which is estimated from the co-located HVAS at the Newstan Colliery Surface Site (see **Section 7.1.1**). Therefore, for cumulative analysis purposes, the annual average background TSP concentration is estimated to be 38.8 µg/m^3.

7.2.4 Nitrogen dioxide

The 1-hour average NO_2 concentrations measured at Wallsend AQMS during 2018 are presented in **Figure 17** and compared to the NSW EPA 1-hour average criterion. The 1-hour average NO_2 concentrations measured at Wallsend AQMS were less than 66 µg/m^3. These concentrations are considerably less than the 1-hour NO_2 guideline of 246 µg/m^3.

Figure 17 1-Hour Average NO_2 Concentrations – Wallsend AQMS



The NO_2 annual average concentration for 2018 was 13.2 µg/m^3, which is well below the NSW EPA guideline of 62 µg/m^3 (refer to **Section 4.3** for more details). For the purpose of cumulative assessment, the constant maximum 1-hour average concentration (65.8 µg/m^3) recorded at Wallsend AQMS was adopted as the background concentrations.

7.2.5 Carbon Monoxide

In the absence of monitoring data for CO from the Wallsend AQMS, data has been acquired from the Newcastle AQMS, located approximately 18 km east-northeast and 23 km east-northeast to the Newstan Colliery Surface Site and Awaba Colliery Surface Site respectively.

The CO monitoring data measured at Newcastle over the year 2018 is presented in **Figure 18** and **Figure 19**. The results show that maximum 8-hour running average and 1-hour average CO concentrations are far below the respective criteria of 10 mg/m^3 and 30 mg/m^3.

Figure 18 1-hour Average CO Concentrations – Newcastle AQMS

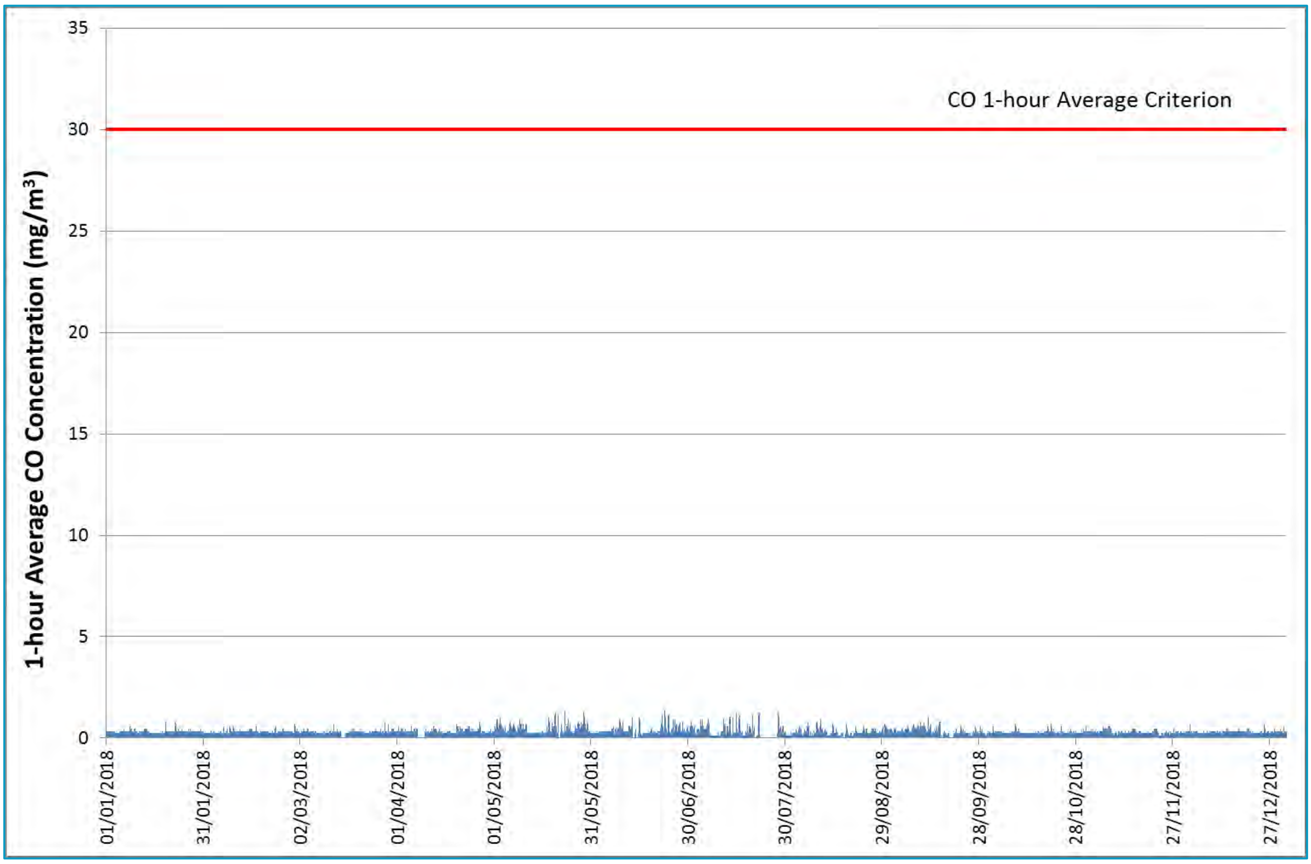
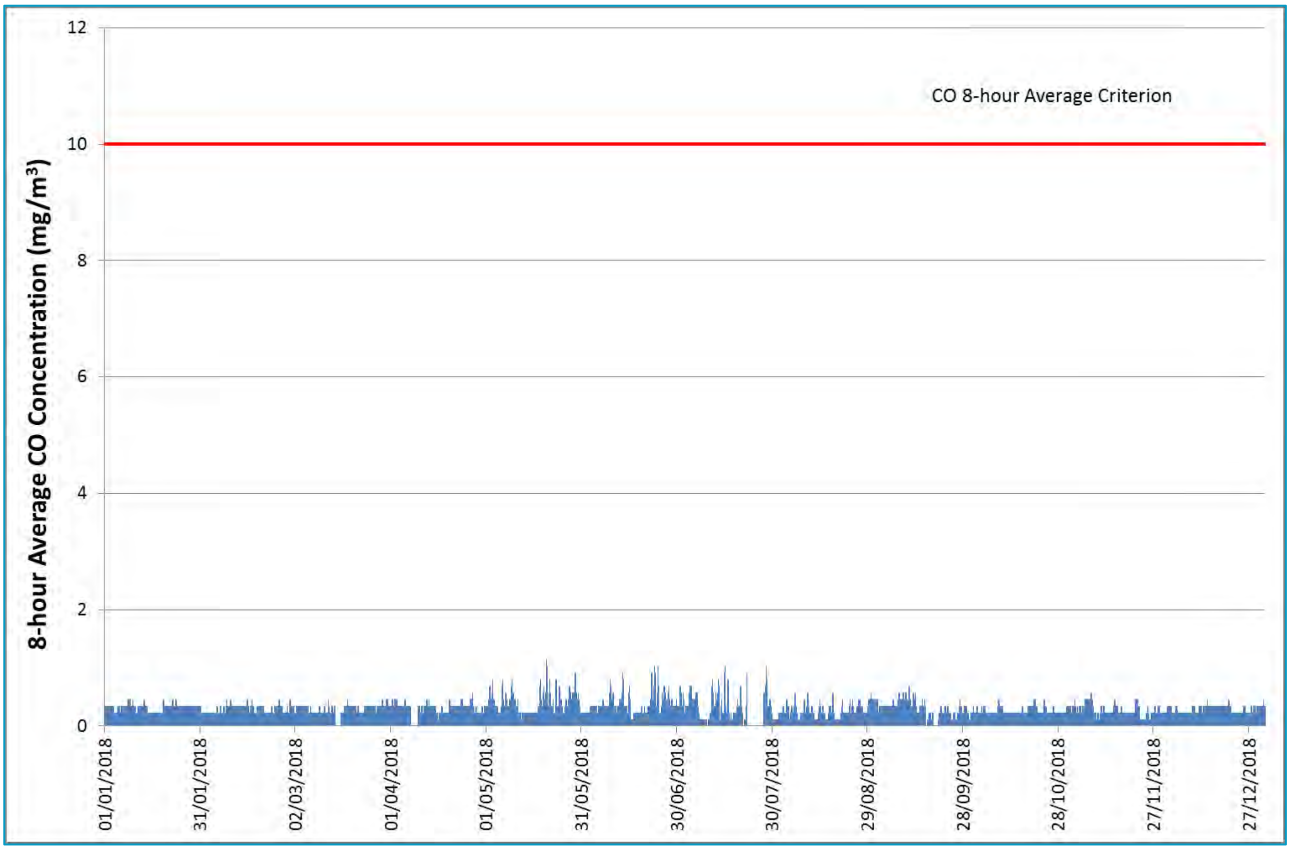


Figure 19 8-hour Average CO Concentrations – Newcastle AQMS



For the purpose of cumulative assessment, the constant maximum 1-hour average (1.4 mg/m^3) and maximum 8-hour average (1.2 mg/m^3) CO concentrations recorded at Newcastle AQMS were adopted as the background concentrations.

The 15-minute average CO concentrations are not available, however these are calculated using the Turner equation (Turner 1974), which was calculated to be 1.85 mg/m^3.

7.2.6 Odour

No site specific odour monitoring has been performed at Newstan Colliery. However, an odour monitoring program was conducted by SLR (SLR 2012b) at the existing Mandalong Mine ventilation fan, located approximately 20 km south-west of Newstan Colliery.

The odour monitoring campaign identified the characteristics of the odour from the ventilation fans as yeast, exhaust and metallic. The only similar sources of odour in the area are the Newstan Colliery Surface Site and Cooranbong Entry Site, both of which are located approximately 6 km away. Considering the large separation distances, it is considered that there are no similar odour sources in the vicinity of Awaba Colliery Surface Site with any potential to have cumulative impacts. Therefore, the background odour concentration is assumed to be negligible (ie zero).

7.3 Power Stations

To determine the background particulate concentrations experienced across the modelling domain, the increment from power stations located in the area needs to be added to the regional background particulate concentrations from **Section 7.2**. The locations of Eraring and Vales Point power stations in relation to the project are presented in **Figure 4**.

A dispersion modelling exercise has been performed using publicly available information to determine the contribution from power station emissions to particulate concentrations within the modelling domain. The information in **Table 24** has been obtained for stack sources associated with Eraring and Vales Point power stations. Emission rates of $PM_{2.5}$ were not publicly available and therefore the $PM_{2.5}$ fraction of 0.1, obtained from *Background Document for Revisions to Fine Fraction Ratios Used for AP-42 Fugitive Dust Emission Factors'* (MRI 2006) has been applied to the PM_{10} emission rates for all particulate emissions sources.

Table 24 Point Source Emissions from Eraring and Vales Point Power Stations

Source	ID	Easting (m)	Northing (m)	Height (m)	Diameter (m)	Temperature (°C)	Velocity (m/s)	TSP (g/s)	PM_{10} (g/s)	$PM_{2.5}$ (g/s)
Eraring	ES1	361,938	6,340,750	200	10.5	107	17	64.0	12.7	1.3
Eraring	ES2	361,975	6,340,938	200	10.5	107	17	64.0	12.7	1.3
Vales Point[1]	VPS1	364,347	6,329,916	178	11	110	15.4	60.0	12.5	1.3

The influence of building wake effects on the power station stack emissions has also been taken into account in the dispersion modelling. Building dimensions were estimated using Google Earth images and the relationship between known stack heights and associated shadow lengths. This relationship has then been applied to the building shadow lengths to estimate building heights. The building heights used in the modelling assessment are presented in **Table 25**.

Table 25 Details of Building Coordinates and Dimensions at Eraring and Vales Point Power Stations

Site	Building	ID	Easting (m)	Northing (m)	Height (m)
Eraring	Powerhouse	EB1	361,836	6,341,059	40
			361,985	6,341,040	
			361,924	6,340,658	
			361,783	6,340,675	
Vales Point	Powerhouse	VPB1	364,169	6,330,013	39
			364,335	6,330,136	
			364,364	6,330,099	
			364,199	6,329,976	
	Coal units	VPB3	364,239	6,329,993	59
			364,317	6,330,055	
			364,348	6,330,031	
			364,261	6,329,973	

In addition to emissions from stack sources, emissions from coal stockpiles and ash dams have also been considered. The location and surface area of coal stockpiles have been obtained from Google Earth imagery. Heights of all coal stockpiles have been assumed to be 5 m above ground level (AGL). For ash dams, half of the total area observed in Google Earth imagery has been taken to be available for wind erosion. For modelling purposes, the height of the ash dams has been taken to be 0 m AGL.

Emission rates for all stockpiles and ash dams have been taken to be the National Pollutant Inventory (NPI) default for wind erosion of 0.4 kg/ha/hr for TSP and 0.2 kg/ha/hr for PM_{10} and 0.02 kg/ha/hr for $PM_{2.5}$. The emission rate for $PM_{2.5}$ has been calculated using the WRAPAIR particle size fractions (MRI 2006).

It is acknowledged that the use of the default value may result in 'under' or 'over' estimation of 24-hour particulate concentrations at some locations. However taking into account the nature and scale of this assessment, it is considered to be appropriate. Details of stockpile and ash dam locations are presented in **Table 26**.

Table 26 Details of Stockpile and Ash Dam Locations at Eraring and Vales Point Power Stations

Site	Stockpile	ID	Easting (m)	Northing (m)	Height (m)
Eraring	Coal	ESP1	361,715	6,341,677	5
			361,715	6,341,345	
			362,097	6,341,345	
			362,097	6,341,677	
	Coal	ESP2	362,161	6,341,677	5
			361,897	6,341,674	
			361,897	6,341,935	
			362,161	6,341,935	
	Ash Dam	EAD1	363,128	6,342,672	0
			362,915	6,342,178	
			364,080	6,341,921	
			364,142	6,342,278	
Vales Point	Coal	VPSP1	363,648	6,329,355	5
			363,937	6,329,204	
			363,815	6,328,965	
			363,519	6,329,106	
	Coal	VPSP2	364,787	6,329,587	5
			364,852	6,329,562	
			364,760	6,329,398	
			364,700	6,329,429	
	Ash Dam	VPAD1	362,437	6,328,584	0
			363,447	6,327,984	
			362,433	6,326,172	
			361,976	6,327,423	

The particulate concentrations from the power stations were estimated, so that these contributions can be eliminated from the background. Additionally, impacts have also been predicted at the Wallsend AQMS to verify that concentrations of particulate measured at the station do not include a significant contribution from power station related emissions.

The maximum modelled 24-hour average PM_{10} and $PM_{2.5}$ concentrations at the Wallsend AQMS from power station operations was predicted to be 0.8 µg/m^3 and 0.01 µg/m^3 respectively. It is therefore concluded that the PM_{10} and $PM_{2.5}$ monitoring data from Wallsend AQMS does not include a significant contribution from power station operations, and that data may be used as a 'regional background' dataset for the domain.

For each sensitive receptor location, daily-varying background PM_{10} and $PM_{2.5}$ concentration files have been constructed, using the regional background particulate data from Wallsend AQMS, added to the predicted incremental particulate concentrations from modelling of the power stations.

As an example, the daily varying files of background PM_{10} and $PM_{2.5}$ concentrations at receptor 'R1' including the contribution of power stations and regional background concentrations are presented in **Figure 20** and **Figure 21** respectively.

The missing data recorded at the Wallsend AQMS for PM_{10} and $PM_{2.5}$ has been replaced by the respective annual averages. This is considered appropriate in the absence of data, as it ensures that the regional background is taken into account for cumulative impact assessment.

Figure 20 Regional Background and Power Station Increment at Receptor 'R1' (PM_{10})

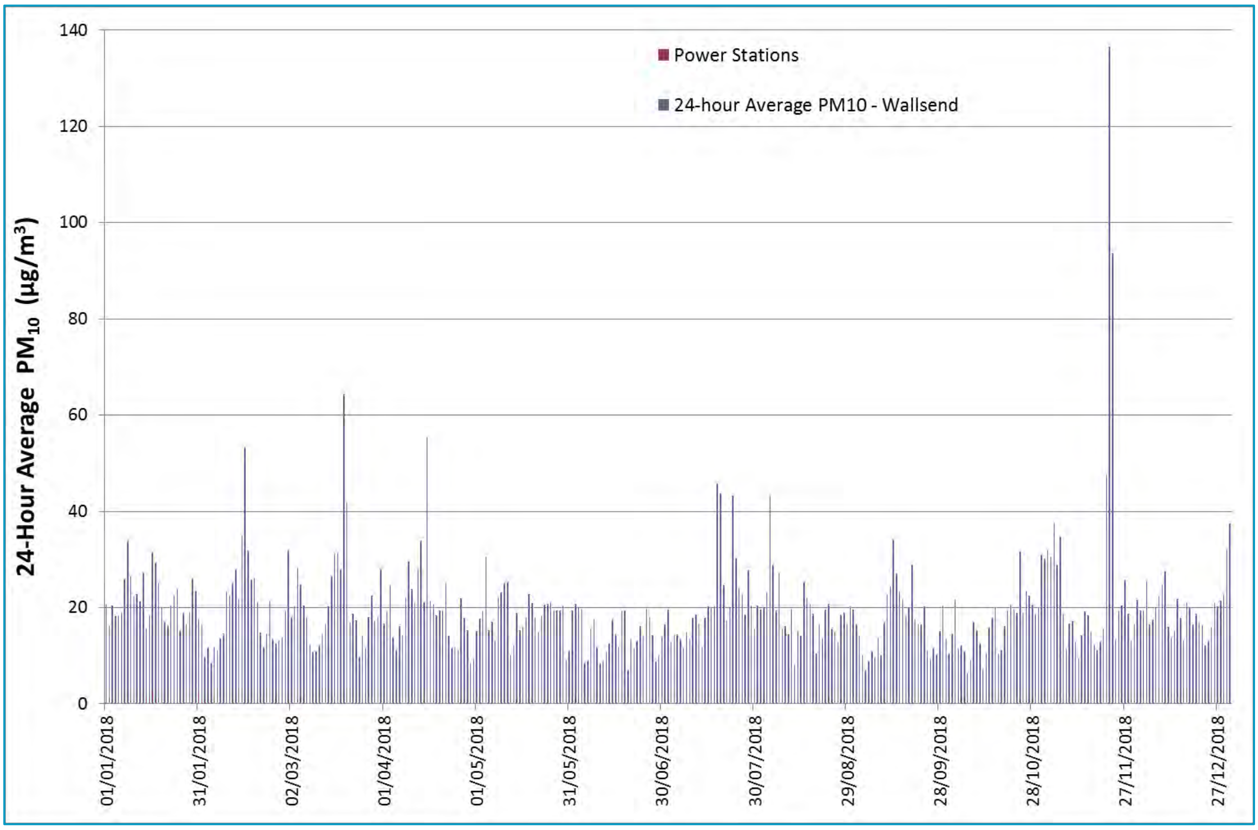
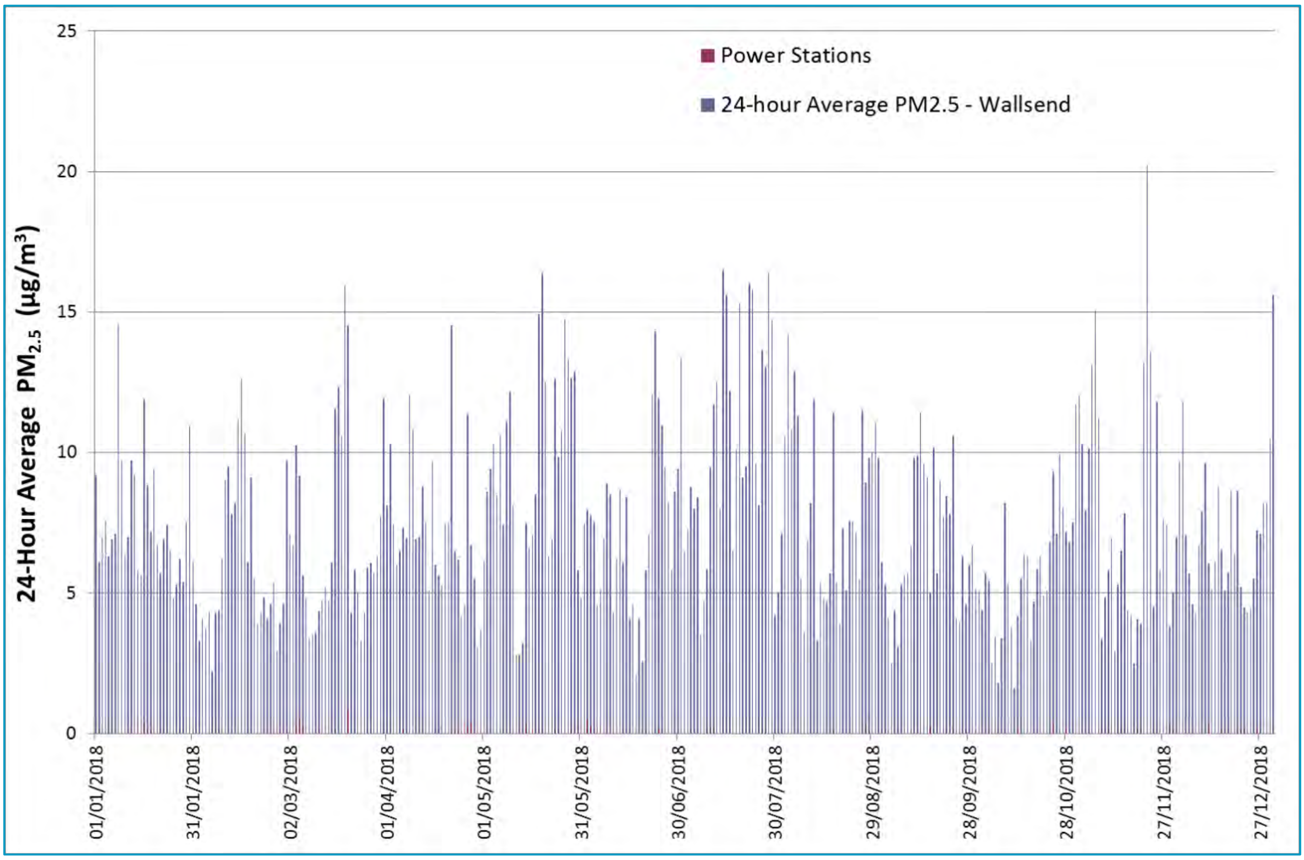


Figure 21 Regional Background and Power Station Increment at Receptor 'R1' ($PM_{2.5}$)



The derived background concentration files (regional background plus power station) vary spatially across the modelling domain based on the results of power station emission modelling results.

7.4 Surrounding Mining and Ancillary Industries

A number of surrounding industries have been identified in the region, which may the potential to have a cumulative impact on the identified sensitive receptors. This section identifies those industries and assesses the possibility of their operations resulting in a cumulative impact on the sensitive receptors. A summary of the industries considered in this regard is shown in **Table 27**.

Table 27 A Summary of the Surrounding Mining and Ancillary Industries

Industry	Location	Section
Northern Coal Logistics Project	~within the PAA	**Section 7.4.1**
Teralba Quarry Extensions	~ 2.5 km northeast of Newstan Colliery Surface Site; and 8.5 km northeast of Awaba Colliery Surface Site	**Section 7.4.2**
Conservation and recreation activities	~within the PAA	**Section 7.4.4**

7.4.1 Northern Coal Logistics Project

An AQIA was completed by SLR Consulting in December 2014 which assessed the air quality impacts associated with the NCL Project. A total of eight (8) operational scenarios were assessed as part of the NCL Project AQIA, based on a range of coal movement and coal handling options.

The dispersion modelling results in the NCL Project AQIA showed that at the identified sensitive receptors around the Newstan Colliery Surface Site, the predicted annual average dust deposition rates, annual average TSP concentrations, annual average PM_{10} concentrations, annual average $PM_{2.5}$ concentrations and maximum 24-hour average $PM_{2.5}$ concentrations were below the respective criteria across all the scenarios.

In regards to the maximum 24-hour average PM_{10} concentrations, exceedances were predicted at receptor NC6 for scenarios 2a, 3a and 3b, with 3a being the highest. Scenario 3a assessed the air quality impacts from the following operations:

- Receipt of 6 Mtpa of coal from the Cooranbong Entry Site;
- Export of 8 Mtpa of coal by rail;
- Trucks dumping coal at ROM stockpile;
- Trucks dumping coal at rail loop stockpile; and
- Manual train loading using FELs.

Condition 8 under the 'Limits of Consent' for Development Consent SSD-5145 is reproduced below:

> *"Prior to transporting more than 5.5 million tonnes of coal by rail in any calendar year, the Applicant must construct the automated coal recovery and train loading system as proposed in the EIS, to the satisfaction of the Secretary. Following its construction, the Applicant must use the automated coal recovery and train loading system for all transport of coal by rail."*

As per Centennial's *Northern Region – Air Quality and Greenhouse Gas Management Plan (May 2018)*, Centennial has committed to automating the train loading operations aspect once the amount of coal exported by rail reaches 5.5 Mtpa. Automation of the train loading facility is expected to reduce the air quality impacts compared to those predicted in the NCL Project AQIA, resulting in a lower risk of predicted exceedance.

A source contribution analysis was also conducted for predicted maximum 24-hour PM_{10} concentrations at the worst affected receptor . This analysis showed that:

- The contribution of emissions from the Newstan ventilation fans to the total predicted incremental impacts from the NCL Project was less than 0.4%.
- The combined impacts from dozers and front end loaders operating on the rail loop stockpile within the Newstan Colliery Surface Site contributed up to 47% of the total predicted incremental impacts from the NCL Project.
- Trucks transporting and dumping coal at the rail loop stockpile contributed up to 21% of the total predicted incremental impacts from the NCL Project.

Given the above, and the distance between the sensitive receptors identified for the project (see **Section 3.2**), and the NCL Project activities, it is concluded that the NCL Project will not have any significant cumulative impacts with the project.

7.4.2 Teralba Quarry Extension

An AQIA was completed by SLR Consulting in November 2011 which assessed the air quality impacts associated with the proposed Teralba Quarry Extension located approximately 2.5 km northeast of Newstan Colliery Surface Site and 8.5 km northeast of Awaba Colliery Surface Site.

A total of three scenarios were assessed, of which the scenario that assessed the extraction in the Southern Extension Area (Stage C) was regarded as the worst case scenario out of the three scenarios assessed. In order to assess the cumulative impacts from Teralba Quarry Extension Project on the identified sensitive receptors (in **Section 3.2**), it is considered appropriate to assess the predicted 24-hour average PM_{10} concentrations.

Table 28 Predicted 24-hour Average PM_{10} Concentrations for Scenario 5A - Extraction in the Southern Extension Area (Stage C)

Teralba Quarry Receptor	Incremental
A	0.9
B	1.5
C	1.9
D	1.2
E	0.3
F	0.2
G	0.0
H	0.0
I	0.0

Source: SLR 2011a

It is noted that the predicted incremental 24-hour average PM_{10} concentrations were negligible at a receptor 'I' (the furthest receptor from Teralba Quarry), which is located approximately 8 km from the Awaba Colliery Surface Site.

It is therefore concluded that the Teralba Quarry Extension Project will not have any significant cumulative impacts with the project.

7.4.3 Other Industries

Awaba landfill

Awaba Landfill is located approximately 1.5 km east of the Awaba Colliery Surface Site. The main air quality pollutant anticipated from the Awaba Landfill is odour and dust emissions from unloading and handling of wastes materials. There is no publicly available air quality assessment available for Awaba Landfill however the latest aerial images (November 2019) suggest that the southern portion of landfill is capped and the 'dusty' are undertaken towards the north.

In regards to cumulative the odour impacts, the Awaba Landfill is unlikely to have any cumulative impacts on the sensitive receptors due to the nature of odour being different to those from the Project.

In regards to cumulative dust impacts, the Awaba Landfill is unlikely to have any cumulative impacts due to the difference in wind directions that are likely to impact on the receptors, for example the winds will need to be from southeast for Awaba Landfill to have any impacts on the receptors, whereas the winds will need to be from southwest for the Project to have any impacts on the receptors.

Myuna Colliery

The Myuna Colliery is located approximately 5.5 km southeast of the Awaba Colliery Surface Site. The Myuna Colliery undertakes coal handling and transportation activities. Due to the large separation distance, the Myuna Colliery is unlikely to have any cumulative impacts at the identified sensitive receptors.

Cooranbong Entry Site

The Cooranbong Entry Site is located approximately 5.5 km southwest of the Awaba Colliery Surface Site. The Cooranbong Entry Site undertakes coal handling and transportation activities. Due to the large separation distance, the Cooranbong Entry Site is unlikely to have any cumulative impacts at the identified sensitive receptors.

7.4.4 Conservation and Recreation Activities

Conservation and recreation related activities occur within the Olney State Forest and other adjoining areas around the project. Potentially dust-generating activities will be limited to unsealed road use by vehicles. Given the likely infrequent nature of these activities, it is not considered that these will have a significant cumulative impact with the project operation and they have not been considered further.

7.5 Adopted Background for this Assessment

For the purpose of assessing potential cumulative air quality impacts, an estimation of the background TSP, PM_{10} and $PM_{2.5}$ concentrations and dust deposition rates is required. The site-specific background ambient air quality concentrations adopted for use in this assessment are summarised in **Table 29**.

Table 29 Adopted Background Data – Newstan Mine Extension Project

Pollutant	Averaging Period	Regional Background	Notes
TSP	Annual	38.8 µg/m^3	Assumed to be twice the monitored PM_{10} concentrations at Wallsend AQMS
PM_{10}	24-hour	Daily varying	As monitored at Wallsend AQMS during 2018
	Annual	19.4 µg/m^3	As monitored at Wallsend AQMS during 2018
$PM_{2.5}$	24-hour	Daily varying	As monitored at Wallsend AQMS during 2018
	Annual	7.5 µg/m^3	As monitored at Wallsend AQMS during 2018
Deposited dust	Annual	2 g/m^2/month	Estimated from on-site monitoring programme
Odour	1-hour	0 ou	Assumed
NO_2	1-hour	65.8 µg/m^3 (maximum hourly)	As monitored at Wallsend AQMS during 2018
	Annual	12.1 µg/m^3	As monitored at Wallsend AQMS during 2018
CO	1-hour	1.4 mg/m^3	As monitored at Newcastle AQMS during 2018

Pollutant	Averaging Period	Regional Background	Notes
	8-hour	1.2 mg/m^3	As monitored at Newcastle AQMS during 2018
	15-minute	1.85 mg/m^3	Calculated using Turner equation (Turner 1974)

8 Air Quality Impact Assessment

Dispersion modelling predictions of TSP, PM_{10}, $PM_{2.5}$, dust deposition rates, CO, NO_2, and odour concentrations at the residences/properties nominated in **Section 3.2** attributable to the project are presented in **Section 8.1** to **Section 8.7**. Pollutant isopleth plots (contour plots) are also provided in **Appendix A** which show the maximum predicted incremental (the project only) concentrations and deposition rates of the pollutants assessed.

As discussed in **Section 7** a detailed assessment of the background concentrations in the area surrounding the Project site has been performed. A regional background concentration has been determined, to which a contribution from local power stations has been added. Within this results section, a contribution from Project activities has been added to the background dataset (refer to **Section 7**), in order to provide information on the cumulative impact of the project activities on the air quality within the local area. For TSP, PM_{10} and $PM_{2.5}$ concentration results, several values are presented. The value presented and an explanation of each is provided in **Table 30**.

Table 30 Results Presentation and Explanation

Heading in Results Tables	Data Presented	Reason for Presentation
Increment Background	Maximum Regional Background Concentration	Allows identification of the maximum regional measured particulate concentration across the entire year without other local sources and Project-related sources.
Increment Power Stations	Maximum Incremental Contribution from Eraring and Vales Point Power Station operations	Indicates the maximum impact at each receptor across the entire year from Eraring and Vales Point Power Station operations only.
Increment Project	Maximum Incremental Contribution from the project, ie, either: Scenario 1- Construction, OR Scenario 2 – Operations	Identifies the maximum impact across the entire year from the project-related sources only.
Cumulative Total Background + Project	Maximum Cumulative Concentration (ALL SOURCES)	Indicates the maximum particulate concentration when regional background, other local sources and Project sources are added together. Note, the day of maximum impact from the Project may not fall on the same day as maximum impact from other local sources or regional background.
Cumulative Maximum Cumulative Concentration on Day of Maximum Increment from Project	Maximum Cumulative Concentration on Day of Maximum Increment from Project	Shows the maximum cumulative particulate concentration predicted on the day of the maximum incremental impact from the Project (including other local sources plus regional background) on that day. The total background particulate concentration on the day of the maximum predicted increment from Project operations is shown in brackets.

8.1 Particles (as TSP)

Table 31 presents the annual average incremental and cumulative TSP concentrations predicted at each of the identified receptors during the project. Contour plots of the predicted incremental increase in annual average TSP concentrations during the project in isolation are presented in **Appendix A**.

Table 31 Predicted Annual Average TSP Concentrations

Receptor ID	Annual Average TSP Concentrations (µg/m³)					
	Background		Scenario 1 (Construction)		Scenario 2 (Operations)	
	Regional	Power Stations	Increment	Cumulative	Increment	Cumulative
R1	38.8	0.6	13.8	51.2	0.8	40.2
R2	38.8	0.6	8.1	45.5	0.9	40.3
R3	38.8	0.6	9.2	46.5	1.0	40.4
R4	38.8	0.6	13.2	50.6	1.2	40.6
Criterion				**90**		**90**

Table 31 shows that the cumulative annual average TSP concentrations at all nominated residences/properties nominated for the project are predicted to be well below the criterion of 90 µg/m³.

8.2 Particles (as PM_{10})

8.2.1 Maximum 24-Hour Average PM_{10} Concentrations

Table 32 presents the maximum incremental and cumulative 24-hour average PM_{10} concentrations predicted at each of the identified receptors during the project construction (Scenario 1). The calculated background PM_{10} concentrations have been discussed in detail in **Section 7**.

Table 32 Predicted Maximum 24-Hour Average PM_{10} Concentrations – Scenario 1 (Construction)

Receptor ID	Maximum 24-Hour Average PM_{10} Concentrations (µg/m³)				
	Background		Increment	Cumulative	
	Regional	Power Stations	Extension Project (Scenario 1)	Maximum Cumulative (Total Background + Scenario 1)	Maximum Cumulative on Day of Maximum Increment from the Project*
R1	136.5	2.6	14.3	136.5	28.7 (14.3)
R2	136.5	2.8	9.8	136.5	27.8 (17.4)
R3	136.5	2.8	10.9	136.5	28.9 (17.4)
R4	136.5	2.8	16.5	136.5	30.8 (14.3)
Criterion				**50**	**50**

* Total Background on day of maximum increment from Project shown in brackets

The maximum increment from the project construction (16.5 µg/m³) is predicted to occur at receptor 'R4'. The predicted maximum cumulative impact in **Table 32** represents the maximum of the sum of contemporaneous increments of regional background, power stations and the project construction (Scenario 1). It is noted that the construction impacts are estimated based on conservative activity rates eg total disturbance area being inclusive of the hardstand area, hence the predicted incremental results should be viewed as conservative in nature.

As shown in the **Table 32**, the maximum 24-hour average cumulative PM_{10} concentrations are predicted to exceed the criterion of 50 µg/m³ at all identified sensitive receptor locations, however this is entirely due to the maximum background concentration of 136.5 µg/m³ recorded at Wallsend in November 2018 due to a dust storm.

Similarly, **Table 33** presents the maximum incremental and cumulative 24-hour average PM_{10} concentrations predicted at each of the identified receptors during the project operations (Scenario 2).

Table 33 Predicted Maximum 24-Hour Average PM_{10} Concentrations – Scenario 2 (Operations)

Receptor ID	Maximum 24-Hour Average PM_{10} Concentrations (µg/m³)				
	Background		Increment	Cumulative	
	Regional	Power Stations	Extension Project (Scenario 2)	Maximum Cumulative (Total Background + Scenario 2)	Maximum Cumulative on Day of Maximum Increment from the Project*
R1	136.5	2.6	0.9	136.5	2.7 (0)
R2	136.5	2.8	1.3	136.5	17 (14.1)
R3	136.5	2.8	1.5	136.5	17.3 (14.1)
R4	136.5	2.8	1.2	136.5	2.8 (0)
Criterion				**50**	**50**

* Total Background on day of maximum increment from Project shown in brackets

The maximum increment from the project operations (1.5 µg/m³) is predicted to occur at receptor 'R3'. The predicted maximum cumulative impact in **Table 33** represents the maximum of the sum of contemporaneous increments of regional background, power stations and the project operations (Scenario 2).

As shown in the **Table 33**, the maximum 24-hour average cumulative PM_{10} concentrations are predicted to exceed the criterion of 50 µg/m³ at all identified sensitive receptor locations, however this is entirely due to the maximum background concentration of 136.5 µg/m³ recorded at Wallsend in November 2018 during a dust storm. This is evident from the results showing the maximum cumulative (17.3 µg/m³ at R3) on the day of maximum predicted increment (14.1 µg/m³ at R3) being well below the Project criterion.

Sensitivity of Background Data Selection to Cumulative Impact Assessment

Given that the Wallsend AQMS recorded notably high PM_{10} concentrations during the 2018 calendar year, an analysis of potential cumulative PM_{10} concentrations has been performed using the recorded background PM_{10} concentrations for previous four years to investigate the sensitivity of the results to the background data used.

A summary of the number of additional exceedances of the 24-hour average criterion predicted using the daily-varying background data for the years 2014 to 2018 is presented in **Table 34**.

Table 34 Background Air Quality Data Sensitivity Analysis Test

Receptor ID	2014	2015	2016	2017	2018
Number of exceedances recorded by the Wallsend AQMS	**0**	**1**	**1**	**0**	**5**
Additional exceedances predicted at R1	0	0	0	0	0
Additional exceedances predicted at R2	0	0	0	0	0
Additional exceedances predicted at R3	0	0	0	0	0
Additional exceedances predicted at R4	0	0	0	0	0

Note: Industrial and commercial receptor locations are shaded in grey

Table 34 indicates that if background data years 2014 to 2017 had been used in lieu of 2018 data:

- the number of exceedances of the 24-hour average PM_{10} impact assessment criterion predicted for each year would be fewer than the number predicted using the 2018 dataset; and
- there would be no additional exceedances of the 24-hour average PM_{10} impact assessment criterion than those predicted in the background dataset for each year.

It is also noted that the number of predicted exceedances correspond to the number of exceedances in the background data set.

8.2.2 Annual Average PM_{10} Concentrations

Table 35 presents the annual average incremental and cumulative PM_{10} concentrations predicted at each of the identified receptors during the project. Contour plots of the predicted incremental increase in annual average PM_{10} concentrations during the project in isolation are presented in **Appendix A**.

Table 35 Predicted Annual Average PM_{10} Concentrations

Receptor ID	Annual Average PM_{10} Concentrations (µg/m³)					
	Background		Scenario 1 (Construction)		Scenario 2 (Operations)	
	Regional	Power Stations	Increment	Cumulative	Increment	Cumulative
R1	19.4	0.2	1.4	21.0	0.1	19.7
R2	19.4	0.2	0.8	20.4	0.1	19.7
R3	19.4	0.2	0.9	20.5	0.1	19.7
R4	19.4	0.2	1.3	20.9	0.1	19.7
Criterion				**25**		**25**

The results indicate that annual average PM_{10} concentrations at all nominated residences/properties nominated for the project are predicted to be well below the criterion of 25 µg/m³.

8.3 Particles (as $PM_{2.5}$)

8.3.1 Maximum 24-Hour Average $PM_{2.5}$ Concentrations

Table 36 presents the maximum incremental and cumulative 24-hour average $PM_{2.5}$ concentrations predicted at each of the identified receptors during the project construction (Scenario 1). The calculated background $PM_{2.5}$ concentrations have been discussed in detail in **Section 7**.

Table 36 Predicted Maximum 24-Hour Average $PM_{2.5}$ Concentrations – Scenario 1 (Construction)

Receptor ID	Maximum 24-Hour Average $PM_{2.5}$ Concentrations (µg/m³)				
	Background		Increment	Cumulative	
	Regional	Power Stations	Extension Project (Scenario 1)	Maximum Cumulative (Total Background + Scenario 1)	Maximum Cumulative on Day of Maximum Increment from the Project*
R1	20.2	0.4	7.2	20.2	15.3
R2	20.2	0.5	5.0	20.2	14.4
R3	20.2	0.5	5.6	20.2	14.9
R4	20.2	0.5	8.3	20.2	16.4
Criterion				**25**	**25**

* Total Background on day of maximum increment from Project shown in brackets

The maximum increment from the project construction (8.3 µg/m^3) is predicted to occur at receptor 'R4'. The predicted maximum cumulative impact in **Table 36** represents the maximum of the sum of contemporaneous increments of regional background, power stations and the project construction (Scenario 1).

As shown in **Table 36**, the maximum 24-hour average cumulative $PM_{2.5}$ concentrations are predicted to be below the criterion of 25 µg/m^3 at all identified sensitive receptor locations.

Similarly, **Table 37** presents the maximum incremental and cumulative 24-hour average $PM_{2.5}$ concentrations predicted at each of the identified receptors during the project operations (Scenario 2).

Table 37 Predicted Maximum 24-Hour Average $PM_{2.5}$ Concentrations – Scenario 2 (Operations)

Receptor ID	Maximum 24-Hour Average $PM_{2.5}$ Concentrations (µg/m³)				
	Background		Increment	Cumulative	
	Regional	Power Stations	Extension Project (Scenario 2)	Maximum Cumulative (Total Background + Scenario 2)	Maximum Cumulative on Day of Maximum Increment from the Project*
R1	20.2	0.4	0.4	20.2	0.6
R2	20.2	0.5	0.6	20.2	6.1
R3	20.2	0.5	0.8	20.2	6.2
R4	20.2	0.5	0.6	20.2	0.8
Criterion				**25**	**25**

* Total Background on day of maximum increment from Project shown in brackets

The maximum increment from the project operations (0.8 µg/m³) is predicted to occur at receptor 'R3'. The predicted maximum cumulative impact in **Table 37** represents the maximum of the sum of contemporaneous increments of regional background, power stations and the project operations (Scenario 2).

As shown in **Table 37**, the maximum 24-hour average cumulative $PM_{2.5}$ concentrations are predicted to be below the criterion of 25 µg/m³ at all identified sensitive receptor locations.

8.3.2 Annual Average $PM_{2.5}$ Concentrations

Table 38 presents the annual average incremental and cumulative $PM_{2.5}$ concentrations predicted at each of the identified receptors during the project. Contour plots of the predicted incremental increase in annual average $PM_{2.5}$ concentrations during the project in isolation are presented in **Appendix A**.

Table 38 Predicted Annual Average $PM_{2.5}$ Concentrations

Receptor ID	Annual Average $PM_{2.5}$ Concentrations (µg/m³)					
	Background		Scenario 1 (Construction)		Scenario 2 (Operations)	
	Regional	Power Stations	Increment	Cumulative	Increment	Cumulative
R1	7.5	<0.1	0.7	<8.3	<0.1	<7.7
R2	7.5	<0.1	0.4	<8.0	<0.1	<7.7
R3	7.5	<0.1	0.5	<8.1	<0.1	<7.7
R4	7.5	<0.1	0.7	<8.3	0.1	<7.7
Criterion				**8**		**8**

The results indicate that annual average $PM_{2.5}$ concentrations at all nominated residences/properties nominated for the project are predicted to exceed the criterion of 8 µg/m³, at receptors 'R1', 'R2', and 'R4' during construction. It was noted that the predicted exceedances are due to the high annual average $PM_{2.5}$ regional background concentrations.

8.4 Dust Deposition

Table 39 shows the results of the dispersion modelling for dust deposition from the project at each of the identified receptors during the project.

Table 39 Predicted Annual Average Dust Deposition Rates

Receptor ID	Annual Average Dust Deposition Rate (g/m²/month)					
	Background		Scenario 1 (Construction)		Scenario 2 (Operations)	
	Regional	Power Stations	Increment	Cumulative	Increment	Cumulative
R1	2.0	<0.1	0.3	<2.4	<0.1	<2.1
R2	2.0	<0.1	0.4	<2.5	0.1	<2.2
R3	2.0	<0.1	0.4	<2.5	0.1	<2.2
R4	2.0	<0.1	0.4	<2.5	0.1	<2.2
Criterion			**2**	**4**	**2**	**4**

The results indicate that incremental and cumulative annual average dust deposition rates at all nominated residences/properties surrounding the PAA are predicted to be well below the criterion of 2 g/m^2/month (incremental increase in dust deposition) and below 4 g/m^2/month (cumulative dust deposition) during both scenarios. As the prediction well below the criterion, contour plots of incremental increase in dust deposition are not presented.

8.5 Nitrogen Dioxide

Table 40 presents the 1-hour average and annual average NO_2 concentrations predicted by the dispersion modelling at each of the nominated residences/properties.

The background concentration for 1-hour average and annual average NO_2 was assumed to be 65.8 µg/m^3 and 12.1 µg/m^3 respectively (see **Section 7.2.4**). Contour plots of the predicted NO_2 concentrations are presented in **Appendix A**.

Table 40 Maximum 1-hour Average and Annual Average NO_2 Concentrations

Receptor ID	Scenario 2 (Operations)			
	Maximum 1-hour Average		Annual Average	
	Maximum Increment (µg/m³)	Maximum Cumulative (µg/m³)	Maximum Increment (µg/m³)	Maximum Cumulative (µg/m³)
R1	11.2	77.0	0.10	12.2
R2	11.3	77.1	0.10	12.2
R3	10.6	76.4	0.10	12.2
R4	10.5	76.3	0.08	12.2
Criterion		**246**		**62**

It is noted that the maximum predicted 1-hour average and annual average NO_2 concentrations are well below the project criterion of 246 µg/m^3 and 62 µg/m^3 respectively at all the sensitive receptors during Scenario 2 (operations).

8.6 Carbon Monoxide

Table 41 presents the maximum 15-minute average, 1-hour average and 8-hour average CO concentrations predicted by the dispersion modelling at each of the nominated residences/properties.

Table 41 Maximum 15-minute Average, 1-hour Average and 8-hour Average CO Concentrations

Receptor ID	Scenario 2 (Operations)					
	Maximum 15-minute Average		Maximum 1-hour Average		Maximum 8-hour Average	
	Maximum Increment (µg/m³)	Maximum Cumulative (mg/m³)	Maximum Increment (µg/m³)	Maximum Cumulative (mg/m³)	Maximum Increment (µg/m³)	Maximum Cumulative (mg/m³)
R1	97.8	1.9	74.1	1.5	14.1	1.2
R2	89.2	1.9	67.6	1.5	27.0	1.2

Receptor ID	Scenario 2 (Operations)					
	Maximum 15-minute Average		Maximum 1-hour Average		Maximum 8-hour Average	
	Maximum Increment	Maximum Cumulative	Maximum Increment	Maximum Cumulative	Maximum Increment	Maximum Cumulative
	(µg/m³)	(mg/m³)	(µg/m³)	(mg/m³)	(µg/m³)	(mg/m³)
R3	84.2	1.9	63.8	1.5	22.7	1.2
R4	90.2	1.9	68.3	1.5	17.5	1.2
Criterion		**100**		**30**		**10**

The maximum 15-minute average, 1-hour average and 8-hour average background CO concentrations were adopted for cumulative assessment (see **Section 7.2.5**), therefore these results should be viewed as very conservative.

The predicted maximum 15-minute average, 1-hour average and 8-hour average cumulative impacts are well below the respective project criteria.

8.7 Odour

Table 42 presents the 99th percentile 1-hour average odour concentrations predicted by the dispersion modelling at each of the nominated residences/properties. The background odour concentration is assumed to be zero.

As discussed in **Section 2.2.2**, the only odour source from the project operations is the mine ventilation fans to be located at the Awaba Colliery Surface Site. Contour plots of the predicted odour concentrations are presented in **Appendix A**.

Table 42 99th percentile 1-hour Average Odour Concentrations

Receptor ID	Increment (ou)
R1	<2
R2	<2
R3	<2
R4	<2
Criterion	**4**

It is noted that the 99th percentile 1-hour average odour concentration is predicted to be below the Project criterion of 4 ou at all the identified sensitive receptors.

9 Compliance with POEO Requirements

As outlined in **Section 8**, the Protection of the Environment Operations (Clean Air) Regulation 2010 imposes a range of conditions for the operation of a range of processes and/or plant that have the potential to cause impacts through discharges to atmosphere.

Table 43 includes the relevant POEO requirements and identifies the compliance status of the Project with each. Where compliance is reliant upon operational plans/strategies, this is noted.

Table 43 Assessment against the POEO (Clean Air) Regulation 2010

Description		Compliance
49. Operation of Group 6 Plant:	An occupier of premises on which any Group 6 treatment plant is operated must ensure that: (a) any flare operated for the treatment of air impurities is operated in such a way that a flame is present at all times while air impurities are required to be treated, and (b) either or both of the following requirements relating to the operation of any such plant are complied with: (i) the requirements in clauses 50 and 51, (ii) the requirements in clause 52.	Flare to be designed and operated to ensure compliance
50. Residence time	(1) An afterburner, other than one that employs a catalytic control system, must be operated in such a way that the time between an air impurity entering and exiting the afterburner is: (a) more than 2 seconds if the air impurity originates from material containing any principal toxic air pollutant, or (b) more than 0.3 seconds in any other case. (2) An enclosed ground-level flare for the treatment of landfill gas must be operated in such a way that the time between landfill gas entering and exiting the flare is more than 0.6 seconds. (3) For the purposes of this clause, the time elapsing between an air impurity (including landfill gas) entering and exiting an afterburner or flare is to be calculated: (a) using the volumetric flow rate for the air impurity, as determined in accordance with TM-2 or CEM-6, and (b) using a 1 hour rolling averaging period.	Flare to be designed and operated to ensure compliance
51. Combustion temperature	(1) An afterburner, other than one that employs a catalytic control system, must be operated in such a way that the temperature for the combustion of an air impurity by the afterburner is: (a) more than 980°C if the air impurity originates from material containing any principal toxic air pollutant, or (b) more than 760°C in any other case. (2) An enclosed ground-level flare for the treatment of landfill gas must be operated in such a way that the temperature for the combustion of landfill gas by the flare is more than 760°C. (3) A reference in this clause to the temperature for the combustion of an air impurity (including landfill gas) is a reference to that temperature as determined in accordance with TM-2, using a 1 hour rolling averaging period.	Compliant

<table>
<tr><th>Description</th><th></th><th>Compliance</th></tr>
<tr><td>52. Destruction efficiency</td><td>(1) Group 6 treatment plant (other than flares) must be operated in such a way that the destruction efficiency of the plant, in relation to an air impurity entering the plant, is:
(a) if the air impurity originates from material containing any principal toxic air pollutant—more than 99.9999%, or
(b) in any other case—more than 99.99%.
(2) An enclosed ground-level flare for the treatment of landfill gas must be operated in such a way that the destruction efficiency of the flare, in relation to landfill gas entering the flare, is more than 98%.
(3) A reference in this clause to the destruction efficiency of Group 6 treatment plant in relation to an air impurity (including landfill gas) is a reference to the destruction efficiency of the plant, in relation to the air impurity, calculated by using the following equation:
$$DE = [1 - (MW_{out} / MW_{in})] \times 100$$
where:
DE is the destruction efficiency, expressed as a percentage.
MW_{out} is the mass emission rate of the air impurity in exhaust emissions prior to its release to the atmosphere using a 1 hour rolling averaging period.
MW_{in} is the mass feed rate of the air impurity in a waste feedstream using a 1 hour rolling averaging period.</td><td>Flare to be designed and operated to ensure compliance</td></tr>
<tr><td>Schedule 2: Standards of concentration for scheduled premises</td><td>Flares
<u>Air impurity</u> | <u>Plant</u> | <u>Standard of concentration</u>
Volatile organic compounds (VOCs), as n-propane equivalent | Any enclosed ground-level flare treating landfill gas | Group 6 | 40 mg/m³ VOCs
Smoke | Any flare | Group 6 | No visible emission other than for a total period of no more than 5 minutes in any 2 hours</td><td>Flare to be designed and operated to ensure compliance (VOC not modelled)

Flare to be designed and operated to ensure compliance (“smoke” not modelled)</td></tr>
</table>

10 Dust Management and Mitigation

10.1 Construction

The following procedures and requirements should be incorporated into the Construction Environmental Management Plan to be prepared for the project construction to minimise the impact of dust generated:

- Watering of materials and roads and sealing of roads where practicable;
- Establishing wind breaks composed of earth banks and other screens to minimise wind-borne dust;
- Trucks entering and leaving the sites should be well maintained in accordance with the manufacturer's specifications to comply with all relevant regulations.
- Truck movement should be controlled on site and restricted to the existing designated roadways.
- All loaded trucks should be covered to minimise transport of dust offsite; and,
- If necessary, modifying construction activities during periods of high wind.
- Working areas, disturbance areas and access roads should be watered down as soon as practicable to prevent or minimise windblown dust.
- All unsealed trafficable areas be kept sufficiently damp during working hours to minimise windblown or traffic generated dust emissions.
- Water sprays, sprinklers and water carts may be employed if needed to adequately dampen stockpiles, work areas and exposed soils to prevent the emissions of dust from the site.
- Stockpiles and handling areas should be maintained in a condition which minimises windblown or traffic generated dust.
- Materials and other combustible wastes should not be burnt on site.
- Silt should be removed from behind filter fences and other erosion control structures on a regular basis, so that collected silt does not become a source of dust.
- Any dust, soil or mud deposited on public roads by sub contractor's construction activities and vehicle movements should be removed as soon as practicable.

10.2 Operation

The operational air quality management measures are in line with those listed in the *Air Quality and Greenhouse Gas Management Plan (AQGGMP) for Northern Region* (Centennial 2017). The AQGGMP will be updated to incorporate the operations at the Awaba Colliery Surface Site should the project be approved.

The mitigation measures relevant to the Project, and response to the NSW EPA's comments are presented in **Table 44**.

Table 44 Mitigation Measures and Response to EPA's Comments

EPA's Requirement	Response
Explicit linkage of proposed emission controls to the site specific best practice determination assessment	The site specific best practice determination assessment is not considered necessary for the Project. This is due to the main source of particulate emissions being proposed ventilation fans. Notwithstanding, the following mitigation measures are proposed to best manage the onsite activities. Unsealed roads Use of water carts to dampen trafficable areas. Truck speeds restricted to 40 km/hr. Mobile equipment Regular maintenance of plant and equipment in accordance with the manufacturer's specifications to ensure optimal operating conditions. Ventilation fans Use of low sulfur diesel and diesel engines that conform to the United States EPA Tier 3 standards for exhaust emissions. Implementation of an underground dust suppression system involving the use of water sprays on coal cutting machinery and rubber conveyor belts.
Timeframe for implementation of all identified emission controls	Post approval
Key performance indicators for emission controls	Key performance indicators are the Project criteria listed in **Section 4.**
Response mechanisms	The Trigger Action Response Plan (TARP) as defined in the AQGGMP for the Northern Region will be adopted for the Project. The TARP is reproduced in **Appendix B**.
Responsibilities for: demonstrating and reporting achievement of KPIs record keeping and complaints response register	**Mine Manager** - promoting compliance with the Environmental Policy and fulfilling relevant requirements of the EMS and this Management Plan **Employees & Contractors** - immediately reporting of environmental incidents and community complaints or enquiries to the Environment & Community Coordinator; **Environment and Community Coordinator** - registration of community complaints and regulatory liaison in the Environment & Community Database (ECD)

Further, the *Voluntary Land Acquisition and Mitigation Policy* (DPE 2018) states that in the case the development contributes to the exceedances of the criteria (see **Section 4.1**), the following mitigation measures may be included with the aim of reducing the potential human health and amenity impacts of the development at a residence or at a workplace:

- Air conditioning, including heating;
- Insulation;
- First flush water systems;
- Installation and regular replacement of water filters;
- Cleaning of rainwater tanks;
- Clothes dryers; and
- Regular cleaning of any residence and its related amenities, such as barbeque areas and swimming pools.

10.3 Air Quality Monitoring

Dust deposition monitoring and High Volume Air Sampling (PM_{10})is currently performed around the Awaba Colliery Surface Site, as discussed in **Section 7.1**. This monitoring is proposed to be continued during construction and operation of the Project.

The details of the monitoring program will be incorporated into the Northern Air Quality Management Plan (AQMP), following the Project approval.

11 Greenhouse Gas Assessment

11.1 Background

11.1.1 The Greenhouse Effect

The greenhouse effect is a process that aids in heating the Earth's surface and atmosphere. It results from the fact that certain atmospheric gases, such as carbon dioxide, water vapour, and methane, are able to change the energy balance of the planet by absorbing longwave radiation emitted from the Earth's surface.

The amount of heat energy added to the atmosphere by the greenhouse effect is controlled by the concentration of greenhouse gases (GHGs) in the Earth's atmosphere. Emissions of GHGs can result from natural or man-made (anthropogenic) sources. The separation of natural versus anthropogenic sources is complicated by the fact that natural processes may be manipulated by humans, resulting in increased emissions of GHGs.

Examples of natural sources include the decomposition or burning of plant material and emissions of methane from animal digestion processes. Emissions that occur as a result of human activities include the burning of fossil fuels, the use and leakage of refrigerants, and the use of fertilisers. The clearing of forest and other vegetation by humans also contributes to the greenhouse effect. Vegetation and soils typically act as a carbon sink, storing carbon dioxide that is absorbed through photosynthesis. When the land is disturbed, part of the stored carbon dioxide is emitted, through mechanisms such as burning or decomposition of vegetation etc., and re-enters the atmosphere.

11.1.2 Greenhouse Gases

A number of gases are involved in the human-caused enhancement of the greenhouse effect. These include:

- **Carbon dioxide** (CO_2): A minor but very important component of the atmosphere, CO_2 is released through natural processes such as respiration and volcanic eruptions and through human activities such as deforestation, land use changes, and burning fossil fuels.
- **Methane** (CH_4): A hydrocarbon gas produced both through natural sources and human activities, including the decomposition of wastes in landfills, agriculture (especially paddy rice cultivation), and ruminant digestion and manure management associated with domestic livestock. CH_4 is also released from coal during mining and storage due to exposure to the atmosphere. On a molecule-for-molecule basis, CH_4 is a far more active GHG than CO_2, but also one which is much less abundant in the atmosphere.
- **Nitrous oxide** (N_2O): A powerful GHG produced by soil cultivation practices, especially the use of commercial and organic fertilizers, fossil fuel combustion, nitric acid production, and biomass burning.
- **Hydrofluorocarbons** (HFCs): HFCs have been increasingly used in the last decade or so as an alternative to ozone damaging chlorofluorocarbons (CFCs) in refrigeration systems. Unfortunately, though they provide an effective alternative to CFCs, HFCs can also be powerful greenhouse gases with long atmospheric lifetimes. The three main HFCs are HFC-23, HFC-134a and HFC152a, with HFC-134a being the most widely used refrigerant.
- **Sulphur hexafluoride** (SF_6): A greenhouse gases with an atmospheric lifetime of more than 1,000 years. Electrical transmission and distribution equipment, which use SF_6 as an insulator, are the primary source of SF_6 emissions.

For comparative purposes, non-CO_2 GHGs are awarded a "CO_2-equivalence" (CO_2-e) based on their contribution to the enhancement of the greenhouse effect. The CO_2-e of a gas is calculated using an index called the Global Warming Potential (GWP) which represents the combined effect of the differing times GHGs remain in the atmosphere and their relative effectiveness in absorbing outgoing infrared radiation.

The GWPs of relevance to this assessment, as taken from the IPCC's Fourth (AR4) and Fifth (AR5) Assessment Reports are presented in **Table 45**. The AR5 values (IPCC 2013) are the most recent, but the AR4 values (IPCC 2007) are also listed because they are currently used in Australia for inventory and reporting purposes.

Table 45 Global Warming Potentials

Gas	Chemical Formula	IPCC GWP (100 year horizon)	
		Fourth Assessment Report [1]	Fifth Assessment Report [2]
Carbon dioxide	CO_2	1	1
Methane	CH_4	25	28
Nitrous oxide	N_2O	298	265
Hydrofluorocarbons[3]	CH_2FCF_3	1,430	1,300
Sulphur hexafluoride	SF_6	22,800	23,500

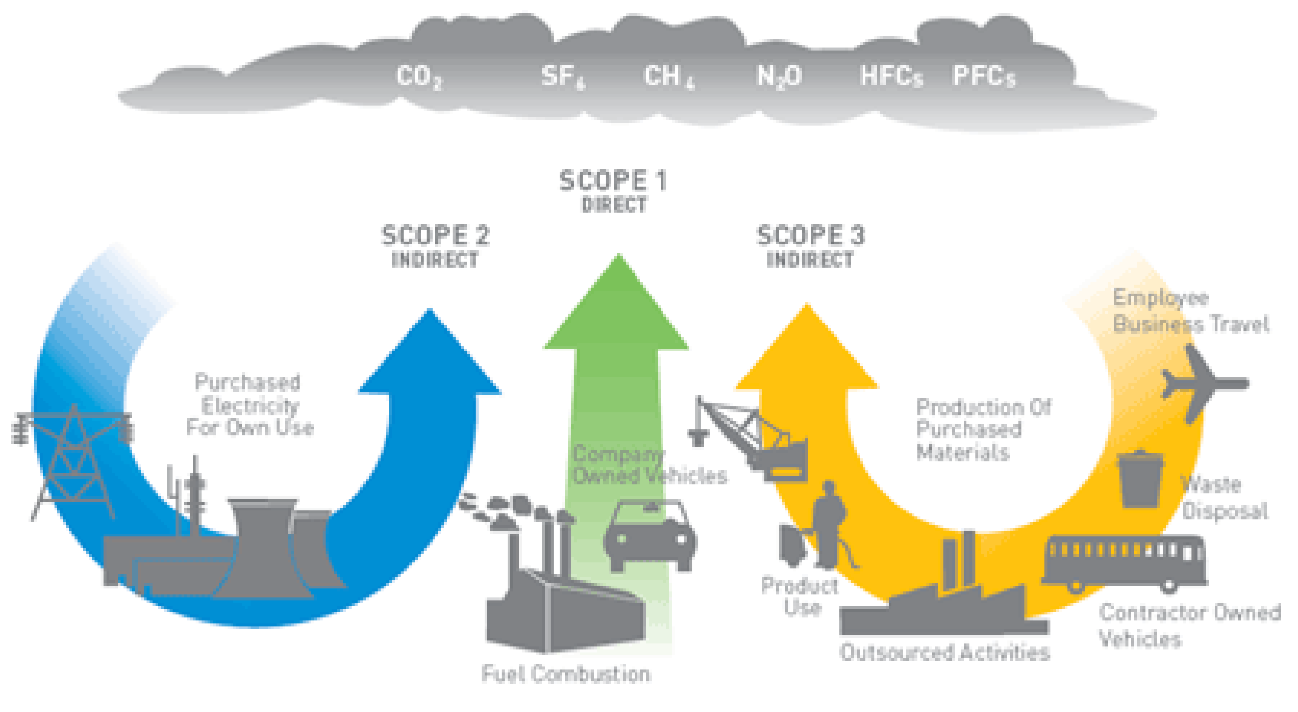
1 (IPCC 2007)
2 (IPCC 2013)
3 HFCs assumed to be HFC-134a

11.1.3 Scope Definition

Emissions of GHG can be termed as being *Scope 1, Scope 2* or *Scope 3*, and '*direct*' or '*indirect*' emissions (**Figure 22**). A discussion of what each Scope refers to, and how it relates to the project is presented below.

The definitions below have been taken from the WRI and WBCSD GHG Protocol (WRI 2004). These documents provide detailed information on the activities which should be included in each of the Scope 1, 2 and 3 boundaries. The definition of these boundaries allows the determination of those sources of GHG emissions which can be directly controlled by Centennial Newstan (Scope 1 and Scope 2), or those which Centennial Newstan would have some, but limited control over (Scope 3).

Figure 22 Scope 1, 2 and 3 GHG Emissions as Defined in the GHG Protocol Initiative



Source: WRI 2004

Direct Emissions (Scope 1)

Direct emissions of GHG are termed Scope 1 emissions and are produced from sources within the boundary of an organisation and as a result of the organisation's activities. These direct emissions mainly arise from the following sources:

- Transportation of materials, products, waste or people e.g. the combustion of diesel in mobile equipment, including on-road and off-road vehicles and stationary equipment;
- Generation of electricity, heat and/or steam, e.g. the combustion of diesel in generators;
- Fugitive emissions, both intentional and unintentional, e.g. through the use of switchgear, methane from exposed coal, land clearing etc; and
- On-site waste management, e.g. solid and liquid waste management through landfill, sewage treatment, incineration etc.

Indirect Emissions (Scope 2)

Indirect emissions are generated in the wider economy as a consequence of an organisation's activities but are physically produced by the activities of another organisation.

The most important category of indirect emissions is from the consumption of purchased electricity (Scope 2 emissions). Scope 2 emissions relate to the GHG emissions from the generation of purchased electricity consumed in Project-owned or controlled equipment or operations. In Australia, this is primarily from coal fired power generation.

Indirect Emissions (Scope 3)

Scope 3 indirect emissions are related to the upstream emissions generated in the extraction and production of fossil fuels and in the emissions from contracted/outsourced activities.

Scope 3 emissions are generally Scope 1 or 2 emissions for other companies. For example, in general, diesel use by contractors is a Scope 3 emission, yet is referred to as a Scope 1 emission in the GHG inventory of the contractor. Combustion of coal to produce electricity will result in a Scope 1 emission at the power station or a Scope 2 emission for industry or householders.

Scope 3 emissions may be, but are not required to be, reported as part of a project's GHG emissions assessment.

11.2 Relevant Legislation, Guidelines and Policies

11.2.1 The International Response to Climate Change

Intergovernmental Panel on Climate Change

The Intergovernmental Panel on Climate Change (IPCC) is the international body tasked with assessing scientific knowledge on climate change. It was established by the World Meteorological Organization (WMO) and the United Nations Environment Programme (UNEP) in 1988, and endorsed by the UN General Assembly, to provide policy makers with regular scientific assessments of climate change, its impacts and future risks, and the mitigation and adaptation options.

The first meeting of the IPCC was held in Geneva in 1988. Since it was established, the IPCC has prepared five assessment reports, which have provided key inputs into the international negotiations to tackle climate change. The Fifth Assessment Report was released by IPCC in March 2014, which considers new evidence of climate change based on independent analyses from observations of the climate system and includes refined estimates of impact probability.

Kyoto Protocol

The Kyoto Protocol is an international agreement linked to the United Nations Framework Convention on Climate Change (UNFCCC). The major feature of the Kyoto Protocol is that it sets binding targets for 37 industrialised countries and the European community for reducing GHG emissions. These targets amount to an average of five per cent reduction against 1990 levels over the five-year period 2008-2012.

Countries must meet their targets primarily through national measures to avoid, abate or offset GHG emissions. However, the Kyoto Protocol offers additional means of meeting targets through the following market-based mechanisms:

- Emissions trading: Gives corporations or individuals the opportunity to offset their GHG emission liability by purchasing Kyoto certified carbon credits generated by carbon emission reduction projects.
- Clean Development Mechanism (CDM): Where industrialised (or "Annex One" as defined in the Protocol) nations can implement Kyoto-approved GHG reduction projects in developing nations (or "Non-Annex One" as defined in the Protocol) in order to generate Carbon Emission Reductions (CERs).
- Joint Implementation (JI): Allows developed (Annex One) nations to engage in emission reduction projects with other developed (Annex One) nations to generate CERs.

These mechanisms help stimulate investment in GHG-friendly actions and technologies and to meet emission targets in a cost-effective manner. Comprehensive mechanisms have been set up under the UNFCCC that aim to ensure the validity and credibility of emissions avoidance, abatement and offset projects under the CDM and JI.

Paris Agreement

The Paris Agreement, from the 21st Conference of the Parties (COP21) in Paris in December 2015, sets in place a framework for all countries to take climate action from 2020, building on the existing international efforts in the period up to 2020. Key outcomes included:

- A global goal to hold the average temperature increase to well below 2°C and pursue efforts to keep warming below 1.5°C above pre-industrial levels.
- All countries to set mitigation targets from 2020 and review targets every five years to build ambition over time.
- Robust transparency and accountability rules to provide confidence in countries' actions and track progress towards targets.
- Promoting action to adapt and build resilience to climate impacts.
- Financial, technological and capacity building support to help developing countries implement the Agreement.

The Greenhouse Gas Protocol Initiative

Greenhouse gas accounting and reporting principles are intended to underpin all aspects of GHG accounting and reporting. The five principles outlined below are consistent with the World Resources Institute/World Business Council for Sustainable Development (WRI/WBCSD) GHG Protocol Initiative (a globally adopted and leading GHG accounting strategy), and ISO 14064-1, 2, and 3 (GHG) guidelines (internationally accepted best practice). These principles are based on financial accounting and reporting standards and are taken from the GHG Protocol documentation (WRI, 2004).

The following outlines the basic requirements of any GHG assessment, as defined by WRI/WBCSD.

- **Relevance:** The relevance of a company's GHG report relates to the information which it contains. The information should allow stakeholders, both internal and external to the organisation, to make informed decisions about GHG management. An important aspect of relevance is the selection of appropriate boundary conditions which reflect the reality of the company's operations. The operation of the company, the purpose of the information and the needs of users will all inform the choice of the inventory boundary.
- **Completeness:** All relevant emission sources within the chosen inventory boundary need to be accounted for so that a comprehensive and meaningful inventory is compiled. WRI (2004) states that no materiality threshold (or minimum emissions accounting threshold) should be defined as this is not in line with the principle of completeness. However, if emissions are not able to be estimated or estimated at a sufficient level of quality, then these should be transparently documented and justified.
- **Consistency:** Consistency in an emissions inventory allows stakeholders to compare GHG emissions performance from year to year. This consistency also allows trends to be identified and performance against objectives and targets to be tracked. Any changes in the inventory (accounting approaches, boundaries, calculation methods) need to be transparently documented and justified.

- **Transparency:** All processes, procedures, assumptions and limitations of an inventory should be presented clearly and accurately. Information needs to be recorded, compiled and analysed in a way that enables internal reviewers and external auditors to verify the credibility of the inventory. Specific exclusions and inclusions are to be documented and justified, assumptions disclosed and appropriate references provided for the calculation methods applied and the data sources used. Transparency is essential in the production of a credible GHG inventory.
- **Accuracy:** Accuracy describes how close the estimates of GHG emissions are to the 'true' value. The accuracy of a GHG inventory should be sufficient for stakeholders to make decisions with reasonable assurance of the integrity of the reported information. Quality management measures should be implemented to maximise inventory accuracy.

Additional to the principles of GHG reporting, data materiality can be used to simplify the accounting process by omitting low level emission sources that do not make a significant contribution to overall Project emissions. Emissions that are within emission reporting errors or make up less than 5% or of the total Project emissions are deemed to be immaterial, as their inclusion or omission does not have significant bearing on Project behaviours or processes (DoE 2008).

11.2.2 Australian GHG Policy and Regulation

Australia ratified the Kyoto Protocol (the Protocol) in 2007 and as such made a commitment to reducing GHG emissions. In response to this ratification Australia adopted a number of Federal and State Government initiatives to achieve a reduction in GHG emissions to 5% below 2000 levels.

Ahead of COP21, countries were invited to submit indicative post-2020 targets, known as Intended Nationally Determined Contributions (INDCs). Australia's target is to reduce emissions by 26-28% below 2005 levels by 2030, which builds on the 2020 target of reducing emissions by 5% below 2000 levels.

Australia's targets are proposed to be achieved through a suite of policies to reduce emissions, encourage technological innovation and expand the clean energy sector.

National Greenhouse and Energy Reporting (NGER)

The National Greenhouse and Energy Reporting (NGER) Act 2007 provides a single national framework for the reporting and dissemination of information about the GHG emissions, GHG projects, and energy use and production of corporations. It makes registration and reporting mandatory for corporations whose energy production, energy use or greenhouse gas emissions meet specified thresholds. Centennial reports emissions from the corporation on an annual basis, including those from Centennial Newstan, in accordance with the NGER Act.

National Greenhouse Accounts (NGA) Factors

The National Greenhouse Accounts (NGA) Factors document is prepared by the Department of the Environment and Energy (DEE) and is designed for use by companies and individuals to estimate greenhouse gas emissions. The NGA default emission factors listed in this document have been estimated by the DEE using the Australian Greenhouse Emissions Information System (AGEIS) and are determined simultaneously with the production of Australia's National Greenhouse Accounts. This promotes consistency between inventories at company or facility level and the emission estimates presented in the National Greenhouse Accounts. The methods used at the national level, and reflected in the NGA Factors document, are consistent with international guidelines and are subject to international expert review each year.

11.2.3 Lake Macquarie City Council

The *Greenhouse Gas Emissions Reduction Targets - Council Policy* (LMCC 2016) sets a greenhouse gas emission reduction target of a 3% per annum reduction in greenhouse gases from the city's emissions (measured on a per capita basis).

11.3 Estimated GHG Emissions and Assessment

A quantitative GHG assessment has been performed to assess the potential impact of the project on GHG emissions from Centennial Newstan. In accordance with standard practice, this assessment has been guided with reference to the requirements of the GHG Protocol and IPCC and Australian Government emission calculation methodologies.

The calculation of GHG emissions from the project has been performed in a five stage process:

- Definition of the Project boundary (**Section 11.4**)
- Identification of emission sources within the Project boundary (**Section 11.5**)
- Identification of activity data for each emission source (**Section 11.6**)
- Identification of emission calculation methodologies for each source (**Section 11.7**)
- Calculation of GHG emissions (**Section 11.8**)

11.4 Definition of the Project Boundary

The geographical and operational boundary set for the GHG assessment includes the Newstan Colliery underground workings and delivery of the coal to the Newstan Colliery Surface Site. Fugitive emissions of CO_2 and CH_4 from the Newstan Colliery ventilation system are included, however additional fugitive CH_4 emissions that arise during post-mining activities, such as transportation and stockpiling of the coal, due to the release of residual gases not released during the mining process, are not included. These residual emissions form part of the GHG inventory for the Northern Coal Logistics Project.

Scope 3 GHG emissions associated with production of fuels used on site have also been estimated, along with emissions associated with international shipping of the coal.

Boundaries of a GHG assessment can be chosen to include/exclude sources as long as the process of definition is transparent and the inventory for the selected boundary is as complete as possible (refer **Section 11.2.1**).

11.5 Identification of Emission Sources

The proposed changes to the Newstan Colliery operations associated with the project that will contribute to GHG emissions from the site have been identified as follows:

- Scope 1:
  - Diesel use in equipment used to mine 25.9 Mt of ROM coal over approximately 15 years (assuming the project will commence on 1 January 2021 and run until expiry on 31 December 2036)
  - CO_2 emissions from the gas drainage system after flaring to convert fugitive CH_4 to CO_2
  - Consumption of oils during the 15 year period
- Scope 2:

  - Electricity consumption associated with the underground mine during the 15 year period
- Scope 3:
  - Emissions associated with the production and transport of diesel and oil consumed at the site during the 15 year period (upstream)
  - Rail transport of product coal (downstream)
  - Shipping of product coal overseas (downstream)
  - End use (combustion) of the product coal produced (downstream)

The following activities/sources also have the potential to generate minor emissions of GHGs, however based on SLR's experience in preparing GHG emission inventories for similar projects, it can be assumed that they would contribute less than 5% of the total project emissions and can be deemed to be immaterial:

- Scope 1:
  - Treatment and disposal of sewage and solid waste generated on site during the 15 year period
- Scope 3:
  - Fuel consumption associated with transporting workers and raw materials to site during the 15 year period
  - Transmission losses associated with the electricity consumed at the site

11.6 Activity Data

Projected activity data for the proposed the project operations have been estimated based on data provided by Centennial Newstan for historical operations at Newstan Colliery for the months of November 2008 and April 2009. The average ROM coal throughput for November 2008 and April 2009 was 167,536 tonnes. This is similar to 1 month's extraction (ie 144,000 tonnes) assuming 25.9 Mt total extraction divided by 15 years. The other activity data provided for these two months (diesel consumption, oil consumption and ventilation shaft emissions) were therefore averaged to provide activity data estimates for the project. The data provided are summarised in **Table 46**.

The projected electricity consumption shown in **Table 46** was estimated by Centennial Newstan based on an expected power demand of 2.254 kW for the plant and equipment required for the proposed operations (including consideration of anticipated load factors for each piece of equipment).

The activity data for scope 3 emissions associated with rail transport and shipping of product coal are expressed in tonnes-kilometre (t-km) which is the product of the quantity of coal multiplied by the distance transported. For this assessment, the assumptions regarding the movement of coal are identical to those adopted in the NCL GHG assessment (BDM 2014), specifically:

- 96% of the coal is transported 40 km by rail to the Port of Newcastle;
- 4% of the coal is transported 240 km to Kembla Port; and
- All coal is transported overseas using sea freight travelling a total distance of 16,000 km (return trip). This is a conservative assumption given coal will also be used domestically resulting in reduced transport emissions.

Table 46 Newstan Colliery Activity Data – Newstan Mine Extension Project

Parameter	Newstan Colliery Historical Data			Estimate for the Project	
	November 2008	April 2009	Average/ Month	Total (15 years)	Per Annum
ROM throughput (tonnes)	193,746	141,325	167,536	25,900,000	1,730,000
Diesel consumption (kL)	44.05	14.00	29.03	4,487	299
Oil consumption (kL)	0.0	0.0	0.0	0.0	0.0
CO_2 emissions vented (1,000 m^3)	342.3	305.6	324.0	-	-
CH_4 emissions vented (1,000 m^3)	1,654.3	1,473.5	1,563.9	-	-
CO_2 emissions flared (1,000 m^3)	-	-	-	50,082	3,339
CH_4 emissions flared (1,000 m^3)	-	-	-	241,770	16,118
Electricity consumption (MWh)	-	-	-	254,350	16,957
Product coal transported to Port of Newcastle (t)	-	-	-	24,900,000	3,850,000
Product coal transported to Kembla Port (t)	-	-	-	1,000,000	150,000
Product coal shipped (t)	-	-	-	25,900,000	4,000,000

It is also noted that to calculate the maximum annual GHG emissions, the annual freight rate is assumed to be a maximum of 4 Mtpa. In reality, the annual freight rate is likely to be much less than the maximum 4 Mtpa.

11.7 Emission Factors

The emission factors used in the calculations for the estimates of Scope 1, 2 and 3 GHG emissions are presented in **Table 47**. Except for the product transport activities, these factors were sourced from the most recent NGA Factors workbook (DEE 2018).

To convert the volumetric flows of CO_2 from the ventilation shaft (in m^3) shown in **Table 46** to mass emissions (tonnes) of CO_2-e, the following conversion factor was used (DoE 2018).

- $CO_2 = 1.861 \times 10^{-3}$ tonnes CO_2-e/m^3

The emission factors for transport of the product coal by rail and ship were sourced from the GHG assessment completed for the Port Waratah Coal Services Terminal 4 Project (Environ 2012).

Table 47 GHG Emission Factors

Source/Activity	Energy Content Factor	Emission Factor			
		CO_2	CH_4	N_2O	Units
Scope 1					
Diesel combustion - Stationary energy [1]	38.6 GJ/kL	69.9	0.1	0.2	kg CO_2-e/GJ
Petroleum based oils	38.8 GJ/kL	13.9	0.0	0.0	kg CO_2-e/GJ
Flaring	37.7 GJ/kL	51.4	0.2	0.03	kg CO_2-e/GJ
Scope 2					
Electricity consumption	-	0.83			kg CO_2-e/kWh
Scope 3					
Diesel	38.6 GJ/kL	3.6			kg CO_2-e/GJ
Petroleum based oils	38.8 GJ/kL	3.6			kg CO_2-e/GJ
Coal transport by rail	-	0.020			kg CO_2-e/t-km
Coal transport by sea freight	-	0.0035			kg CO_2-e/t-km
Coal combustion by end user	27.0 GJ/t	90.23			kg CO_2-e/GJ

1 Section 2.2 of the NGA Factors workbook states "*No transport factors are provided for vehicles not registered for road use. Stationary energy factors for individual fuel types should be used in these cases.*"

11.8 Estimated Emissions

The estimated GHG emissions for the project are shown in **Table 48** and compared to the annual emission rates estimated for first workings in the MOD8 GHG assessment (SLR, 2018).

Based on information presented in **Table 48**, the annual Scope 1 and Scope 2 GHG emissions from the project are estimated to be 0.03 tonnes of CO_2-e per tonne of ROM coal produced. The main contributor to the estimated emissions of the project is flaring of fugitive CH_4, which accounts for 60% of the total combined Scope 1 and Scope 2 emissions. Fugitive CO_2, electricity and diesel fuel consumption are estimated to account for 11.9%, 26.6% and 1.5% respectively.

As shown in **Table 48**, the annual Scope 1 and Scope 2 GHG emissions from the project operations are significantly less than the annual emissions estimated for MOD 8. This is due to the proposed introduction of flaring of the fugitive CH_4 emissions, rather than venting it direct to atmosphere. As shown in **Table 45**, the GWP for methane is 25 times higher than CO_2, thus flaring these emissions prior to release results in a significant reduction in CO_2-e emissions.

The most significant measure proposed for the abatement of emissions from the project is the capture of Newstan ventilation air and redirection to a centralised gas drainage abatement and utilisation plant, including two new flares to be installed at the Awaba Colliery Surface Site. The gas flares will be installed and operational prior to the commencement of secondary extraction. Flaring CH_4 emissions from the ventilation system of Newstan Colliery through the Awaba Colliery Surface Site flaring system will result in considerable reductions in the project's total GHG emissions, saving an estimated 89% of total Scope 1 and Scope 2 emissions, or 3.7 Mt CO_2-e across the life of the project.

Table 48 GHG Emission Inventory

Activity/Source	Estimated GHG Emissions (tonnes CO_2-e)	
	Newstan Mine Extension Project	
	Total (15 Years)	Maximum Per Annum
Scope 1		
Diesel and oil consumption	12,159	811
Fugitive	93,203	6,214
Flaring	470,593	31,373
(Venting)[1]	(4,193,614)[1]	(279,574)[1]
Sub-Total – Scope 1	***575,954***	***38,397***
Scope 2		
Electricity consumption	208,567	13,904
Sub-Total – Scope 2	**208,567**	**13,904**
Scope 3		
Diesel and oil production	624	42
Product coal transport (rail)	24,605	3,800
Product coal transport (sea freight)	1,450,400	224,000
Coal combustion	63,097,839	9,744,840
Sub-Total – Scope 3	**64,573,468**	**9,972,682**

[1] The venting emissions are shown for comparison purposes only and do not form part of the Scope 1 emissions as all gas is proposed to be flared at the Awaba Colliery Surface Site.

11.9 Comparison to National and State Emission Inventories

Australia's net GHG emissions totalled 610.6 Mt CO_2-e in 2017 (Australian Greenhouse Emission Information System [DEE 2018]). The energy sector accounted for over 65% of the total national emissions with energy generation through the combustion of fossil fuels accounting for 65% of the national energy sector emissions. Fugitive emissions accounted for approximately 10% of energy sector emissions.

The reported 2017 total NSW emissions of 160.7 Mt CO_2-e accounted for approximately 26% of national GHG emissions. The energy sector contributed 117.7 Mt CO_2-e which is approximately 73% of the state emission total. Fugitive emissions account for approximately 15% of NSW total energy sector emission total.

The contributions of the predicted annual Scope 1 and 2 emissions resulting from the proposed project operations are detailed in **Table 49**. As can be seen, the emissions are a relatively small proportion of both the Australian and NSW total emissions, accounting for less than 0.01% of total Australian GHG production. As such, the relatively small amount of GHG emissions generated by the project will have an undetectable effect on global climate change.

Table 49 Project Emission Contribution to State and National Annual Emission Totals

	Newstan Mine Extension Project Scope 1 and 2	Total Emissions (2017)	
		Australia	NSW
Newstan Mine Extension Project Operations (Mt CO_2-e/annum)	0.052	610.6	160.7
Newstan Mine Extension Project as a percentage of National/State inventory	-	0.009%	0.03%

The estimated GHG emissions for the Extension Project may also be assessed in relation to Australia's national GHG emissions reduction target set out in the Paris Agreement, i.e. a 26-28% reduction on 2005 levels by 2030. This translates into a range of 435-447 Mt CO_2-e/annum (including land use, land-use change, and forestry - LULUCF) allowed emissions in 2030. Under both these emission scenarios, the Extension Project would represent approximately 0.012% of Australia's national emissions. On this basis, it is concluded that the Extension Project will have a minimal impact on Australia's ability to meet its emission reduction target.

11.10 Abatement and Avoidance of Emissions

Table 48 highlights the significant contribution that fugitive CH_4 and CO_2 emissions (72% of Scope 1 and Scope 2 emissions) make to Newstan Colliery's GHG profile for the proposed Extension Project activities.

The most significant change to the abatement of emissions proposed as part of Extension Project is the capture of Newstan ventilation air and redirection to a centralised gas drainage abatement and utilisation plant, including two new flares to be installed at the Awaba Colliery Surface Site. The gas flares will be installed and operational prior to the commencement of secondary extraction. Flaring CH_4 emissions from the ventilation system of Newstan Colliery through the Awaba Colliery Surface Site flaring system will result in considerable reductions in the Project's total GHG emissions, saving an estimated 82% of total emissions or 3,629,819 t CO_2-e across the life of the project.

In addition to the above, Centennial Newstan has received approval under Part 4 of the EP&A Act (DA/477/2018) to install of a 200 kW solar farm (the Solar Farm), within the confines of the existing parking facilities at the Awaba Colliery Surface Site. The Solar Farm (which does not form part of the project) will provide power to onsite compressors that supply compressed air to underground workings at Newstan Colliery, and hence reduce the demand for electricity from the grid, reducing its carbon footprint.

The Solar Project is expected to supply approximately 3% of the Awaba Colliery Surface Site electricity consumption, hence in the long term the Scope 2 emissions will be lower than those presented in this report. The plant will also supply the grid with any electricity generated but not required at the site. As the 3% reduction is an approximate estimate only, the reduction in Scope 2 emissions has not been included in this assessment. Once the Solar Farm is operational, the reduction in purchased electricity will be tracked and the relevant data will be available for use in future GHG emission inventory calculations for the site. The Solar Farm also helps in meeting the Lake Macquarie City Council's objective of reducing the GHG as a whole.

12 Conclusion

SLR Consulting was commissioned by Centennial Newstan to conduct an Air Quality Impact Assessment (AQIA) and Greenhouse Gas (GHG) Assessment for the Newstan Mine Extension Project.

The Extension Project proposes to extract up to 4 Mtpa of ROM coal and a total of 25.9 Mt over a fifteen year mine life from the West Borehole underground seam. The aim of this AQIA was to assess the incremental and cumulative impacts from the relevant construction and operational activities associated with the project.

The air quality goals adopted for particulate matter in this study conform to current EPA and Federal air quality criteria. Emission estimation and dispersion modelling was conducted to predict off-site air quality impacts associated with emissions from identified construction and operational activities (including TSP, PM_{10}, $PM_{2.5}$ dust deposition rates, NO_2, CO and odour). The modelling was performed using the CALPUFF model and site-representative, 3-dimensional meteorological data for the 2018 calendar year.

To enable an assessment of potential cumulative air quality impacts, regional background concentrations were derived based on monitoring data collected by the DPIE monitoring stations in Wallsend and Newcastle for the 2018 calendar year. In addition, a number of other existing industrial operations with the potential to have a cumulative impact on the local airshed were identified. These sources were therefore also included in the dispersion modelling exercise to ensure the background data was representative of local site conditions. Background dust deposition rates were estimated based on on-site monitoring data collected by Newstan Colliery Surface Site.

The dispersion modelling study predicted that the off-site short term and long term particulate concentrations and annual average dust deposition rates would be below the respective NSW EPA criteria, except for 24-hour average PM_{10} concentrations and annual average $PM_{2.5}$ concentrations. A detailed review of the maximum predicted off-site PM_{10} and $PM_{2.5}$ concentrations showed that:

- The predicted exceedances of the 24-hour average PM_{10} criterion occur on days of high backgrounds when the assessment criterion is already exceeded or very close to 50 µg/m^3, and the incremental impact of the Project on these days is relatively low. A sensitivity analysis was conducted to show that the modelling year selected for the contemporaneous analysis (ie 2018) has an unusually high number of exceedances, and that there would be no additional exceedances at any of the residential receptors, if any another year between 2014 to 2017 had been selected in lieu of 2018. Therefore, it is concluded that the proposed operation is highly unlikely to cause any additional exceedances of the 24-hour average PM_{10} criterion at the identified receptor locations.
- The cumulative annual average $PM_{2.5}$ concentrations at three of the four nominated residences/properties are predicted to be above the criterion of 8 µg/m^3, however these exceedances are predicted because the background annual average $PM_{2.5}$ concentration recorded at Wallsend in 2018 was very close to the criterion. The incremental impacts predicted due to the estimated emissions from the Project are very low and represent a negligible contribution to the total cumulative concentrations.

Based on the results of this assessment, it is concluded that incremental concentrations due to the activities proposed as part of the Project are unlikely to result in any additional exceedances of the air quality criteria at the nearest sensitive receptors.

A GHG assessment has also been prepared to estimate the Scope 1, 2 and 3 GHG emissions associated with the additional coal resource to be extracted by the project. These emissions have been compared to those estimated for the current approved activities at the mine, as well as State and national GHG emission inventories.

The geographical and operational boundary set for the GHG assessment includes the Newstan Colliery underground workings and delivery of the coal to the Newstan Colliery Surface Site. Fugitive emissions of CO_2 and CH_4 from the Newstan Colliery ventilation system are included, however additional fugitive CH_4 emissions that arise during post-mining activities, such as transportation and stockpiling of the coal, due to the release of residual gases not released during the mining process, are not included. These residual emissions would form part of the GHG inventory for the Northern Coal Logistics Project. Other sources of Scope 3 GHG emissions associated with the processing, rail transport, shipping and end use of the product coal are also included.

GHG emission estimates for the project were completed based on activity data provided by Centennial and published emissions factors. The main contributor to these emissions is fugitive CH_4 and CO_2 emissions, which account for 72% of the total combined Scope 1 and Scope 2 emissions. Flaring of the CH_4 emissions from the ventilation system through the proposed Awaba Colliery Surface Site flaring system will result in considerable GHG abatement, saving an estimated 82% of total emissions over the life of the project. Electricity and diesel fuel consumption are estimated to account for 27% and 1% respectively.

This assessment concluded:

- The total direct (Scope 1) emissions from the proposed Extension Project operations are estimated to be approximately 38,398 t CO_2-e/annum, while the estimated Scope 2 (electricity consumption) emissions are approximately 13,904 t CO_2-e/annum.
- Based on these estimates, the GHG intensity of the proposed Extension Project operations is estimated to be 0.03 t CO_2-e/t ROM coal produced (Scope 1 and Scope 2).
- The maximum annual indirect (Scope 3) emissions from mining coal, transport and end use of the product coal are estimated to be 9,972,682 t CO_2-e/annum, out of which approximately 98% are attributed to the end use of the product coal.
- Comparison of the estimated Scope 1 and 2 emissions with State and National GHG emission totals indicates that the GHG emissions from the project operations are a relatively small proportion of both the Australian and NSW total emissions, accounting for less than 0.01% of total Australian GHG production.

The relatively small amount of GHG emissions generated by the project will have an undetectable effect on global climate change.

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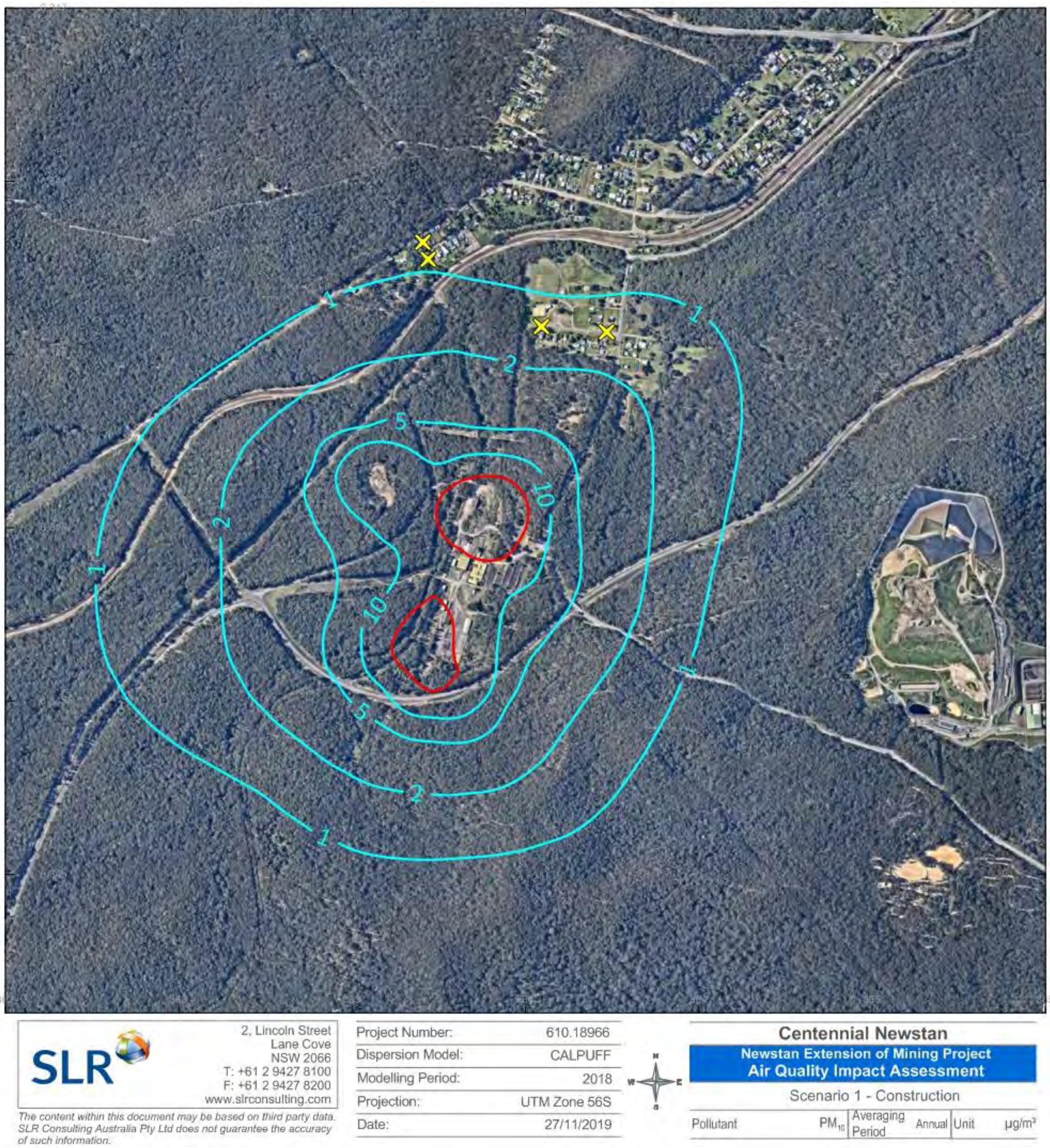
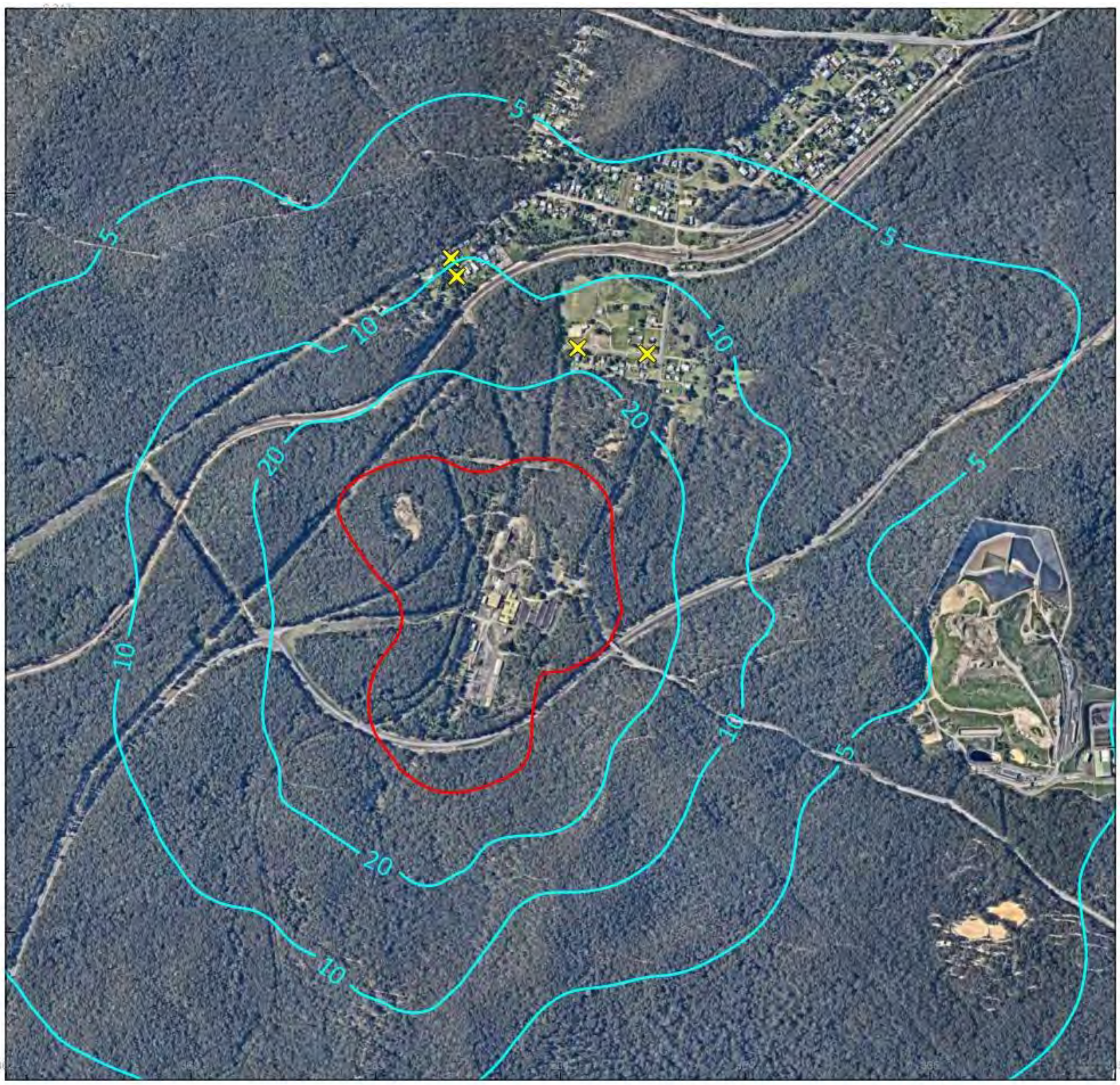
APPENDIX A

CONTOUR PLOTS - Construction





Project Number:	610.18966
Dispersion Model:	CALPUFF
Modelling Period:	2018
Projection:	UTM Zone 56S
Date:	27/11/2019

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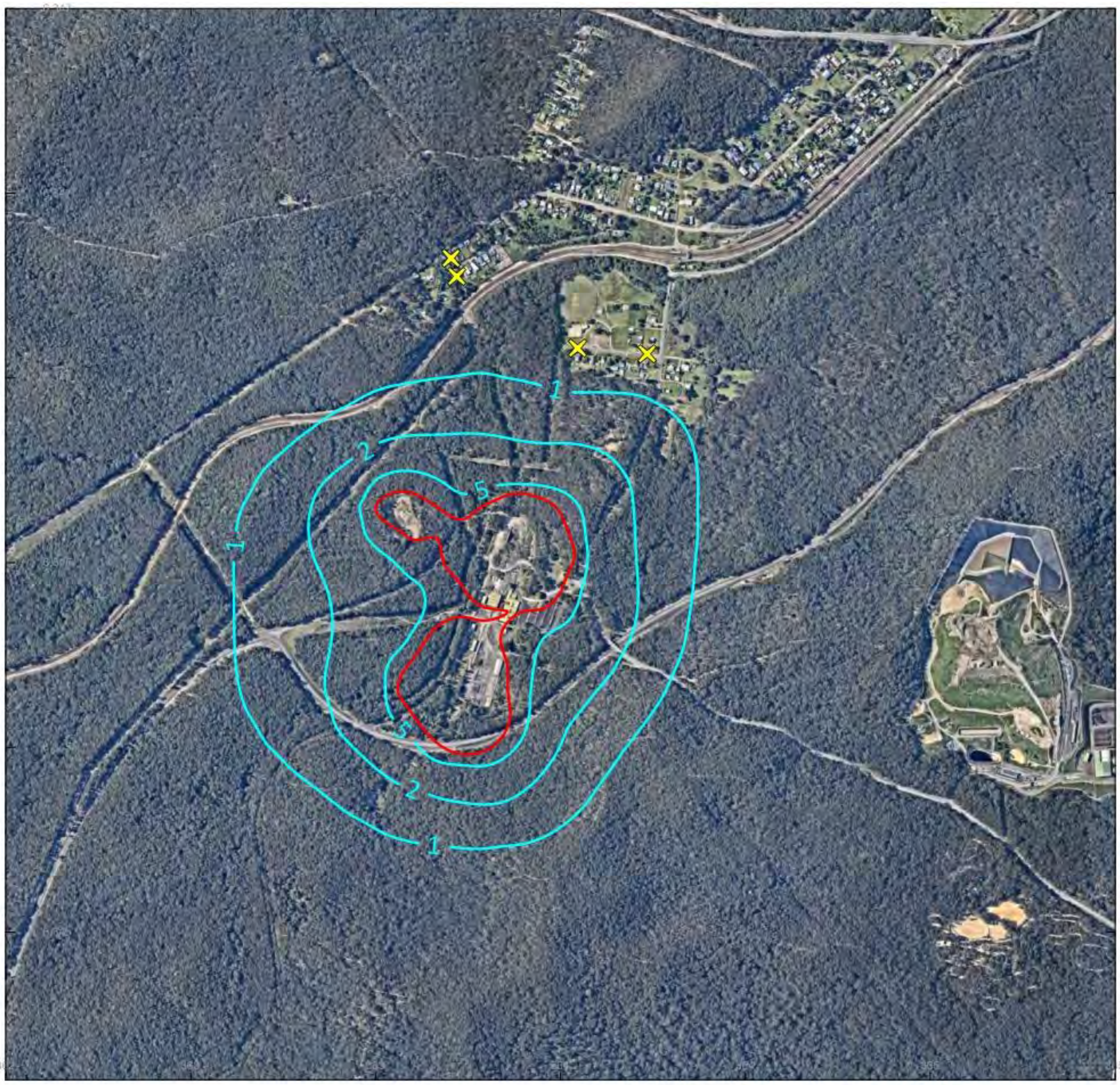
Centennial Newstan
Newstan Extension of Mining Project
Air Quality Impact Assessment
Scenario 1 - Construction

Pollutant	PM_{10}	Averaging Period	24-Hour	Unit	µg/m³



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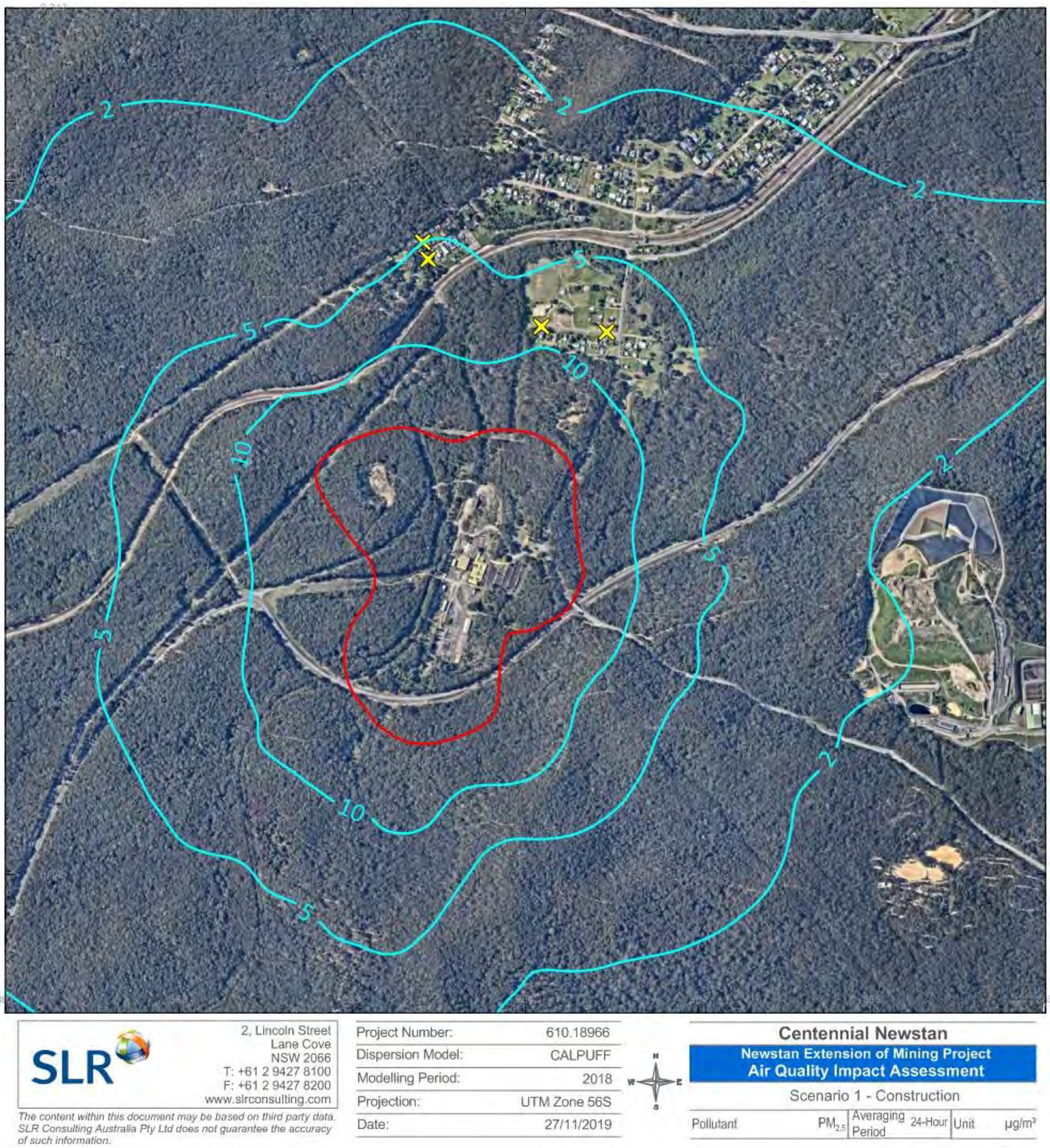
N / W / E / S

Centennial Newstan

Newstan Extension of Mining Project
Air Quality Impact Assessment

Scenario 1 - Construction

Pollutant	$PM_{2.5}$	Averaging Period	Annual	Unit	µg/m³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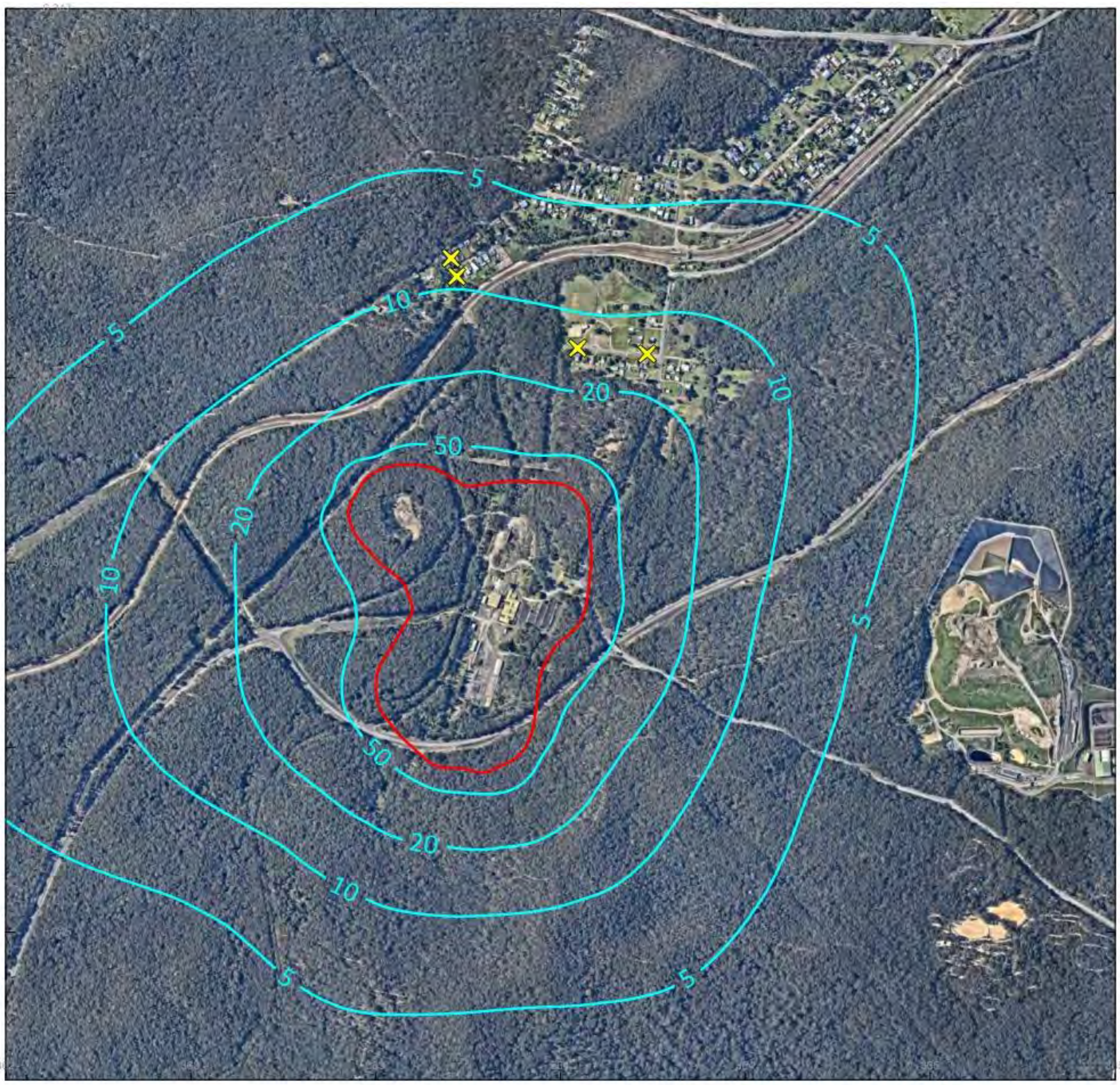
Centennial Newstan
Newstan Extension of Mining Project
Air Quality Impact Assessment
Scenario 1 - Construction
Pollutant $PM_{2.5}$
Averaging Period 24-Hour
Unit µg/m³



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Centennial Newstan

Newstan Extension of Mining Project
Air Quality Impact Assessment

Scenario 1 - Construction

Pollutant	TSP	Averaging Period	Annual	Unit	µg/m³

CONTOUR PLOTS - Operations

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www.slrconsulting.com

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Project Number:	610.18966
Dispersion Model:	CALPUFF
Modelling Period:	2018
Projection:	UTM Zone 56S
Date:	27/11/2019

Centennial Newstan
Newstan Extension of Mining Project
Air Quality Impact Assessment
Scenario 2 - Operations

Pollutant	PM_{10}	Averaging Period	Annual	Unit	µg/m³

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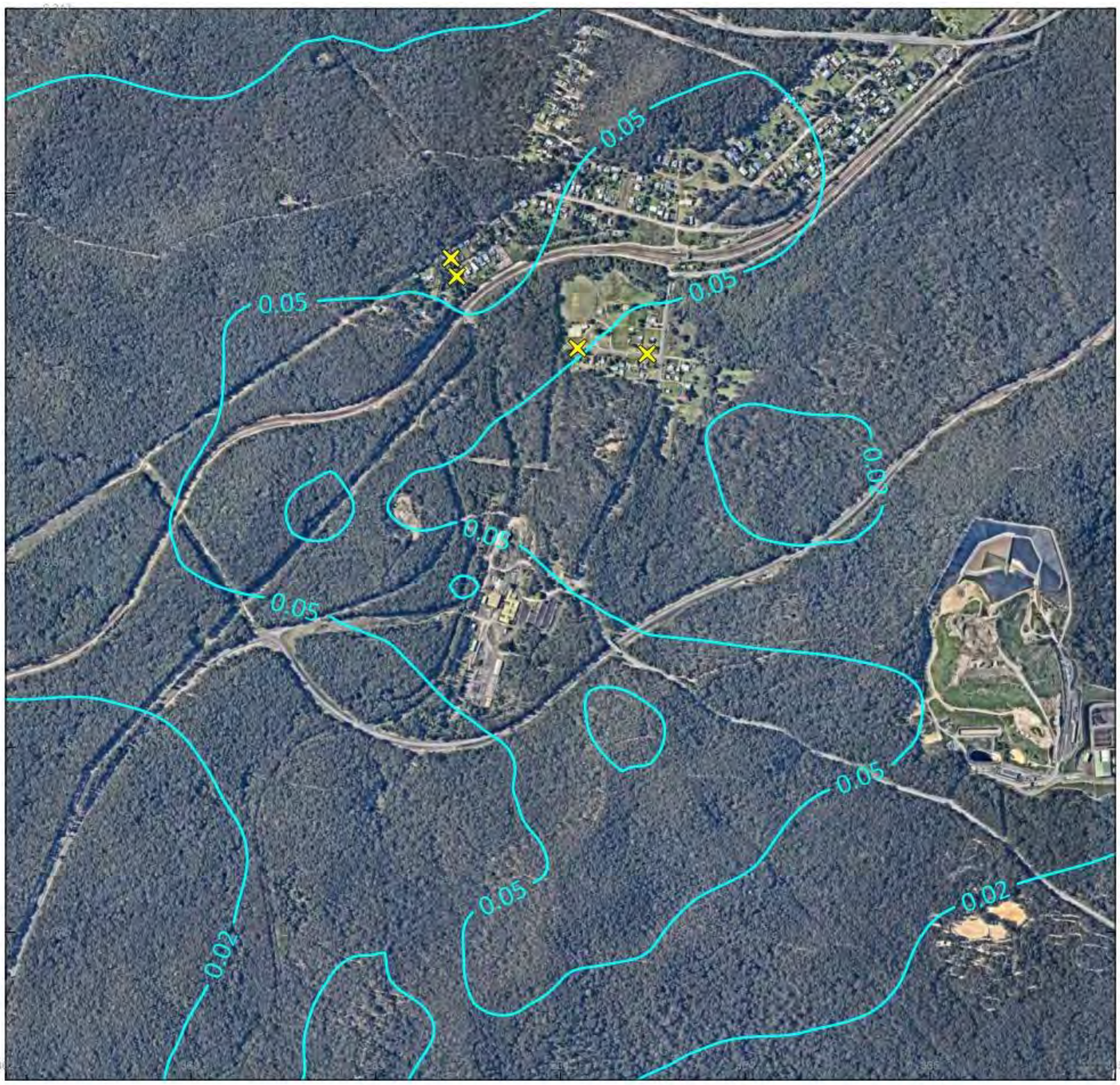
Centennial Newstan
Newstan Extension of Mining Project
Air Quality Impact Assessment
Scenario 2 - Operations

Pollutant	PM_{10}	Averaging Period	24-Hour	Unit	µg/m³



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Centennial Newstan

Newstan Extension of Mining Project
Air Quality Impact Assessment

Scenario 2 - Operations

Pollutant	$PM_{2.5}$	Averaging Period	Annual	Unit	$\mu g/m^3$

SLR — 2, Lincoln Street, Lane Cove NSW 2066, T: +61 2 9427 8100, F: +61 2 9427 8200, www.slrconsulting.com	Project Number:	610.18966	Centennial Newstan
	Dispersion Model:	CALPUFF	Newstan Extension of Mining Project Air Quality Impact Assessment
	Modelling Period:	2018	Scenario 2 - Operations
	Projection:	UTM Zone 56S	Pollutant: $PM_{2.5}$ — Averaging Period: 24-Hour — Unit: µg/m³
	Date:	27/11/2019	

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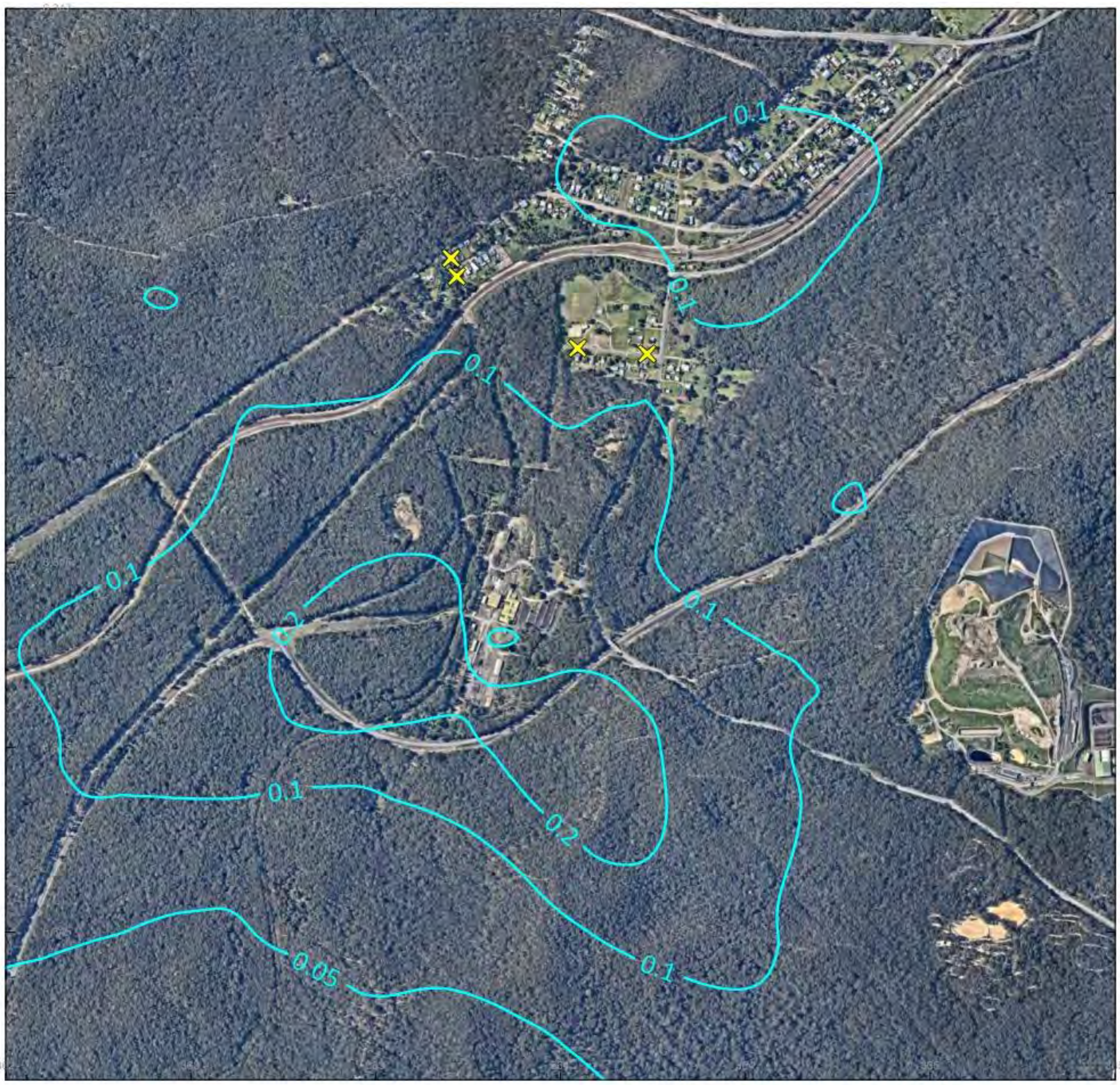

Project Number:	610.18966
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Date:	27/11/2019

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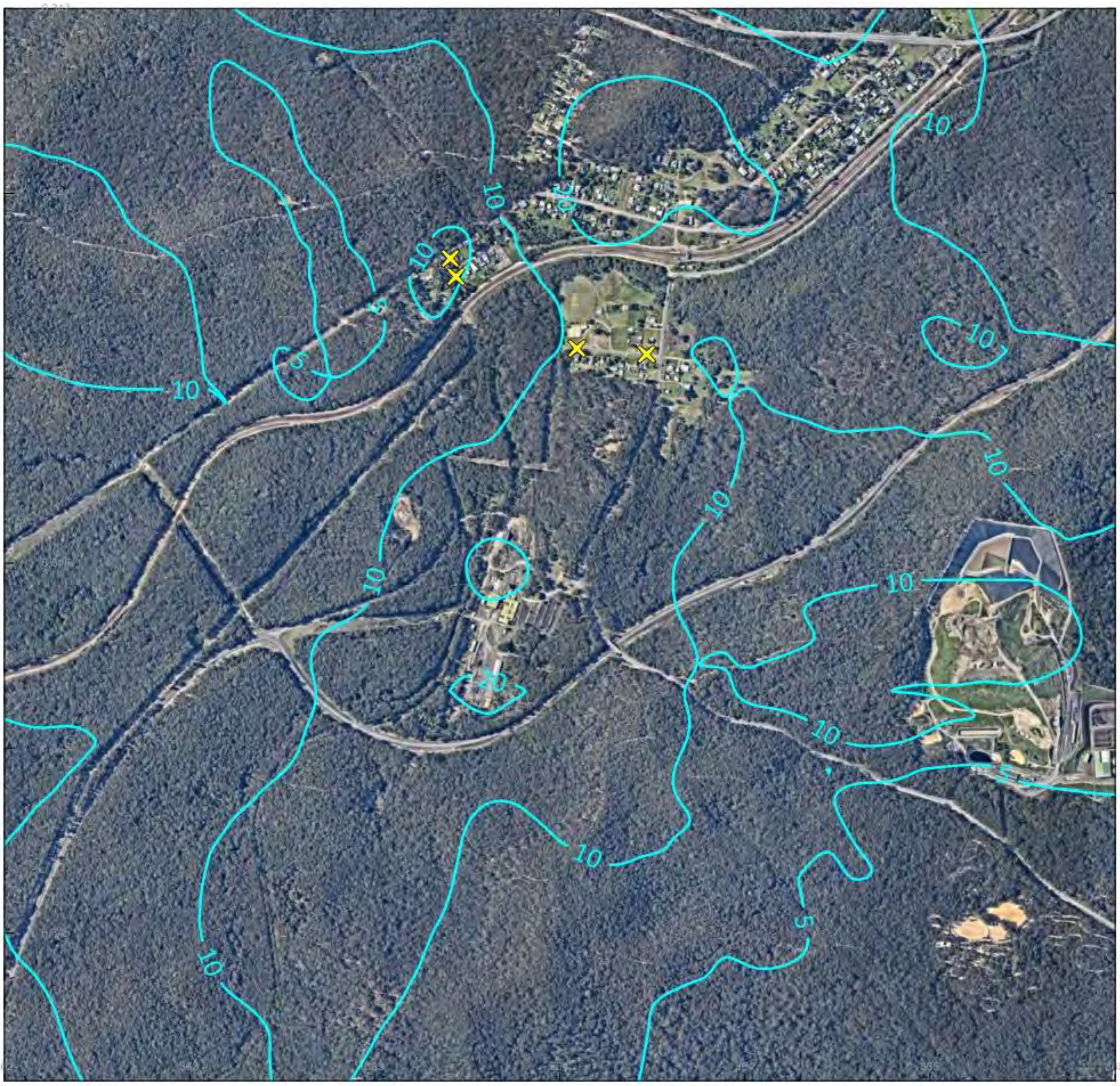
Centennial Newstan
Newstan Extension of Mining Project
Air Quality Impact Assessment
Scenario 2 - Operations

Pollutant	NO_2	Averaging Period	Annual	Unit	µg/m³



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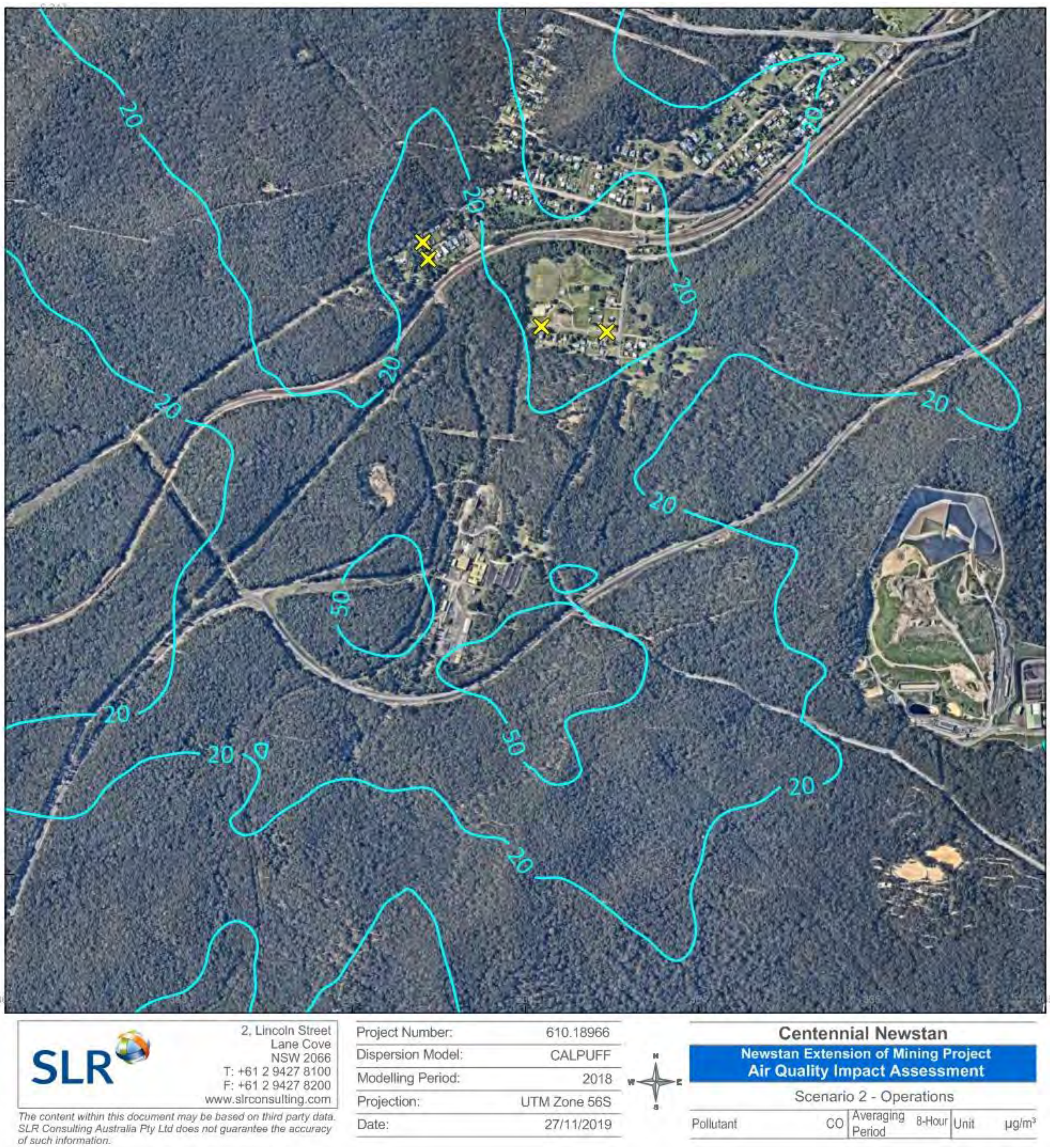
Centennial Newstan
Newstan Extension of Mining Project
Air Quality Impact Assessment
Scenario 2 - Operations

Pollutant	NO_2	Averaging Period	1-Hour	Unit	µg/m³


20
50
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20
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Project Number: 610.18966
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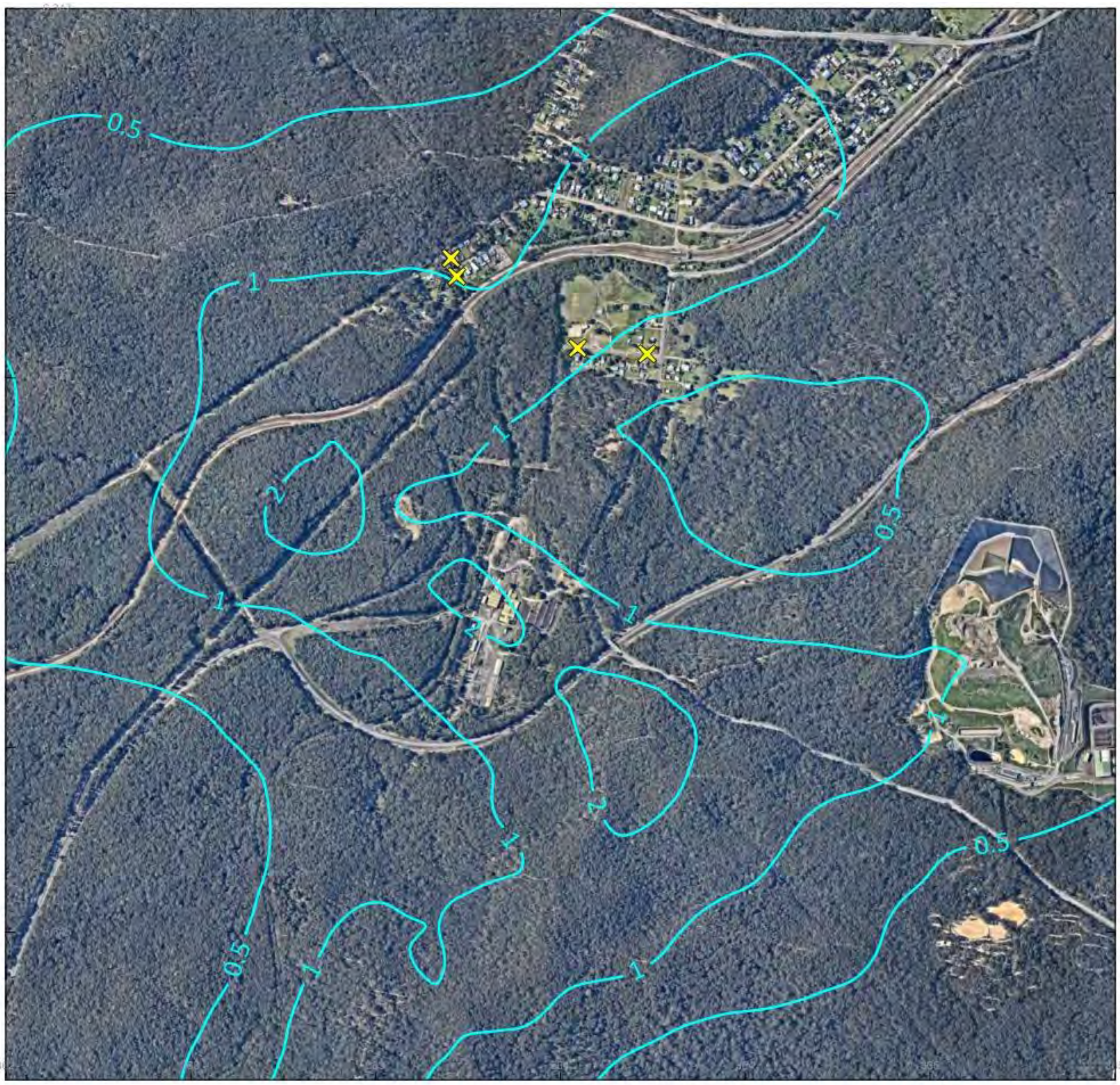
Projection: UTM Zone 56S
Date: 27/11/2019
Centennial Newstan
Newstan Extension of Mining Project
Air Quality Impact Assessment
Scenario 2 - Operations
Pollutant CO
Averaging Period 8-Hour
Unit µg/m³



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Centennial Newstan
Newstan Extension of Mining Project
Air Quality Impact Assessment
Scenario 2 - Operations

Pollutant	TSP	Averaging Period	Annual	Unit	µg/m³

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Centennial Newstan
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Air Quality Impact Assessment
Scenario 2 - Operations

Pollutant	Odour	Averaging Period	Nose Response	Unit	OU

APPENDIX B

TRIGGER ACTION RESPONSE PLAN

Aspect	Condition Green	Condition Orange	Condition Red
PM_{10}	**Trigger**	**Trigger**	**Trigger**
	Monitoring results within criteria. PM_{10} trigger level not exceeded.	Real time monitoring indicates PM_{10} level exceeds trigger level of 50 µg/m^3 over a 1 hour period. (note once tripped, alarms will not reset until back under trigger level) OR HVAS Monitoring data exceeds 80% of the PM_{10} 24-hour air quality criteria (40 µg/m^3.) OR HVAS Annual average exceeds 80% of the PM_{10} Annual Average air quality criteria (24 µg/m^3).	HVAS or Real Time monitoring indicates an exceedance of the PM_{10} 24-hour air quality criteria of 50 µg/m^3. OR HVAS Monitoring indicates an exceedance of the PM_{10} Annual Average criteria of 30 µg/m^3.
	Action	**Action**	**Action**
	No response required. Continue monitoring programme	Review operations to reduce dust emissions. Implement any additional mitigation measures as required. Modify operations if applicable.	Complete incident investigation to determine the cause of the exceedance. Review effectiveness of mitigation measures. Modify operations if applicable. Notify relevant government agencies and impacted landowners in accordance with the procedure in the Management Plan. Consider review of Management Plan if required.
TSP	**Trigger**	**Trigger**	**Trigger**
	Monitoring results within criteria	Monitoring result exceeds a TSP value of 90 µg/m^3. OR Monitoring indicates annual average TSP level exceeds 80% of criteria level (72 µg/m^3).	Monitoring results indicates an exceedance of the TSP Annual Average criteria of 90 µg/m^3
	Action	**Action**	**Action**
	No response required. Continue monitoring programme	Review operations to reduce dust emissions. Implement any additional mitigation measures as required. Modify operations if applicable.	Complete incident investigation to determine the cause of the exceedance. Review effectiveness of mitigation measures. Modify operations if applicable. Notify relevant government agencies and impacted landowners in accordance with the procedure in the Management Plan. Consider review of Management Plan if required.
Depositional	**Trigger**	**Trigger**	**Trigger**

Aspect	Condition Green	Condition Orange	Condition Red
Dust	Monitoring results within criteria	Monitoring indicates monthly depositional dust levels exceeds 4 g/m^2/month of criteria. OR Monitoring indicates annual average Dust Depositional level exceeds 80% of criteria level (3.2 g/m^2/month).	Monitoring indicates annual average exceeds 4g/m^2/month
	Action	**Action**	**Action**
	No response required. Continue monitoring programme	Analyse data to determine source of dust. Review operations to reduce dust emissions. Implement any additional mitigation measures as required. Modify operations if applicable.	Complete incident investigation to determine the cause of the exceedance. Review effectiveness of mitigation measures. Modify operations if applicable. Notify relevant government agencies and impacted landowners in accordance with the procedure in the Management Plan. Consider review of Management Plan if required.
Odour	**Trigger**	**Trigger**	**Trigger**
	No complaints or odour reports from site personnel.	On site identification of odour source reported.	External complaint of odour emissions received.
	Action	**Action**	**Action**

Aspect	Condition Green	Condition Orange	Condition Red
	No response required.	Analyse information to determine source of odour emissions. Review operations to reduce odour emissions if source of odour emissions determined to be from site.	Analyse information to determine source of odour emissions. Review operations to reduce odour emissions if source of odour emissions determined to be from site. Notify relevant government agencies and report complaint and actions implemented in the Annual Review.

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