

Appendix - D



global environmental solutions

Springvale Mine Modification Air Quality and Greenhouse Gas Assessment

Report Number 630.10123.02030-R1

26 August 2013

Springvale Coal Pty Ltd
PO Box 198
Wallerawang NSW 2845

Version: Revision 1

Springvale Mine Modification

Air Quality and Greenhouse Gas Assessment

PREPARED BY:

SLR Consulting Australia Pty Ltd
ABN 29 001 584 612
2 Lincoln Street Lane Cove NSW 2066 Australia

(PO Box 176 Lane Cove NSW 1595 Australia)
T: 61 2 9428 8100 F: 61 2 9427 8200
E: sydney@slrconsulting.com www.slrconsulting.com

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DOCUMENT CONTROL

Reference	Status	Date	Prepared	Checked	Authorised
630.10123.02030-R1	Revision 1	26 August 2013	Fardausur Rahaman	Martin Doyle	Martin Doyle
630.10123.02030-R1	Revision 0	6 August 2013	Martin Doyle	Kirsten Lawrence	Martin Doyle

Executive Summary

Introduction

SLR Consulting Australia Pty Ltd (SLR) has been commissioned by Springvale Coal Pty Ltd (Springvale) to undertake an Air Quality and Greenhouse Gas (GHG) Impact Assessment for the proposed Springvale Mine Modification (the modification).

Key aspects of the modification relevant to air quality issues are as follows:

- Increase extraction of run of mine (ROM) coal from the Lithgow Seam up to a rate of 4.5 million tonnes per annum (Mtpa).
- Continue to process ROM coal through a crusher and screening plant at Springvale pit top.
- Continue to operate 24 hours per day seven days per week.

The aim of this assessment is to quantify the air quality impacts on surrounding sensitive receivers associated with the modification and also estimate GHG emissions for the Project.

Methodology

The air quality impact assessment has been completed in accordance with the “*Approved Methods for the Modelling and Assessment of Air Pollutants in NSW*” (OEH, 2005) (the Approved Methods) issued by the New South Wales Office of Environment and Heritage (NSW OEH).

Dispersion modelling was conducted for the identified sources for the proposed modification. The pollutants assessed were particulate matter as Total Suspended Particulate (TSP), particulate matter with an aerodynamic diameter of 10 microns (PM₁₀), 2.5 microns (PM_{2.5}) and deposited dust. The particulate emissions from the modification were calculated for using default or calculated emission factors for the relevant emission sources. Emission factors were sourced from the National Pollutant Inventory (NPI) *EETM for Mining* version 3.1 (DSEWPC 2012), or from the US EPA AP-42 Emission Factor Handbook (US EPA, 2006) where suitable factors do not exist within the NPI documentation. The particulate emissions from ventilation fans were based on particulate monitoring conducted on the Angus Place Colliery ventilation fans in February 2013.

In order to assess the background air quality of the region, a review of High Volume Air Sampling (HVAS) monitoring data collected on site was reviewed and compared against HVAS data collected by Centennial at the nearby Angus Place Colliery and continuous PM₁₀ monitoring data collected by NSW OEH at Bathurst. This review indicated that use of the continuous ambient monitoring data from Bathurst for 2010 would provide a conservative and appropriate approach for the assessment of potential cumulative impacts for the modification.

The results of the modelling were assessed based on air quality criteria specified by the NSW OEH were adopted as stipulated in the Approved Methods. In the absence of criteria applicable to PM_{2.5} in the Approved Methods, the NEPM advisory reporting standard (2003) was adopted.

The assessment also considers emissions of GHG's (methane (CH₄), carbon dioxide (CO₂) and sulphur hexafluoride (SF₆)) from the modification and includes estimates of direct and indirect GHG emissions.

Executive Summary

Results

The ground level particulate concentrations and deposition rates predicted by the modelling showed that the proposed modification is unlikely to cause any exceedences of the relevant ambient air quality criteria for TSP, PM₁₀ and PM_{2.5} concentrations or dust deposition at any identified surrounding sensitive receptors.

The total lifetime direct (Scope 1) emissions from the Project are estimated to be approximately 26,629 CO₂-e in any one year.

Indirect (Scope 2 and 3) emissions would be released in the process of mining coal, and through the transport and end use of the coal. The total lifetime indirect emissions (Scope 2 and 3) from mining coal and end use of the coal are estimated to be 1,152,661 t CO₂-e per annum.

Comparison of the estimated Scope 1 Project emissions with State and National GHG emission totals indicates that the modification is likely to represent approximately 0.02% of NSW GHG emissions (Scope 1) when compared to the latest available emissions data (2010) (Scope 1) and 0.005% of Australian GHG emissions (Scope 1).

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ABBREVIATIONS

%	percent
°C	degrees Celsius
µg	Microgram
µg/m ³	microgram per cubic metre of air
µg/Nm ³	microgram per normalised cubic metre of air (273K, 101.3kPa)
µm	micrometre or micron
AGL	above ground level
AHD	Australian Height Datum
AP-42	US EPA Emission Factor Handbook
AQIA	air quality impact assessment
AWS	automatic weather station
DECC	NSW Department of Environment and Climate Change (see OEH)
DECCW	NSW Department of Environment, Climate Change and Water (see OEH)
DDG	dust deposition gauge
EETM	Emission Estimation Technique Manual
EF	Emission Factor
EIS	Environmental Impact Statement
g	gram
g/m ² /month	grams per square metre per month
ha	hectare
kg	kilogram
kg/hr	kilogram per hour
km	kilometre
km E	kilometres east
km N	kilometres north
L	litre
m	metre
M	million
m/s	metre per second
m ²	square metre
m ³	cubic metre
min	minute
mm	millimetre
MPPS	Mount Piper Power Station
Mt	million tonnes
Mtpa	million tonnes per annum
NEPC	National Environment Protection Council
NEPM	National Environment Protection Measure
NPI	National Pollutant Inventory (Australia)
NSW	New South Wales
OEH	NSW Office of Environment and Heritage
PM	Particulate Matter
PM ₁₀	particular matter with an equivalent aerodynamic diameter of 10 microns or less
PM _{2.5}	particular matter with an equivalent aerodynamic diameter of 2.5 microns or less
ROM	run of mine
SMEP	Springvale Mine Expansion Project
t	tonne
TEOM	tapered element oscillating microbalance
tpa	tonnes per annum
TSP	total suspended particulate matter
US EPA	United States Environmental Protection Agency
UTM	Universal Transverse Mercator
WPS	Wallerawang Power Station

GLOSSARY

air dispersion model	A computer-based software program which provides a mathematical prediction of how pollutants from a source will be distributed in the surrounding area under specific conditions of wind, temperature, humidity and other environmental factors
airshed	The geographical area associated with a given air supply
algorithms	A step-by-step problem-solving procedure, especially an established, recursive computational procedure for solving a problem in a finite number of steps
ambient	Pertaining to the surrounding environment or prevailing conditions
anemometer	An instrument for measuring wind force and velocity
atmosphere	A gaseous mass surrounding the planet Earth that is retained by Earth's gravity. It is divided into five layers. Most of the weather and clouds are found in the first layer
atmospheric stability	The tendency of the atmosphere to resist or enhance vertical motion
atmospheric pressure	The force per unit area exerted against a surface by the weight of air above that surface in the Earth's atmosphere
background	The existing air quality in the Project area excluding the impacts from the proposed development
CALMET	A meteorological model that develops wind and temperature fields on a three-dimensional gridded modelling domain
CALPOST	A post-processor used to process CALPUFF files, producing tabulations that summarize results of the simulation for user-selected averaging periods
CALPUFF	A transport and dispersion model that advects "puffs" of material emitted from modelled sources, simulating dispersion and transformation processes
climatological	The science dealing with climate and climatic phenomena
combustion	The process of thermal oxidation (burning). A chemical change accompanied by the production of heat and conversion of chemical species.
crushers	A machine designed to reduce large rocks into smaller rocks, gravel, or rock dust
dust deposition	Settling of particulate matter out of the air through gravitational effects (dry deposition) and scavenging by rain and snow (wet deposition)
dispersion	The spreading and dilution of substances emitted in a medium (e.g. air or water) through turbulence and mixing effects
diurnal	Relating to or occurring in a 24-hour period; daily
downwash	The grounding of an air pollution plume as it flows over nearby buildings or other structures due to turbulent eddies being formed in the downwind side of the building, resulting in elevated ground level concentrations.
downwind	The direction in which the wind is blowing
emission factor	A measure of the amount of a specific pollutant or material emitted by a specific process, fuel, equipment, or source based on activity data such as the quantity of fuel burnt, hours of operation or quantity of raw material consumed.
emissions inventory	A database that lists, by source, the amount of air pollutants discharged into the atmosphere from a facility over a set period of time (e.g. per annum, per hour)
erodible	A term used to describe a soil that is vulnerable to erosion by the agents of wind, water, ice

evapotranspiration	The process by which water is transferred from the land to the atmosphere by evaporation from the soil and other surfaces
epidemiological	The branch of medicine that deals with the study of the causes, distribution, and control of disease in populations
fossil fuel	A natural fuel such as coal, diesel or gas, formed in the geological past from the remains of living organisms
fugitive emissions	Pollutants which escape from an industrial process due to leakage, materials handling, transfer, or storage
guideline	A general rule, principle, or piece of advice. A statement or other indication of policy or procedure by which to determine a course of action.
materiality threshold	Represents the amount of insignificant emissions allowed which do not need to be quantified and accounted for.
meteorological	The science that deals with the phenomena of the atmosphere, especially weather and weather conditions
mixing height	The height to which the lower atmosphere will undergo mechanical or turbulent mixing, producing a nearly homogeneous air mass
modelling domain	The area over which the model is making predictions
particulate	Of, relating to, or formed of minute separate particles. A minute separate particle, as of a granular substance or powder
plume	A space in air, water, or soil containing pollutants released from a point source
point source	A pollution source that is fixed and/or uniquely identifiable, such as a stack, chimney, outlet pipe or vent
pollutant	A substance or energy introduced into the environment that has undesired effects, or adversely affects the usefulness of a resource
prognostic	A prediction of the value of variables for some time in the future on the basis of the values at the current or previous times
qualitative assessment	An assessment of impacts based on a subjective, non-statistical oriented analysis
quantitative assessment	An assessment of impacts based on estimates of emission rates and air dispersion modelling techniques to provide estimate values of ground level pollutant concentrations.
receptor	Coordinate locations specified in an air dispersion model where ground level pollutant concentrations are calculated by the model
sensitive receptor	Locations such as residential dwellings, hospitals, churches, schools, recreation areas etc where people (particularly the young and elderly) may often be present, or locations with sensitive vegetation and crops.
spatial variation	Pertaining to variations across an area
standard	The prescribed level of a pollutant in the outside air that should not be exceeded during a specific time period to protect public health
synoptic meteorological data	A surface weather observation, made at periodic times (usually at 3-hourly and 6-hourly intervals), of sky cover, state of the sky, cloud height, atmospheric pressure reduced to sea level, temperature, dew point, wind speed and direction, amount of precipitation, hydrometeors and lithometeors, and special phenomena that prevail at the time of the observation or have been observed since the previous specified observation
temporal variation	Pertaining to variations with time

topography	Detailed mapping or charting of the features of a relatively small area, district, or locality
wind direction	The direction from which the wind is blowing
wind erosion	Detachment and transportation of loose topsoil or sand due to action by the wind
wind rose	A meteorological diagram depicting the distribution of wind direction and speed at a location over a period of time

1 INTRODUCTION

SLR Consulting Australia Pty Ltd (SLR) has been commissioned by Springvale Coal Pty Ltd (Springvale Coal) to undertake an Air Quality and Greenhouse Gas Impact Assessment for the proposed Springvale Mine Modification (the modification).

Springvale Coal proposes to modify its approval to allow extraction of up to 4.5 million tonnes per annum (Mtpa) from the existing operations at Springvale Mine located 15 km northwest of Lithgow (refer **Figure 1**).

Springvale Mine was originally granted development consent in respect of development application 11/92 (DA 11/92) on 27 July 1992 by the Hon. Robert Webster, the then Minister for Planning, pursuant to Section 101 of the *Environmental Planning and Assessment Act 1979* (EP&A Act). This consent permitted the construction and operation of an underground coal mine to produce up to 3.4 Mtpa of Run of Mine (ROM) coal, along with an overland conveyor system and a coal preparation plant (CPP). Longwall mining at Springvale commenced in 1995, extracting thermal coal from the Lithgow Seam.

Springvale Coal is seeking a modification to development consent DA 11/92 under Section 75W of the EP&A Act to allow extraction of up to 4.5 Mtpa from the existing operations.

Broadly, the objective of this assessment was to identify the potential impacts of air quality and greenhouse gas emissions associated with the modification, the cumulative impacts of the modification with existing Springvale Mine mining operations and the cumulative impacts of the modified Springvale Mine operations with other activities/operations in the proximity of the mine.

The air quality impact assessment has been prepared in accordance with the Office of Environment and Heritage (OEH) document Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales (OEH, 2005), hereafter referred to as 'The Approved Methods'. This assessment involves the modelling of local meteorology and the dispersion of potential emissions from the Project Application Area to predict the level of impact that may be experienced in the surrounding environment. The sections of this report where the requirements of the Approved Methods are met are as follows:

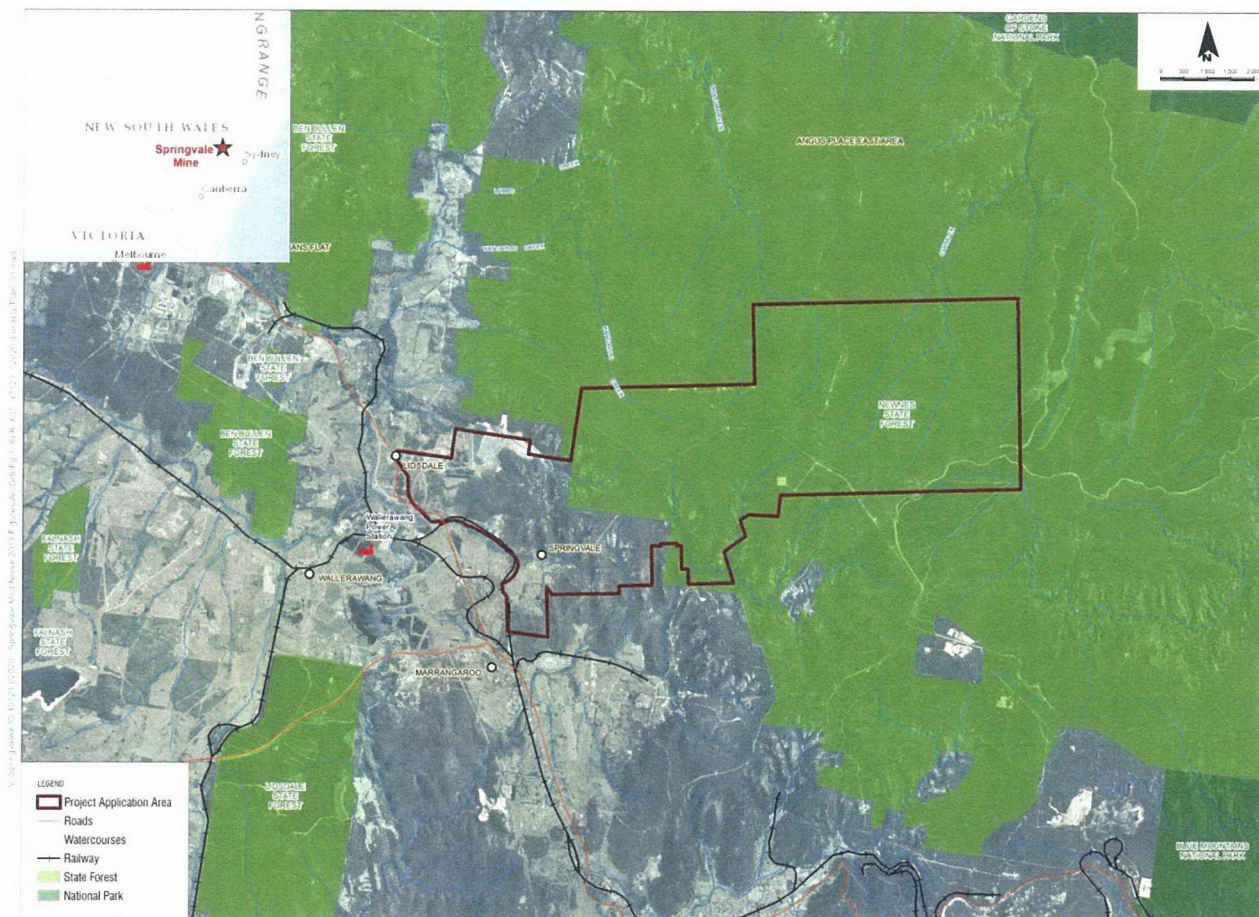
- Description of local topographic features and sensitive receptor locations (**Section 7**).
- Establishment of air quality assessment criteria (**Section 6**).
- Analysis of climate and dispersion meteorology for the region (**Section 9.3**).
- Description of existing air quality environment (**Section 10**).
- Compilation of a comprehensive emissions inventory for the existing and proposed activities (**Section 8.5**).
- Completion of atmospheric dispersion modelling and analysis of results (**Section 9** and **Section 11**).
- Preparation of an air quality impact assessment report comprising the above.

Although no Director-Generals Requirements (DGRs) have been issued for the modification, the scope of the air and greenhouse gas assessments was designed to address the broad Director-Generals Requirements (DGRs) required for similar Projects. A synopsis of these broad requirements is provided in **Table 1**.

Table 1 Typical Director-General's Requirements (not specifically applicable to modification, shown for information only)

Director-General's Requirement (Broad Requirement)	Section Addressed
Air Quality	
Air Quality – including a quantitative assessment of potential:	
- Construction and operational impacts, with a particular focus on dust emissions including PM _{2.5} and PM ₁₀ emissions and dust generation from coal transport	Section 8 and Section 11
- Reasonable and feasible mitigation measures to minimise dust emissions, including evidence that there are no such other available measures	Section 8.3
- Monitoring and best practice management measures, in particular real time air quality monitoring	Section 8.3 and Section 10
Greenhouse Gas	
Greenhouse Gases – including:	
- A quantitative assessment of potential Scope 1, 2 and 3 greenhouse gas emissions	Section 13
- A qualitative assessment of the potential impacts of these emissions on the environment	Section 13.6
- An assessment of reasonable and feasible measures to minimise greenhouse gas emissions and ensure energy efficiency	Section 13.7
Attachment 1 Technical & Policy Guidelines	
Air Quality	
- Protection of the Environment Operations (Clean Air) Regulation 2002	Section 6
- The Assessment and Management of Odour from Stationary Sources in NSW: Technical Framework and Notes (OEH)	Not Applicable
- Approved Methods for the Modelling and Assessment of Air Pollutants in NSW	Section 9
- Approved Methods for the Sampling and Analysis of Air Pollutants in NSW (DEC)	Section 10
Greenhouse Gas	
- National Greenhouse Accounts Factors (Australian Department of Climate Change (DCC))	Section 12
- Guidelines for Energy Savings Action Plans (DEUS)	Section 12

Figure 1 Springvale Mine – Locality Plan



2 PROJECT DESCRIPTION

2.1 Background

Development consent in respect of development application 11/92 (DA 11/92) was granted to Springvale Coal Pty Ltd by the then Minister for Planning on 27 July 1992 under Section 101 of Part 4 of the EP&A Act. Under the development consent, production at Springvale Mine is limited to 3.4 Mtpa of ROM coal.

Springvale Mine is an underground coal mine producing high quality thermal coal which is supplied to both domestic and international markets. Domestically, Springvale Mine has established long term contracts with two local power stations: Wallerawang and Mount Piper. All coal is distributed to these sites via dedicated overland conveyors. The international market is accessed via Centennial's Lidsdale Siding rail loading facility.

The main components of Springvale Mine's operations are an underground longwall mine and development panels and supporting surface infrastructure within the Springvale Mine pit top area and in the Newnes State Forest. Currently coal processing and distribution is managed by Springvale Coal Services, a separate Centennial business unit. Springvale Mine is also the subject of the following development assessments currently in progress:

- Director-General's Requirements (DGRs) have been issued by Department of Planning and Infrastructure (DP&I) for a proposal (ref SSD 12_5594) to continue mining operations at Springvale Mine beyond 28 September 2014 and to extend mining to the east and the southwest of its existing operations.
- DGRs have been issued by DP&I for a proposal (ref SSD 12_5579) for the Western Coal Services Upgrade project that proposes to upgrade the existing infrastructure within the Springvale Coal Services site at Blackman's Flat to support its ongoing Western Operations. As part of this upgrade, it is proposed to amalgamate the existing coal processing and transport facilities, currently undertaken as part of Springvale Mine's operations.

2.2 Project Objectives and Overview

The overall objective of the modification is to obtain an approval for Springvale Mine which allows for the extraction of up to 4.5 Mtpa of coal from the existing mining operations at Springvale Mine.

The increase in production will be achieved through the installation and operation of new generation mining equipment and the implementation of other operational practices to achieve greater utilisation of the equipment. A small increase in the total employment on site will be required to facilitate the operation of an additional continuous miner in anticipation of greater longwall utilisation. The proposed modification does not require any other changes to the existing mine operation to achieve this increase in production.

The installation of new longwall equipment at the start of LW416 will facilitate a production increase in 2013 due to the absence of the longwall changeover period between LW415 and LW416. It is the scheduled increase in production for the 2013 year that has necessitated this modification to be sought as a separate application to the other development assessments that are currently in progress.

3 EXISTING OPERATIONS AND INFRASTRUCTURE

3.1 Overview of Current Approved Operations

Springvale Mine received development consent in 1992 which provided for the construction of an underground longwall operation and associated infrastructure. The approval covered the construction of the overland conveyor system and coal handling, processing, stockpiling and reject disposal at the Springvale Coal Services site.

Springvale commenced mining in 1995, extracting coal from the Lithgow seam using longwall mining techniques. The mine supplies coal to both domestic and export markets. Coal for export markets is processed prior to transport to Port Kembla. The principal components of the currently approved Springvale Mine operation are illustrated on **Figure 1** and include an underground longwall coal mine with a maximum production level of 3.4 Mtpa for the domestic and export markets.

3.2 Overview of Existing Operations

Springvale Mine undertakes the following existing activities:

- **Production** – Annual extraction limit of 3.4 million tonnes per annum of ROM coal.
- **Mining method** – Longwall mining methods are used for the extraction of each longwall block. Development headings are mined using continuous miner units, which also install roof and rib support.
- **Mining area** – Longwall blocks are mined in sequence. Mining currently occurs at Springvale Mine in accordance with the Subsidence Management Plan for LW414 to LW418, approved on 22 October 2010.
- **ROM stockpile** – When conveyed from the underground mine, the ROM coal is deposited on the 85,000 tonne ROM stockpile prior to being crushed and conveyed off site.
- **Coal preparation** – Coal is crushed on site within the Coal Handling Plant. No reject material is generated at the pit top.
- **Product coal transport** – All ROM coal produced is loaded onto conveyors from the final product bin after stockpiling and sizing. The conveyors transfer the coal to the Springvale Coal Services site for further processing or directly to the two local power stations. Washed coal from the Springvale Coal Services site is transferred via conveyors to the power stations or Lidsdale Siding.
- **Coal Washing** – Coal is washed at the Springvale Coal Services site which currently handles all coal produced by Springvale Mine (other than that delivered to Wallerawang Power Station). At present the washery is capable of processing approximately 2 Mtpa of coal and producing over 300,000 tonnes per annum (tpa) of reject. The Springvale Coal Services site includes a washery, raw and product coal stockpiles, coal reject disposal areas, coal handling infrastructure, offices and control room.
- **Site water management** – Surface water at the Springvale Mine pit top and at the Springvale Coal Services site is managed in accordance with separate Site Water Management Plans.
- **Mine access** – Access to Springvale Mine is via a roadway from the Castlereagh Highway. Access into the mine is via existing workings. Access to infrastructure situated on the Newnes State Forest is via the Old Bells Line of Road from Clarence.
- **Land preparation** – As Springvale Mine is a well-established underground mine with adequate supporting infrastructure, minimal land preparation occurs. In recent years, minor land preparation has been undertaken to facilitate the exploration drilling program and for establishment of infrastructure associated with the de-watering bores which form part of the Springvale Delta Water Transfer Scheme.

- **Rehabilitation** – Given that Springvale Mine pit top is an underground coal mine which tends not to alter significantly in footprint, rehabilitation undertaken is currently associated with the exploration program and dewatering bore sites on the Newnes State Forest following the cessation of the activities. Rehabilitation at the Springvale Coal Services site is in operation and rehabilitation activities are minimal.
- **Employment** – Springvale Mine currently employs approximately 280 permanent staff and up to 70 contractors.
- **Operating times** – Springvale operates activities 24 hours per day, 7 days a week.

3.3 Existing Infrastructure and Operations

3.3.1 Surface Infrastructure

The existing Springvale Mine surface facilities area is located off the Castlereagh Highway at Lidsdale and includes:

- Administration building and portable offices on the pit top site;
- Bathhouse with adequate facilities and services for the intended workforce;
- Coal Handling Plant and coal stockpile;
- Various workshops, service buildings and material storage sheds;
- Visitor and employee parking areas;
- Personnel and materials drift for access to underground workings;
- Coal conveyor drift and coal conveyor drive to transport coal from the underground workings to the surface;
- Diesel, solcenic hydraulic fluid and oil storage facilities;
- A dirty and clean water management control system; and,
- Mine dewatering infrastructure.

An existing overland conveyor system link the Springvale Mine pit top (from the rill tower) to the Springvale Coal Services site, Mount Piper Power Station and, Wallerawang Power Station and Lidsdale Siding. A single conveyor system runs the entire route which is approximately 10 km in length.

Surface infrastructure at the Springvale Coal Services site includes a washery, raw and product coal stockpiles, coal reject disposal areas, coal handling infrastructure, offices and control room.

3.3.2 Mining Method

The longwall mining method is utilised at Springvale Mine. Longwall mining is a form of underground coal mining where a block of coal is mined using a longwall shearer. In the current mining area, the longwall blocks have typically been approximately 3 km long by 315 m wide at a depth of cover of 280 – 420 m. The mine layout is constrained by the lease boundary and subsidence protection zones designed to protect sensitive surface escarpment areas.

The longwall mining method is supported by the development of underground roadways which enable access to future longwall extraction areas. Underground roadways are mined using continuous miners. Development activities require the installation of strata support (for example roof bolts and mesh) as part of the process of mining the underground roadways.

Entry to the mine is via two in-seam portals. These entries extend for approximately 2,500 m past the abandoned Renown Colliery workings prior to connecting with the five heading main roadways. The main mine entry is adjacent to the bathhouse and is a dedicated transport route; the other is used as a belt road with walking access as a second entry and or exit if required.

3.3.3 Mine Ventilation

The ventilation system at Springvale Mine provides a continuous stream of fresh air to the underground mine workings. Fresh air is drawn into the mine workings through two surface portals located at the pit top as well as two separate intake shafts located off the pit top site on privately owned land (Ventilation Shafts 1 and 2). Air is exhausted to the atmosphere from the underground mine workings via a single 3.5 m diameter shaft (Ventilation Shaft No. 3) located on the Newnes State Forest. Air flow is provided by a main ventilation fan system positioned on top of the No. 3 exhaust shaft. Ventilation control devices installed throughout the underground mine ensure intake air is drawn to the production panels before it is exhausted as return air up the No.3 shaft.

3.3.4 Mine Services

Existing compressor units exist at the pit top in addition to mine portal entrances to the personnel and materials drift and the main conveyor belt drift. Other mine services located at the pit top include dirty and clean water management systems, sewage treatment, licenced mine water discharge points, workshops, storage bays, bathhouse, administration buildings and parking facilities. Power reticulation and access tracks support the operation of these mine services. Additional compressor units and a concrete borehole are situated at the No. 3 shaft site on the Newnes State Forest.

3.3.5 Material and Service Supply Boreholes

Currently there is an existing delivery borehole situated at the No. 3 shaft site on the Newnes State Forest which is used for delivering concrete to the underground workings. Concrete is typically used in underground coal mines to reinforce roadway floors, construct ventilation overcasts as well as other civil construction works. Underground vehicles transport the concrete to the required destination from the base of the borehole.

3.3.6 Underground Mine Water Management

Groundwater is currently pumped from the underground workings to the surface by the existing dewatering borehole (Bore 6), for transfer, via the Springvale-Delta Water Transfer Scheme (SDWTS), to Wallerawang power station to be used as part of the cooling process. An additional dewatering borehole is situated at the No. 3 shaft site which also connects into the SDWTS. This importantly reduces the volume of water sourced by the power station from the regional surface rivers and lakes which feed into the Sydney water catchment. Two emergency licenced discharge points (LDP004 and LDP005) exist as contingencies when water is unable to be transferred via the SDWTS.

A pit top collection system is also used to source mine inflows for operational requirements (dust suppression for both underground and surface, cooling of machinery, and for fire fighting supplies). Surplus water is discharged to the Springvale Creek via LDP001.

3.4 Coal Handling and Transport

ROM coal is transported underground from the longwall face to the Springvale Mine surface ROM stockpile by a high capacity conveyor system. ROM coal is crushed and sized at the Springvale Mine pit-top and is then transported using an overland conveyor system to either Mount Piper Power Station or Wallerawang Power Station; or to the Springvale Coal Services site at Blackmans Flat.

The conveyor system allows for separate raw coal handling. Raw coal can be delivered directly to Mount Piper Power Station from Springvale Mine or fed to the washery. Coal requiring washing is delivered to a 150,000 tonne capacity stockpile within the Springvale Coal Services site which can then be conveyed into the washery.

Additional stockpile capacity of up to 600,000 tonnes can be used if Mount Piper Power Station is unable to receive coal for an extended period. The stockpile area can also be used to blend reject and to store and feed raw coal produced from other operations.

Coal for export is washed at the Springvale Coal Services site prior to transfer to the Lidsdale Siding, using the overland conveyor system.

The infrastructure and operation of the overland conveyor and the Springvale Coal Services site is the subject of the development assessment (ref SSD 12_5579) currently in progress.

3.5 Reject Management

Coal reject material, produced by the preparation of product coal in the washery at the Springvale Coal Services site, is managed at the Springvale Coal Services site. Coarse reject material is transported via haul trucks to the Huon No. 6 REA or the 'A Pit' REA. It may also be used as part of general operations or made available for other projects.

Fine coal reject from the washery is fed to the co-disposal dam via slurry pipes. Decant pipes are positioned to collect pooled water after settling of the fine material. The water is discharged to the retention dam below the co-disposal unit for either reuse in the washery as clarified process water or disposed off site under licence conditions. The area is designed to contain 382,000 m³ of material and is fully bunded to contain reject material. The fines may be dried and blended into product coal for both domestic and export markets.

3.6 Water Management and Supply

Water management at Springvale Mine pit top is undertaken in accordance with the Springvale Water Management System (SV-MS-034). The surface water management system at Springvale Mine relies on the separation of clean and dirty water and the treatment of dirty water prior to discharge. A comprehensive Site Water Balance has been developed for Springvale Mine.

Water for Springvale Mine operations is sourced from groundwater ingress into the mine (for process water, dust suppression, and fire fighting) through the pit collection system bore (Licence number 10BL602017). Potable water is sourced from Lithgow City Council and Lithgow Valley Springs\Neverfail Springwater. The mine inflows at Springvale Mine are managed through operation of dewatering facilities which discharge into the SDWTS for delivery to the Wallerawang Power Station for use in the cooling towers (refer Section 3.3.7).

Water is discharged from Springvale Mine through the licensed discharge points LDP001, LDP002, LDP004, LDP005, LDP009 and LDP010 in accordance with EPL3607. LDP007 is used for discharge from the conveyor system into Cocks River, which is on EPL3607.

4 PROPOSED PROJECT

4.1 Overview

Table 2 provides an overview of the proposed modification, summarising and comparing the major components of the existing operations at Springvale Mine and the proposed modification.

Table 2 Comparison of Existing Operation and Proposed Modification

Aspect	Existing Operation	Proposed Modification
Production	Springvale is approved to produce up to 3.4 Mtpa of ROM coal.	It is proposed to produce up to 4.5 Mtpa of ROM coal.
Mine Life	Development Consent DA 11/92 limited to 21 years from granting of Coal Lease (ML1326), expiry 28 September 2014.	No change
Hours of Operation	The mine currently operates 24 hours per day, 7 days per week.	No change
Employment	Springvale currently employs 280 personnel.	It is proposed to operate the mine with 310 personnel
ROM Stockpile	Current stockpile capacity at the pit top is 85,000 t	No change
Coal Preparation	Coal is crushed at the on-site screening and crusher plant	No change
Land Preparation	As Springvale Mine is an established underground mine, minimal land preparation occurs. Minor land preparation is occasionally required for exploration purposes and the installation of support infrastructure.	No change
Product Coal Transport	Coal is transferred on to overland conveyors and transported to either Mount Piper or Wallerawang power stations, or to the Springvale Coal Services Site for washing and export.	No change
Waste Management	Coarse reject material from the CPP at the Springvale Coal Services site is transported via truck to the Huon REA and 'A Pit' REA, also at the site. Fine coal reject from the coal preparation plant is fed to the Co-disposal REA via slurry pipes.	No change
Surface Water Management	The surface water management system at Springvale relies on the separation of clean and dirty water and the treatment of dirty water prior to discharge through LDP001. Current water management occurs in accordance with the site water management plan.	No change
Rehabilitation	Given that Springvale Mine is as an underground coal mine, rehabilitation is currently limited to small areas in the Newnes State Forest following the cessation of exploration activities, or when surface infrastructure is decommissioned.	No change

4.2 Background

Springvale Coal is seeking approval to modify its approved mining operations to allow extraction of up to 4.5 million tonnes per annum (Mtpa) from the existing operations at Springvale Mine.

The Project will continue to use existing surface and underground facilities. The increase in production will be predominantly achieved through the installation and operation of new generation mining equipment and the implementation of other operational practices to achieve greater availability of the equipment. A small increase in the total employment on site will be required to facilitate the operation of an additional continuous miner. The proposed modification does not require any other changes to the existing mine operation to achieve this increase in production and does not require any change to the approved project area.

4.3 Production Limit Increase

It is proposed to extract up to 4.5 Mtpa of ROM coal. Springvale will install new longwall equipment at the start of LW416. Production increase in 2013 will arise due to the absence of the longwall changeover period between LW415 and LW416; a longwall changeover could typically last six weeks. In 2014 an additional continuous miner will be operated to help facilitate continued production. In addition to the operation of new generation mining equipment, the ongoing increase in productivity will also be achieved by overall process improvements and implementation of operational practices to achieve greater availability of the equipment and resources.

4.4 Mining Method

Mining is proposed to be undertaken using the existing retreat longwall mining method implemented at Springvale Mine described in **Section 3.3.2**.

Springvale has procured a new longwall which will replace the existing ageing longwall in use at the mine. This longwall has a slightly narrower face of 250 m rather than the 305 m wide face of the current longwall. Springvale Mine is currently in the process of preinstalling the new longwall in LW416 prior to the completion of LW415. The associated changes in the mine plan and possible subsidence impacts have been approved by Department of Resources and Energy and SEWPaC for longwalls LW415 to LW417.

4.5 Infrastructure

The proposed Project will utilise the existing infrastructure at Springvale Mine.

4.6 Coal Handling and Transport

The proposed Project will utilise the existing coal handling infrastructure at Springvale Mine.

4.7 Reject Management

No coarse or fine reject materials will be produced at the Springvale Mine pit top and no changes are proposed the reject management. These materials will be produced and handled at the Springvale Coal Services site, in accordance with existing and any future development consent for that site.

4.8 Water Management

No change is proposed to the surface water management system at the Springvale Mine pit top, which will continue to utilise the existing infrastructure. The changes in water use and inflows that will occur as a result of the increase production and new generation mining equipment are negligible within the overall water balance and do not require any change to water management.

Improvements are proposed to the existing sewerage treatment and effluent utilisation area at the Springvale Mine pit top to accommodate the addition personnel proposed to be on-site.

4.9 Hours of Operation and Personnel

Springvale will operate 24 hours a day, seven days a week, 52 weeks per year.

Springvale will provide employment to a full time workforce of up to 310 persons comprising 280 existing personnel and up to an additional 30 full time employees.

5 PROJECT ELEMENTS WITH POTENTIAL FOR AIR QUALITY IMPACTS

5.1 Springvale Mine Pit Top

No modifications are proposed to the existing Springvale Mine pit top as part of the modification, aside from the additional coal being conveyed to the ROM stockpile and transferred to the coal handling plant. Given the proximity of the pit top operations to the sensitive receptor locations, a quantitative assessment of particulate emissions (TSP, deposited dust, PM₁₀ and PM_{2.5}) has been performed as per **Table 1**.

Ventilation Facilities

No changes to the existing ventilation facilities are proposed as part of this modification. For the existing upcast ventilation shaft, currently being upgraded, the assessment has used particulate emissions monitoring data recently collected at the nearby Angus Place Mine. This is considered to be appropriate given that both mines access the Lithgow coal seam. Emissions of carbon monoxide (CO) and odour from the ventilation shaft during operation were previously assessed as not having any significant off-site impacts and have not been considered further.

Dewatering Boreholes

Dewatering bores are used for the management of mine inflows as part of safety and operational requirements. No changes to the operation of existing dewatering bores will occur as part of this modification.

No air quality impacts will be experienced during the operation of the existing boreholes and they are not considered further within this assessment.

6 AIR QUALITY CRITERIA

6.1 Air Pollutants Considered

Given the foregoing discussion relating to the Project operation and previously performed assessments, only emissions of particulate matter (TSP, deposited particulate, PM₁₀ and PM_{2.5}) are considered within this assessment of modified operations.

6.2 Review of Air Quality Criteria

State air quality guidelines adopted by the NSW EPA are published in the Approved Methods (OEH, 2005).

The Approved Methods has been consulted during the preparation of this assessment report. The Approved Methods lists the statutory methods that are to be used to model and assess emissions of air pollutants from stationary sources in NSW. Section 7.1 of the Approved Methods clearly outlines the impact assessment criteria for the Project. The criteria listed in the Approved Methods are derived from a range of sources (including NHMRC, NEPC, WHO and ANZECC). The criteria specified in the Approved Methods are the defining ambient air quality criteria for NSW, and are considered to be appropriate for the setting.

6.2.1 Suspended Particulate Matter

Airborne contaminants that can be inhaled directly into the lungs can be classified on the basis of their physical properties as gases, vapours or particulate matter. In common usage, the terms “dust” and “particulates” are often used interchangeably. The term “particulate matter” refers to a category of airborne particles, typically less than 30 microns (µm) in diameter and ranging down to 0.1 µm and is termed total suspended particulate (TSP). The annual goal for TSP recommended by the NSW EPA is 90 micrograms per cubic metre of air (µg/m³).

The TSP goal was developed before the more recent results of epidemiological studies which suggested a relationship between health impacts and exposure to concentrations of finer particulate matter.

Emissions of particulate matter less than 10 µm and 2.5 µm in diameter (referred to as PM₁₀ and PM_{2.5} respectively) are considered important pollutants due to their ability to penetrate into the respiratory system. In the case of the PM_{2.5} category, recent health research has shown that this penetration can occur deep into the lungs. Potential adverse health impacts associated with exposure to PM₁₀ and PM_{2.5} include increased mortality from cardiovascular and respiratory diseases, chronic obstructive pulmonary disease and heart disease, and reduced lung capacity in asthmatic children.

The NSW EPA PM₁₀ assessment goals set out in the Approved Methods are as follows:

- a 24-hour maximum of 50 µg/m³.
- an annual average of 30 µg/m³.

The Approved Methods do not set any assessment goals for PM_{2.5}. In December 2000, the National Environment Protection Council (NEPC) initiated a review to determine whether a national ambient air quality criterion for PM_{2.5} was required in Australia, and the feasibility of developing such a criterion. The review found that:

- there are health effects associated with these fine particles;
- the health effects observed overseas are supported by Australian studies; and
- fine particle standards have been set in Canada and the USA, and an interim criterion is proposed for New Zealand.

The review concluded that there is sufficient community concern regarding PM_{2.5} to consider it an entity separate from PM₁₀.

As such, in July 2003, a variation to the Ambient Air Quality NEPM was made to extend its coverage to PM_{2.5}, setting the following Interim Advisory Reporting Standards for PM_{2.5}:

- a 24-hour average concentration of 25 µg/m³; and
- an annual average concentration of 8 µg/m³.

It is noted that the Advisory Reporting Standards relating to PM_{2.5} particles are reporting guidelines only at the present time and not intended to represent air quality criteria. A summary of the particulate guidelines is shown in **Table 3**.

Table 3 EPA Goals for Suspended Particulates

Pollutant	Averaging Time	Goal
TSP	Annual	90 µg/m ³
PM ₁₀	24 Hours	50 µg/m ³
	Annual	30 µg/m ³
PM _{2.5}	24 Hours	25 µg/m ³ (interim advisory reporting standard only)
	Annual	8 µg/m ³ (interim advisory reporting standard only)

6.2.2 Deposited Particulate

The preceding section is concerned in large part with the health impacts of airborne particulate matter. Nuisance impacts need also to be considered, mainly in relation to deposited dust. In NSW, accepted practice regarding the nuisance impact of dust is that dust-related nuisance can be expected to impact on residential areas when annual average dust deposition levels exceed 4 grams per square metre per month (g/m²/month).

Table 4 presents the impact assessment goals set out in the Approved Methods for dust deposition to avoid dust nuisance.

Table 4 EPA Goals for Allowable Dust Deposition

Averaging Period	Maximum Increase in Deposited Dust Level	Maximum Total Deposited Dust Level
Annual	2 g/m ² /month	4 g/m ² /month

Source: Approved Methods, OEH 2005.

6.3 Summary of Project Air Quality Goals

The air quality goals adopted for this assessment, which confirm to current EPA and Federal air quality criteria, are summarised in **Table 5**.

Table 5 Project Air Quality Goals

Pollutant	Averaging Time	Goal
TSP	Annual	90 $\mu\text{g}/\text{m}^3$
PM ₁₀	24 Hours	50 $\mu\text{g}/\text{m}^3$
	Annual	30 $\mu\text{g}/\text{m}^3$
PM _{2.5}	24 Hours	25 $\mu\text{g}/\text{m}^3$ (interim advisory reporting standard only)
	Annual	8 $\mu\text{g}/\text{m}^3$ (interim advisory reporting standard only)
Dust Deposition	Annual	Maximum Incremental (Project only) increase of 2 $\text{g}/\text{m}^2/\text{month}$ Maximum Total of 4 $\text{g}/\text{m}^2/\text{month}$ (Project and other sources)

Source: Approved Methods, OEH 2005.

7 LOCAL TOPOGRAPHY AND SENSITIVE RECEIVERS

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 topography of the local region surrounding the Springvale Mine area is presented in **Figure 2**.

Springvale Mine is located within a region of significant topographical variation as shown in **Figure 2**. The boundary of the Springvale Mine lies along the western edge of the Great Dividing Range and is situated at an altitude of between approximately 900 m to 1100 m AHD. It is bordered by the Wolgan Valley to the north and the Newnes Plateau to the east.

A number of residences are located in the area surrounding the Springvale Mine. A list of the identified nearest residences in the immediate vicinity of the Springvale Mine is presented in **Table 6** and **Figure 3**.

Concentrations of particulate matter have been assessed at each of these receptors, for relevant averaging periods as discussed in **Section 6**.

To maintain consistency with the noise impact assessment and previously submitted AQIAs, concentrations of particulate matter have also been assessed at a number of areas of recreational use. It is noted that air quality impact assessment criteria as outlined in **Section 6** are also applicable to areas where a transient population of primarily recreational users may be located, and it is therefore considered to be appropriate to present predicted impacts at these locations. The locations of these receptors are presented in **Table 7** and **Figure 3**.

Figure 2 Topography of the Surrounding Area

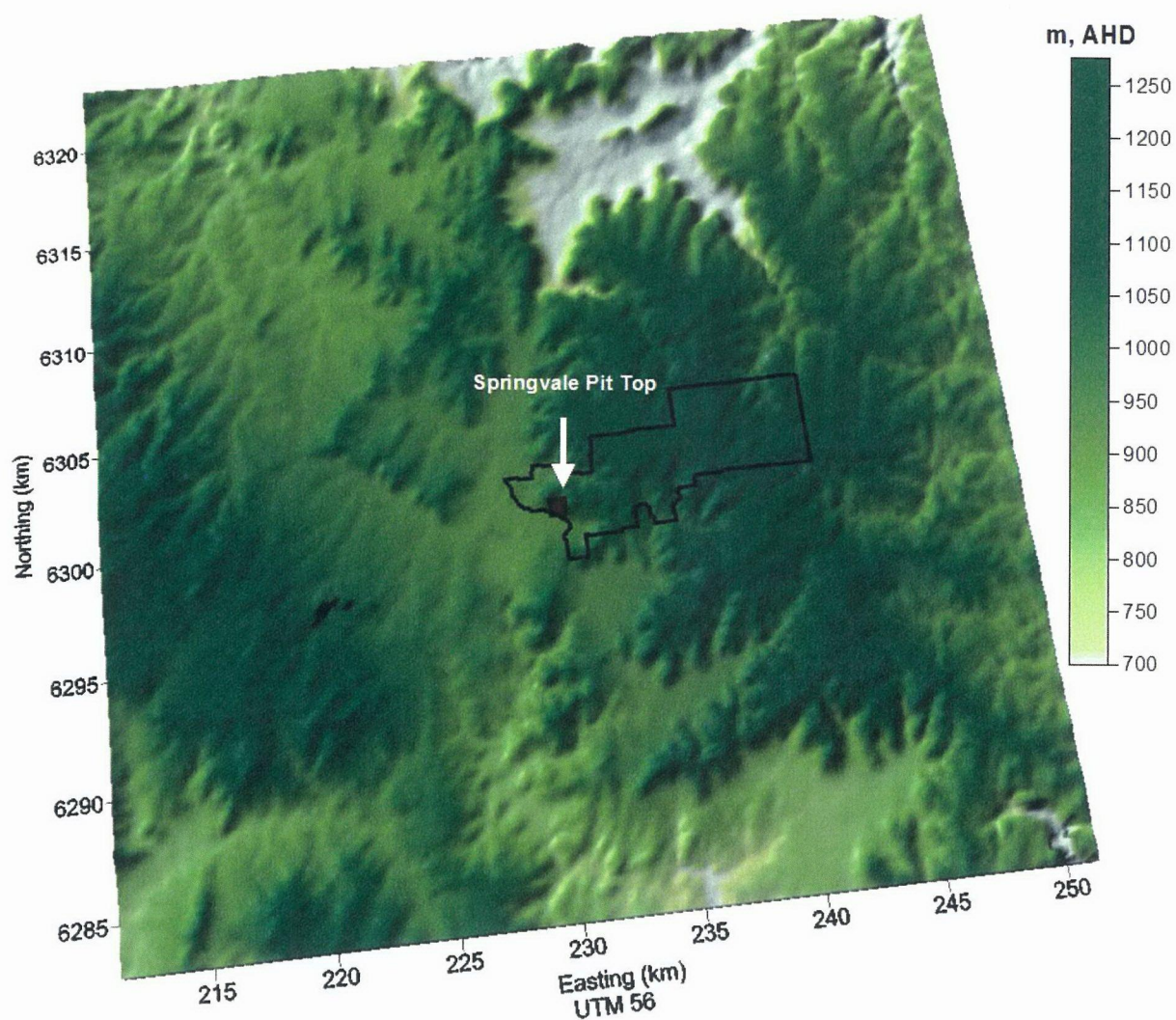


Figure 3 Sensitive Receptor Locations

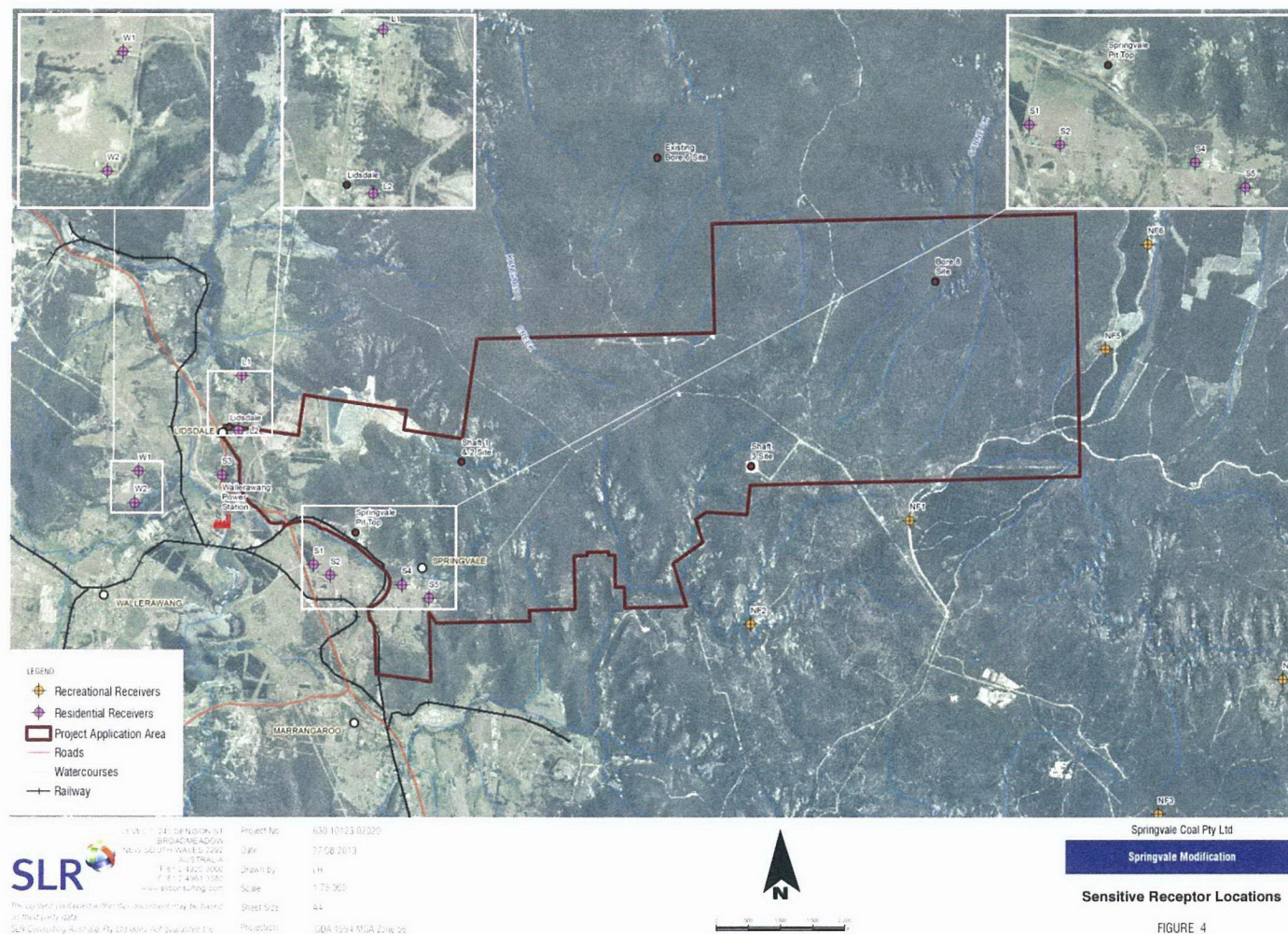


Table 6 Locations of Nearest Residential Receivers to Springvale Pit Top

Receptor	Easting (m)	Northing (m)	Zone	Elevation (m)	Approximate Distance to Nearest Site Component
S1	230,230	6,299,725	56H	905	750 m (Springvale Pit Top)
S2	230,456	6,299,541	56H	910	700 m (Springvale Pit Top)
S3	228,775	6,301,089	56H	880	2.1 km(Springvale Pit Top)
S4	231,589	6,299,387	56H	915	930 m (Springvale Pit Top)
S5	232,009	6,299,182	56H	940	1.4 km (Springvale Pit Top)
W1	227,484	6,301,148	56H	900	3.8 km (Springvale Pit Top)
W2	227,420	6,300,654	56H	887	3.9 km (Springvale Pit Top)
L1	229,078	6,302,626	56H	905	2.8 km (Springvale Pit Top)
L2	229,028	6,301,777	56H	912	2.4 km (Springvale Pit Top)

Table 7 Approximate Location of Nearest Sensitive Receivers on Newnes Plateau

Receptor	Easting (m)	Northing (m)	Zone	Elevation (m)	Approximate Distance to Nearest Site Component
NF1	239,483	6,300,390	56H	1,165	1.9 km (Bore 10 site)
NF2	237,015	6,298,782	56H	1,060	2.4 km (Shaft 3 site)
NF3	243,358	6,295,836	56H	1,160	6.3 km (Bore 10 site)
NF4	245,304	6,297,921	56H	970	5.4 km (Bore 10 site)
NF5	242,528	6,303,041	56H	1,080	1.9 km (Bore 10 site)
NF6	243,182	6,304,671	56H	1,045	2.6 km (Bore 9 site)
NF7	242,516	6,307,266	56H	925	3.9 km (Bore 8 site)
NF8	238,709	6,308,496	56H	1110	4.5 km (Bore 8 site)
NF9	235,079	6,309,656	56H	1030	7.3 km (Bore 8 site)

8 EMISSION ESTIMATION

8.1 Particulate Emission Sources - Operation

Activities associated with the modification that are likely to generate dust emissions include:

- Material handling (conveyor transfer points);
- Crushing;
- Dozers;
- Wheel generated dust;
- Ventilation shaft emissions; and
- Wind erosion.

Particulate emissions from these activities have been estimated as discussed below.

8.2 Activity Data and Assumptions - Operation

The fugitive particulate emissions from the modification were estimated based on emission estimation techniques listed in the NPI Emission Estimation Technique Manual for Mining, v 3.1 (DEH, 2012) and USEPA AP-42 emission factors.

In the absence of any site-specific monitoring data, measured data from the nearby Angus Place Colliery ventilation shaft was used to estimate the potential particulate emissions from the upcast ventilation shaft at Springvale Mine. Given that coal is extracted from the Lithgow seam from both Springvale Mine and Angus Place Colliery, it is considered appropriate to use the same emissions data for the ventilation fan at Springvale Mine.

A monitoring campaign was performed at the existing Angus Place Colliery vent shaft on 5 February 2013 and data relevant to this assessment is provided in **Table 8**.

Table 8 Emission Parameters – Upcast Ventilation Shaft

Parameter	Unit	Measured Value
Temperature	°C	25.4
Velocity	m/s	12.1
Volumetric Flow	Nm ³ /s	221.06
Moisture	%	1.6
Oxygen	%	20.7
Total Solid Particulates	mg/Nm ³	0.6
PM ₁₀	mg/Nm ³	<0.04
PM _{2.5}	mg/Nm ³	0.03

Note: Data used for existing upcast

Note: A different method was used for PM_{2.5} analysis than for PM₁₀ and TSP analysis. The limit of reporting (LOR) for the PM_{2.5} analysis method is lower than for the PM₁₀ method. A value at the LOR for PM₁₀ has been used in the assessment.

The activity data used in the emission estimation calculations are summarised in **Table 9**. For the purpose of developing the emission inventories, the following assumptions have also been applied.

- 6% silt content for coal in stockpile (SLR, 2012);
- 10% moisture content for coal in stockpile (SLR, 2012);
- Heavy vehicle frequency on the on-site unsealed road is two trips per hour;

- Crushing operation is enclosed;
- Ventilation rate at the upcast ventilation shaft is similar to the existing upcast ventilation shaft at Angus Place Colliery.

Table 9 Summary of Activity Data used to Estimate Particulate Emissions - Operation

Parameter	Activity Data
Coal throughput	4.5 Mtpa
Dozer operation	24 hours per day
Average number of heavy vehicle traffic on unsealed road	2 trips per hour
Potential wind erosion area	2.3 ha
Upcast ventilation fan ventilation rate	221.1 m ³ /s

8.3 Emission Controls

Based on the information provided by Centennial, the following emission control techniques employed on site have been incorporated into the emission estimation. As no particular design measures can be incorporated into the Project to avoid impacts associated with particulate emissions, the measures detailed below are generally management measures.

8.3.1 Coal Conveying Transfer Points

There are four coal transfer points within the Springvale Mine that have been considered within this assessment. These include:

- the conveyor exiting the drift;
- unloading from the conveyor onto the ROM stockpile;
- transfer of ROM coal from the conveyor into the screen/primary crusher; and
- transfer of crushed material onto the overland conveyor system.

The transfer points are enclosed on three sides. It has been estimated that this will reduce the particulate emissions by 40% (Table 96, Katestone 2011).

The above controls will continue to be in operation throughout the life of the Mine operations.

8.3.2 Crushing

The crusher operation is enclosed. It has been estimated that this will reduce the particulate emissions by 70% (Table 4, DSEWPC 2012). These controls will continue to be in operation throughout the life of the Mine operations.

8.3.3 Wind Erosion

Water sprays are used to suppress emissions of dust from coal stockpiles. It has been estimated that this will reduce the particulate emissions by 50% (Table 72, Katestone 2011). These controls will continue to be in operation throughout the life of the Mine operations.

8.4 Emission Estimation Techniques

The emission factors used for the estimation of TSP and PM₁₀ emissions from the Project Application Area are presented overleaf in **Table 10**.

Table 10 Summary of Emission Factors Used to Estimate Emissions

Activity	Emission Factor Equation	Units	Source	Variables	Controls Applied
Dozers on coal	$EF_{TSP} = 35.6 \times \frac{(s)^{1.2}}{M^{1.4}}$ $EF_{PM_{10}} = 0.75 \times 8.44 \times \frac{(s)^{1.5}}{M^{1.4}}$ $EF_{PM_{2.5}} = 0.022 \times 35.6 \times \frac{(s)^{1.2}}{M^{1.3}}$	kg/h/vehicle	AP42	M = moisture content (%) s = silt content (%)	No Control
Miscellaneous Transfer Points	$EF = k \times 0.0016 \times \frac{U^{1.3}}{\frac{2.2}{M^{1.4}}}$	kg/t	AP42	k = 0.74 (TSP) k = 0.35 (PM ₁₀) k = 0.053 (PM _{2.5}) U = mean wind speed (m/s) M = moisture content (%)	Enclosed on three sides – 40%
Primary Crusher	$EF_{TSP} = 0.01$ $EF_{PM_{10}} = 0.004$ $EF_{PM_{2.5}} = 0.0004$	kg/t	NPI EETM v3.1	Assumed PM _{2.5} /PM ₁₀ ratio of 0.1	Enclosed – 70%
Wheel generated dust from unpaved roads (used by light duty vehicles)	$EF = \frac{0.4536}{1.6093} * k \times \left(\frac{s}{12}\right)^a \times \left(\frac{W}{3}\right)^b$	kg/VKT	NPI EETM v3.1	k = 4.9 (TSP) k = 1.5 (PM ₁₀) k = 0.15 (PM _{2.5}) a = 0.7, b = 0.45 (TSP) a = 0.9, b = 0.45 (PM ₁₀) S = mean wind speed (m/s) M = moisture content (%) s = silt content (%)	Level 2 Watering – 50% control for construction and rehabilitation. No control for operation
Wind Erosion	$EF_{TSP} = 0.4$ $EF_{PM_{10}} = 0.2$ $EF_{PM_{2.5}} = 0.03$	kg/ha/yr	NPI EETM v3.1	Assumed PM _{2.5} /PM ₁₀ ratio of 0.15	Water Sprays – 50%

The National Pollutant Inventory Manual for Mining, Version 3.1 (DSEWPC, 2012) and US EPA AP-42 Compilation of Emission Factors contain emission factors for TSP and PM₁₀. PM_{2.5} emission factors are provided for some activities, however no PM_{2.5} emission factors are provided for wind erosion within the NPI or US EPA AP-42. Some research has been conducted by the Midwest Research Institute (MRI) on behalf of the Western Regional Air Partnership (WRAP) with findings published within the document entitled *'Background Document for Revisions to Fine Fraction Ratios Used for AP-42 Fugitive Dust Emission Factors'* (MRI, 2006). This document provides a proposed PM_{2.5}/PM₁₀ ratio of 0.15 for wind erosion sources. This ratio was used within this assessment to calculate the emissions of PM_{2.5} attributable to wind erosion at the Project Application Area.

8.5 Emission Inventory

Based on the information presented above, a particulate emissions inventory has been compiled for the modification (**Table 11**). Details of the emission calculations and emission factors used in estimating emissions are presented in **Appendix B**.

Table 11 Emission Inventory for the Modification

Activity	Estimated Emissions (kg/annum)		
	TSP	PM ₁₀	PM _{2.5}
Conveyor transfer points	2,996	1,417	215
Crushing	13,500	5,400	540
Dozers	134,195	32,444	2,952
Vehicle movements on unpaved roads	29,268	6,790	679
Wind erosion from exposed areas	4,030	2,015	302
Ventilation fan	4,183	279	209
Total Particulate Emissions	188,172	48,345	4,897

9 ATMOSPHERIC DISPERSION MODELLING

9.1 Model Selection

Emissions from the proposed modification have been modelled using the US EPA's CALPUFF (Version 6.267) modelling system. CALPUFF is a transport and dispersion model that ejects "puffs" of material emitted from modelled sources, simulating dispersion and transformation processes along the way. In doing so it typically uses the fields generated by a 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 concentration or hourly deposition fluxes evaluated 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.

The advantages of using CALPUFF (rather than using a steady state Gaussian dispersion model such as AUSPLUME) is its ability to handle calm wind speeds (<0.5 m/s) and the effects of complicated terrain on plume dispersion. Steady state models assume that meteorology is unchanged by topography over the modelling domain and may result in significant over or under estimation of air quality impacts. More advanced dispersion models (such as CALPUFF) are approved for use by many regulatory authorities in situations where these models may be more appropriate than use of the Ausplume model. Such situations include those noted above (i.e. high frequency of calm wind conditions and/or complicated terrain).

9.2 Meteorological Modelling Methodology

To adequately characterise the dispersion meteorology of the Project Application Area, information is needed on the prevailing wind regime, ambient temperature, rainfall, relative humidity, mixing depth and atmospheric stability. The meteorology of the Project Application Area was characterised based on a 3-dimensional prognostic meteorological dataset for the region surrounding the Project Application Area.

9.2.1 MM5

The three dimensional prognostic dataset generated by the Pennsylvania State University/National Centre for Atmospheric Research, or MM5, model was created and assimilated in the CALMET modelling process. The MM5 model is a prognostic mesoscale wind field model with four-dimensional data assimilation. CALMET's wind model allows MM5 generated data to be used as initial pseudo-observations (Scire *et al.*, 2006).

For this study, an MM5 meteorological dataset was obtained for a 120 km x 120 km domain for the 2009 and 2010 calendar years, centred over the Project Application Area, with a spatial grid resolution of 12 km. The model has 40 vertical levels, with the lowest level beginning at 11 m above ground level ranging to 3,500 m. The MM5 dataset contains the two-dimensional and three-dimensional parameters listed in **Table 12**.

Table 12 MM5 Dataset Parameters

Hourly 3-Dimensional Parameters	Hourly 2-Dimensional Parameters
Wind speed and direction	Sea-level pressure
Temperature	Rainfall amount
Pressure	Snow cover
Geopotential height	Short wave and long wave radiation at the surface
Vertical velocity	Air temperature and specific humidity at 2m
Relative humidity	Wind speed and direction at 10m
Mixing ratios for water vapour, cloud water, rain and other precipitation	Sea surface temperature

9.2.2 CALMET

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.

The MM5 data generated by the Pennsylvania State University/National Centre for Atmospheric Research was used for input into CALMET. The CALMET model was run for both the 2009 and 2010 calendar years. **Table 13** details the parameters used in the meteorological modelling. No surface, upper air or buoy observations were used in the CALMET model ('No-Obs Mode' hereafter). This approach is recommended by NSW EPA (2010) as:

- No-Obs mode allows the important benefits of the non-steady-state approach in CALPUFF to be included in the dispersion modelling (e.g., spatially varying meteorology and dispersion, causality, recirculation, stagnation, pollutant build-up, fumigation, etc.);
- No-Obs mode makes use of three-dimensional, hourly prognostic meteorological data often available at high resolution to drive CALMET and CALPUFF;
- No-Obs mode greatly simplifies the preparation of the CALMET inputs because a large number of input variables dealing with observational data are not required and the difficulties of dealing with potentially incomplete observational datasets are eliminated;
- No-Obs mode provides a relatively straightforward approach that facilitates agency review and approval of the CALMET/CALPUFF simulations;

It was concluded from the meteorological analysis for the years 2009 and 2010, that there was no apparent trend in the meteorological parameters suggesting the suitability of one year over the other. Therefore the meteorological conditions in the most recent year of available data (2010) were used for CALPUFF dispersion modelling. The modelled data for year 2010 for Springvale Mine are presented in the following sections. The data for 2009 and 2010 can be found in **Appendix C**.

Table 13 CALMET Configuration Used for this Study

Meteorological grid domain	40 km x 40 km
Meteorological grid resolution	0.2 km
Vertical Resolution (Cell Heights)	10 (0 m, 20 m, 40 m, 80 m, 160 m, 320 m, 640 m, 1,200 m, 2,000 m, 3,000 m and 4,000m)
Modelling Year	2010
Initial guess field	3D output from MM5 data

9.3 Meteorological Data Used in Modelling

9.3.1 Wind Speed and Direction

A summary of the annual wind behaviour predicted by CALMET for the site is presented as windroses in **Figure 4**. The frequency of wind speed variation is presented in **Figure 5**.

Figure 4 Wind Roses for the Project Site, as Predicted by CALMET (2010)

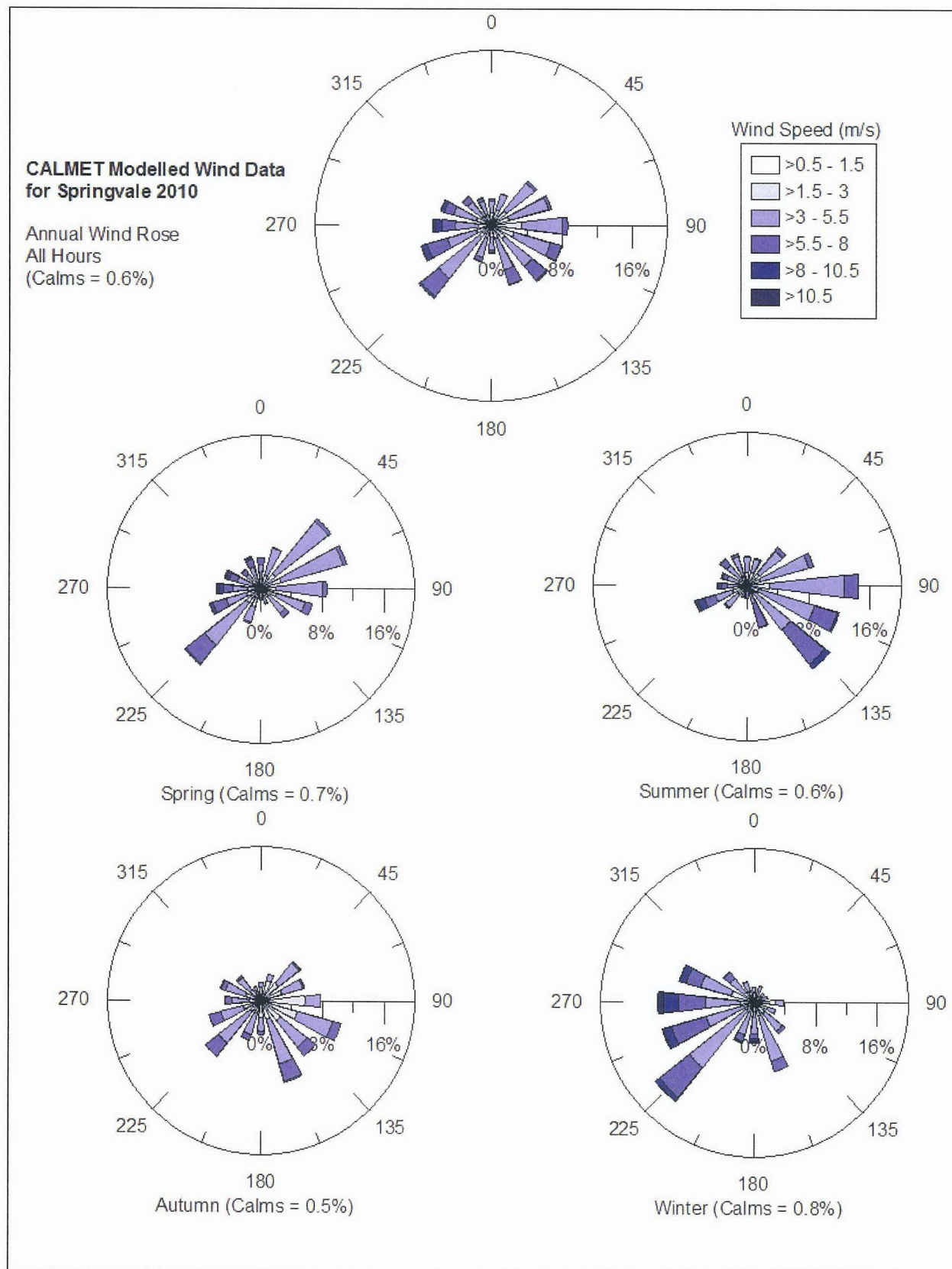


Figure 5 Wind Speed Distribution Predicted by CALMET for the Project Site (2010)

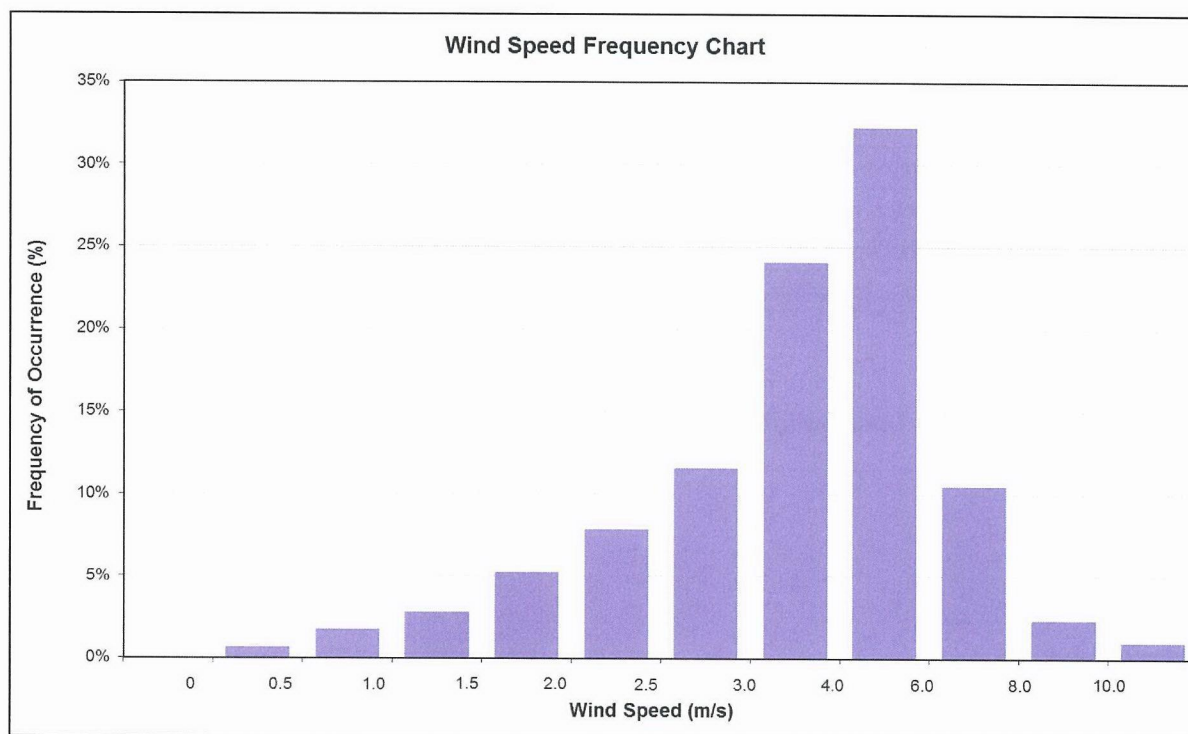


Figure 4 and **Figure 5** indicate that the site experienced predominantly light to moderate winds (between 1.5 m/s and 8 m/s), with the prevailing wind direction from the southwest and southeast quadrants. Calm wind conditions (wind speed less than 0.5 m/s) were predicted to occur 0.6% of the year during 2010.

The seasonal wind roses indicate that:

- In spring, winds are light to moderate (1.5 m/s to 8 m/s) from the southwest and the north-eastern quadrant.
- In summer, the winds are light to strong (1.5 m/s to 10.5 m/s) from the southeastern quadrant.
- In autumn, winds are light to moderate from the southeastern quadrant.
- In winter, winds are light to strong and are predominantly from the southwest.

9.3.2 Atmospheric Stability

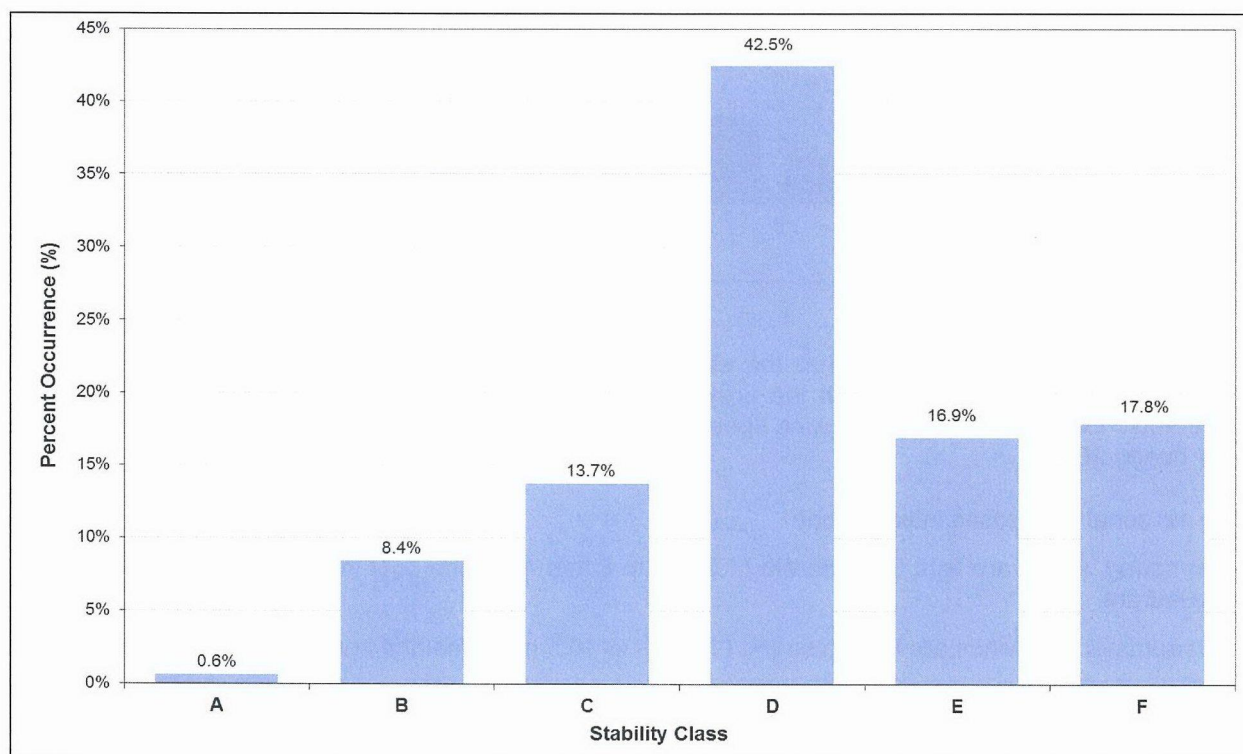
Atmospheric stability refers to the tendency of the atmosphere to resist or enhance vertical motion. The Pasquill-Turner assignment scheme identifies six Stability Classes, A to F, to categorise the degree of atmospheric stability (see **Table 14**). These classes indicate the characteristics of the prevailing meteorological conditions and are used as input into various air dispersion models.

The frequency of each stability class predicted by CALMET is presented in **Figure 6**. The results indicate a high frequency of conditions typical to Stability Class D. Stability Class D is indicative of neutral conditions, conducive to a moderate level of pollutant dispersion due to mechanical mixing.

Table 14 Description of Atmospheric Stability Classes

Atmospheric Stability Class	Category Description
A	Very unstable, low wind, clear skies, hot daytime conditions
B	Unstable, clear skies, daytime conditions
C	Moderately unstable, moderate wind, slightly overcast daytime conditions
D	Neutral, high winds or cloudy days and nights
E	Stable, moderate wind, slightly overcast night-time conditions
F	Very stable, low winds, clear skies, cold night-time conditions

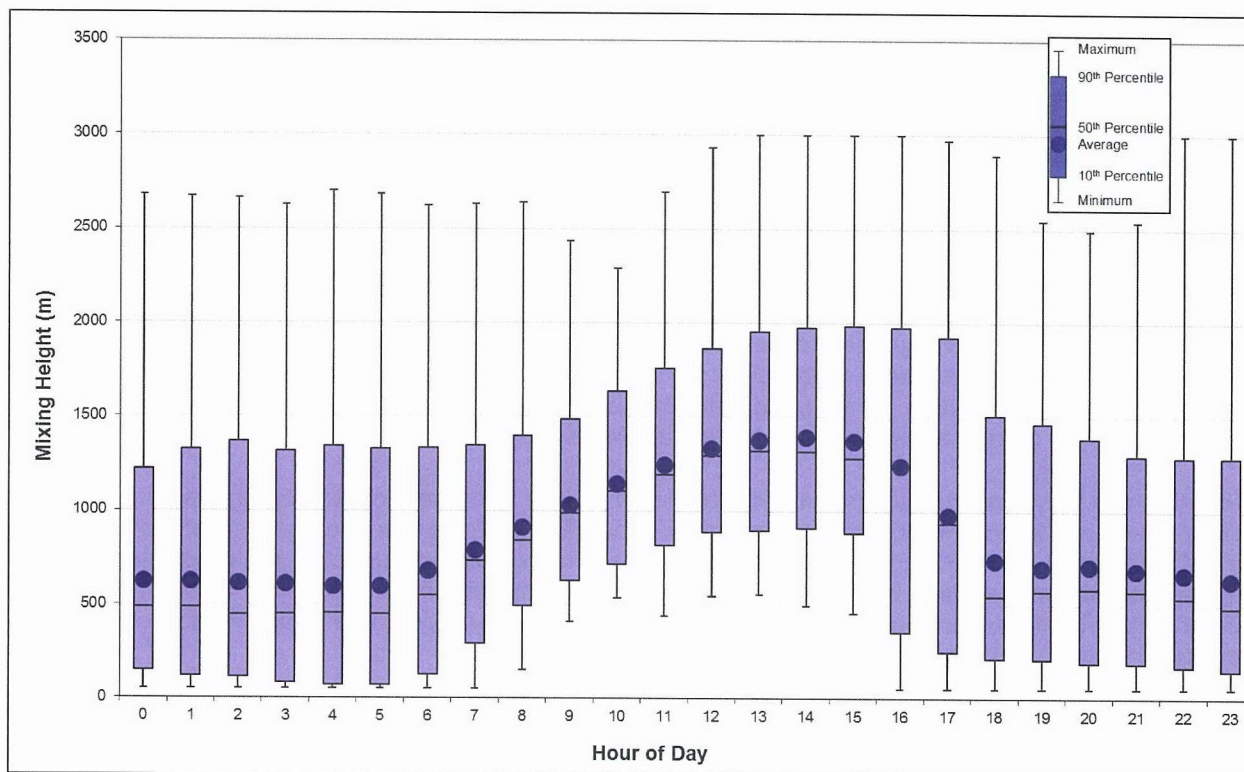
Figure 6 Stability Class Distribution Predicted by CALMET for the Project Site (2010)



9.3.3 Mixing Heights

Diurnal variations in maximum and average mixing depths predicted by CALMET at the Project Application Area during 2010 are illustrated in **Figure 7**. 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 7 Mixing Heights Predicted by CALMET for the Project Site (2010)



9.4 Modelling of Wind Erosion Emissions

An hourly-variable emission file was developed for the wind erosion sources from the total estimated annual emissions using a relationship between the cube of the hourly averaged wind speeds and sum of the hourly cubic wind speeds contained in the meteorological file. This cubic relationship provides a more realistic distribution of emissions with the peak emissions being modelled during high wind speed events and lower emissions being modelled during lower wind speed events.

10 EXISTING BACKGROUND PARTICULATE LEVELS

The main focus of this report is the assessment of the potential impacts of the modification on the closest sensitive receptors to the mine. In this case, these sensitive receptors are six residences and seven recreational areas, identified in **Section 7**. The purpose of assessing background air quality is to determine the concentrations of air pollutants currently experienced at these residences, with the predicted concentrations from the modification added to these background concentrations to identify the likely future air quality impacts. It is therefore important to gain an understanding of current background air quality at these residential locations.

The air quality in the region surrounding the Springvale Mine is influenced by emissions generated by a range of sources, originating from both within and outside of the local area. Specifically, air quality will be influenced by traffic-generated pollution (e.g. motorised recreational vehicles travelling in the Newnes State Forest), emissions from power stations and associated ash dams in the area, other coal mining operations, pollution transported into the area from more distant sources and pollution generated by the current emissions from Springvale Mine itself.

To determine the incremental impact of particulate emissions from the modification on the surrounding environment and sensitive receptors, a dispersion modelling exercise has been performed, as detailed in **Section 8** and **Section 9**. To appropriately assess the *cumulative* impact of the modification, this incremental impact needs to be added to a dataset which includes the influences of all other sources of particulate in the region, and is representative of the air quality likely to be experienced at sensitive receptor locations without the impact of Springvale Mine.

As required by the Approved Methods, this background dataset is required to be contemporaneous with the meteorological data used within the assessment, and (for PM₁₀) include daily measurements. Given the limited availability of datasets in the area which meet both of these criteria, data from Bathurst has been selected for use within the assessment where appropriate, with justification for its use detailed below.

10.1 Suspended Particulate Matter

TSP and PM₁₀

On-site ambient TSP and PM₁₀ monitoring has been performed by Centennial at the Springvale Mine since December 2010. The ambient air quality monitoring program has been incorporated into a wider environmental monitoring campaign, and includes PM₁₀ and TSP measurements using two co-located High Volume Air Samplers (HVAS, refer **Figure 8**). The monitoring is undertaken in accordance with AS3580.9.3:2003 and AS3580.9.6:2003 for TSP and PM₁₀, respectively.

The measured 24-hour average PM₁₀ and TSP concentrations are presented graphically in **Figure 9**, while the annual average TSP and PM₁₀ concentrations recorded during 2011 are summarised in **Table 15**.

Of note, the ratio of mean TSP to PM₁₀ measurements in 2011 is of the order of 2.5 to 1. This ratio is the same as that measured at the nearby Angus Place Colliery which indicates that the mining operations occurring at both sites results in the same ratio of downwind TSP/PM₁₀ concentrations. Also, it is noted that the monitored TSP and PM₁₀ concentrations at Springvale HVAS includes contributions from existing activities at Springvale Mine as well as other industrial facilities in the region.

The monitoring data was measured on a 1-in-6-day cycle and is also collected during a different year to the meteorological data used in this study, and therefore is not suitable for use in a contemporaneous cumulative impact analysis.

Figure 8 Location of the HVAS and Dust Deposition Gauges at Springvale Mine

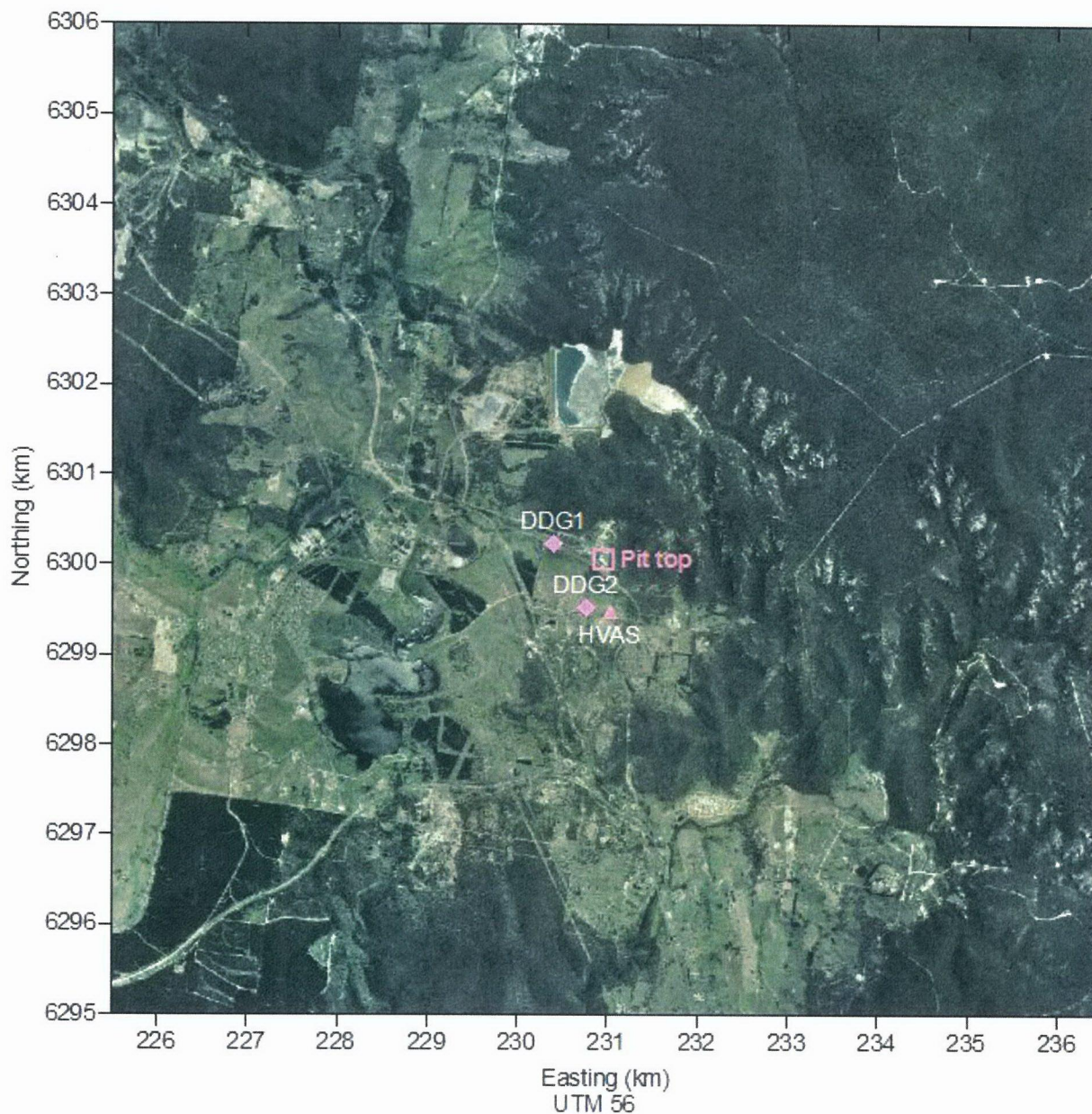


Figure 9 24-Hour Average TSP and PM₁₀ Concentrations Measured by the Springvale HVAS

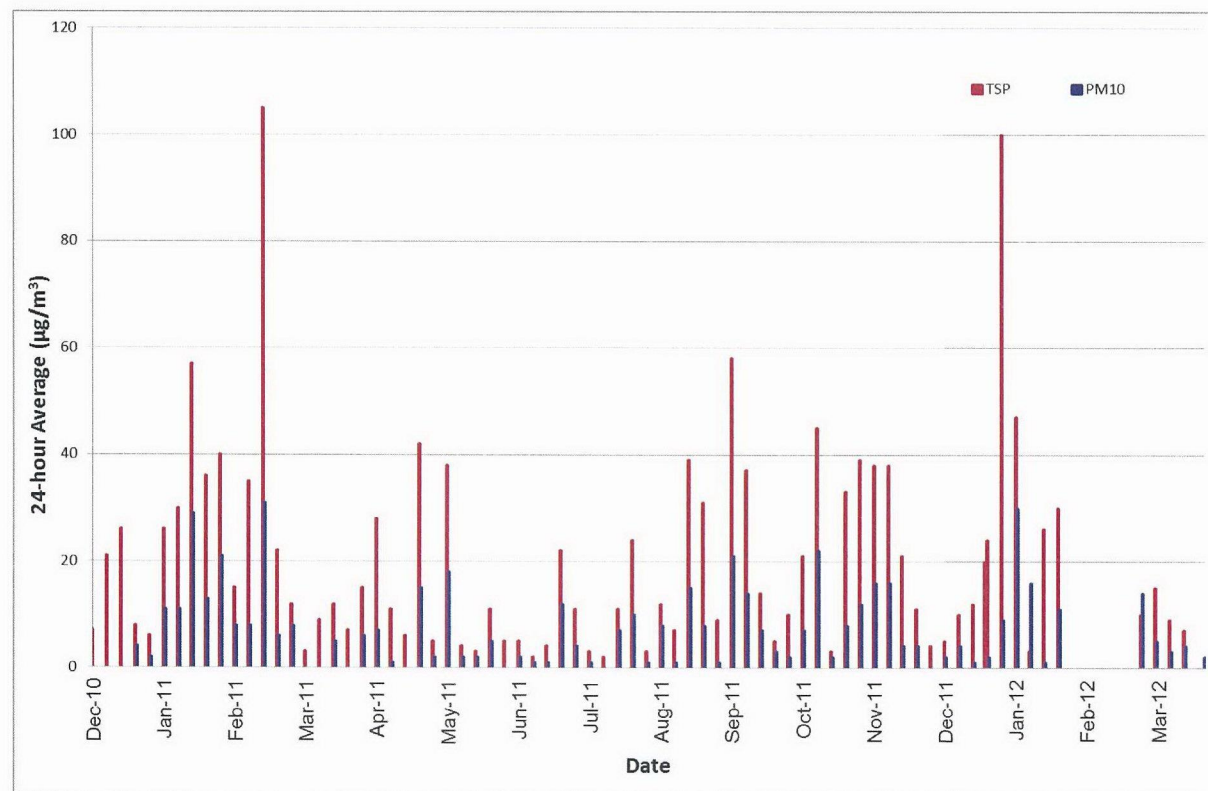


Table 15 Springvale HVAS 2011 Annual Average Particulate Concentrations

Particulate Size	2011 Annual Average (µg/m ³)
TSP	19.7
PM ₁₀	8.2

The nearest OEH monitoring station measuring continuous PM₁₀ concentrations is located in Bathurst, approximately 50 km northwest of the Project Application Area. It is recognised that local dust-generating activities surrounding the Project Application Area and Bathurst are significantly different. Mining, coal processing activities and Wallerawang Power Station are the key local potential suspended particulate sources in the area surrounding the Springvale Mine. Residential activities (such as lawn mowing, wood heaters) and vehicle emissions are the likely local sources of suspended particulate in the Bathurst area. Since the intensity and type of potential dust generating activities at Bathurst and the area surrounding the Springvale Mine are different, a further investigation was carried out to justify the use of ambient monitoring data recorded at the OEH-operated Bathurst monitoring site in this assessment.

Since ambient monitoring data at Springvale HVAS are not available for 2010 calendar year, data from the Angus Place HVAS (located approximately 5 km north of SMEP) are also included in this study for investigation purposes. **Figure 12** and **Figure 13** present comparisons of the 24-hour average PM₁₀ concentrations measured at Bathurst, Springvale HVAS and Angus Place HVAS. It is noted that the monitoring data at Springvale HVAS includes the contribution from the existing operations at Springvale Mine.

It can be observed from **Figure 12** and **Figure 13** that PM₁₀ concentrations measured at Springvale Mine are consistently lower than those measured at the Bathurst monitoring station. It is difficult to identify any trend between the two datasets but from examination of **Figure 12**, which shows a scatter plot of contemporaneous PM₁₀ measurements at Springvale and Bathurst, the Bathurst data can be seen to provide a conservative approximation of the background air quality experienced at the Springvale Mine and surrounding receptors.

Based on the comparison shown in **Figure 10** and **Figure 13**, the use of continuous ambient monitoring data from Bathurst for 2010 is concluded to be a conservative and appropriate approach for the assessment of potential cumulative impacts for the Springvale Mine.

Figure 10 Comparison of Measured 24-Hour Average PM₁₀ Concentrations – All days

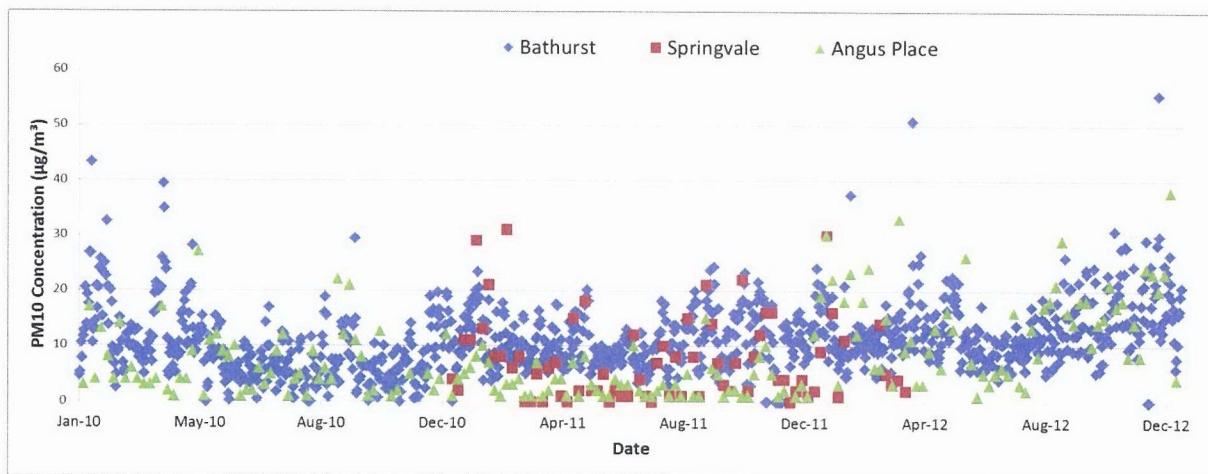


Figure 11 Comparison of Measured 24-Hour Average PM₁₀ Concentrations – HVAS Sampling Days Only

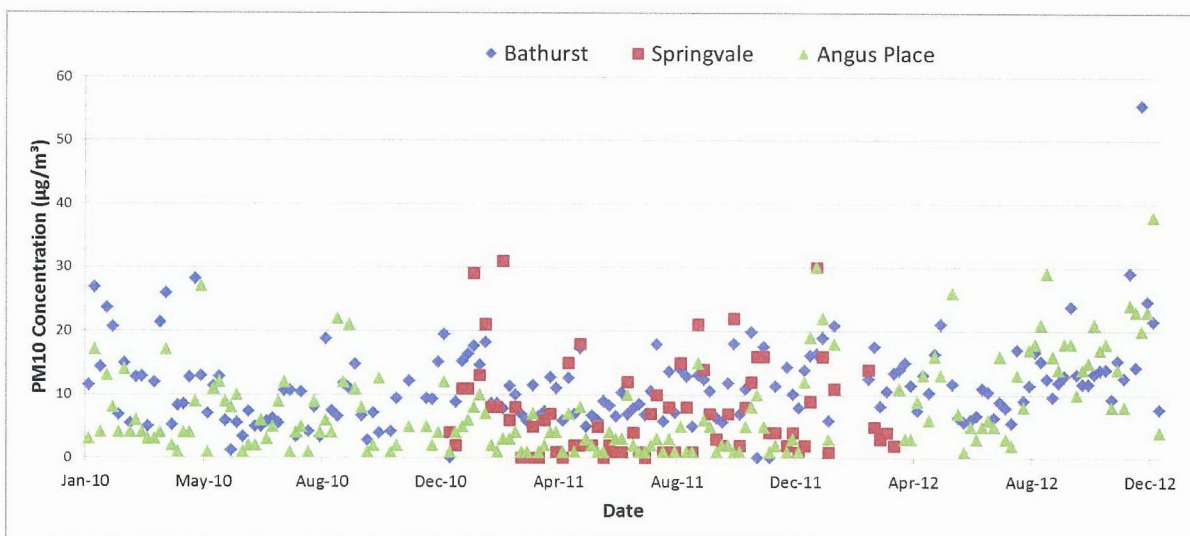
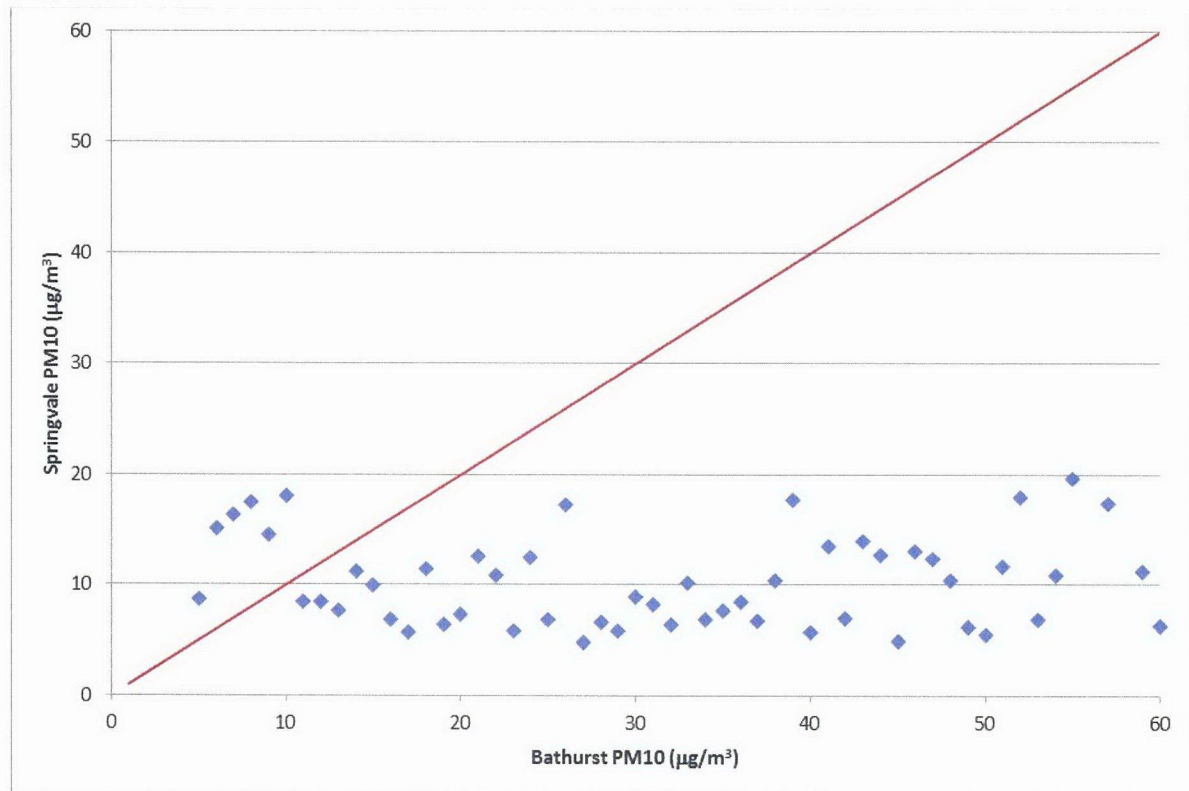


Figure 12 Bathurst PM₁₀ versus Springvale PM₁₀ data (December 2010 to April 2012)



Note: Red line denotes 1:1 relationship

A summary of the 24-hour average PM₁₀ concentrations measured by the Bathurst monitoring site is presented in **Table 16**. All data is presented as 24-hour average concentrations in µg/m³, except averaging period (hours), monitoring start and end dates (dates), skew and kurtosis (dimensionless), and data capture (percentage of the monitoring period).

Table 16 indicates that the mean PM₁₀ 24-hour concentrations for 2010, 2011 and 2012 calendar years range between 9.5 µg/m³ and 13.5 µg/m³. The maximum PM₁₀ 24-hour concentration for 2010 (43.3 µg/m³) is significantly higher than 2011 (24.3 µg/m³) but approximately 12 µg/m³ lower than for 2012.

Table 16 Statistical Summary of Measured 24-Hour Average PM₁₀ Concentration at Bathurst

Statistic				
Averaging period		24 hours	24 hours	24 hours
Monitoring data start		01-01-2010	01-01-2011	01-01-2012
Monitoring data end		31-12-2010	31/12/2011	31-12-2012
Data points		357	355	364
Mean		9.5	11.0	13.4
Standard deviation		6.5	4.4	6.3
Skew ¹		1.6	0.6	2.0
Kurtosis ²		3.8	-0.2	8.5
Minimum		0.1	2.8	3.9
Percentiles	1	0.5	3.4	4.7
	2	0.7	3.8	5.2
	3	1.3	4.5	5.5
	5	1.9	5.2	5.8
	10	3.1	5.9	6.8
	25	5.0	7.8	9.2
	50	8.0	10.3	12.2
	75	12.5	13.8	16.3
	90	18.3	17.5	21.3
	95	21.1	18.6	24.1
	97	24.8	20.0	26.4
	98	26.5	21.0	27.9
	99	30.8	22.3	30.2
Maximum		43.3	24.3	55.5
Data Capture		98%	97%	99%

- Notes
- 1 Skew represents an expression of the distribution of measured values around the derived mean. Positive skew represents a distribution tending towards values higher than the mean, and negative skew represents a distribution tending towards values lower than the mean. Skew is dimensionless.
 - 2 Kurtosis represents an expression of the value of measured values in relation to a normal distribution. Positive skew represents a more pointed distribution, and negative skew represents a distribution more flattened than a normal distribution. Kurtosis is dimensionless.

PM_{2.5}

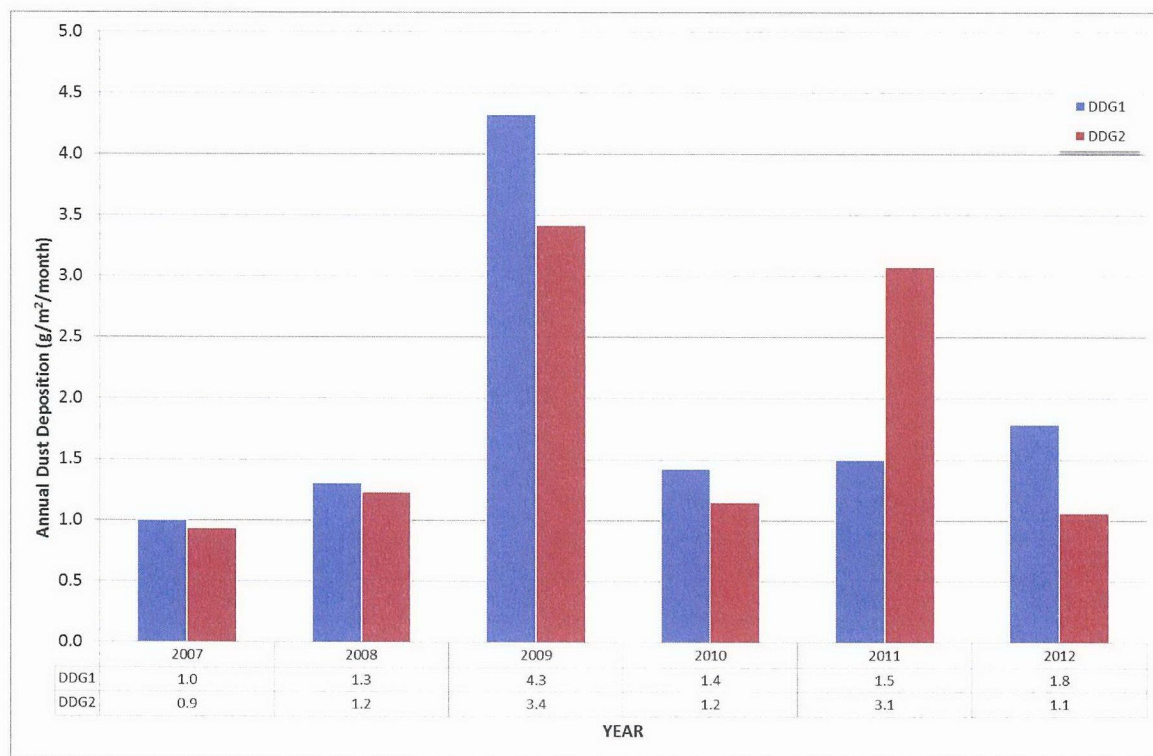
No ambient background monitoring data for PM_{2.5} are available in the local area or at nearest OEH monitoring sites. Therefore a background PM_{2.5} dataset cannot be used within this assessment and comparison of the incremental concentrations to the criteria has been performed.

10.2 Deposited Dust

Static dust monitoring commenced in January 2007 at two monitoring locations (DDG1 and DDG2) surrounding the Project Application Area. The locations of the two dust deposition gauges are shown in **Figure 8**.

Monitoring results for dust deposition are presented in **Figure 13** for the years 2007 to 2011. All dust deposition results met the assessment criterion of 4 g/m²/month with the exception of 2009. Monthly dust deposition results were shown to be elevated in September 2009 (between 10 g/m²/month and 28 g/m²/month) and October 2009 (between 7 g/m²/month and 10 g/m²/month) due to several dust storms experienced at the end of September 2009.

Figure 13 Monitoring Results for Dust Deposition – Springvale Mine



10.3 Assessment of Cumulative Impacts

A number of other industrial facilities located in the vicinity of Springvale Mine may contribute to the cumulative impacts on the local airshed. The identified industrial facilities which are likely to have a cumulative impact on the local airshed are identified in **Table 17**.

Table 17 Identified Industrial Facilities in the Vicinity of the Springvale Mine

Industrial Facility	Location (Figure 14)	Impact Assessment
Springvale Pit Top	A	Section 11
Springvale Coal Services, north of Blackmans Flat	B	Section 10.3.1
Mount Piper Power Station (Mt Piper A)	C1	Section 10.3
New Base Load Power Station (Mt Piper B)	C2	Section 10.3
Western rail coal unloader	C3	Section 10.3.2
Wallerawang Power Station (WPS)	D	Section 10.3
Angus Place Colliery	E	Section 10.3.3
Lidsdale Siding Coal Loading Facility (LSCLF)	F	Section 10.3.4
Pine Dale Coal Mine (Yarraboldy extension)	G	Section 10.3.5
Ivanhoe and Invincible Collieries	Not Shown	Section 10.3.6
Clarence Colliery	Not Shown	Section 10.3.7

The location of the Springvale Pit Top with respect to the locations of other identified industrial facilities in its vicinity is shown in **Figure 14**.

It is noted that the Western rail coal unloader (C3) associated with Mount Piper Power Station was approved in June 2009 but construction is yet to start on this facility. Also included in this assessment is the Mount Piper Base Load power station which was approved in January 2010.

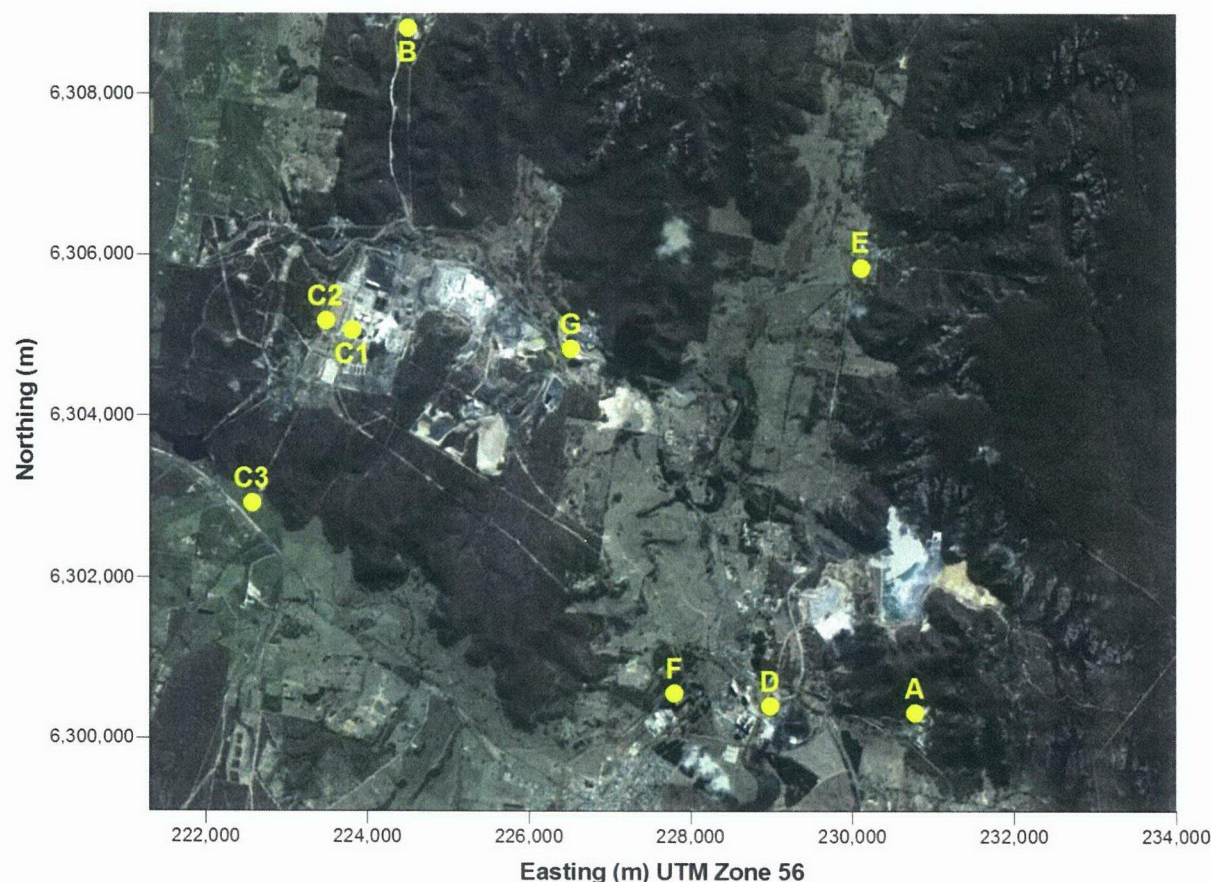
Given that the continuous particulate monitoring data obtained from the Bathurst OEH site is clearly shown in **Section 10.1** to be a conservative estimation of the actual particulate environment (as monitored) surrounding the Springvale Mine, it can be confidently considered that the following existing activities and projects located in the area surrounding the Springvale Mine are taken into account within the AQIA.

- Wallerawang Power Station (coal-fired, 1,000 MW).
- Mount Piper Power Station (Mt Piper A).

The above also include associated infrastructure such as coal stockpiles and ash dams.

- Haul roads to Mount Piper and Wallerawang Power Stations.
- Existing Angus Place Colliery.
- Current Lidsdale Siding and Coal Services Operations.
- Clarence, Ivanhoe and Invincible Collieries.
- Surrounding forestry activities and recreational activities (e.g. vehicles within the Newnes State Forest).

Figure 14 Location of Springvale Mine and other Industrial Facilities



Given the conservatism in the adoption of the Bathurst particulate data it can also be considered that applications not approved, but advanced within the planning system may also be appropriately taken into account within the AQIA. Further discussion of each of the following projects is considered below:

- Wallerawang Power Station Development Application (024/11DA) for new storage silos.
- Mount Piper Power Station (Mt Piper B) approved in January 2010 and new rail coal unloader (new rail line of 5 km length and coal conveyor 4 km length) approved June 2009.
- Part 3A application for new ash placement areas at the existing Mount Piper Power Station.
- Part 3A application for an open cut mining extension to the Pine Dale Coal Mine (located near Blackmans Flat 17 km northwest of Lithgow).
- A (soon to be) approved (not yet constructed) new upcast ventilation shaft at Angus Place Colliery.
- Lidsdale Siding Upgrade Project – a Centennial project to improve rail loading facilities including a reclaim tunnel and train track extension, near Wallerawang.
- Centennial Western Coal Services Project – a Centennial project for a new washery, a private haul road (linking, via a bridge, the existing Angus Place to Mount Piper private haul road with the Springvale Coal Services Site), and new reject emplacement areas.

10.3.1 Springvale Coal Services

Springvale Coal Services is located to the immediate west of the Springvale Mine and processes coal from the Springvale operations. All processing operations within the Springvale Coal Services site are enclosed and it is not considered that cumulative impacts would occur between that operation and the Project Application Area, especially given the 10.5 km separation distance between these two operations.

10.3.2 Mount Piper Power Station Western Coal Unloader

The Western Coal Unloader (WCU) associated with the Mt Piper Power Station gained Project Approval in June 2009. The WCU is designed to enable the supply of coal by rail to the Power Station from a number of mines, mainly to the north of the Power Station (SKM, 2007). The WCU will be located approximately 2 km to the south of the Mt Piper Power Station and approximately 9 km northwest of the Project Application Area. The Environmental Assessment (SKM, 2007) for the WCU assessed the impact of particulate matter for the construction and operational scenarios.

It was concluded that during the operational scenario, maximum predicted 24-hour average incremental PM₁₀ concentration at 'Receiver 1' was 9 µg/m³ (SKM, 2007). The location of 'Receiver 1' is approximately 6 km from the Springvale Pit Top.

Given such low concentrations at these distances from the Springvale Pit Top, it is considered that the WCU will not have a cumulative impact on particulate concentrations associated with the Project. The WCU has therefore not been considered further within this report.

10.3.3 Angus Place Colliery

Angus Place Colliery is located approximately 6 km north of the Springvale Mine pit top as shown in **Figure 14**. A proposal to extend longwall operations and associated surface infrastructure is currently being assessed. The assessment currently being performed examines particulate impacts during construction, operation and rehabilitation, and indicates predicted maximum incremental 24 hour PM₁₀ concentrations during construction (and concurrent operation) of between 0.1 µg/m³ and 6 µg/m³ at locations which are approximately 5 km to the north of the Springvale Mine pit top (refer **Figure 14**). At the closest receptor to the Springvale Mine operations (1.9 km to the northwest of the Springvale Mine pit top), maximum 24 hour average PM₁₀ concentrations are approximately 0.3 µg/m³.

Given the small predicted incremental impact from the Angus Place Colliery at locations close to the Springvale Mine pit top, it has not been considered further within this report.

10.3.4 Lidsdale Siding

A dispersion modelling exercise has been performed by SLR Consulting (SLR 2012c) and the impacts from the upgraded Project operations were assessed at ten identified sensitive receptors in the vicinity of the Lidsdale Siding Coal Loading Facility (LSCLF). The maximum incremental (Project only) 24-hour average PM₁₀ concentrations (17.1 µg/m³) were predicted to occur at a receptor which is approximately 4 km to the west of the Springvale Mine.

Further investigation of the potential cumulative impacts from this Project on the receptors closest to the Springvale pit top was performed during the AQIA for the "*Springvale Colliery Bore 8 Dewatering Facility Project*" (SLR 2012d). Predicted maximum 24 hour average PM₁₀ concentrations from the operation of the LSCLF were 0.5 µg/m³ at Receptor R2 (refer **Figure 3**).

Considering the small incremental concentration resulting from the proposed operation of the LSCLF at receptors surrounding the Project Application Area, it is considered that the background data from Bathurst (refer **Section 10.4**) will appropriately include such impacts. The operation of the LSCLF is not considered further within this assessment.

10.3.5 Pine Dale Coal Mine Extension Project

The Pine Dale Coal Mine is located approximately 5 km northwest of the Springvale Mine pit top operations. Recently, an application has been submitted to the Department of Planning to extend the Pine Dale Coal Mine (Pine Dale Coal Mine Stage 2 Extension Project, SLR Consulting, 2011). The Stage 2 extension extraction operations are not anticipated to occur in conjunction with existing extraction operations, although the Yarraboldy extension is located closer to the Springvale Mine pit top and sensitive receptor locations than current operations. Dispersion modelling predictions of the proposed operations (Stage 2 extension) indicated predicted maximum incremental 24-hour average PM₁₀ concentrations of between 2 µg/m³ and 5 µg/m³ at a receptor located approximately 6.5 km northeast of the Springvale Mine pit top. Given the small predicted incremental impact from the Pine Dale Coal Mine Extension, the proposed expansion has not been considered further within this report.

10.3.6 Ivanhoe and Invincible Collieries

Ivanhoe and Invincible Collieries are located approximately 15 km to the northwest of the Springvale Mine. Given the separation distance between the Ivanhoe and Invincible Collieries and the Springvale Mine, it is not considered that cumulative impacts would occur between the three operations.

10.3.7 Clarence Colliery

Clarence Colliery is located approximately 13 km to the southeast of the Springvale Mine. Given the separation distance between the Clarence Colliery and the Springvale Mine, it is not considered that cumulative impacts would occur between the two operations.

10.3.8 Forestry and Recreation Activities

Forestry and recreation activities occur within the Newnes State Forest although in the immediate area surrounding the Project will be limited to unsealed road use by 4WD vehicles and occasional forestry vehicles. Given the likely infrequent nature and small scale of these activities, it is not considered that these will have cumulative effects with the Project operation.

10.4 Adopted Background for this Assessment

To provide an assessment of potential cumulative pollutant concentrations at surrounding sensitive receptors, measured long term (≥1 year) ambient air quality data are required. However, as stated in **Section 10**, no long term continuous ambient monitoring data are available in the vicinity of the Project Application Area.

Following the analysis presented in **Section 10.1**, it has been established that the use of continuous PM₁₀ monitoring data (2010) from the OEH operated monitoring site at Bathurst provides a conservative estimate of regional background levels and includes the impact of surrounding industries as discussed in **Section 10.3**.

The annual average background TSP concentration was calculated based on the annual average PM₁₀ concentration at Bathurst and the TSP to PM₁₀ ratio derived from Springvale HVAAS data (presented in **Section 10.1**). An annual average background dust deposition rate was calculated based on the average of 2010 data measured at the five dust deposition gauges surrounding the Springvale Mine. The adopted background data are presented in **Table 18**.

Table 18 Adopted Background Data

Pollutant	Averaging Period	Background Concentration ($\mu\text{g}/\text{m}^3$)	Basis
PM ₁₀	24-hours	Daily varying background	Monitoring data at Bathurst (2010)
	Annual	9.5	Monitoring data at Bathurst (2010)
TSP	Annual	23.4	TSP to PM ₁₀ ratio of 2.5
Dust Deposition	Annual	1.4 g/m ² /month	Average of dust deposition monitoring data in 2010

11 AIR DISPERSION MODELLING RESULTS

The ground level particulate concentrations and deposition rates predicted by the modelling at the nearest sensitive receptors are presented and discussed below.

11.1 Dust Deposition

Table 19 shows the results of the dispersion modelling for dust deposition from the Project Application Area at each of the identified receptors using the emission rates calculated in **Section 8**. Contour plots of the predicted incremental increase in dust deposition rates are also presented in **Appendix D**.

Table 19 Predicted Annual Average Dust Deposition Rates

Receptor ID	Dust Deposition Annual Average (g/m ² /month)		
	Background	Increment	Cumulative
S1	1.4	0.2	1.6
S2	1.4	0.1	1.5
S3	1.4	<0.1	<1.5
S4	1.4	<0.1	<1.5
S5	1.4	<0.1	<1.5
W1	1.4	<0.1	<1.5
W2	1.4	<0.1	<1.5
L1	1.4	<0.1	<1.5
L2	1.4	<0.1	<1.5
NF1	1.4	<0.1	<1.5
NF2	1.4	<0.1	<1.5
NF3	1.4	<0.1	<1.5
NF4	1.4	<0.1	<1.5
NF5	1.4	<0.1	<1.5
NF6	1.4	<0.1	<1.5
NF7	1.4	<0.1	<1.5
NF8	1.4	<0.1	<1.5
NF9	1.4	<0.1	<1.5
Criterion		2	4

The results indicate that incremental and cumulative annual average dust deposition rates at all nominated residences/properties/sensitive areas surrounding the Project Application Area are predicted to be well below the criterion of 2 g/m²/month (incremental increase in dust deposition) and below 4 g/m²/month (cumulative dust deposition). The incremental increases predicted as a result of the proposed modification are negligible and would not result in measureable increases above existing levels.

11.2 Suspended Particulate

11.2.1 TSP

Table 20 presents the annual average TSP concentrations predicted by the dispersion modelling at each of the nominated residences/properties using the emission rates calculated in **Section 8**. The calculated background TSP concentrations have been discussed in detail in **Section 10.1**. Contour plots of the predicted cumulative increase in TSP concentrations are presented in **Appendix D**.

Table 20 Predicted Annual Average TSP Concentrations

Receptor ID	TSP Annual Average ($\mu\text{g}/\text{m}^3$)		
	Background	Increment	Cumulative
S1	23.4	3.0	26.4
S2	23.4	2.5	25.9
S3	23.4	0.7	24.1
S4	23.4	0.9	24.3
S5	23.4	0.5	23.9
W1	23.4	0.5	23.9
W2	23.4	0.4	23.8
L1	23.4	0.4	23.8
L2	23.4	0.8	24.2
NF1	23.4	<0.1	<23.5
NF2	23.4	<0.1	<23.5
NF3	23.4	<0.1	<23.5
NF4	23.4	<0.1	<23.5
NF5	23.4	<0.1	<23.5
NF6	23.4	<0.1	<23.5
NF7	23.4	<0.1	<23.5
NF8	23.4	<0.1	<23.5
NF9	23.4	<0.1	<23.5
Criterion			90

Annual average TSP concentrations are predicted to be well below the criterion of $90 \mu\text{g}/\text{m}^3$ at all nominated residences/properties/sensitive areas surrounding the Project Application Area. The incremental increases predicted as a result of the modification are very low and are not predicted to give rise to significant increases above existing levels.

11.2.2 PM_{10}

Annual Average PM_{10} Concentrations

Table 21 presents the annual average PM_{10} concentrations predicted by the dispersion modelling at each of the nominated residences/properties/sensitive areas using the emission rates calculated in **Section 8**. The assumed background PM_{10} concentrations have been discussed in detail in **Section 10.1**. Contour plots of the predicted cumulative increase in annual average PM_{10} concentrations are presented in **Appendix D**.

Table 21 Predicted Annual Average PM₁₀ Concentrations

Receptor ID	PM ₁₀ Annual Average (µg/m ³)		
	Background	Increment	Cumulative
S1	9.5	1.1	10.6
S2	9.5	0.9	10.4
S3	9.5	0.3	9.8
S4	9.5	0.4	9.9
S5	9.5	0.2	9.7
W1	9.5	0.2	9.7
W2	9.5	0.2	9.7
L1	9.5	0.2	9.7
L2	9.5	0.3	9.8
NF1	9.5	<0.1	<9.6
NF2	9.5	<0.1	<9.6
NF3	9.5	<0.1	<9.6
NF4	9.5	<0.1	<9.6
NF5	9.5	<0.1	<9.6
NF6	9.5	<0.1	<9.6
NF7	9.5	<0.1	<9.6
NF8	9.5	<0.1	<9.6
NF9	9.5	<0.1	<9.6
Criterion			30

Annual average PM₁₀ concentrations are predicted to be well below the criterion of 30 µg/m³ at all nominated residences/properties/sensitive areas surrounding the Project Application Area. The incremental increase predicted as a result of the modification are very low and are not predicted to give rise to a significant increase above existing levels.

Maximum 24-Hour Average PM₁₀ Concentrations

To assess the cumulative maximum 24-hour average PM₁₀ concentrations at each of the identified sensitive receptors, a contemporaneous analysis was performed following the Approved Methods. At each receptor, each individual incremental prediction was added to the corresponding measured background concentration to obtain cumulative 24-hour average PM₁₀ concentrations.

Table 22 presents the summary of the contemporaneous analysis at each surrounding sensitive receptor listed in **Table 6** and **Table 7**.

Table 22 Summary of Contemporaneous PM₁₀ Analysis

Receptor ID	Date	PM ₁₀ 24-Hour Average (µg/m ³)			Date	PM ₁₀ 24-Hour Average (µg/m ³)		
		Highest Background	Increment	Total		Background	Highest Increment	Total
S1	13-01-2010	43.3	<0.1	<43.4	18-04-2010	10	14.4	24.4
S2	13-01-2010	43.3	<0.1	<43.4	18-03-2010	21.3	18.7	40.0
S3	13-01-2010	43.3	<0.1	<43.4	02-06-2010	6.4	4.0	10.4
S4	13-01-2010	43.3	0.5	43.8	02-05-2010	13.3	9.1	22.4
S5	13-01-2010	43.3	0.3	43.6	02-05-2010	13.3	4.9	18.2
W1	13-01-2010	43.3	<0.1	<43.4	25-07-2010	4.6	2.9	7.5
W2	13-01-2010	43.3	<0.1	<43.4	15-02-2010	5.7	2.9	8.6
L1	13-01-2010	43.3	0.4	43.7	23-09-2010	14.6	4.2	18.8
L2	13-01-2010	43.3	0.3	43.6	23-09-2010	14.6	7.5	22.1
NF1	13-01-2010	43.3	<0.1	<43.4	17-02-2010	12	0.4	12.4
NF2	13-01-2010	43.3	<0.1	<43.4	02-05-2010	13.3	0.7	14.0
NF3	13-01-2010	43.3	<0.1	<43.4	02-05-2010	13.3	0.2	13.5
NF4	13-01-2010	43.3	<0.1	<43.4	02-05-2010	13.3	0.1	13.4
NF5	13-01-2010	43.3	<0.1	<43.4	15-09-2010	3.1	0.2	3.3
NF6	13-01-2010	43.3	<0.1	<43.4	15-09-2010	3.1	0.2	3.3
NF7	13-01-2010	43.3	<0.1	<43.4	12-07-2010	7.6	0.1	7.7
NF8	13-01-2010	43.3	<0.1	<43.4	18-11-2010	3.7	0.3	4.0
NF9	13-01-2010	43.3	<0.1	<43.4	18-11-2010	3.7	0.3	4.0
Criterion		50			50			

The results presented in **Table 22** show that the predicted cumulative 24-hour average PM₁₀ concentrations are below the criterion of 50 µg/m³ and therefore the proposed modification is unlikely to cause any exceedences at any surrounding sensitive receptor locations. Contour plots of the maximum predicted cumulative 24-hour average PM₁₀ concentrations are presented in **Appendix D**.

12.1.1 PM_{2.5}

Table 23 presents the maximum 24-hour and annual average PM_{2.5} concentrations predicted by the dispersion modelling at each of the nominated residences/properties using the emission rates calculated in **Section 8**. As discussed in **Section 10.1**, no ambient background monitoring data for PM_{2.5} are available in the local area or at the nearest OEH monitoring sites hence the modelling results have been assessed by comparison of the incremental concentrations against the criteria.

Table 23 Predicted 24-Hour and Annual Average PM_{2.5} Concentrations

Receptor	Annual Average PM _{2.5} Increment (µg/m ³)	24-Hour Average PM _{2.5} Increment (µg/m ³)
S1	0.1	1.4
S2	<0.1	1.8
S3	<0.1	0.4
S4	<0.1	0.9
S5	<0.1	0.5
W1	<0.1	0.3
W2	<0.1	0.3
L1	<0.1	0.4
L2	<0.1	0.8
NF1	<0.1	<0.1
NF2	<0.1	<0.1
NF3	<0.1	<0.1
NF4	<0.1	<0.1
NF5	<0.1	<0.1
NF6	<0.1	<0.1
NF7	<0.1	<0.1
NF8	<0.1	<0.1
NF9	<0.1	<0.1
Advisory Reporting Standards	8 (Cumulative)	25 (Cumulative)

Table 23 shows that the incremental increase in 24-hour average and annual average PM_{2.5} concentrations predicted as a result of the proposed modification are minor and are unlikely to cause any exceedences at any surrounding sensitive receptor locations.

12.2 Air Quality Monitoring

Given the foregoing minor impacts relating to the modification predicted by the dispersion modelling exercise and the geographically disperse sensitive receptor locations, the installation and operation of real-time particulate monitoring equipment is not considered to be warranted by the modification. Impacts can be mitigated through the continued implementation of existing management measures such as water spraying, minimisation of exposed areas and ceasing work during adverse weather conditions.

Continuation of the HVAS monitoring at the Springvale Mine pit top will be continued, as will be the monitoring of dust deposition.

13 GREENHOUSE GAS ASSESSMENT

The following tasks have been performed in relation to greenhouse gas (GHG) emissions:

- A quantitative assessment of potential Scope 1, 2 and 3 GHG emissions;
- A qualitative assessment of the potential impacts of these emissions on the environment; and,
- An assessment of reasonable and feasible measures to minimise GHG emissions and ensure energy efficiency.

This GHG assessment has been performed with reference to the Australian Department of Climate Change and Energy Efficiency (DCCEE) document "*National Greenhouse Accounts Factors*" (July, 2012), the NSW Department of Energy, Utilities and Sustainability (DEUS) document "*Guidelines for Energy Savings Action Plans*" (2005), the National Greenhouse and Energy Reporting Act 2007, the Centennial Coal Greenhouse Gas Assessment Guidance Notes (Centennial Coal, 2010) and Climate Change Response Policy (Centennial Coal, 2012b).

This assessment considers the impact of the proposed modification and compares this predicted impact to that currently experienced at the Project Application Area.

Activity data for the following have been obtained from Centennial for the period 1 July 2011 to 31 June 2012:

- Total Run of Mine (ROM) Coal Production (tonnes [t]);
- Total Electricity Consumption (kilowatt-hours [kWh]);
- Total Diesel Consumption (litres [L]);
- Solid Waste to Landfill (t);
- Fugitive Emissions of Coal Seam Methane (CH₄) and CO₂ via ventilation shafts (m³ and percentage content of CO₂ and CH₄ in ventilation return air);
- Emissions from the use of Liquid Petroleum Gas (LPG); and
- Emissions from the use of oils and greases (consumed without combustion).

Data have been sourced from the Centennial provided spreadsheet 'SPJ Greenhouse Report 1112 excluding Lidsdale Siding' (covering the period 1 July 2011 to 31 June 2012).

Data was made available for the period July 2011 to June 2012, being the most recent complete financial year of data which has been independently audited and verified to meet the requirements of the National Greenhouse and Energy Reporting System (NGERS) legislation. However, current approval of the Springvale Mine relates to the extraction of up to 3.4 Mtpa of coal and this report presents a 'base case' GHG emission scenario associated with this extraction rate. Data presented in this report for Scope 1 and 2 emissions is directly extracted from Springvale NGERS reports for the July 2011 to June 2012 period, scaled to 3.4 Mtpa extraction rate and utilises NGERS emission factors, and other acceptable NGERS emission calculation methodologies. Scope 3 emissions have been calculated using data provided by Springvale.

Although this report is concerned with the modification of Project operations, data for all greenhouse gas generating processes are presented. A Development Application was approved in May 2012 in relation to the construction of an upgraded ventilation shaft (No. 3 Ventilation Shaft) and a GHG assessment was performed for this proposed upgrade. Furthermore, an application to modify the existing consent for the construction and operation of a new dewatering bore (Bore 8) was approved in March 2013. Baseline GHG emissions are therefore considered to be emissions associated with a 3.4 Mtpa extraction rate plus emissions associated with the approved No. 3 Ventilation Shaft and Dewatering Bore 8.

A GHG assessment is presented for the following:

1. Baseline GHG emissions (3.4 Mtpa extraction rate plus No. 3 Ventilation Shaft plus Dewatering Bore 8 – hereafter “Approved Operations”).
2. Baseline GHG emissions plus increased ROM extraction to 4.5 Mtpa and processing (hereafter “Modified Operations”).

Relevant information relating to the approved upgrade to the No. 3 Ventilation Shaft plus Dewatering Bore 8 is presented in **Table 24**.

Table 24 Activity Data relating to Approved Upgrade to No. 3 Ventilation Shaft and Dewatering Bore 8

Upgrade	Activity Data	Data Source
No. 3 Ventilation Shaft	Electricity Consumption to increase by 15,592,800 kWh Diesel Consumption to increase by 22,114 L	Centennial Springvale – “Springvale Coal Pty Ltd, Springvale Vent Shaft, Air Quality and GHG Assessment”, November 2011
Dewatering Bore 8	Electricity Consumption to increase by 11,216,822 kWh Diesel Consumption to increase by 17 kL	Centennial Springvale – “Springvale Coal Pty Ltd, Springvale Colliery Dewatering Bore 8 Project, Air Quality and GHG Assessment”, September 2012

Information for the No. 3 Ventilation Shaft upgrade is taken directly from the DA documentation (Springvale Coal Pty Ltd, Springvale Vent Shaft, Air Quality and GHG Assessment, November 2011).

Information relating to the anticipated electricity use as a result of the installation of Bore 8 was provided by Centennial. Electricity use at the existing Bore 6 is available within the provided NGRS data for the Springvale Mine, although approximately 25% of the electricity usage reported for this bore is associated with a dewatering bore at Angus Place Mine. Therefore, 75% of the reported value is taken to be associated with Bore 6. Furthermore, Bore 8 is likely to deal with approximately 5% more mine inflow than Bore 6, and therefore the electricity consumption is assumed to be 5% higher. A figure of 11,216,822 kWh has been taken to be representative of the annual electricity consumption of Bores 8, 9 and 10. Centennial has also advised that a backup diesel generator will be associated with Bore 8, a similar generator used 17 kL of diesel at the Bore 6 site in the year 2010 – 2011, assumed to remain consistent for 2011 - 2012.

Contractor diesel consumption, fugitive emissions through the ventilation shaft, LPG use and oil and grease consumption is not anticipated to change following either the approved ventilation shaft upgrade or proposed Bore 8 operation.

To assess the impact of ROM extraction at 4.5 Mtpa, some scaling of activity data is required, and assumptions are required to be made. These assumptions are outlined below:

- Electricity consumption
 - Electricity consumption at Springvale Mine is associated with conveyors, boreholes pumps (existing) and current ventilation requirements, as well as bath house operations etc. It is assumed that these requirements will not change as a result of additional ROM extraction.
- Diesel consumption

- Diesel consumption will be linked to production and it has therefore been assumed that diesel consumption will increase in line with ROM extraction. To assess the impact of the proposed 4.5 Mtpa extraction rate versus the approved 3.4 Mtpa extraction rate, data for the (2011/2012) extraction rate of 2.2 Mtpa has been scaled by 1.54 (to 3.4 Mtpa), plus a further scaling of 1.3 has been applied (from 3.4 Mtpa to 4.5 Mtpa). These scaling factors have been applied to both Centennial and contractor diesel consumption data.
- Ventilation requirements
 - It has been assumed that no increase in the ventilation rate, or composition of ventilation air will change as a result of increased ROM extraction.
- Solid waste
 - Given the proposed increase in full time workforce to 310 persons from 280, the quantity of solid waste generated has been assumed to increase. A scaling factor of 1.1 (310 / 280) has been applied to solid waste generation.
- Oil and grease and LPG usage is assumed to remain constant.

13.1.1 Operational Traffic

Traffic and personnel movements associated with the dewatering and ventilation site will be minimal with the occasional light vehicle trip required for maintenance and inspection purposes only. It is anticipated that these vehicles would be owned and operated by Centennial Coal and the additional emissions of GHG would be considered to be a Scope 1 (direct) emission. It has been assumed that these additional operational trips (assuming a 40 km round trip once per week and 10 L/100km fuel efficiency) would result in an additional 200 L of diesel combustion per year and are included within the base case emission scenario.

A summary of the activity data related to the 2011/2012 reported data, calculated baseline (3.4 Mtpa extraction rate) and modified operations (4.5 Mtpa extraction rate) is provided in **Table 25**. In all further discussions, modified operations are compared to the baseline of approved operations (3.4 Mtpa extraction rate).

Table 25 Summary of Project Related Activity Data Relevant to GHG Emissions (Baseline and Modified Operations)

Activity	2011/2012 Project Operations	Approved Project Operations	Modified Project Operations
Annual ROM production (Mt)	2.2 Mtpa	3.4 Mtpa	4.5 Mtpa
Annual Electricity Consumption (kWh)	88,851,643 ¹	88,851,643	88,851,643
Annual Diesel Consumption (litres) – Springvale Coal	808,226 ²	1,228,003	1,608,184 ³
Annual Diesel Consumption (litres) - Contractor	341,888	528,372	697,452 ⁴
Annual Fugitive Emissions from Mine Ventilation Shaft (Million m ³)	4,792	4,792	4,792
Solid Waste to Landfill (t)	616	678	678
Liquid Petroleum Gas (LPG) (kg)	32,323	32,323	32,323
Petroleum Based Oil/ greases used (L)	244,663	244,663	244,663

Note1: Includes 62,042,021 kWh (SPJ Greenhouse Report 1112), 15,592,800 kWh (assumed additional electricity consumption through Ventilation Shaft No.3), 11,216,822 kWh for Bore 8 operation).

Note 2: 769,152 litres (SPJ Greenhouse Report 1112) plus additional 22,114 litres for ventilation shaft number 3 and 17,000 litres for Dewatering Bore 8

Note 3: Scaling factor of 2.04 applied to current diesel usage (769,152 litres [SPJ Greenhouse Report 1112]) plus additional 22,114 litres for ventilation shaft number 3 and 17,000 litres for Dewatering Bores 8

Note 4: Scaling factor of 2.04 applied to current contractor diesel usage of 341,888 litres (SPJ Greenhouse Report 1112).

Values for are different to those quoted in "Springvale Dewatering Bore 8, Air Quality and GHG Assessment, September 2012". NGER data was updated since this time following audit.

13.2 Direct and Indirect Emissions (Emissions Scope)

National Greenhouse and Energy Reporting Regulations 2008 defines scope 1 and scope 2 emissions as:

Division 2.5 Meaning of *emissions*, production and consumption: section 10

2.23 Meaning of *emissions*, production and consumption

- (1) **Emissions** of greenhouse gas, in relation to a facility, means the release of greenhouse gas into the atmosphere as a direct result of one of the following:
 - (a) an activity, or series of activities (including ancillary activities) that constitute the facility (**scope 1 emissions**);
 - (b) 1 or more activities that generate electricity, heating, cooling or steam that is consumed by the facility but that do not form part of the facility (**scope 2 emissions**).
- (2) **Production** of energy, in relation to a facility, means 1 of the following:
 - (a) the extraction or capture of energy from natural sources for final consumption by or from the operation of the facility or for use other than in the operation of the facility;

- (b) the manufacture of energy by the conversion of energy from 1 form to another form for final consumption by or from the operation of the facility or for use other than in the operation of the facility.
- (3) **Consumption** of energy, in relation to a facility, means the use or disposal of energy from the operation of the facility including own-use and losses in extraction, production and transmission.

The NGERS legislation does not include scope 3 emissions.

The National Greenhouse Accounts workbook (NGA) the methodology used for estimating scope 3 emissions in this assessment is defined as follows:

- Various emission factors can be used to calculate scope 3 emissions. For ease of use, this workbook reports specific 'scope 3' emission factors for organisations that:
 - (a) *burn fossil fuels: to estimate their indirect emissions attributable to the extraction, production and transport of those fuels; or*
 - (b) *consume purchased electricity: to estimate their indirect emissions from the extraction, production and transport of fuel burned at generation and the indirect emissions attributable to the electricity lost in delivery in the T&D network.*

It is noted that Centennial has a restricted capacity to reduce their GHG emissions under Scope 3 at Springvale Mine. Reductions in the emissions of GHG resulting from the extraction and transport of fossil fuels for use in electricity production or onsite diesel combustion are beyond the control of Centennial but are reported here for completeness, as normally required by the Department of Planning and Infrastructure.

13.3 Greenhouse Gas Calculation Methodology

Quantification of potential Project emissions has been undertaken in relation to both carbon dioxide (CO₂) and other non-CO₂ greenhouse gas emissions.

For comparative purposes, non-CO₂ greenhouse gases are awarded a "CO₂-equivalence" (CO₂-e) based on their contribution to the enhancement of the greenhouse effect. The CO₂-e of a gas is calculated using an index called the Global Warming Potential (GWP). The GWPs for a variety of non-CO₂ greenhouse gases are contained within the Intergovernmental Panel on Climate Change (IPCC), (1996) document "*Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories*".

The GWPs of relevance to this assessment are:

- methane (CH₄): GWP of 21 (21 times more effective as a greenhouse gas than CO₂);
- nitrous oxide (N₂O): GWP of 310 (310 times more effective as a greenhouse gas than CO₂); and,
- Sulphur hexafluoride (SF₆): GWP of 23,900 (23,900 times more effective as a greenhouse gas than CO₂).

The short-lived gases such as carbon monoxide (CO), nitrogen dioxide (NO₂), and non-methane volatile organic compounds (NMVOCs) vary spatially and it is consequently difficult to quantify their global radiative forcing impacts. For this reason, GWP values are generally not attributed to these gases nor have they been considered further as part of this assessment.

It is noted that at the United Nations Framework Convention on Climate Change meeting in November-December 2011 in Durban (South Africa), countries agreed to adopt updated GWPs including new greenhouse gases published in the Intergovernmental Panel on Climate Change's (IPCC) 2007 Fourth Assessment Report (AR4) from 2015 onwards (reporting emissions for the 2013 inventory year) and for commitments under a second commitment period. These GWPs replace those used from the IPCC's Second Assessment Report (AR2).

The most significant change is the increase in methane's GWP from 21 to 25. A new greenhouse gas has been added, nitrogen trifluoride, as well as new species of hydrofluorocarbons. As these updated GWP's are related to reporting from 2015 onwards, the GWP's for each GHG from the AR2 report are adopted within this assessment.

The greenhouse gas emissions associated with the Project have been assessed in terms of direct (Scope 1) emission potential, indirect (Scope 2) emission potential and significant upstream/downstream (Scope 3) emission potential.

A summary of the potential Project GHG emission sources is provided in **Table 26**.

Table 26 Summary of Potential Project Greenhouse Gas Emissions

Project Component	Direct Emissions	Indirect Emissions	
	Scope 1	Scope 2	Scope 3
Fugitive Emissions	Emissions from the release of coal seam methane and carbon dioxide as a result of extraction activities.	N/A	N/A
Diesel	Emissions from the combustion of diesel at the Project in both mobile and fixed plant and equipment)	N/A	Emissions associated with contractor diesel usage. Estimated emissions attributable to the extraction, production and transport of diesel consumed at the Project Site.
Liquid petroleum gas	Emissions from the combustion of LPG at the Project in mobile equipment	N/A	N/A
Use of Oils and Greases	Consumption (non-combustion) of oils and greases	N/A	N/A
Electricity	N/A	Emissions associated with the consumption of generated and purchased electricity at the mine.	Estimated emissions from the extraction, production and transport of fuel burned for the generation of electricity consumed at the mine and the electricity lost in delivery in the transmission and distribution network.
Solid Waste	N/A	N/A	Emissions associated with the disposal of solid waste to landfill
Coal Combustion	N/A	N/A	Emissions from the combustion of coal from the Project.

N/A = Not applicable

13.3.1 Scope 1 (Direct) Emissions

Fugitive emissions - Coal Seam Methane and Carbon Dioxide

The process of coal formation creates significant amounts of CH₄. Some of this CH₄ remains trapped in the coal until the pressure on the coal is reduced, which occurs during the coal mining process. The stored CH₄ is then released to the atmosphere.

Fugitive emissions from extraction of coal as defined by NGERS were estimated for the 11-12 financial year using Method 4, subdivision 3.2.2.2 of the NGERS Measurement Determination 2008.

Based on information provided by Centennial, the ventilation fan at the Springvale Mine currently results in ventilation emissions of:

- 4,792 Mm³/yr at 0.11% CO₂ and 0.02% CH₄

The molecular weights of CO₂ and CH₄ have been taken to be 44.01 and 16.04, respectively. Temperature of the gas stream has been provided by Centennial to be 290 K.

The proposed construction of underground roadways will result in the exposure of coal seams which will have the capacity to release CH₄ which will be required to be extracted through the proposed ventilation system. However, in concert with this seam exposure, other mined longwall areas will be sealed, resulting in effectively no net change in coal seam exposure in the Springvale underground mine. It may therefore be assumed that the rate of CH₄ release into the underground workings will remain relatively constant over the course of the Project, and therefore the quantity of CH₄ to be removed through the ventilation system will also remain relatively constant.

Scope 1 emissions calculated are as presented in **Table 27** for the current operations, using information on the temperature, gas volumes and composition of the ventilation gas stream (provided within the NGER data).

Table 27 Calculated Fugitive Emissions from Ventilation (tonnes) SCOPE 1

Source	Fugitive Emissions (tonnes CO ₂ -e)
Existing Ventilation Systems	20,056

Diesel Usage

The primary fuel source for the vehicles operating at Springvale Mine is diesel. Diesel consumption for all mobile and fixed equipment is calculated as 1,297,524 L used in the underground operation in the baseline year (3.4 Mtpa extraction). 769,152 L is used by Centennial owned vehicles and equipment and 528,372 L used by contractors. An additional 22,114 L of diesel is calculated to be consumed by the fan at the Ventilation Shaft No. 3 upgrade and a further 17,000 L through the Dewatering Bore 8 Project (Centennial owned). These values have been scaled using the scaling factor of 1.3 to obtain likely diesel consumption due to a 4.5 Mtpa ROM extraction rate as discussed previously.

Scope 1 emissions from use of diesel fuel as defined by NGERS were estimated for the baseline year using Method 1, Division 2.4.2 section 2.41 of the NGERS Measurement Determination 2008. The energy content of diesel fuel is taken to be 38.6 GJ/kL with a Scope 1 emission factor of 69.9 kg CO₂-e/GJ (DCCEE, 2012).

Scope 1 emissions of CO₂-e from the combustion of diesel fuel are presented in **Table 28** for the baseline and proposed operations.

Table 28 Calculated Emissions from Diesel Combustion (tonnes) SCOPE 1

Source	Emissions (tonnes CO ₂ -e)
Baseline	
Centennial	3,313
Contractor	1,426
Total	4,739
Modification	
Centennial	4,3340
Contractor	1,887
Total	6,226

Liquid Petroleum Gas

LPG consumption is estimated as 32,323 kg per annum, which is not expected to change due to the modified Project operations. It has been assumed that 1 kg LPG is equal to 1.76 L and contains 25.7 GJ/kL with a Scope 1 emission factor of 59.9 kg CO₂-e/GJ (DCCEE, 2012).

Scope 1 emissions from use of LPG as defined by NGERs were estimated for the baseline year using Method 1, Division 2.4.2 section 2.41 of the NGERs Measurement Determination 2008.

Emissions of GHG due to LPG use are not expected to change due to the modification.

Scope 1 emissions of CO₂-e from the use of oils and greases are presented in **Table 29**.

Table 29 Calculated Emissions from LPG Consumption (tonnes) SCOPE 1

Source	Emissions (tonnes CO ₂ -e)
Baseline	
LPG consumption	88
Total	88
Modification	
LPG consumption	88
Total	88

Oils and Greases

Oils and greases are used for lubrication of equipment and machinery. Oil and grease consumption are estimated as presented in **Table 25**. Scope 1 emissions from use of oils and greases as defined by NGERs were estimated for the baseline year using the method detailed in Section 2.68 part b (iii) of the NGERs Measurement Determination 2008. The energy content of oil and grease is taken to be 38.8 GJ/kL with a Scope 1 emission factor of 27.9 kg CO₂-e/GJ (DCCEE, 2011).

Scope 1 emissions of CO₂-e from the use of oils and greases are presented in **Table 30**.

Table 30 Calculated Emissions from Oil and Grease Consumption (tonnes) SCOPE 1

Source	Emissions (tonnes CO ₂ -e)
Baseline	
Oil and Grease consumption	264
Total	264

Modification	
Oil and Grease consumption	264
Total	264

13.3.2 Scope 2: Indirect Emissions through the Consumption of Purchased Electricity

Scope 2 GHG emissions as defined by NGERS were estimated for the baseline year using Method 1, Chapter 7, section 7.2 of the NGERS Measurement Determination 2008.

State emission factors are used because electricity flows between states are significantly constrained by the capacity of the inter-state interconnectors and in some cases there are no interconnections.

Electricity consumption at the Springvale Mine has been calculated as (approximately) 62 Megawatt-hours (MWh) in the base case (3.4 Mtpa extraction rate). An additional 15 MWh has been assumed for the operation of the upgraded Ventilation Shaft No. 3 and a further 11 MWh attributable to the operation of Dewatering Bore 8, resulting in a total baseline electricity consumption of 88.8 MWh.

It is expected that this will not increase due to the modification.

The emission factor for Scope 2 (0.89 tonnes of CO₂-equivalents per kilowatt hour [t CO₂-e/kWh]) represents the consumption of purchased electricity in NSW.

Scope 2 emissions of CO₂-e from the consumption of purchased electricity are presented in **Table 31**.

Table 31 Calculated Emissions from Electricity Consumption (tonnes) SCOPE 2

Source	Emissions (tonnes CO₂-e)
Baseline	
Electricity consumption	79,078
Total	79,078
Modification	
Electricity consumption	79,078
Total	79,078

13.3.3 Scope 3: Other Indirect Emissions

As discussed previously, Scope 3 emissions of GHG attributable to the Project are reported for completeness. Centennial has a restricted capacity to reduce their GHG emissions under Scope 3 at Springvale Mine. Reductions in the emissions of GHG resulting from the extraction and transport of fossil fuels for use in electricity production or onsite diesel combustion are beyond the control of Centennial. Also beyond the control of Centennial are the operations of coal consumers.

Combustion of Product Coal

Indirect emissions of GHG from the combustion of product coal are expected “downstream” due to the combustion of coal produced by the Project. Up to 4.5 Mtpa of ROM coal may be produced by Springvale Mine.

This calculation assumes that 100% of ROM coal produced by the Project is combusted to produce electricity.

The GHG emissions from combustion of product coal by other (non-Centennial) entities have been based on a coal energy content of 27 GJ/t for thermal (black coal) (Table 1 of the NGA Factors).

It is noted that no Scope 3 emission factor exists for black coal used for electricity generation purposes within the most recent (July 2012) version of the NGA Factors. In this instance, the Scope 3 emission factor for "Black coal" published in Table 1 of the July 2011 version of the NGA Factors has been used within this assessment.

Scope 3 emissions of CO₂-e from the combustion of saleable product coal are presented in **Table 32**.

Table 32 Calculated Emissions from Combustion of Product Coal (tonnes) SCOPE 3

Source	Emissions (tonnes CO ₂ -e)
Combustion of Product Coal (3.4 Mtpa)	798,660
Combustion of Product Coal (4.5 Mtpa)	1,057,050

Extraction, Production and Transport of Fuel Burned for the Generation of Electricity and Electricity Consumed in the Transmission and Distribution System

The NGA Factors provides Scope 3 emission factors for the consumption of purchased electricity by each state. State emission factors are used because electricity flows between states are significantly constrained by the capacity of the inter-state interconnectors and in some cases there are no interconnections.

The NSW Scope 3 emission factor (0.17 kg CO₂-e/kWh) covers both the emissions from the extraction, production and transport of fuels used in the production of the purchased electricity (i.e. fugitive emissions and stationary and mobile fuel combustion emissions) and also the emissions associated with the electricity lost in transmission and distribution on route to the customer. In this report, Scope 2 and 3 emissions for the consumption of purchased electricity have been reported separately so that the share of the transport and distribution loss can be correctly attributed under Scope 3 emissions - Generation of Electricity Consumed in a transmission and distribution system.

Scope 3 emissions of CO₂-e from the consumption of purchased electricity are presented in **Table 33**.

Table 33 Calculated Emissions from Electricity Consumption (tonnes) SCOPE 3

Source	Emissions (tonnes CO ₂ -e)
Baseline	
Electricity consumption	15,105
Total	15,105
Modification	
Electricity consumption	15,105
Total	15,105

Extraction, Production and Transport of Diesel Consumed at the Project

Scope 3 GHG emissions attributable to diesel used at the Project relate to its extraction, production and transport.

The annual emissions of CO₂ and other GHG from this source have been estimated using Table 38 of the NGA Factors, an emission rate of 5.3 kg CO₂-e/GJ and an assumed energy content of Diesel of 38.6 GJ/kL.

Scope 3 emissions of CO₂-e from the combustion of diesel fuel are presented in **Table 34**. These also include the use of contractor construction vehicles (Scope 3 only) and Centennial operational vehicles (Scope 1 and Scope 3).

Table 34 Calculated Emissions from Diesel Combustion (tonnes) SCOPE 3

Source	Emissions (tonnes CO ₂ -e)
Baseline	
Centennial	251
Contractor	108
Total	359
Modification	
Centennial	329
Contractor	143
Total	472

Extraction, Production and Transport of Oils and Greases Consumed at the Project

Scope 3 GHG emissions attributable to oils and greases used at the Project relate to its extraction, production and transport.

The annual emissions of CO₂ and other GHG from this source have been estimated using an emission rate of 5.3 kg CO₂-e/GJ and an assumed energy content of 38.8 GJ/kL.

Scope 3 emissions of CO₂-e from the use of oils and greases are presented in **Table 35**.

Table 35 Calculated Emissions from Oil and Grease Consumption (tonnes) SCOPE 3

Source	Emissions (tonnes CO ₂ -e)
Baseline	
Oil and Grease consumption	50
Total	50
Modification	
Oil and Grease consumption	50
Total	50

Waste Generation

Solid waste generated at the Project Application Area and disposed of in landfill is estimated as presented in **Table 25**. It has been assumed that generation of waste will be 678 tonnes per annum.

Waste sent to landfill results in emissions of CH₄ as waste is degraded. Table 42 of the NGA Factors provides GHG emission factors based on broad waste streams (municipal solid waste, commercial and industrial waste and construction and demolition waste). To provide a worst case assessment of GHG emissions from waste sent to landfill, the emission rate for municipal solid waste (1.2 t CO₂-e / tonne waste) has been used within this assessment.

Scope 3 emissions of CO₂-e from the disposal of solid waste are presented in **Table 36**.

Table 36 Calculated Emissions from Waste Disposal (tonnes) SCOPE 3

Source	Emissions (tonnes CO ₂ -e)
Baseline	
Waste Disposal	813
Total	813
Proposed	
Waste Disposal	813
Total	813

Liquid Petroleum Gas

Scope 3 GHG emissions attributable to LPG used at the Project relate to its extraction, production and transport. It has been assumed that 1 kg LPG is equal to 1.76 L and contains 25.7 GJ/kL with a Scope 3 emission rate of 5.3 kg CO₂-e/GJ.

Scope 3 emissions of CO₂-e from the use of LPG are presented in **Table 37**.

Table 37 Calculated Emissions from LPG Consumption (tonnes) SCOPE 3

Source	Emissions (tonnes CO ₂ -e)
Baseline	
LPG consumption	8
Total	8
Modification	
LPG consumption	8
Total	8

Employees Commuting To and From Work

Fuel usage and consequent GHG emissions attributable to company employees commuting to and from work can be reported under Scope 3 GHG emissions. Data has been provided by Centennial on the assumed number of mine employees (280 currently and 310 as part of the modified Project operations). It has been assumed that the number of trips will be 280 vehicle movements per day or 102,200 movements per year (one way) currently and 310 vehicle movements per day or 113,150 movements per year (one way) as part of the modified operations.

It is assumed that 50% of staff originate from Lithgow. It has therefore been assumed that 50% of employee vehicle trips originate in Lithgow, approximately 13 km to the southeast of the Project Application Area, with the remaining 50% of staff trips originating in Bathurst, approximately 56 km to the west of the Project Application Area. Assuming that all employee-owned vehicles have a fuel efficiency of 10 L/100 km and operate on diesel as a *worst case assumption*, the total annual diesel consumption by employee owned vehicles would be 705 kL per annum currently and 781 kL per annum as part of the modified operations.

The annual emissions of CO₂ and other GHG from this source have been estimated using Table 38 of the NGA Factors, an emission rate of 5.3 kg CO₂-e/GJ and an assumed energy content of diesel of 38.6 GJ/kL.

Scope 3 emissions of CO₂-e from the combustion of diesel fuel in employee vehicles are presented in **Table 38**.

Table 38 Calculated Emissions from Diesel Combustion (tonnes) SCOPE 3

Source	Emissions (tonnes CO ₂ -e)
Baseline	
Employee Vehicles	144
Total	144
Modification	
Employee Vehicles	159
Total	159

Sources not Included

The following Scope 3 GHG emission sources were not included within the assessment:

- Employee business travel; and
- Outsourced activities.

13.4 Greenhouse Gas Calculation Results

Calculated Scope 1, Scope 2 and Scope 3 emissions of greenhouse gas resulting from the emissions sources outlined are presented in **Table 39**.

Table 39 Summary of Scope 1, 2 and 3 GHG Emissions (tonnes per annum)

Source	Baseline Operations (3.4 Mtpa Extraction Rate)	Modified Operations (4.5 Mtpa Extraction Rate)
Scope 1		
Fugitive Emissions	20,056	20,056
Diesel Combustion	3,313	6,221
LPG Combustion	88	88
Oil and Grease Consumption	264	264
<i>Total</i>	<i>25,147</i>	<i>26,629</i>
Scope 2		
Electricity Consumption	79,078	79,078
<i>Total</i>	<i>79,078</i>	<i>79,078</i>
Scope 3		
Product Coal Combustion	798,660	1,057,050
Diesel Combustion	359	472
Oil and Grease Consumption	50	50
Electricity Consumption	15,105	15,105
LPG Combustion	8	8
Waste Disposal	813	813
Employee Travel	144	159
<i>Total</i>	<i>815,139</i>	<i>1,073,658</i>

13.4.1 Scope 1 Emissions Estimations

Direct (Scope 1) GHG emissions (CO₂-e) resulting from modified Project operations are estimated to be 26,634 t per annum, an increase of approximately 1,488 tonnes per annum on approved operations of 3.4 Mtpa extraction rate. It is noted that no net increase in coal seam methane generation is anticipated as a result of the proposed Project.

13.4.2 Scope 2 Emissions Estimations

Indirect (Scope 2) GHG emissions (CO₂-e) resulting from modified Project operations are estimated to be 79,078 tonnes per annum, no increase on approved operations of 3.4 Mtpa extraction rate.

13.4.3 Scope 3 Emissions Estimations

Indirect (Scope 3) GHG emissions (CO₂-e) resulting from modified Project operations are estimated to be 1,073,658 tonnes per annum, an increase of approximately 258,518 tonnes per annum on approved operations of 3.4 Mtpa extraction rate. The increased emissions are due to increases in coal combustion by customers and site diesel and electricity consumption.

13.5 Comparison with National and State GHG Emissions

The estimated annual emissions associated with the modified Project are presented in **Table 40**.

Table 40 GHG Emissions Estimated to Result from the Modification

Emission Scope	Estimated Emissions (t CO ₂ -e/annum)
1	26,634
2	79,078
3	1,073,658
TOTAL	1,179,370

Emissions of GHG in NSW were reported to be 157.4 Mt in 2010, 28% of the Australian total GHG emissions of 560.8 Mt. Comparison of the emissions attributable to the Project with NSW and Australia emission totals is presented in **Table 41**.

Table 41 Comparison of Modified Project GHG Emissions with State and National Totals 2010

Emission Scope	Estimated Emissions (tCO ₂ -e/annum)	Percentage of NSW 2010 GHG Emission Total	Percentage of Australian 2010 GHG Emission Total
Scope 1	26,629	0.02	0.005
TOTAL (1,2 and 3)	1,179,290	0.8	0.2

13.6 Potential Impacts of Greenhouse Gas Emissions on the Environment

Increased emissions of GHG are widely accepted to exert a warming influence on climate. Increasing concentrations of the long-lived GHG's (CO₂, CH₄, N₂O, halocarbons and SF₆) have led to a combined radiative forcing (RF) of +2.63 [±0.26] Watts per square metre (W m⁻²). A 9% increase in this RF since the publication of the Third Assessment Report of the IPCC (IPCC, 2001) is the result of concentration changes since 1998 (IPCC, 2007). The IPCC state that it is very likely that there has been a substantial anthropogenic (man-made) contribution to surface temperature increases in every continent except Antarctica since the middle of the 20th Century, although difficulties exist in the attribution of temperature changes on smaller than continental scales and on timescales of less than 50 years.

Scientists at the 2005 conference, 'Avoiding Dangerous Climate Change: Symposium on Stabilisation of Greenhouse Gases' concluded that at the level of 550 parts per million (ppm) CO₂ concentration, a 2°C increase in global mean temperature above present levels would be experienced, and that stabilisation at a concentration of 400 ppm would be necessary to avoid a 2°C warming. IPCC reports (IPCC, 2007) have suggested that stabilising concentrations at 450 ppm by 2020 would only result in a 50% likelihood of limiting global warming to 2°C.

The linkages between emissions of CO₂ from an individual project, resulting global CO₂ concentrations and climate warming (as often required within DGRs for a Project) is not possible due to a host of uncertainties and a lag in the climate system. However, action by National Governments aimed at reducing GHG emissions by sector and national totals will result in mitigation of climate change, and accurate quantification of GHG emissions will aid the ongoing assessment of climate impacts and will reduce the impact on global climate warming influenced by all countries.

13.7 Greenhouse Gas Mitigation Measures

Centennial is currently implementing a number of measures to minimise to the greatest extent practicable GHG emissions from the Springvale Mine. Relevant measures are described below:

- Maximising energy efficiency as a key consideration in the development of the mine plan. For example, significant savings of greenhouse gas emissions (through increased energy efficiency) are achieved by mine planning decisions.
- The mine has developed and implemented an Energy and Greenhouse Management System and monitors and reports energy usage at the mine. Key Performance Indicators including energy demand and GHG emissions per tonne of ROM coal produced are tracked.

Additional measures that Centennial are striving to achieve include:

- Identify and implement cost effective measures to improve energy efficiency;
- Regular maintenance of plant and equipment to minimise fuel consumption; and
- Consideration of energy efficiency in plant and equipment selection/phase.

Centennial Coal is currently investigating at a corporate level the measures which may be taken to offset Scope 1 emissions from their operations. This work is ongoing, but measures may include (but not limited to) alignment with biodiversity offsets, purchase of greenpower and switching to biodiesel fuel if considered feasible. These measures are being investigated and all measures taken to offset GHG emissions associated with the modified Project will be in alignment with the highest standards, such as the National Carbon Offset Standard).

No particular design measures can be incorporated into the modification to avoid impacts associated with GHG emissions.

14 CONCLUSIONS

SLR was commissioned by Springvale Coal Pty Ltd (Centennial) to undertake an Air Quality Impact Assessment and Greenhouse Gas Assessment for a modification to the Springvale Mine for extraction of up to 4.5 Mtpa of ROM coal.

The surface operations at the Springvale Mine include receipt and processing of coal from the underground mine. It is noted that transferring the processed coal to Springvale Coal Services Washery, or Mt Piper or Wallerawang Power stations via an overland conveyor system has not been included in this assessment. The coal is currently being crushed using a rotary breaker and the crushing plant located on-site and is handled using bulldozers.

Potential dust emissions from the modified operation were estimated based on published emission factors and measured data from Angus Place Colliery's Ventilation Shaft. Dispersion modelling was performed for operation of the modified Project to predict the future incremental and cumulative impacts from the modified operation.

Ambient air quality monitoring data from the OEH-operated Bathurst monitoring station were used as background to assess the cumulative impact from the modified Project.

The predicted results showed that the proposed Project operations are unlikely to cause any exceedences of the relevant ambient air quality criteria for TSP, PM₁₀ and PM_{2.5} concentrations or dust deposition at any identified surrounding sensitive receptors.

The assessment also considers emissions of Greenhouse Gases (CH₄, CO₂ and SF₆) from the SMEP and includes estimates of direct and indirect GHG emissions.

The total lifetime direct (Scope 1) emissions from the Project are estimated to be approximately 26,634 CO₂-e in any one year.

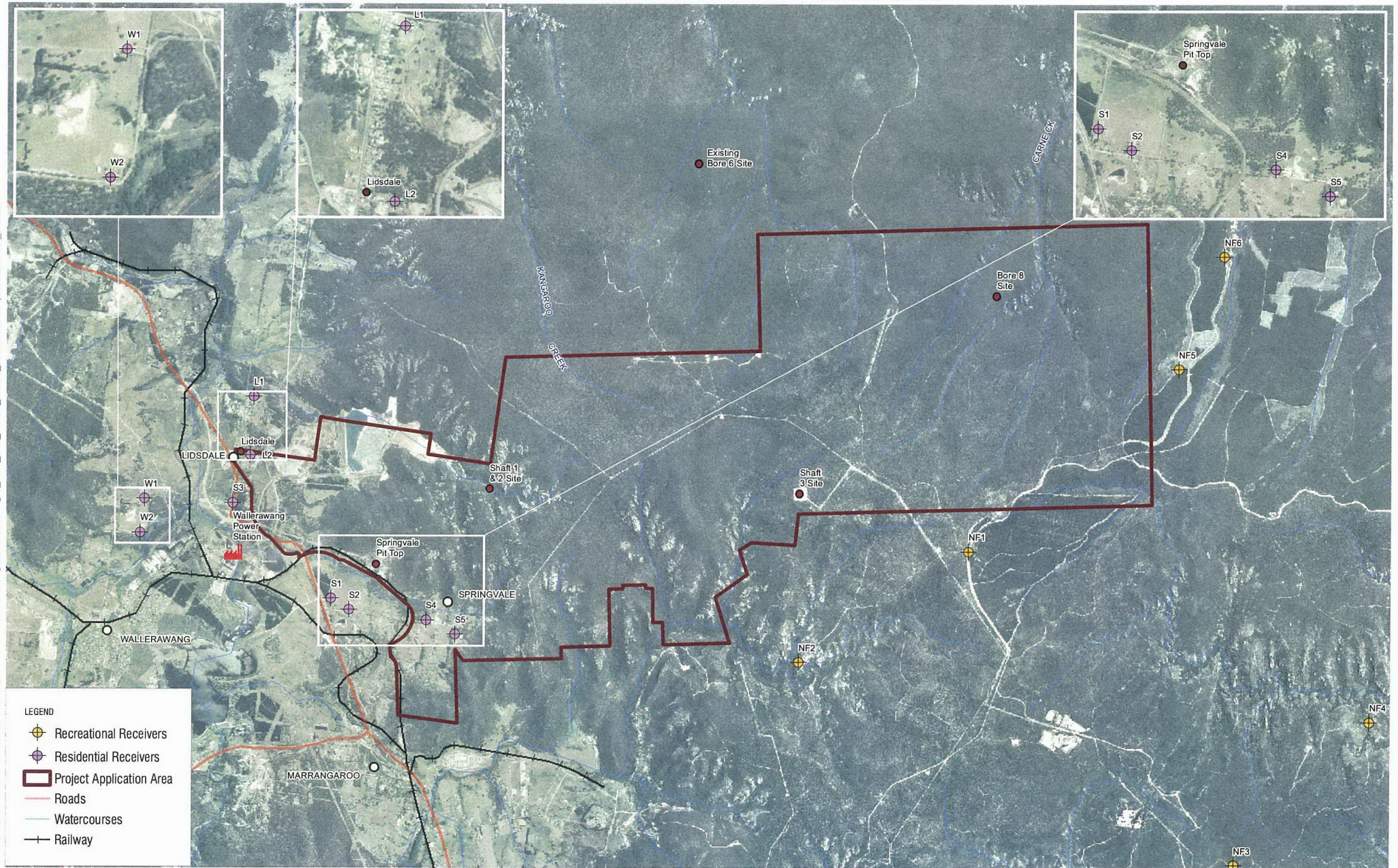
Indirect (Scope 2 and 3) emissions would be released in the process of mining coal, and through the transport and end use of the coal. The total lifetime indirect emissions (Scope 2 and 3) from mining coal and end use of the coal are estimated to be 1,152,735 t CO₂-e per annum.

Comparison of Project emissions with State and National GHG emission totals indicates that the modified Project is likely to represent approximately 0.02% of NSW GHG emissions (Scope 1) when compared to the latest available emissions data (2010) (Scope 1) and 0.005% of Australian GHG emissions (Scope 1).

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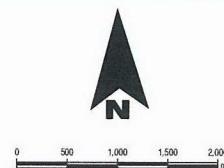
ESA Areas, Proposed Infrastructure and Sensitive Receptor Locations



LEVEL 1, 241 DENISON ST
BROADMEADOW
NEW SOUTH WALES 2292
AUSTRALIA
T: 61 2 4920 3000
F: 61 2 4961 3360
www.slrconsulting.com

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Project No.: 630.10123.02020
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Projection: GDA 1994 MGA Zone 56



Springvale Coal Pty Ltd

Springvale Modification

Sensitive Receptor Locations

FIGURE 4

Emission Estimation

Table B-1 Emission Estimation - Operation

Activity	Intensity		Emission Factor			Variables			Ref
	Value	Units	TSP	PM ₁₀	PM _{2.5}	Units	Parameter	Value	
Conveyor transfer points	18,000,000	tpa	0.0003	0.0001	0.00002	kg/t	Wind speed factor ¹	2.23	AP42
							Moisture content	10%	
							Control efficiency	40%	
Crushing	4,500,000	tpa	0.0100	0.0040	0.00040	kg/t	Control efficiency	70%	AP42
Dozers	8,760	hr/yr	15.3	3.7	0.34	kg/h	Silt content	6%	AP42
							Moisture content	10%	
Vehicle movement on unpaved roads	15,768	VKT/yr	1.856	0.431	0.04	kg/VKT	Silt content	3%	AP42
							Average gross mean vehicle weight	50 tonnes	
							Control efficiency	50%	
Wind erosion - Exposed areas	2.3	ha	0.40	0.20	0.03	kg/ha/hr	Hours per year	8,760 hours	NPI
							Control efficiency	50%	
Ventilation fan (Vertical)	221.1	m³/s	0.60	0.04	0.03	mg/m³			

Note: Wind Speed Factor = average of (wind speed/2.2)^{1,3}

Figure C-1 Annual and Seasonal Windroses (2009)

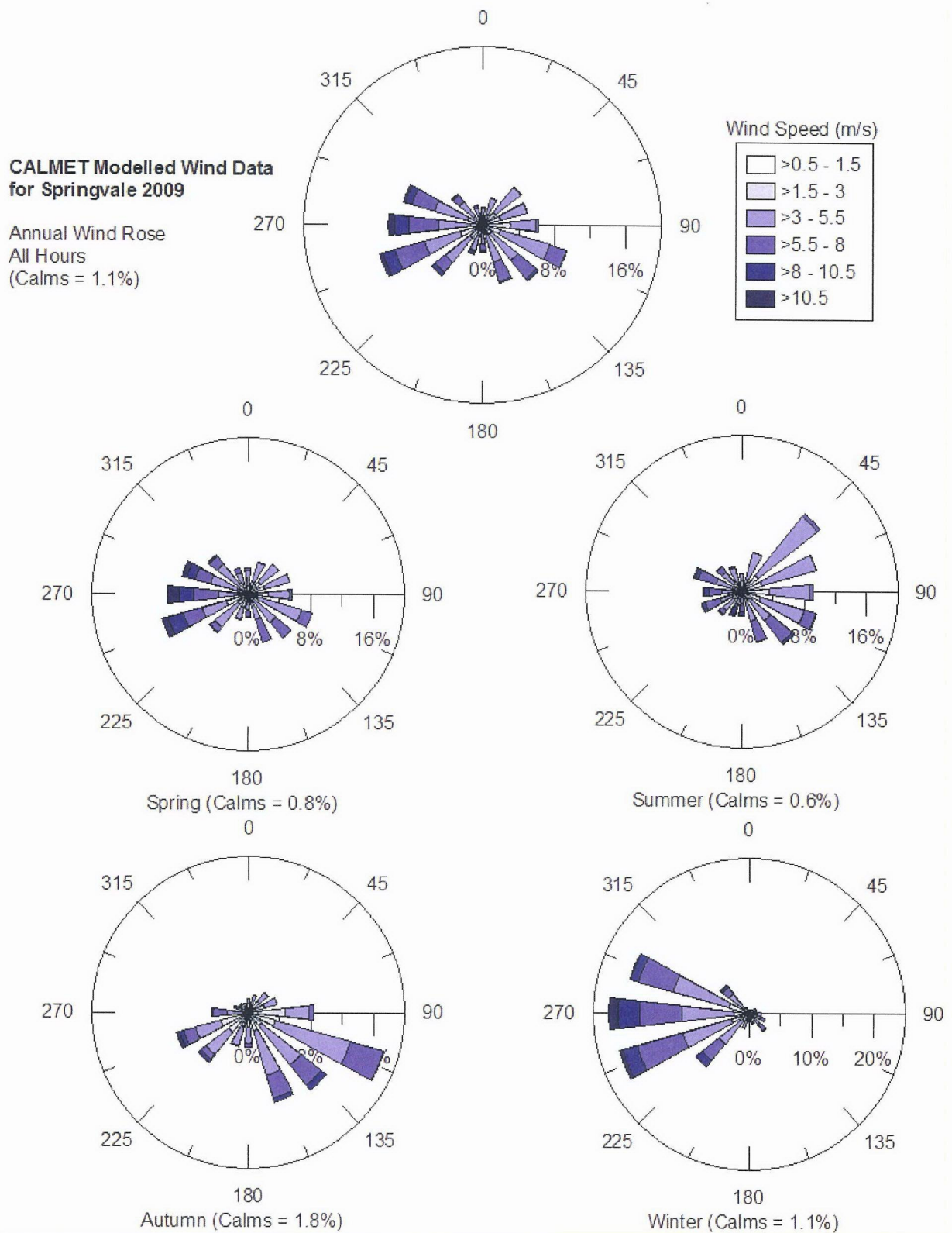
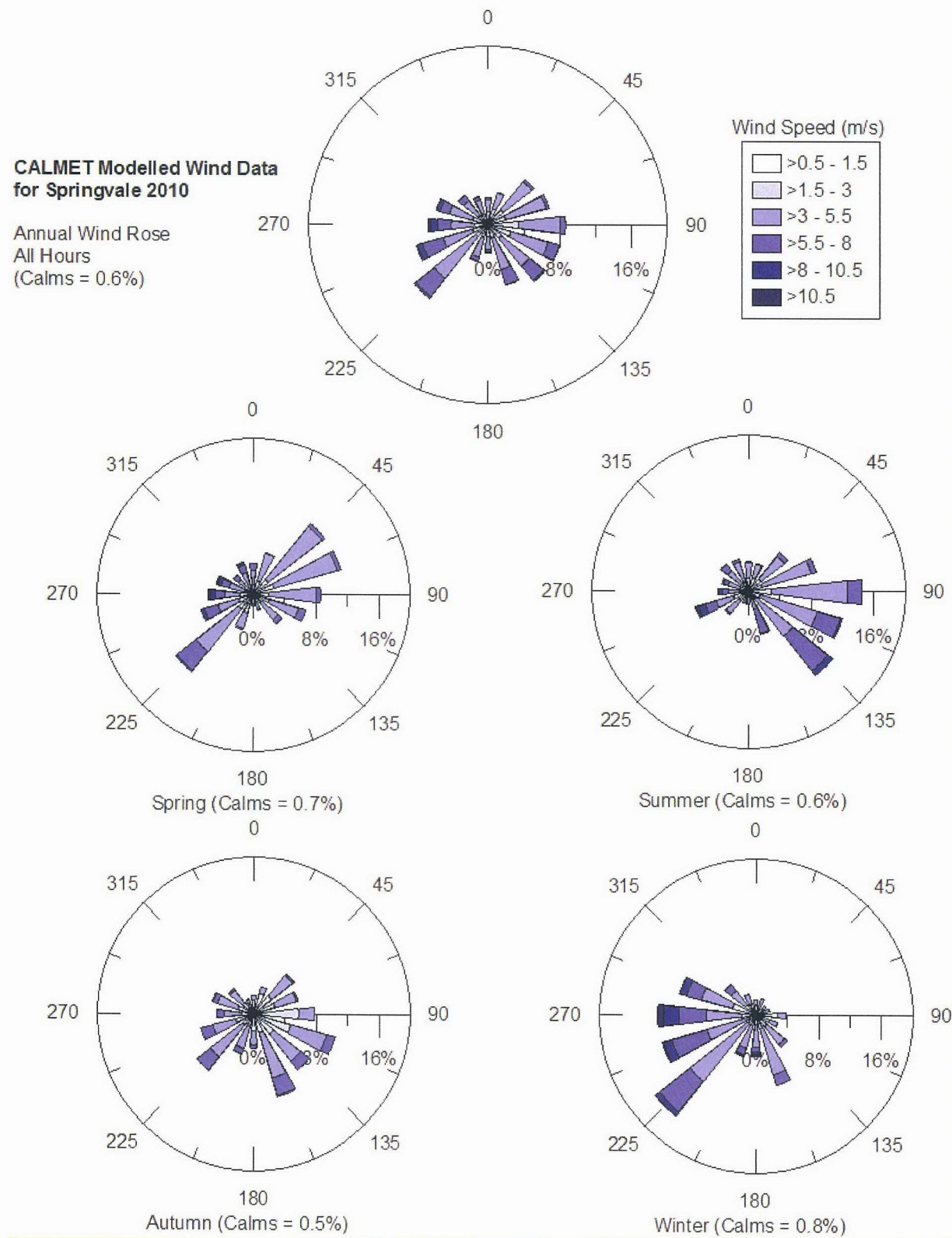
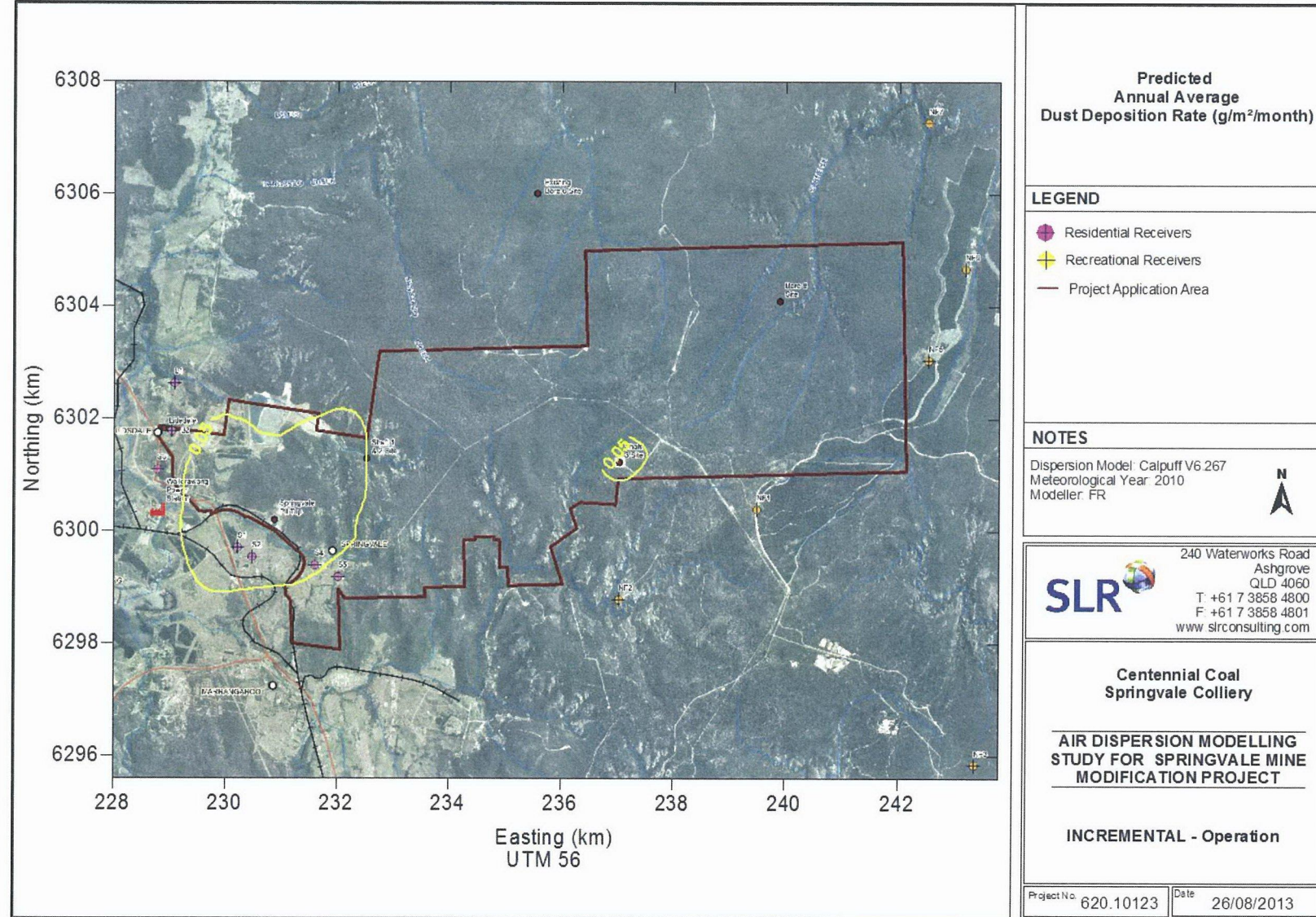


Figure C-2 Annual and Seasonal Windroses 2010



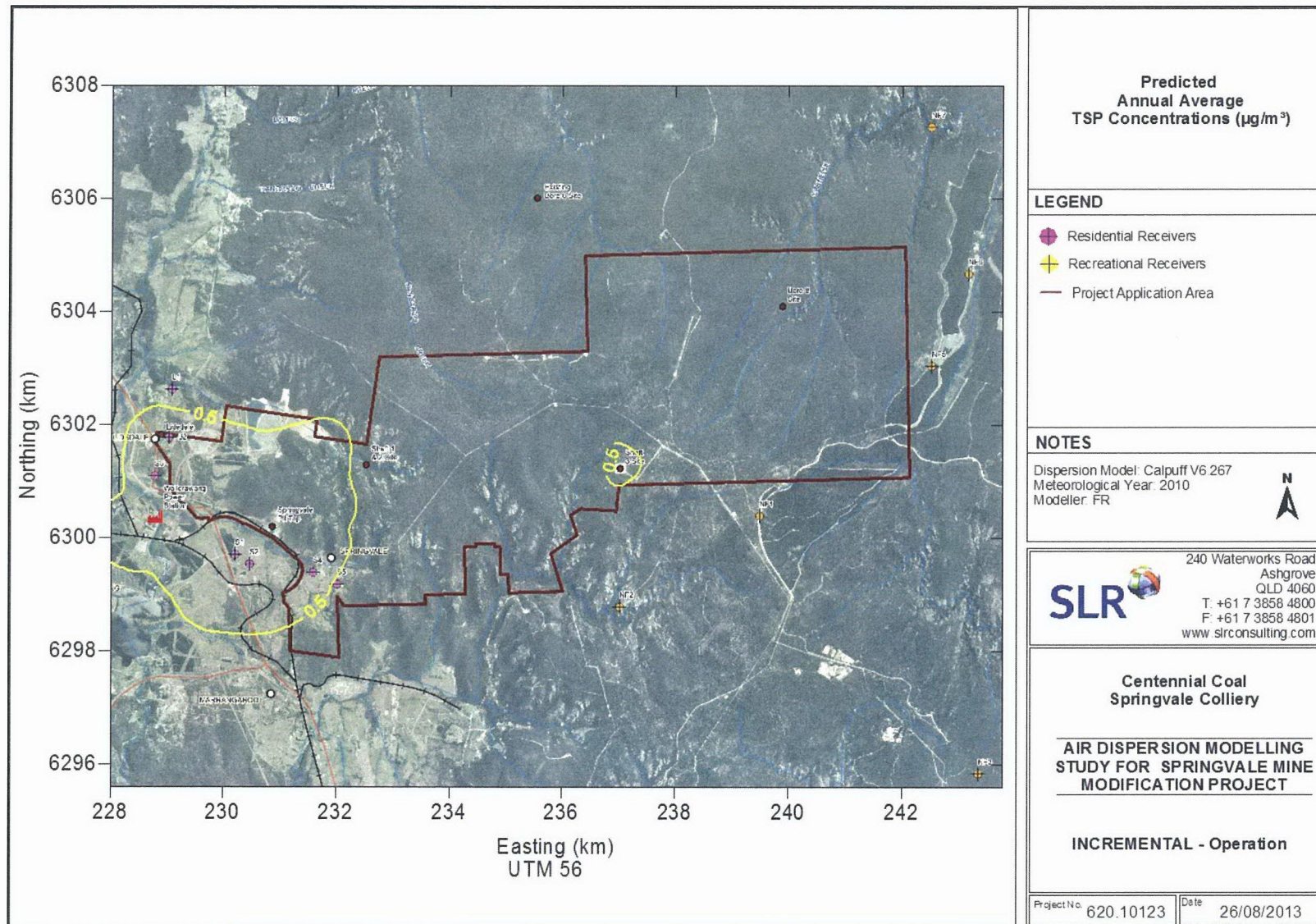
MODELLING RESULTS – CONTOUR PLOTS

Figure 1 Predicted Annual Average Dust Deposition Rate



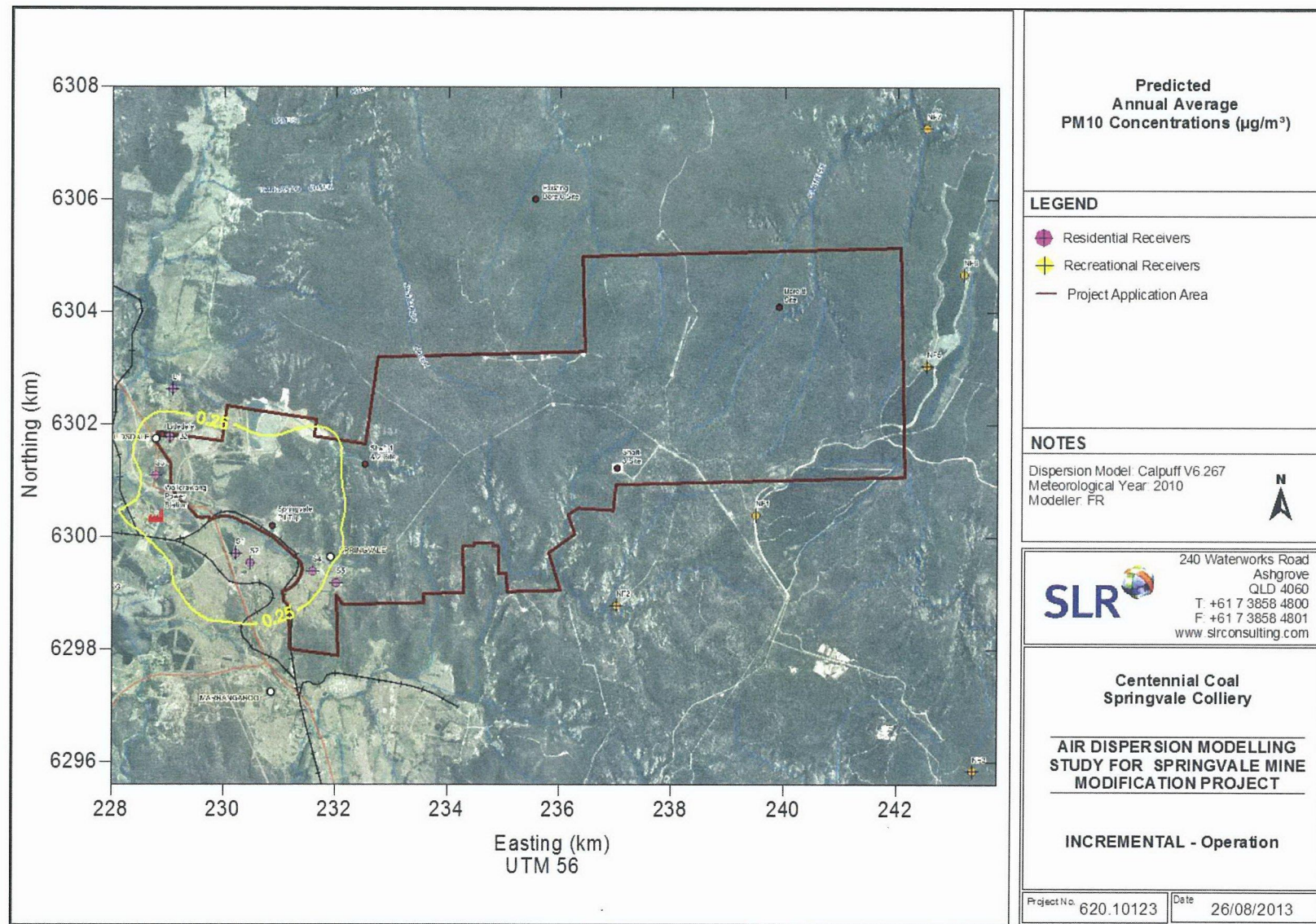
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Figure 2 Predicted Annual Average Incremental TSP Concentrations



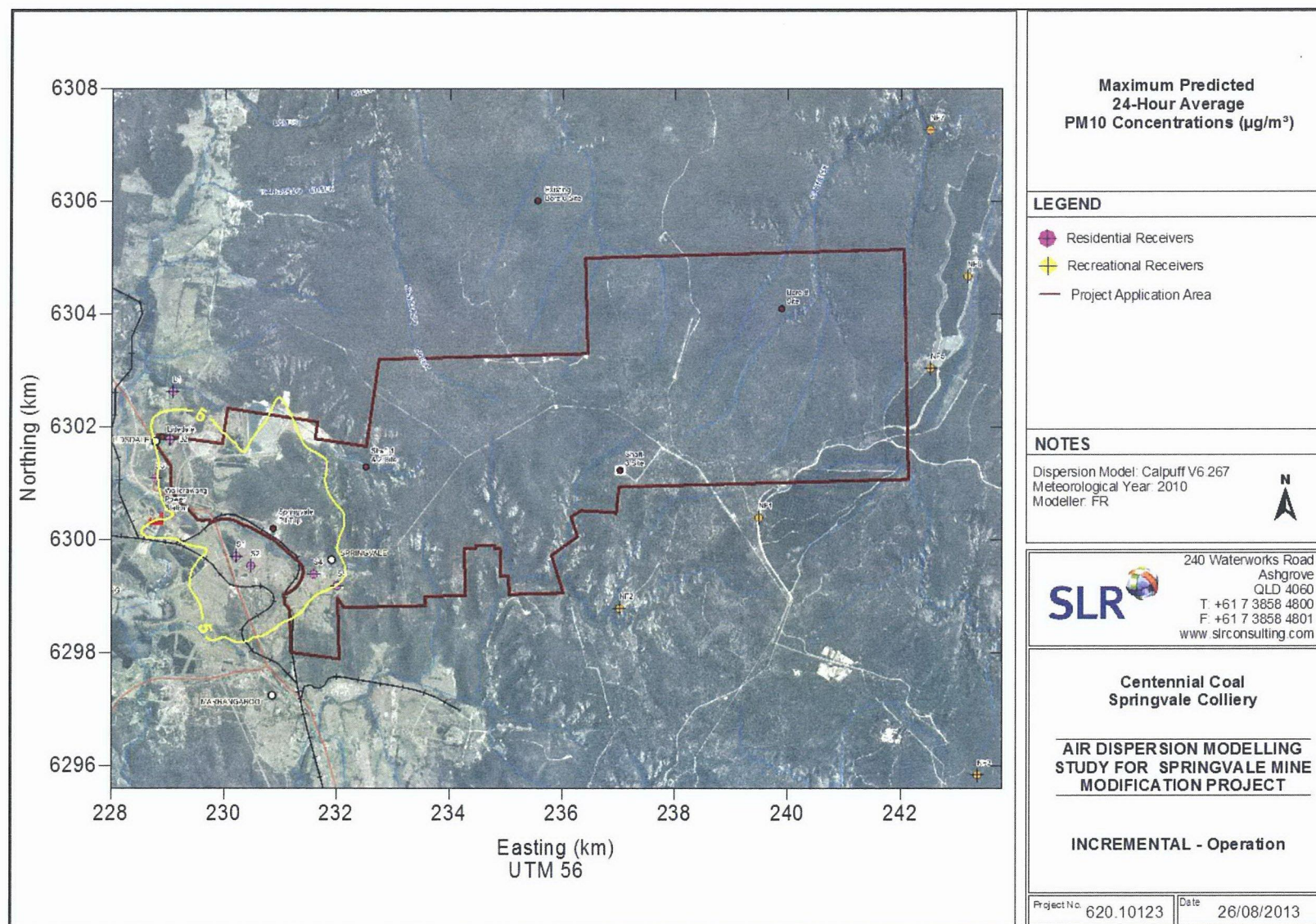
MODELLING RESULTS – CONTOUR PLOTS

Figure 3 Predicted Annual Average Incremental PM₁₀ Concentrations



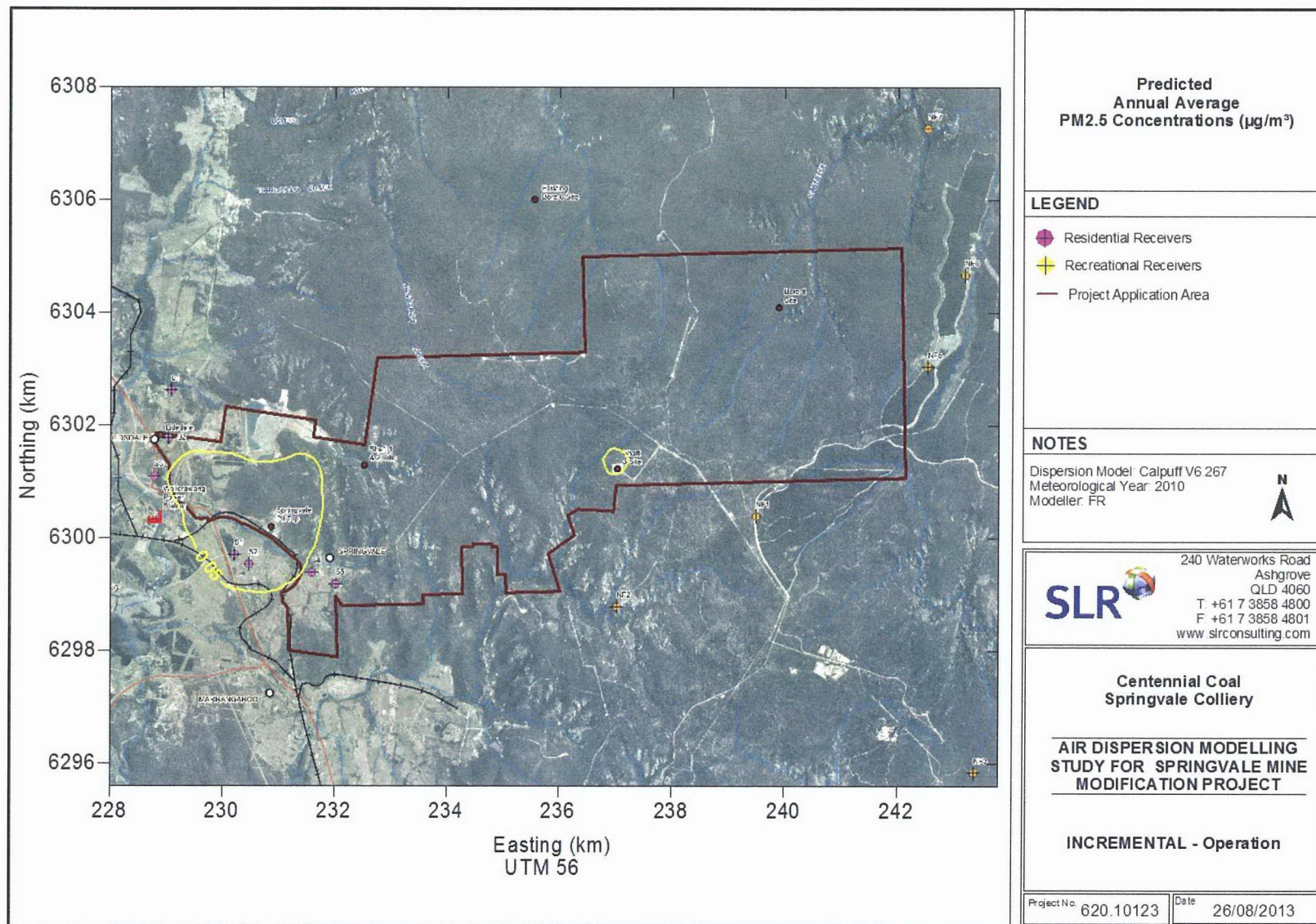
MODELLING RESULTS – CONTOUR PLOTS

Figure 4 Maximum Predicted 24-Hour Average Incremental PM₁₀ Concentrations



MODELLING RESULTS – CONTOUR PLOTS

Figure 5 Predicted Annual Average Incremental PM_{2.5} Concentrations



MODELLING RESULTS – CONTOUR PLOTS

Figure 6 Maximum Predicted 24-Hour Average Incremental PM_{2.5} Concentrations

