APPENDIX M

Air quality and greenhouse gas assessment

Cobbora Holding Company Pty Limited

EMM
EMGA Mitchell McLennan

Air Quality and Greenhouse Gas Assessment for the Proposed Cobbora Coal Project

Prepared for:
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Executive Summary

An air quality and greenhouse gas assessment was undertaken for the proposed Cobbora Coal Project (the Project), an open cut coal mine proposed by Cobbora Holding Company Pty Limited (CHC).

The primary objectives of the study were to identify the potential air quality and greenhouse gas related impacts associated with the Project, to satisfy the Director-General's Environmental Assessment Requirements and to make recommendations for additional mitigation and management measures if required.

Air Quality Assessment

Air emissions associated with the Project will primarily comprise of fugitive particulate matter releases. Emissions for a number of key mine stages were calculated based on a combination of Australian NPI and USEPA AP-42 emission estimation documents. Air emissions were quantified for all mobile mining equipment (haul trucks, bulldozers, etc) and processes (drilling, blasting, etc), coal processing and handling, fuel combustion by mobile equipment and wind erosion.

Emissions of total suspended particulates (TSP), particulate matter less than 10 microns in aerodynamic diameter (PM_{10}), particulate matter less than 2.5 microns in aerodynamic diameter ($PM_{2.5}$) and a range of gaseous pollutants were quantified for proposed Year 1, Year 2, Year 4, Year 8, Year 12, Year 16 and Year 20 operational mine plans. These were used to assess the temporal and spatial variations of potential air quality impacts related to the Project.

The calculated annual emissions were input into the USEPA regulatory AERMOD model, populated with site-specific terrain, land use and meteorological input data, in order to undertake atmospheric dispersion modelling. The dispersion modelling was conducted for a 24km x 24km domain, centred over the mining areas of the Project, to predicted ground level concentrations of pollutants resulting from the calculated emissions.

The air quality assessment, undertaken in accordance with the Approved Methods for Modelling, provides a conservative (upper bound) estimate of the potential for air quality impacts occurring due to the Project. Emission reductions due to the best practice management measures to be implemented by the Project were accounted for where the control effectiveness of measures could be quantified. Real-time operational dust management, informed by the proposed reactive/predictive air quality control system, was not included in the model. Real-time operational dust management will assist in the control of dust emissions, particularly during meteorological conditions when potential emissions (as modelled) are high.

Despite the conservative modelling approach adopted, it was predicted that air pollutants will remain below the applicable air quality criteria and standards at all but a small number of privately-owned residences. Incremental air pollutant concentrations and dust deposition rates associated with all mining years were predicted to be within OEH criteria. However, taking background concentrations into account, resultant cumulative concentrations were predicted to result in infrequent 24-hour PM_{10} criterion exceedances at nearby private residences on days when background concentrations are elevated. Given the easterly

airflow which prevails in the region, the potential exceedances were predicted to occur primarily at private residences located immediately west of mining areas. Across all assessed mine years combined, exceedances were predicted as follows:

- 24-hour Average PM_{10} – at receptors 1222, 1223, 1230, 1232, 3224 and 5025;
- 24-hour Average $PM_{2.5}$ – at receptors 1222, 1223 and 3224; and
- Annual Average $PM_{2.5}$ – at receptors 1222, 1223 and 3224;

Predicted exceedances of the 24-hour average PM_{10} criterion were generally restricted to one or two occurrences in most cases.

A conservative (upper bound) estimate of background $PM_{2.5}$ concentrations was derived from the site-specific PM_{10} dataset for use in the assessment. The derived annual average $PM_{2.5}$ concentrations of 4.7µg/m^3, comprises over 50% of the annual average $PM_{2.5}$ Advisory Reporting Standard of 8µg/m^3, and is considered a potential over-estimate of background concentrations.

It is noted that at the time of reporting, CHC was in the process of negotiating the acquisition of these properties with the relevant owners. It is understood that the owner of residence 3224 is seeking to stay and enter an amenity arrangement with CHC.

During mining operations, measures will be put in place to protect residents renting CHC properties from health impacts. Houses will not be leased if health-based criteria are likely to be exceeded.

In order to address the potential for exceedances in the surrounding environment, real time dust and meteorological monitoring will be undertaken. This will allow proactive management of potential dust impacts during unusual wind or weather events.

Gaseous emissions associated with fuel combustion by mobile plant and rail locomotives, and routine blasting operations were quantified and assessed. Constituents assessed were sulphur dioxide (SO_2), nitrogen dioxide (NO_2), carbon monoxide (CO and volatile organic compounds (VOCs); benzene, toluene, and toluene. Combustion emissions were predicted to be in compliance with all applicable criteria across all assessed years.

Management and monitoring measures have been recommended to ensure that the risks of abnormal emissions related to post-blast fume and spontaneous combustion remain throughout the life of mine.

The proposed construction stage activities will have a lower emissions intensity and spatial footprint than the operational mining stage of the Project. With the application of emission reduction measures, emissions from these activities are unlikely to adversely impact upon the surrounding environment.

Generally, the predictions presented in this report incorporate a level of conservatism due to worst case assumptions and the inherent conservative nature of dispersion modelling. As a result, it is expected that actual ground level concentrations would be lower during the normal operation of the Project. Notwithstanding, it is proposed that the emissions would be managed day-to-day using a best practice real-time dust management system.

Given that OEH PM_{10} criteria exceedances are predicted to occur infrequently at private residences, and that such exceedances tend to coincide with elevated background concentrations, the reactive/predictive system will reduce PM_{10} concentrations, potentially to below the criteria.

It is considered that through the implementation of proposed particulate matter emission control techniques, including the real-time monitoring network and reactive/predictive air quality control system, and the acquisition of nearby private land and dwellings, the air quality-related impact of the Project on the surrounding environment will be minimised.

Greenhouse Gas Assessment

To evaluate the Project's greenhouse gas (GHG) emissions and determine the Project's contribution to NSW and Australian annual GHG emissions, emissions were estimated based on information provided by the CHC and relevant GHG emission factors.

GHG emissions were calculated for:

- Direct emissions produced from sources within the boundary of the Project and as a result of CHC's activities (Scope 1 emissions); and
- Indirect emissions generated in the wider economy as a consequence of CHC's activities, but which are physically produced by the activities of another organisation indirectly (Scope 2 and 3 emissions).

The GHG assessment's key findings are as follows:

- Total Project GHG emissions (from direct and indirect sources) were estimated between 0.9 Mt and 30.0 Mt of Carbon Dioxide Equivalent per year (CO_2–e/yr);
- Indirect emissions (Scope 2 and 3) are the major contributor towards the Project's GHG emissions;
- Of the indirect emissions, downstream product transport and combustion of coal by end-customers constitutes, on average, 99.9% of the total emissions; and
- Direct (Scope 1) emissions generated by the Project represent between 0.024% and 0.152% of annual NSW emissions, 0.007% to 0.045% of Australian emissions and between 0.0001% and 0.0005% of global emissions.

Glossary of Key Acronyms and Symbols

AEMR	Annual Environmental Monitoring Report
AHD	Australian Height Datum
ANFO	Ammonium Nitrate with Fuel Oil
Approved Methods for Modelling	Approved Methods for the Modelling and Assessment of Air Pollutants in NSW
AWS	Automatic Weather Station
BMP	Best management practice
BoM	Australian Bureau of Meteorology
CH_4	Methane
CHC	Cobbora Holding Company Pty Limited
CHPP	Coal Handling and Processing Plant
CO	Carbon monoxide
CO_2	Carbon dioxide
CO_2-e	CO_2 equivalent
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DCCEE	Department of Climate Change and Energy Efficiency
DEC	NSW Department of the Environment and Conservation
DGRs	Director General's Assessment Requirements
EMM	EMGA Mitchell McLennan
ENVIRON	ENVIRON Australia Pty Ltd
EP&A Act	Environmental Planning and Assessment Act 1979
GHG	Greenhouse Gas
GWP	Global Warming Potential
IPCC	Intergovernmental Panel on Climate Change
mg	Milligram (g x 10^{-3})
µg	Microgram (g x 10^{-6})
µm	Micrometre or micron (metre x 10^{-6})
m^3	Cubic metre
Mbcm	Million bank cubic metre
Mtpa	Million tonnes per annum
NEPC	National Environment Protection Council
NEPM	National Environment Protection Measure
NHMRC	National Health and Medical Research Council
NGAF	National Greenhouse Accounts Factors
NPI	National Pollutant Inventory
NO_2	Nitrogen Dioxide
N_2O	Nitrous Oxide
PAA	Project Application Area
PM_{10}	Particulate matter less than 10 microns in aerodynamic diameter
$PM_{2.5}$	Particulate matter less than 2.5 microns in aerodynamic diameter
O_3	Ozone
OEH	Office of Environment and Heritage
OLM	Ozone Limiting Method
ROM	Run of Mine
SO_2	Sulphur Dioxide
TAPM	"The Air Pollution Model"
TEOM	Tapered Element Oscillating Microbalance
The Project	The Cobbora Coal Project

TSP	Total Suspended Particulate
USEPA	United States Environmental Protection Agency
VOC	Volatile Organic Compounds
VKT	Vehicle Kilometres Travelled

1 Introduction

ENVIRON Australia Pty Ltd (ENVIRON) has been commissioned by EMGA Mitchell McLennan (EMM) on behalf of Cobbora Holding Company Pty Limited (CHC) to prepare an Air Quality and Greenhouse Gas Assessment for the proposed Cobbora Coal Project (the Project).

The Project is a new open cut coal mine proposed by CHC. The mine will supply thermal coal, primarily to power stations in NSW. In addition, some coal will be produced for a combination of the export and spot domestic markets.

The Project is located approximately 5 km south of Cobbora, 22 km southwest of Dunedoo, 64 km northwest of Mudgee and 60 km east of Dubbo in the central west of NSW. The Project will include an open cut mine; a coal handling and preparation plant (CHPP); a train loading facility and rail spur; and a mine infrastructure area. Supporting infrastructure will include access roads; water supply and storage; and electricity supply. Construction is planned to commence in mid-2013. Mine operations will start in the first half of 2015. A mine life of 21 years is proposed.

A Major Project application under Part 3A of the Environmental Planning and Assessment Act 1979 (NSW) (EP&A Act) was submitted to the NSW Department of Planning on 5 January 2010 (application number MP 10_0001). The Director General's environmental assessment requirements (DGRs) for the Project were issued on 4 March 2010. In response to changes in the proposed Project and government assessment requirements, revised DGRs were issued for the Project on 23 December 2011.

1.1 Study Objective

The objectives of the study are to identify the potential air quality and greenhouse gas related impacts associated with the project, satisfy the DGRs and to make recommendations for additional mitigation and management measures if required.

1.2 Director General Requirements

The DGRs for the Project are as follows:

- **Air Quality** – including a quantitative assessment of potential:
  - Construction, operational, blasting and rail transport impacts;
  - Spontaneous combustion properties of overburden or reject material;
  - Reasonable and feasible mitigation measures, including evidence that there are no such measures available other than those proposed; and
  - Monitoring and management measures, in particular real-time air quality monitoring and predictive meteorological modelling.
- **Greenhouse Gases** – including:
  - A qualitative assessment of the potential scope 1, 2 and 3 greenhouse gas emissions of the project;

- A qualitative assessment of the potential impact of these emissions on the environment; and

- An assessment of all reasonable and feasible measures that could be implemented to minimise greenhouse gas emission and ensure energy efficiency.

The requirements in respect of air quality are specifically addressed in **Section 6**, 8 and **9** of the report with the earlier Sections providing the baseline information and study methodology.

The requirements in respect of greenhouse gas are specifically addressed in **Section 10** of the report.

1.3 Regulatory Framework

This Air Quality Assessment has principally been guided by the following approved methods and guidance documents:

- *The Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* ("the Approved Methods for Modelling", DEC 2005); and
- NSW Office of Environment and Heritage (OEH) *Coal Mine Particulate Matter Control Best Practice, Site-specific determination guideline*, November 2011.

The Greenhouse Gas (GHG) assessment for the Project was undertaken in accordance with the following methods:

- *National Greenhouse Accounts Factors (NGAF) Workbook – July 2011*, issued by the Australian Department of Climate Change and Energy Efficiency (DCCEE), hereafter referred to as the 'NGAF 2011 workbook'. The NGAF workbook is designed for use by companies and individuals to estimate greenhouse gas emissions. The NGAF 2011 workbook is listed in the Guidance, Policies and Plans section of the DGRs as a source of reference;
- *National Greenhouse Accounts Factors (NGAF) Workbook – January 2008*, issued by the DCCEE, hereafter referred to as the 'NGAF 2008 workbook';
- *National Greenhouse and Energy Reporting System (NGERS) Measurement – Technical Guidelines – July 2011*, issued by the DCCEE, hereafter referred to as the 'NGERS 2011 – Technical Guidelines';
- *Guidelines for Energy Savings Action Plans*, issued by NSW-Department of Energy, Utilities and Sustainability (NSW-DEUS) hereafter referred to as the 'GESAP'. The GESAP is listed in the Guidance, Policies and Plans section of the DGRs as a source of reference;
- *Second International Maritime Organisation (IMO) – Greenhouse Gas (GHG) Study 2009*, published by IMO, hereafter referred to as 'IMO-GHG Study'; and
- *National Greenhouse Gas Inventory – Analysis of Recent Trends and Greenhouse Indicators – 1990 to 2005*, published by the Australian Greenhouse Office (AGO) – Department of the Environment and Water Resources, 2007, hereafter referred to as the 'AGO National GHG Inventory'.

2 Project Overview and Setting

2.1 Description of the Project

2.1.1 Project Overview

The Cobbora Coal Project (the Project) is a new open cut coal mine that will be developed near Dunedoo in the central west of New South Wales (NSW). The Project Application Area (PAA) is approximately 274 square kilometres (km^2). The primary purpose of the Project is to provide coal for five major NSW power stations.

The mine will extract around 20 million tonnes per annum (Mtpa) of run-of-mine (ROM) coal. From this, approximately 9.5 Mtpa of product coal will be sold to Macquarie Generation, Origin Energy and Delta Electricity under long term contract. In addition, approximately 2.5 Mtpa will be produced for export or for the spot domestic market.

The Project's key elements are:

- an open cut mine;
- a coal handling and preparation plant (CHPP);
- a train loading facility and rail spur;
- a mine infrastructure area; and
- supporting infrastructure including: access roads; water supply and storage; and electricity supply.

It is envisaged that construction activities will commence in mid-2013 with coal supplied to customers from the second half of 2015. The mine life will be 21 years.

An indicative layout of the Project is presented in **Figure 1**. The area contained within the PAA, is hereafter referred to as the Project Site.

2.1.2 Open Cut Mine

Multiple open cut mining pits will be developed within three mining areas:

- Mining Area A north of the infrastructure area;
- Mining Area B south of the infrastructure area; and
- Mining Area C north-east of the infrastructure area.

There will be three out-of-pit waste rock emplacements:

- AC-OOP between mining areas A and C;
- B-OOP E adjacent to Mining Area B on the east side of Laheys Creek; and
- B-OOP W adjacent to Mining Area B on the west side of Laheys Creek.

The layout of the various open cut mining pits and out-of-pit waste rock emplacement areas is presented in **Figure 2**.

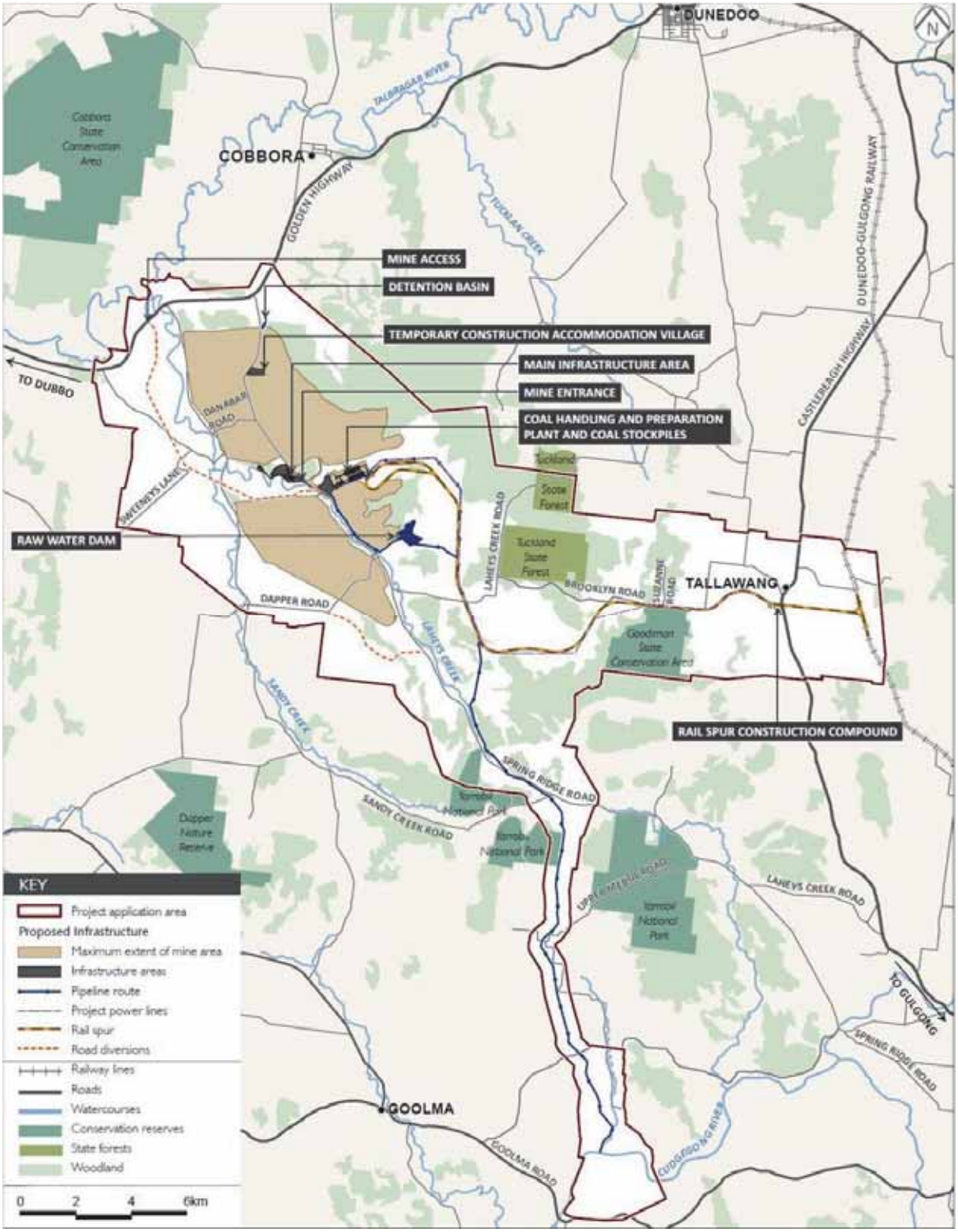

Figure 1: Indicative Project Layout

Image Source: Integrated Design Solutions (2012)

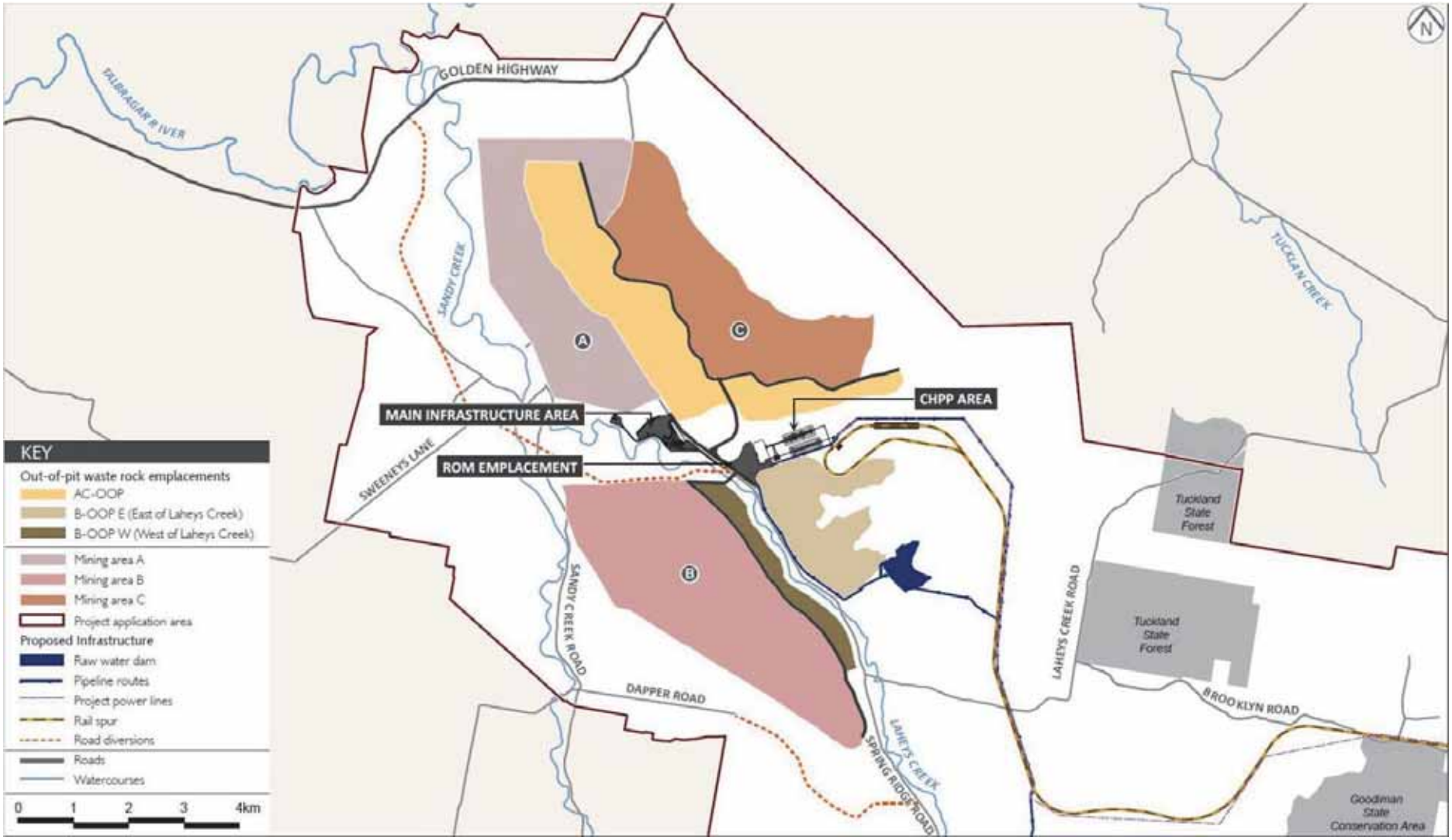

Figure 2: Layout of Proposed Mine Operations Area

A conventional load and haul operation is proposed using excavators, front-end loaders and trucks. Initially, trucks will haul waste rock to out-of-pit emplacements. Following this, the majority of the waste rock will be placed in the mined-out voids.

Trucks will haul excavated ROM coal to the CHPP where it will be tipped into dump hoppers above the primary crushers or onto secondary ROM stockpiles for later rehandling.

2.1.3 Coal Handling and Preparation Plant

The CHPP will treat up to 20 Mtpa of ROM coal to produce a product coal that meets the sizing and coal quality requirements of the customers. Subject to the level of impurities (rejects) in the coal and washability characteristics, the ROM will be either crushed and bypassed or treated (washed) in the preparation plant. The rejects will typically include waste rock from above and below the coal seam as well as material dispersed within the coal.

The CHPP processes will be typical of those used in the majority of CHPPs in NSW with product coal separated from rejects in a series of coal cleaning circuits. The CHPP area will also contain a truck dump station; crushing plants; coal stockpiles; and the infrastructure to move and stockpile the coal. Rejects from the CHPP will be disposed within the footprint of the mining area.

2.1.4 Train Loading Facility and Rail Spur

Coal will be transported by rail to the Project's customers, including Bayswater and Liddell power stations in the Upper Hunter Valley and Eraring, Vales Point and Munmorah power stations on Lake Macquarie on the NSW Central Coast.

Product coal will be loaded onto trains from an overhead train loading bin located on a rail spur balloon loop. Approximately five trains will be loaded each day. The rail spur will be approximately 28 km long and will join the Dunedoo-Gulgong rail line near Tallawang. A locomotive provisioning facility and a siding for fuel delivery may be located adjacent to the balloon loop.

2.1.5 Mine Infrastructure Area

The mine infrastructure area will be located adjacent to the mining areas. It will include workshops; hardstand and lay-down areas; bulk storage buildings; bulk fuel storage and a fuelling station; office buildings; an operations building and change-house; parking; an explosives magazine; and vehicle washdown bays.

2.1.6 Supporting infrastructure

Access Roads

The main access to the mine will be from the Golden Highway to the north of the operations, via a road diversion that will replace an existing section of Spring Ridge Road. There will be limited light vehicle access from the south via Spring Ridge Road.

Internal roads will connect the access road to the workshop, administration buildings and to the mine infrastructure area. Internal roads will also connect the various areas of the Project.

Water Supply

The Project will require water primarily for the CHPP and for dust suppression. Water will be sourced by intercepting surface water and by pumping groundwater that enters the mine pits in accordance with the relevant permits and licences. Water will also be sourced from the Cudgegong River and pumped approximately 26 km to the primary raw water dam south-east of the mining area. Pre-existing high security water access licences have been purchased for the Project to allow up to 3.3 gigalitres (GL) of water to be extracted from the river.

Electricity Supply

The Project will require approximately 20 megawatts (MW) of electrical power. The Project will be connected to the grid at a small switching yard adjacent to the Castlereagh Highway. A power line, generally running parallel to the rail spur, will deliver the electricity to a substation in the mine infrastructure area.

An 11 kV powerline will supply the Cudgegong River pump station from the existing grid approximately 2 km south of the pump station site.

2.1.7 Workforce and Operating Hours

The proposed mine construction workforce will average approximately 350 persons, peaking at approximately 550 persons over a 26 month period covering Q3 2013 to Q2 2016.

The proposed mine operation workforce is estimated to be 300 persons during the first two years of full production in 2016 and 2017. This will increase steadily over the next ten years to reach a peak level of approximately 590 persons between 2027 and 2030.

Mine construction is expected to occur up to 12 hours per day. However, construction may occur up to 24 hours per day at times (e.g. during major concrete pours).

Mine operation will occur up to 24 hours per day, 7 days per week, 52 weeks per year.

2.2 Land Use and Topography

The area within and surrounding the Project Site is predominately rural, with a mixture of cleared agricultural land and forested areas. The majority of the proposed open-cut mining and infrastructure areas for the project are located in previously cleared lands the exception being sections of Mining Area C.

The key extractive and processing operational areas of the Project are situated within an altitudinal range of between 390m Australian Height Datum (AHD) and 470m AHD, with the lower elevations located between the CHPP and the northern extent of mining activities. The higher terrain flanks the mining operations to the southwest and east, with Mining Areas B and C cut into the elevated terrain. Further afield from the designated mining areas to the east and south, the terrain increases gradually to an elevation of approximately 600m AHD. **Figure 3** presents the topography surrounding the Project Site.

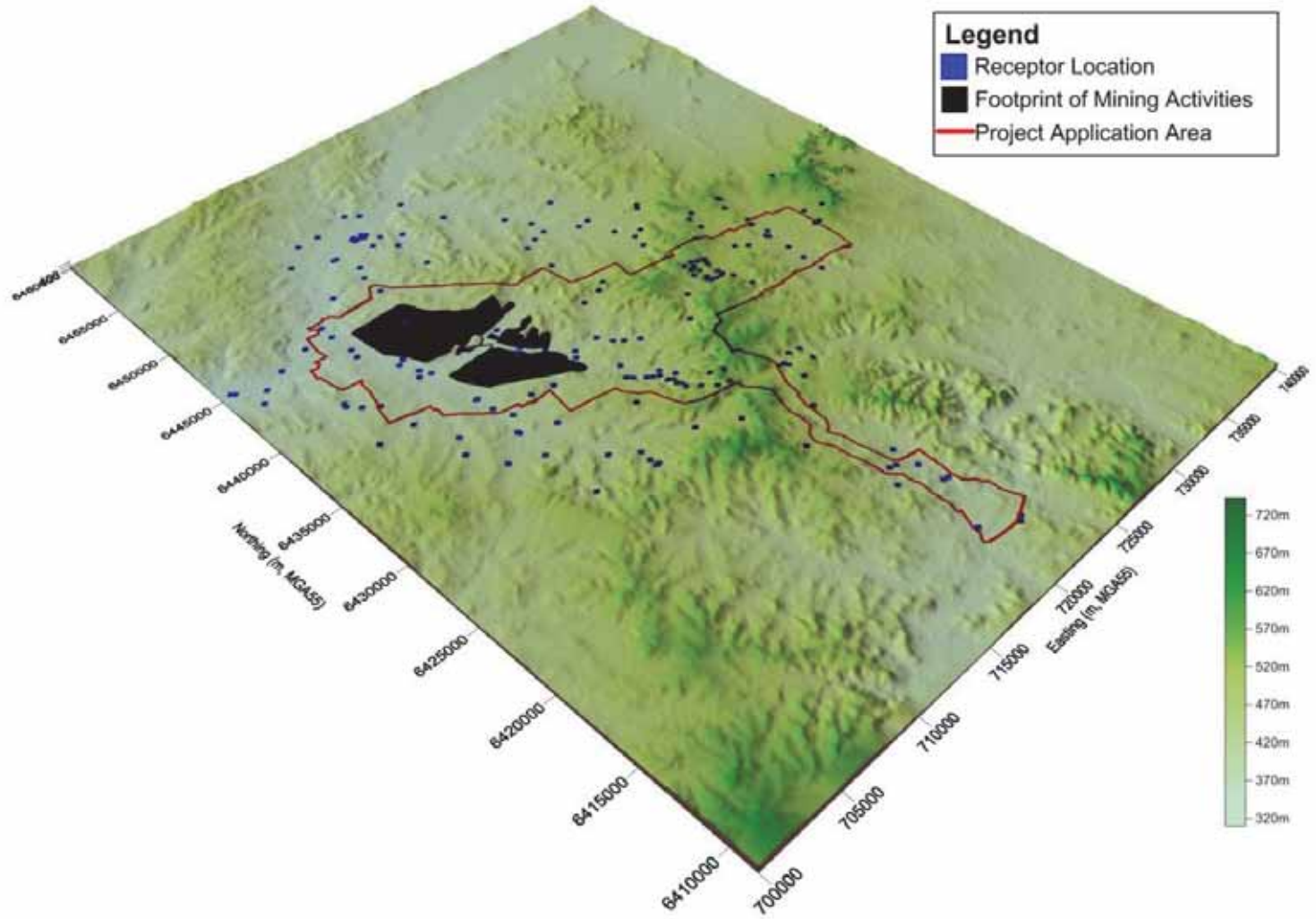

Figure 3: 3-Dimensional Topography surrounding the Project

NOTE: Vertical exaggeration of 2 applied.

2.3 Potential Receptors

The region surrounding the Project contains a number of rural-residential properties situated at varying distances from the proposed mining activities. The dispersion modelling undertaken within this assessment focuses on an area of 24 km by 24 km, centred over the mining area (further discussion in **Section** 7).

The location of privately owned and CHC-owned dwellings situated within the model domain (24 km by 24 km area) is illustrated in **Figure 4**. Predictions of air pollutant concentrations and deposition levels were made at each of these locations to assess air quality compliance. The details of the privately-owned receptor locations, along with the proximity to the proposed CHPP, are presented within **Table 1**.

It is noted that some private and CHC-owned dwellings are located along the rail spur extending to the east of the area marked in **Figure 4**, with the closest privately-owned receptors located approximately 250m from the rail corridor. The emissions associated with the rail spur (including diesel-combustion related emissions and particulate matter from moving rail wagons) are minor relative to the emission generated by the proposed mining activities (further discussion on emissions from the Project provided in **Section** 6). It is therefore considered that the greatest potential impacts from Project-generated emissions to air would be experienced at the properties marked in **Figure 4**. Potential air quality impacts at properties located beyond those shown in **Figure 4** would be lower and have therefore been excluded from the assessment.

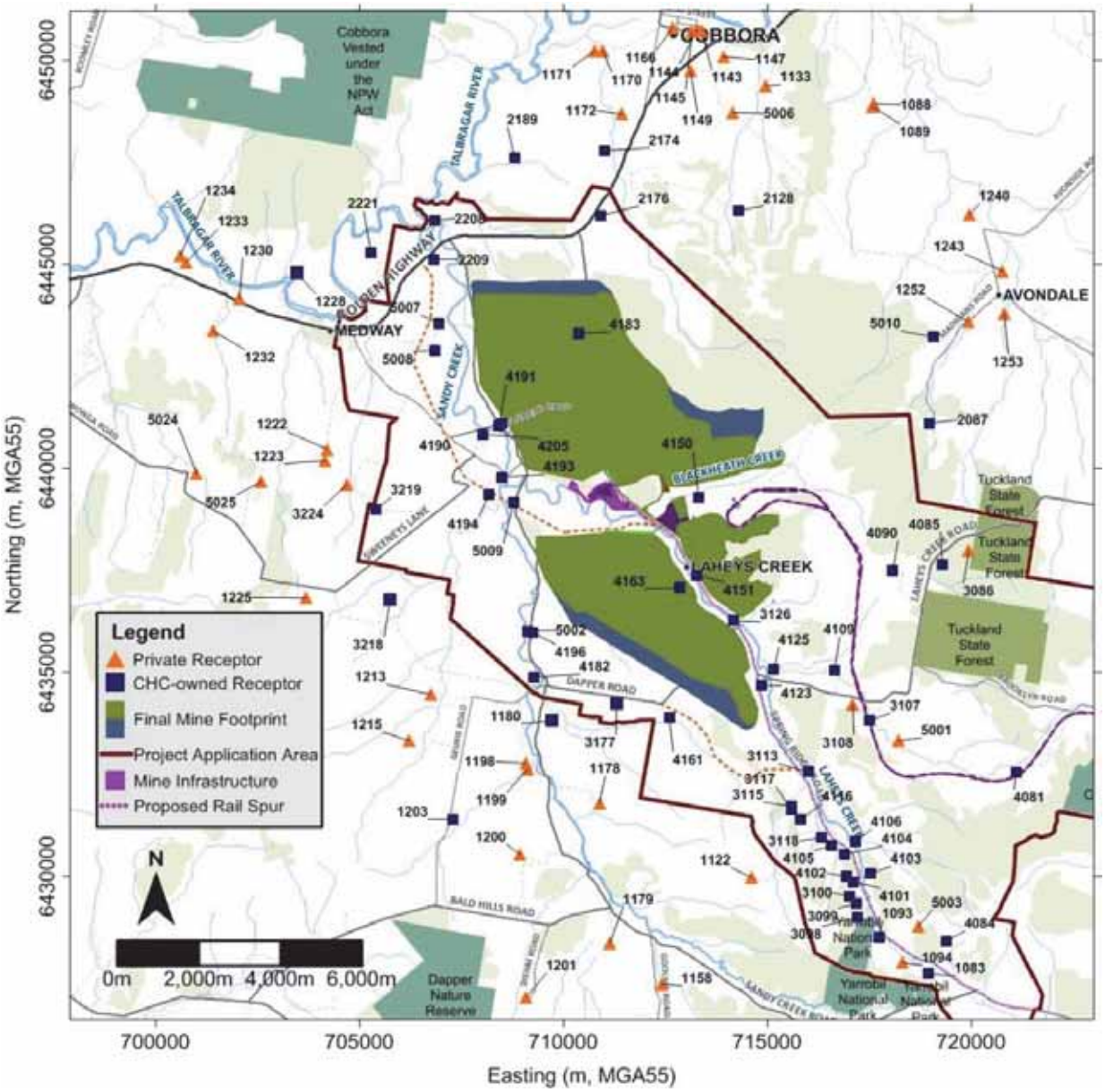

Figure 4: Receptor Locations Surrounding the Project

Table 1: Nearest Privately-Owned Dwellings (Potential Receptors)			
Receptor ID	Receptor Location (m, MGA55)		Distance from CHPP (km)
	Easting	Northing	
1088	717589	6448933	10.7
1089	717566	6448869	10.6
1094	718307	6427895	12.3
1122	714612	6429973	9.2
1133	714961	6449372	10.4
1143	713378	6450733	11.6
1144	713276	6450758	11.7
1145	713147	6450690	11.6
1147	713919	6450085	11.0
1149	713106	6449745	10.6
1158	712393	6427361	11.8
1166	712674	6450791	11.7
1170	710956	6450243	11.4
1171	710758	6450235	11.4
1172	711425	6448680	9.8
1178	710879	6431794	7.7
1179	711134	6428374	11.0
1198	709084	6432771	7.6
1199	709119	6432633	7.7
1200	708931	6430539	9.6
1201	709077	6427040	12.8
1213	706755	6434459	8.0
1215	706203	6433330	9.2
1222	704200	6440473	9.2
1223	704154	6440196	9.2
1225	703677	6436827	9.9
1230	702052	6444167	12.4
1232	701400	6443376	12.7
1233	700741	6445052	13.9
1234	700603	6445211	14.1
1240	719940	6446205	9.7
1243	720766	6444830	9.4
1252	719923	6443593	8.0
1253	720799	6443797	8.8
3086	719935	6437979	6.7
3108	717086	6434221	6.2
3224	704695	6439614	8.6
5001	718201	6433329	7.6

Table 1: Nearest Privately-Owned Dwellings (Potential Receptors)			
Receptor ID	Receptor Location (m, MGA55)		Distance from CHPP (km)
	Easting	Northing	
5003	718703	6428783	11.6
5006	714134	6448718	9.6
5024	701001	6439875	12.2
5025	702590	6439680	10.6

3 Air Quality Assessment Criteria

To satisfy the guidelines of the NSW Office of Environment and Heritage (OEH), proposed operations must demonstrate that cumulative air pollutant concentrations, taking into account incremental concentrations due to the Project's emissions and existing background concentrations, are within ambient, or outdoor, air quality criteria.

For proposed developments within NSW, assessment criteria for air quality at ground level specified by the NSW OEH (formerly Department of Environment and Conservation (DEC)) within the Approved Methods for Modelling (DEC 2005) are applicable. These assessment criteria have been developed to maintain an ambient air quality that allows for the adequate protection of human health and well-being.

Air quality pollutants generated by the Project are assessed within this study, focusing on particulate matter and fuel combustion-related pollutants. These are assessed as the following air quality indicators:

- Total suspended particulates (TSP);
- Particulate Matter less than 10 microns in aerodynamic diameter (PM_{10});
- Particulate Matter less than 2.5 microns in aerodynamic diameter ($PM_{2.5}$);
- Dust Deposition;
- Oxides of Nitrogen (NO_x), with a specific focus on Nitrogen Dioxide (NO_2);
- Sulphur Dioxide (SO_2);
- Carbon Monoxide (CO); and
- Volatile Organic Compounds (VOCs), with a specific focus on the individual compounds Benzene, Toluene and total Xylenes.

Emissions of TSP have been used to assess TSP concentrations and dust deposition levels in the surrounding environment as a result of the operation of the Project.

Criteria issued by Federal and NSW government applicable to the above air quality indicators are summarised in the following sections.

In assessing the compliance of emissions from the Project on the surrounding environment, a Level 2 impact assessment, using refined dispersion modelling techniques with site-specific input data, as per the requirements of OEH (DEC 2005) has been undertaken. Further details relating to the assessment methodology is provided in **Section** 7.

3.1 Airborne Particulate Matter

Air quality limits for particulates are typically given for various particle size fractions, including total suspended particulates (TSP), inhalable particulates or PM_{10} (i.e. particulates with an aerodynamic diameter of less than 10 µm), and respirable particulates or $PM_{2.5}$ (i.e. particulates with an aerodynamic diameter of less than 2.5 µm). Although TSP is defined as all particulates with an aerodynamic diameter of less than 100 µm, an effective upper limit of 30 µm aerodynamic diameter is frequently assigned (USEPA, 2010). PM_{10} and $PM_{2.5}$ are of concern due to their health impact potential (Pope and Dockery, 2006; WHO, 2007).

Air quality criteria issued by Federal and NSW governments for particulates are summarised in **Table 2**.

Table 2: Air Quality Assessment Criteria for Airborne Particulates

Pollutant	Averaging Period	Concentration (µg/m³)	Reference
TSP	Annual	90	OEH[(1)(2)]
PM_{10}	24 hours	50	OEH[(1)]
	24 hours	50[(4)]	NEPM[(3)]
	Annual	30	OEH[(1)]
$PM_{2.5}$	24 hours	25	NEPM[(5)]
	Annual	8	NEPM[(5)]

Note 1: DEC, 2005 *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales*
Note 2: OEH impact assessment criterion based on the subsequently rescinded National Health and Medical Research Council (NHMRC) recommended goal
Note 3: NEPC, 2003, *National Environment Protection (Ambient Air Quality) Measure,* as amended
Note 4: Provision made for up to five exceedances of the limit per year
Note 5: Advisory reporting goal issued by the NEPC (NEPC, 2003)

The NSW 24-hour PM_{10} assessment goal of 50 µg/m^3 is numerically identical to the equivalent National Environment Protection Measure (NEPM) reporting standard except that the NEPM reporting standard allows for five exceedances per year. The NEPM goals were developed by the National Environmental Protection Council (NEPC) in 1998, with compliance to be achieved by 2008. All state jurisdictions commenced formal reporting against the NEPM standards in 2002. It is noted, however, that the OEH requires assessment of predicted 24-hour average PM_{10} against the maximum predicted concentration.

Air quality criteria for TSP were typically set prior to the development of an improved understanding of the relationship between health impacts and exposure to fine particulate concentrations, and have subsequently either been discarded or given reduced importance by countries internationally. The NSW OEH TSP impact assessment criterion is based on the goal recommended by the National Health and Medical Research Council (NHMRC) (DEC, 2005; NHMRC, 1996). It is noted that the NHMRC goals have subsequently been rescinded.

The OEH has not published an ambient air quality criterion for $PM_{2.5}$. Reference may, however, be made to the $PM_{2.5}$ advisory reporting standards and goals issued by the NEPC (NEPC, 2003), as referenced in **Table 2**.

The air quality impact assessment criteria for airborne particulate concentrations are applicable at the nearest existing or likely future off-site dwellings or establishments. Such places are termed sensitive receptors by the Approved Methods for Modelling. In assessing against these criteria, the total air pollutant concentration (incremental plus background concentration) must be reported as the 100th percentile (i.e. maximum) concentration in units consistent with the impact assessment criteria. These must then be compared with the relevant impact assessment criteria.

3.2 Dust Deposition Criteria

Nuisance dust deposition is regulated through the stipulation of maximum permissible dust deposition rates. The OEH impact assessment criteria for dust deposition are summarised in **Table 3** illustrating the allowable increment in dust deposition rates above ambient (background) dust deposition rates which would be acceptable so that dust nuisance could be avoided. Furthermore, a limit is set for total cumulative dust deposition rates which include existing deposition and any increment due to a proposed development. Cumulative annual average dust deposition rates within residential areas which are in excess of 4g/m²/month are generally considered to indicate that nuisance dust impacts are occurring.

Table 3: Dust Deposition Criteria Published by OEH

Pollutant	Maximum Increase in Dust Deposition	Maximum Total Dust Deposited Level
Deposited dust (assessed as insoluble solids)	2g/m^2/month	4g/m^2/month

Source: DEC, 2005 *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales*

3.3 Land Area Criteria

While the criteria for particulate matter and dust deposition listed in the preceding sections is prescribed by OEH for application at individual receptor locations, it is noted that recent project approvals granted by the Department of Planning for similar extractive operations to the Project have included land area criteria. Typically, the Department of Planning requires that the predicted cumulative (project increment plus background) annual average TSP concentrations, 24-hour and annual average PM_{10} concentrations and annual average dust deposition levels do not exceed the relevant criteria (listed in **Section 3.1** and **3.2**) over more than 25 percent of any surrounding privately-owned land.

In order to inform the level of compliance with this Department of Planning requirement, the percentage of private land impacted by predicted concentrations/deposition levels from the Project will be reviewed.

3.4 Gaseous Air Pollutants

Emissions will occur as a result of fuel combustion, including from mobile mining equipment (haul trucks, dozers, excavators, etc) and diesel locomotives, and from blasting processes associated with the Project. Key combustion-related pollutants of interest are NO_2, SO_2, CO and VOCs. While numerous VOC species are emitted during the combustion of diesel fuel, this assessment has focussed primarily on benzene, toluene and total xylenes to assess the potential health impact of individual organic species. These species are quantifiable based on available emission factors, and may be used as markers of the relative toxicity of organic compounds from combustion.

Air quality criteria issued by Federal and NSW governments applicable to these gaseous emissions are summarised in **Table 4**.

The air quality impact assessment criteria for SO_2, NO_2 and CO are applicable at the nearest existing or likely future off-site dwellings or establishments. In assessing against these criteria, the total concentration (incremental plus background concentration) must be reported as the 100th percentile in concentration units consistent with the impact assessment

criteria. These are then compared with the relevant impact assessment criteria (DEC, 2005).

The criterion specified for benzene is applicable at and beyond the boundary of the facility. For a Level 2 assessment, as is undertaken in the current study, the incremental concentration (predicted concentration due to the pollutant source alone) must be reported as the 99.9th percentile 1-hour average (DEC, 2005).

The impact assessment criteria given for toluene and xylenes are applicable at any existing or likely future off-site dwellings or establishments. The incremental concentration (predicted concentration due to the pollutant source alone) must be reported as the 99.9th percentile 1-hour average (DEC, 2005).

Table 4: Criteria for Gaseous Air Pollutants

Pollutant	Averaging Period	Concentration		Reference
		µg/m³	pphm	
NO_2	1-hour	246	12	OEH[1]
		246	12	NEPM[2]
	Annual	62	3	OEH[1]
		62	3	NEPM
SO_2	10-minute	712	25	OEH[1]
	1-hour	570	20	OEH[1]
		570	20	NEPM[2]
	24-hour	228	8	OEH[1]
		228	8	NEPM[2]
	Annual	60	2	OEH[1]
		60	2	NEPM
CO	1-hour	30,000	2,500	OEH[1]
	8-hour	10,000	9,000	OEH[1]
Benzene	1-hour	29	0.9	OEH[1,3,4]
Toluene	1-hour	360	9	OEH[1,3,5]
Xylenes	1-hour	190	4	OEH[1,3,5]

Note 1: DEC, 2005, Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales

Note 2: Provision made for one exceedance of the limit per year

Note 3: For a Level 2 Assessment (defined within the Approved Methods for Modelling), expressed as the 99.9th Percentile Value. The current assessment constitutes a Level 2 Assessment

Note 4: Assessment criteria specified for toxic air pollutant

Note 5: Assessment criteria summarised for odorous air pollutants

pphm: Parts per hundred million

4 Climate and Meteorology

Meteorological mechanisms govern the generation, dispersion, transformation and eventual removal of pollutants from the atmosphere. Dust generation rates are particularly dependent on wind energy and on the moisture budget, which is a function of rainfall and evaporation rates.

The extent to which pollution will accumulate or disperse in the atmosphere is dependent on the degree of thermal and mechanical turbulence within the boundary layer (the general term for the layer of the atmosphere adjacent to the earth's surface).

Thermal turbulence is driven by incoming solar radiation during the day hours. Mechanical turbulence is associated with wind speed, in combination with the surface roughness of the surrounding area. The stability of the atmosphere increases with a decrease in thermal and mechanical turbulence.

Air pollutant dispersion consists of vertical and horizontal components of motion. Vertical motion is defined by the stability of the atmosphere (e.g. a stable atmosphere has low dispersion potential) and the depth of the surface-mixing layer, typically the vertical distance between the earth's surface and a temperature inversion.

The horizontal dispersion of pollution in the boundary layer is primarily a function of the wind field (i.e. wind speed and direction). The wind speed determines both the distance of downwind transport and the rate of dilution as a result of plume 'stretching'. The wind direction, and the variability in wind direction, determines the general path pollutants will follow.

Airborne particulate concentration levels therefore fluctuate in response to changes in atmospheric stability, to concurrent changes in the mixing depth and to shifts in the wind field (Oke, 2003; Sturman and Tapper, 2006; Seinfeld and Pandis, 2006).

In order to characterise the dispersion meteorology of the region surrounding the Project, long-term climate records, time-resolved meteorological monitoring data and meteorological modelling for the region was drawn upon, as documented in the subsequent sections.

4.1 Climate Records and Meteorological Data

The following data sets were used in the meteorological analysis:

- long-term climate statistics (1912 to 2011) obtained from the Bureau of Meteorology (BoM) Dunedoo Post Office Station (Station Number 064009);
- long-term rainfall records obtained from the BoM stations at Cobbora (Station Number 064026 – 1887 to 2011) and Tallawang (Station Number 062105 – 2003 to 2011);
- 10-minute average meteorological data from the CHC-owned monitoring station on the Woolandra Property (MET01) within the Project Site, with valid data available from November 2010; and
- 10-minute average meteorological data from the CHC-owned monitoring station on the Heights Property (MET02) within the Project Site since late August 2011.

The locations of these monitoring stations, including the distance from the CHPP at the Project Site, are summarised in **Table 5**. Additionally, the locations of the two onsite meteorological stations are marked in both **Figure 5** and **Figure 16**.

Table 5: Details of Meteorological Monitoring Sites Used

Monitoring Station	Location (m, MGA55)		Distance (km) / Direction from CHPP	Elevation (m, AHD)
	Easting	Northing		
MET01	713294	6439278	0.4 / NNE	395
MET02	712161	6434925	4.1 / SSW	433
Dunedoo Post Office Climate	726236	6455286	21.0 / NE	388
Cobbora Rainfall	710920	6447654	9.0 / NNW	390
Tallawang Rainfall	729525	6431673	17.7 / ESE	476

It is noted that damage to the weather station mast at MET01 occurred during 2010, with the mast and instrumentation being replaced in October 2010. Analysis of data recorded at MET01 prior to 2010 indicated that the damage to the station had adversely impacted upon the performance of the station, most notably with regards to wind direction. As it is unclear when the damage to the original mast occurred, and to what extent the recorded data was influenced, all data from the MET01 station recorded before October 2010 was disregarded during this assessment.

The NSW OEH specifies in Section 4.1 of the Approved Methods for Modelling that meteorological data representative of a site should be used in the absence of actual onsite observations. Data should cover a period of at least one year with a percentage completeness of at least 90%. Site representative data can be obtained from either a nearby meteorological monitoring station or synthetically generated using the CSIRO prognostic meteorological model The Air Pollution Model (TAPM).

The MET01 dataset between November 2010 and November 2011 has hourly average values for wind speed, wind direction, relative humidity, temperature (2m and 10m above ground level), rainfall and precipitation for 95.8% of the complete year period (i.e. 8,400 hours of a possible 8,760 hours). The MET01 dataset therefore meets the requirements of the Approved Methods for Modelling.

The MET02 dataset for the period between November 2010 and November 2011 only has data from 22nd August 2011. This equates to a data completeness of approximately 20%. Consequently, the MET02 dataset does not meet the requirements of the Approved Methods for Modelling and was not used in the dispersion modelling undertaken for the Project. Data from the MET02 station was, however, used to describe local variations in meteorological conditions in the region (principally wind speed and direction) and to provide a comparison dataset for the MET01 dataset, as discussed in subsequent sections.

The two onsite monitoring stations are illustrated in **Figure 5**. Inspection of the two monitoring stations during a site visit in October 2011 confirmed that both stations are well

sited for the purpose of meteorological monitoring (10m high mast and suitable clearance from trees and structures).

MET01 Station and TEOM

MET02 Monitoring Station

Figure 5: MET01 and MET02 Monitoring Stations

Note: TEOM – Tapered Element Oscillating Microbalance – further description in **Section** 5

4.2 Prevailing Annual Wind Regime

The wind rose of recorded wind speed and direction data from MET01 between November 2010 and November 2011 is presented in **Figure 6**. The annual wind pattern recorded by MET01 is dominated by easterly airflow. A less frequent south-westerly flow component is also experienced, with highest wind speeds generally occurring from this direction. The average recorded wind speed for the November 2010 to November 2011 period was 2.7 m/s, with a frequency of calm conditions (wind speeds less than 0.5 m/s) in the order of 8%. The recorded alignment of wind direction reflects the surrounding topography, in particular the alignment of the minor valley within which the monitoring station is sited (**Figure 9**).

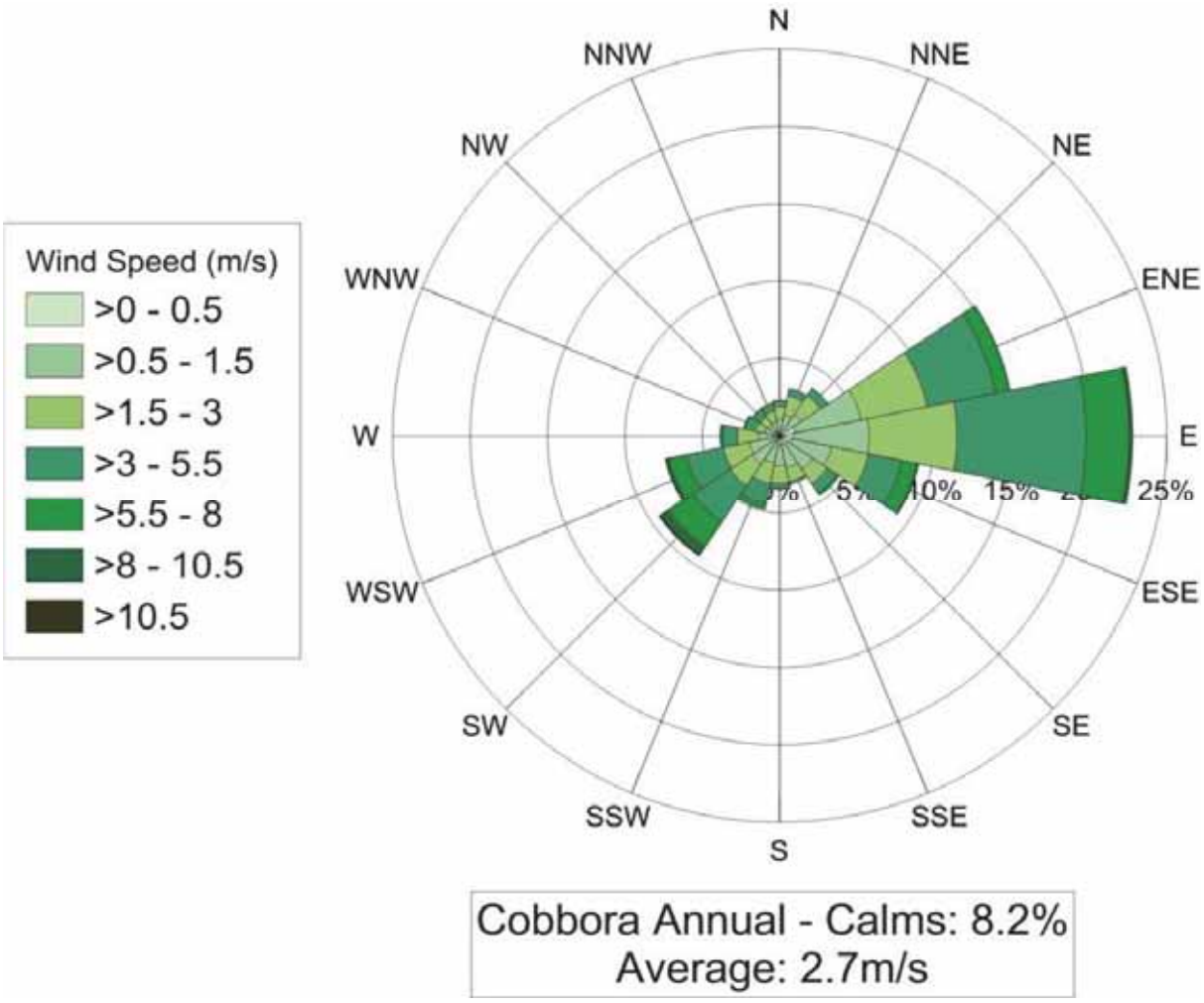

Figure 6: Annual Wind Rose – MET01 Cobbora Site Station (November 2010 to November 2011)

As stated previously, CHC commissioned the installation of a second meteorological monitoring station, MET02, in late August 2011. While the data from this location does not meet the data capture requirements of the Approved Methods for Modelling (minimum 90% 1-hour average observations for a 1 year period), the limited data collected by the MET02 station at the time of reporting has been collated and compared with corresponding observations at the MET01 location. **Figure 7** presents the wind roses generated from the two corresponding datasets, while **Figure 8** illustrates the variation in wind speed with time and the relationship between wind direction and wind speed at the MET01 and MET02 stations.

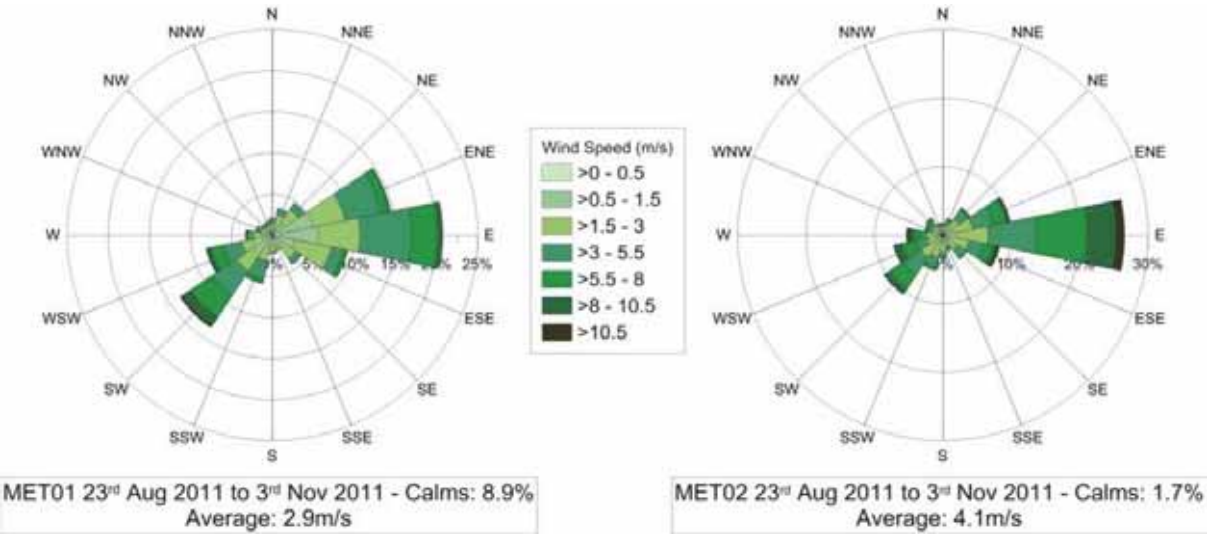

Figure 7: MET01 vs MET02 Wind Rose Comparison (23rd August 2011 to 3rd November 2011)

The wind roses in **Figure 7** indicate that the recorded wind direction at the MET01 and MET02 locations was comparable between 23rd August 2011 and 3rd November 2011, with a dominance of flow from the east and west-southwest quadrants. However, wind speed is notably higher at the MET02 location. This trend is echoed in **Figure 8**, in which the wind speed time series at the two locations highlights a number of occasions where the coinciding recorded wind speed was higher at MET02 than at MET01.

The relationship between wind speed and direction at the two monitoring locations is displayed in the second graph of **Figure 8**. This graph highlights that wind speeds at MET01 were typically lower than those recorded at MET02 when the wind direction was from the east to east-southeast and west-southwest to west-northwest.

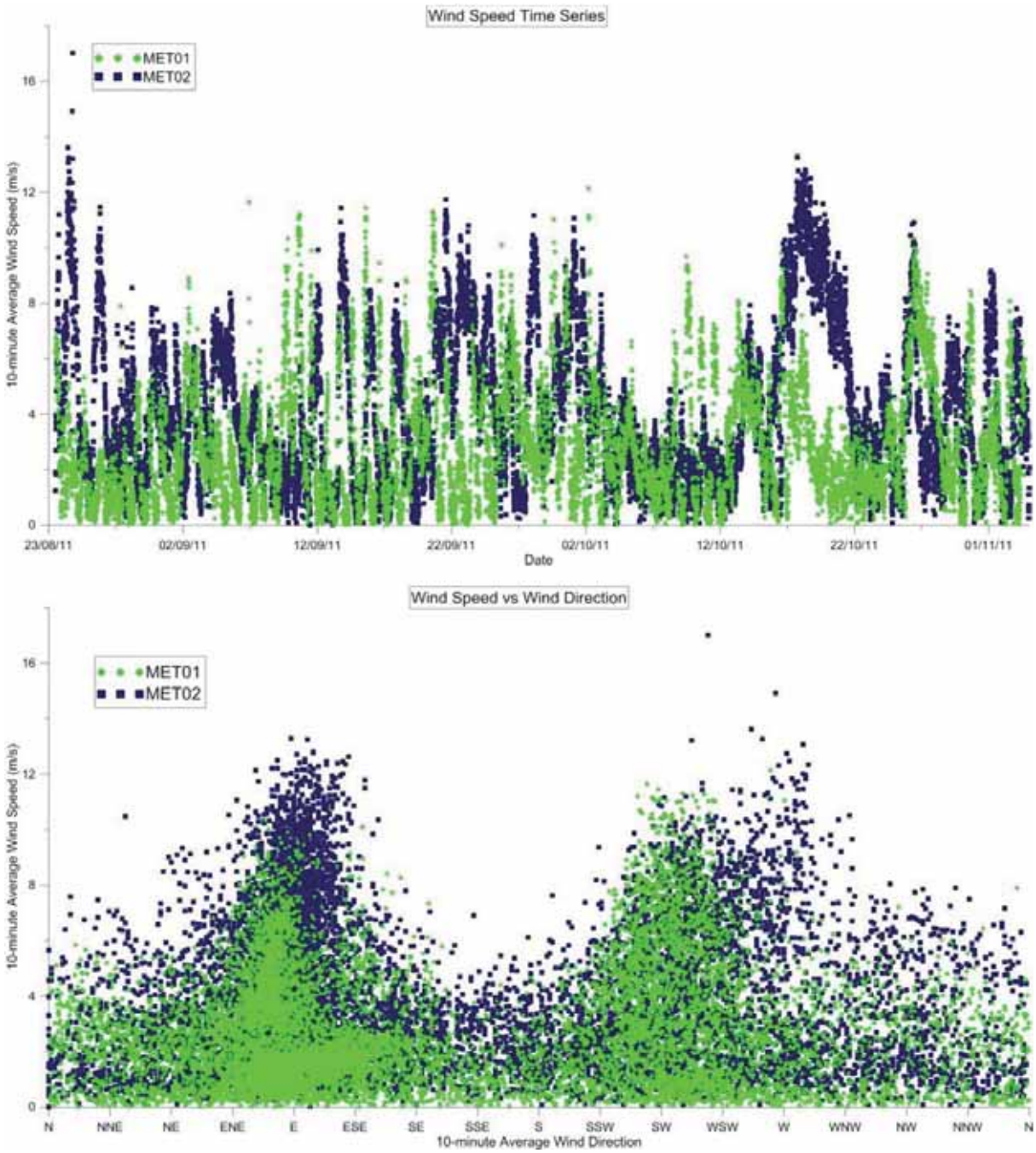

Figure 8: MET01 vs MET02 Comparison (23rd August 2011 to 3rd November 2011) – Time Series and Wind Speed/Direction Relationship

Review of the topographical features surrounding the two meteorological stations, presented within **Figure 9**, highlights that the MET01 station is situated at a lower altitude than the MET02 station (395m AHD versus 430m AHD respectively). Additionally, the MET01 location is located within a minor valley, while the MET02 location is situated on an open hillside. The more exposed setting of the MET02 station is considered to be a key contributing factor in the difference in recorded wind speed when compared with MET01. However, despite the differences between the setting of the two locations, the dominant wind directions experienced is very comparable.

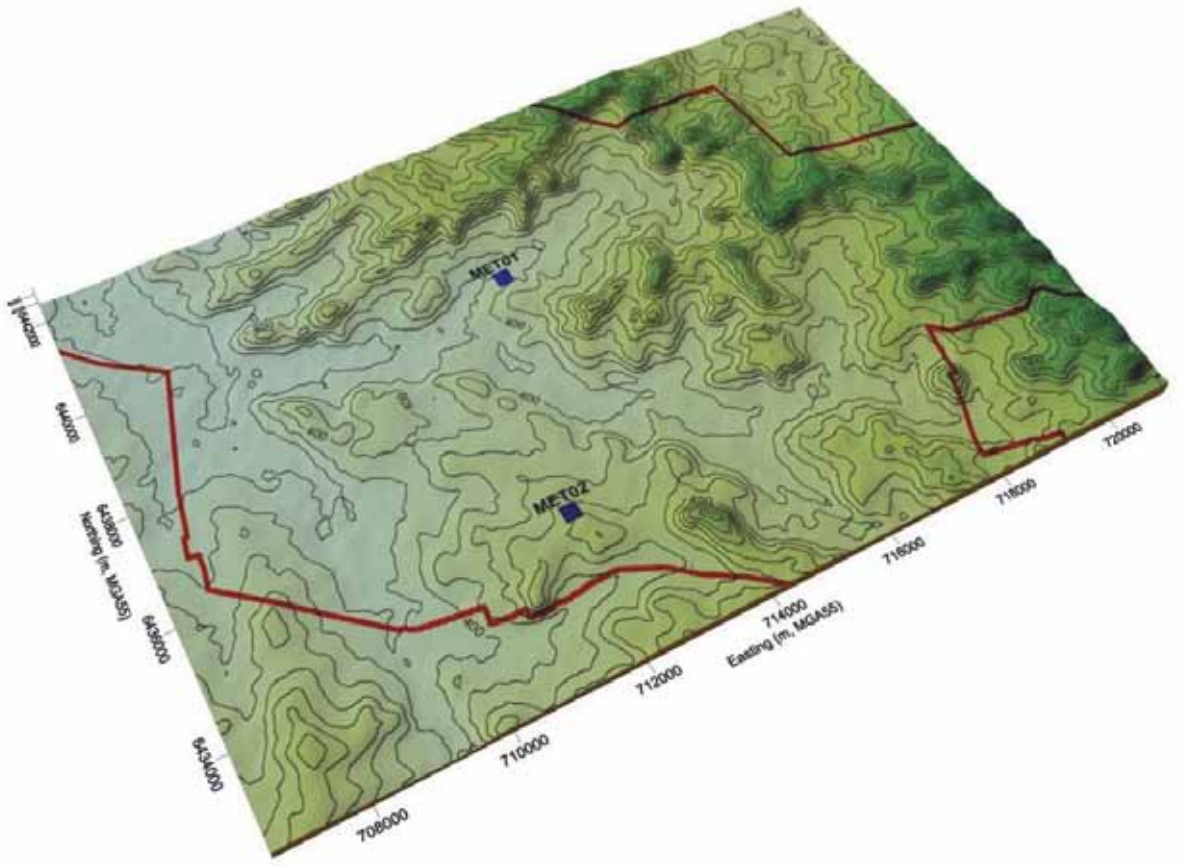

Figure 9: Topographical Features Surrounding MET01 and MET02 Monitoring Locations

Note: Vertical exaggeration of 2 applied. Red Line indicates PAA.

While the wind speed recorded at the MET02 location is typically higher than that recorded at the MET01 location, it is considered that the meteorological monitoring data recorded between November 2010 and November 2011 at the MET01 station is suitable for use in this assessment for the following reasons:

- The direction profile recorded at MET01 is comparable with that recorded at MET02, indicating minor variation in the local surrounds;
- The majority of proposed operations and emission sources throughout the life of the Project occur at an elevation similar to or below (within the pit) the elevation of the MET01 station; and
- Higher percentage of recorded calm to low wind speeds in the MET01 dataset will provide a conservative representation of potential dispersion conditions.

Section 6 and **Appendix D** detail the calculation of emissions for proposed operations at the Project Site. It is noted that a number of the sources for which emissions were estimated, including wind erosion and materials loading operations, are wind-speed dependant, with calculated emissions increasing with an increase in wind speed. The use of higher wind speeds, as contained within the incomplete MET02 dataset, would result in an increase in calculated emissions from these wind dependant sources, however the atmospheric instability and associated pollutant dispersion conditions would also increase. Increased

atmospheric dispersion is generally conducive to lower ground level concentrations of air pollutants.

Conversely, the use of the lower wind speeds recorded at the MET01 location in the dispersion modelling results in a greater frequency of calm, stable conditions and poorer atmospheric dispersion (i.e. dust will take longer to disperse and maximum ground level concentrations would be higher). Emission sources such as haul truck movements and bulldozer operations are not wind speed dependant. As discussed in **Section** 6, haul truck movements and bulldozer operations represent the most significant particulate matter sources for Project. Consequently, it is considered that the use of the MET01 dataset provides a conservative estimate of the dispersion of emissions and resultant ground level concentrations associated with the Project, relative to the MET02 station dataset.

Given similarities in the wind direction field recorded at the two meteorological stations, and considering the relatively uncomplicated terrain and short (sub-10km) distance between the majority of the nearest potential receptors to the proposed mining operations, the use of a steady state air dispersion model is considered appropriate for simulating potential air quality impacts associated with the project. The USEPA regulatory AERMOD model was therefore selected for use in the study. Further discussion regarding the selection and application of the AERMOD model is provided within **Section 7**.

4.3 Seasonal and Diurnal Wind Regime

Seasonal and diurnal (dividing the day into four periods) wind roses for the November 2010 to November 2011 period are presented within **Appendix A**.

Some seasonal variation is notable in the MET01 wind field dataset. Although easterly airflow dominates the wind regime throughout the year, it is particularly dominant during the summer months. During other seasons, south-westerly airflow increases in frequency although easterly airflow still prevails. Summer experiences the lowest average wind speed and the highest incidence of calm conditions. The highest wind speeds and lowest frequency of calm wind conditions occurs during the spring months. The strongest winds at the Project Site tend to occur from the southwest.

Diurnal variations in the local wind regime are illustrated in the day-time and night-time wind roses for the MET01 dataset, as provided in **Appendix A**. Thermo-topographic influences give rise to distinct diurnal shifts in airflow. During the night-time, airflow is predominantly easterly, reflecting the occurrence of katabatic (night-time, down slope) airflow. During the morning, airflow becomes bi-directional, reflecting the alignment of the terrain. Airflow from the south-westerly quadrant, representative of anabatic (up slope) airflow is most prevalent during the afternoon.

The annual and seasonal diurnal variation in average wind speed recorded at MET01 between November 2010 and November 2011 is illustrated in **Figure 10**. Wind speed clearly increases during the day from sunrise, peaking in the mid afternoon before decreasing again as the sun sets. Day-time wind speeds during the summer months were, on average, lower than the remainder of the year.

4.4 Comparison with Regional Conditions

The BoM Dunedoo Post Office climate station records wind speed and direction conditions at 9am and 3pm on a daily basis. Due to a combination of the infrequent nature of observations (twice per day) and the near-ground level height of instrumentation (relative to the 10m height of MET01) at this location, comparison of wind data recorded at Dunedoo with onsite observations is considered limited and has not been conducted in this assessment.

The closest automatic weather stations capable of such measurements are located at Mudgee (55km southeast) and Dubbo (65km west). Despite the spatial distance and differences in local conditions between these two BoM locations and the Project Site, principally related to land cover and topography, wind speed and direction data from these locations can be used to indicate potential inter-annual variability in recorded wind on a regional scale.

Wind roses and frequency histograms of recorded wind speed and direction data have been generated for the period between 2007 and 2011. These figures are presented within **Appendix A** and indicate that minimal inter-annual variation in wind occurred across this five year period. On the basis of the long term analysis of data recorded at Mudgee and Dubbo and illustrated inter-annual consistency, it is considered that the wind regime recorded during the selected meteorological period of November 2010 to November 2011 by MET01 is likely to be representative of wind conditions typically experienced at the Project Site on an annual basis.

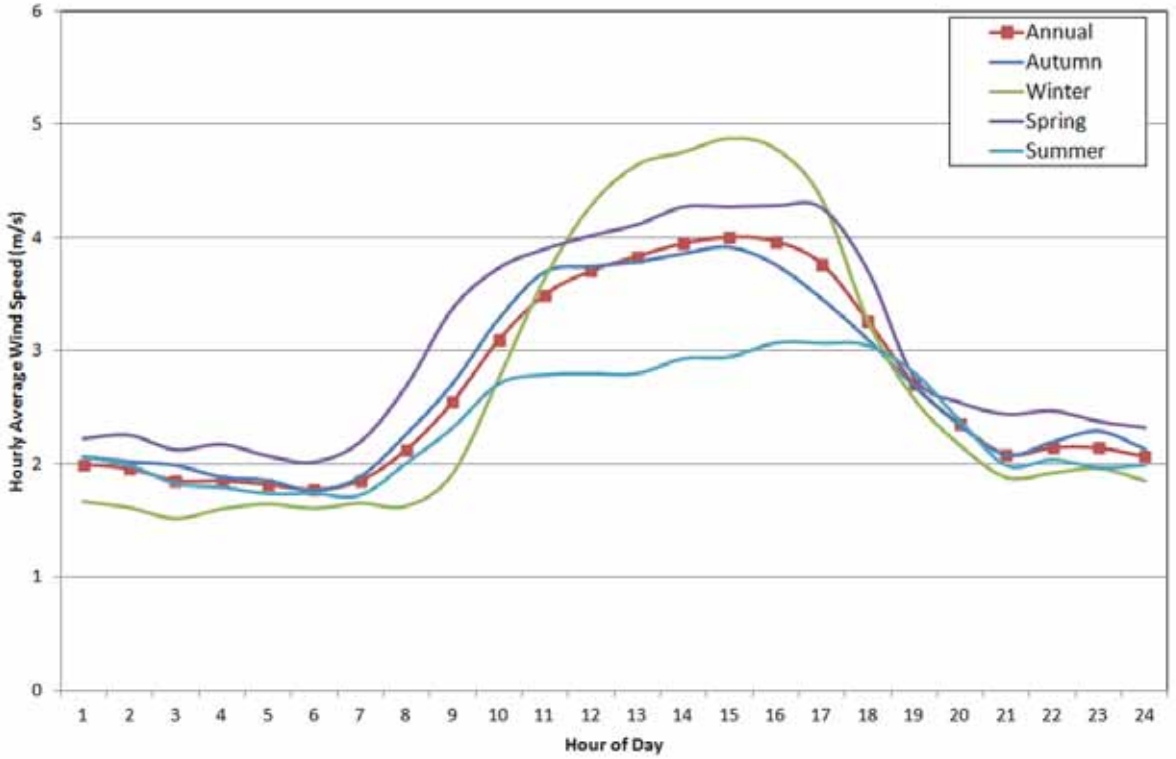

Figure 10: Annual and Seasonal Diurnal Wind Speed Profile – MET01 Cobbora Site Station (November 2010 to November 2011)

4.5 Ambient Temperature

Monthly mean minimum temperatures are in the range of 2°C to 17°C, with mean maxima of 15°C to 32°C, based on the long-term average record. Peaks occur during summer months with the highest temperatures typically being recorded between November and February. The lowest temperatures are usually experienced between June and August.

The recorded temperature from the MET01 station between November 2010 and November 2011 has been compared with long-term trends recorded at the BoM Dunedoo Post Office climate station to determine the representativeness of the dataset. **Figure 11** presents the monthly variation in predicted temperature during 2010 compared with the regional mean, minimum and maximum temperatures recorded at the BoM Dunedoo Post Office climate station. There is good agreement between temperatures recorded at the MET01 location and the recorded historical trends.

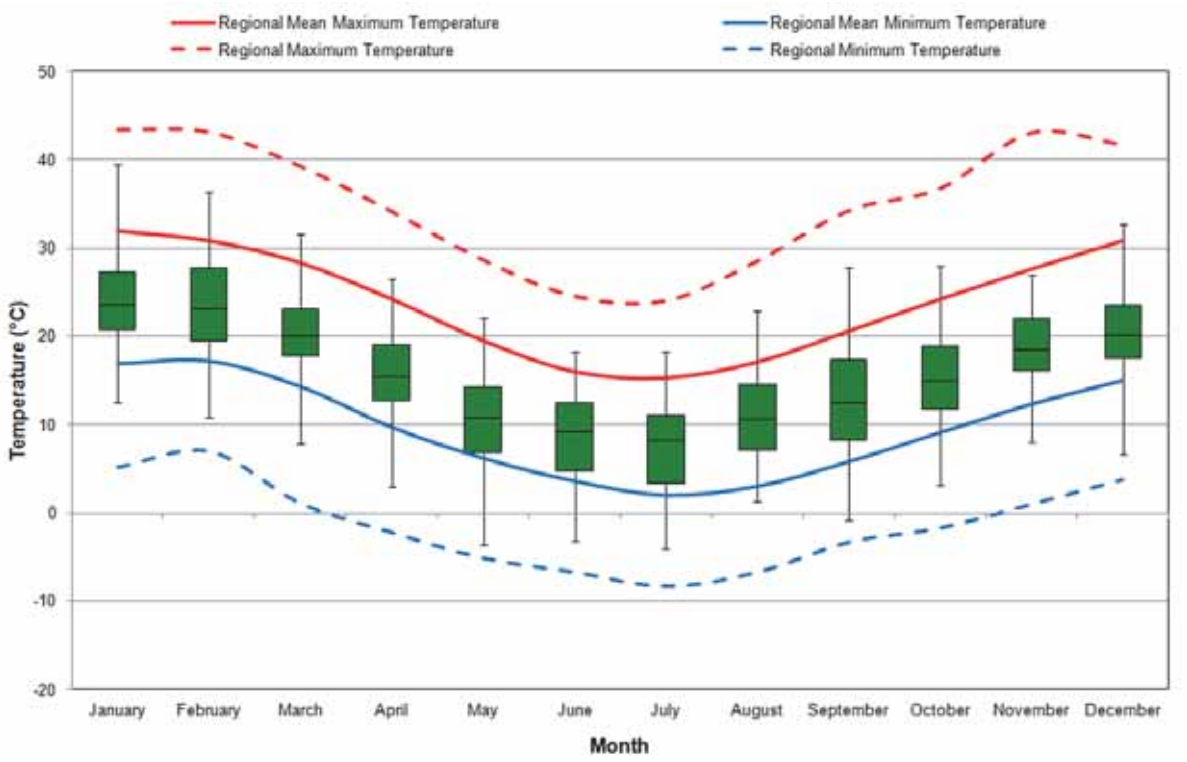

Figure 11: Temperature Comparison between MET01 (November 2010 to November 2011) and Dunedoo Post Office (1912-2011)

Note: Temperatures recorded at MET01 are illustrated by the green 'box and whisker' indicators. Boxes indicate 25th, median and 75th percentile temperature values while upper and lower whiskers indicate maximum and minimum values. Maximum and minimum temperatures from long-term measurements at Dunedoo Post Office are depicted as line graphs.

4.6 Rainfall and Evaporation

Precipitation is important to air pollution studies since it impacts on dust generation potentials and represents a removal mechanism for atmospheric pollutants.

Based on historical data recorded since 1887 at the BoM Cobbora Rainfall monitoring station, the region is characterised by moderate to high rainfall with a mean annual rainfall of 590 mm, and ranges in annual rainfall between 280 mm and 1100 mm. Rainfall is typically higher between November and March than the remainder of the year.

Rainfall data recorded between November 2010 and November 2011 was collated for the two CHC-owned monitoring stations, along with the BoM monitoring stations at Cobbora and Tallawang. Monthly totals have been compared against historic monthly mean rainfall at the BoM Cobbora station (**Figure 12**).

Some notable deviation from the recorded mean monthly rainfall was experienced across the selected stations. A significant increase in recorded rainfall was experienced at all locations during December 2010 (associated with the extensive rainfall caused by the El Nino event that affected the east coast of Australia at that time) and September 2011. Additionally, below average rainfall was recorded at all stations during January, June and July 2011. Annual rainfall totals between November 2010 and November 2011 were higher

than the historical mean annual rainfall amount for the region for each of the three complete dataset monitoring locations (MET02 was established in August 2011).

The measured rainfall data for the period used in the assessment (November 2010 to November 2011) is not typical of long-term average rainfall trends in the region. To provide a conservative (upper bound) estimate of the airborne particulate matter concentrations occurring due to the Project, wet deposition (removal of particles from the air by rainfall) was excluded from the simulations undertaken for the Project.

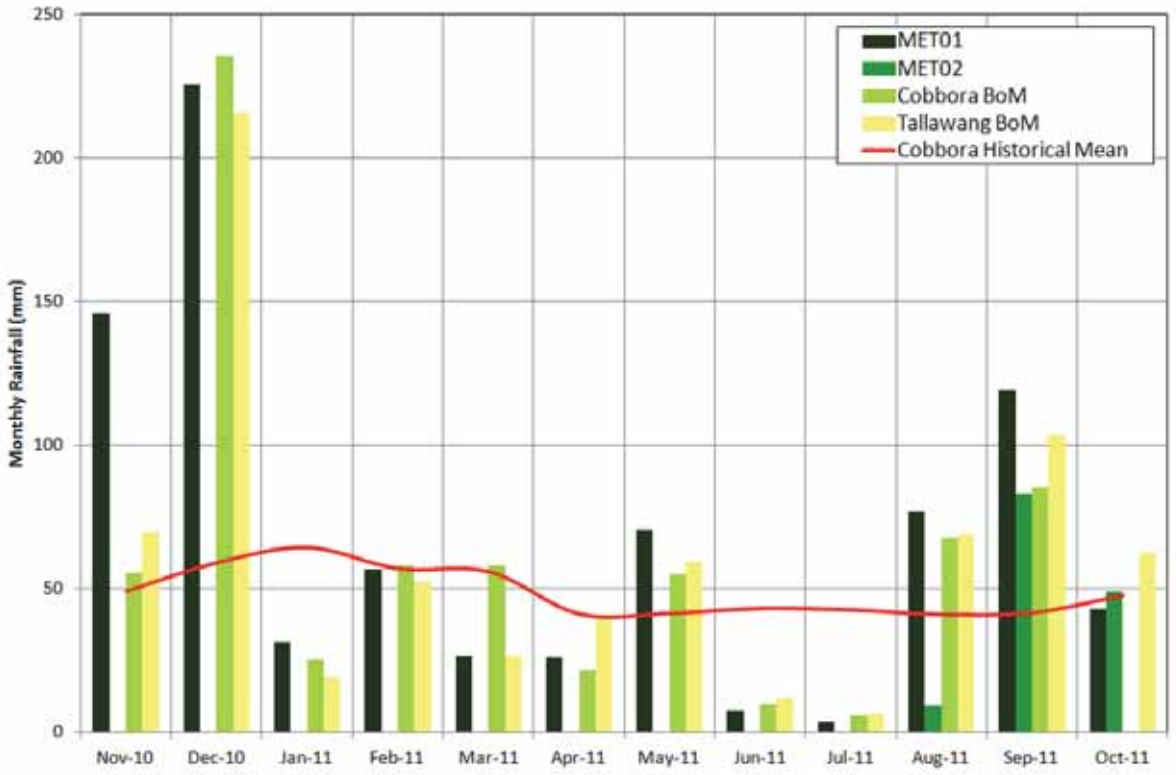

Figure 12: Historic Mean Monthly Rainfall at BoM Cobbora Location (1887-2011) Compared Against Monthly Rainfall Measured Between November 2010 and November 2011

Evaporation is a function of ambient temperature, wind and the saturation deficit of the air. The nearest BoM climate station where evaporation is recorded is at the Wellington Research Centre, approximately 45 km to the southwest of the Project Site. Evaporation and rainfall data from this location were paired to derive an indication of the moisture balance in the greater region, with the difference between mean monthly rainfall and evaporation illustrated in **Figure 13**. It is noted that mean annual rainfall at Wellington is approximately 620 mm which is comparable to the other stations discussed above.

The moisture balance analysis indicates that the region experiences a moisture deficit throughout the year, with evaporation exceeding rainfall for all months. The moisture deficit experienced during the summer months in particular increases the dust erosion potentials of exposed areas and stockpiles and therefore has important implications for fugitive dust control.

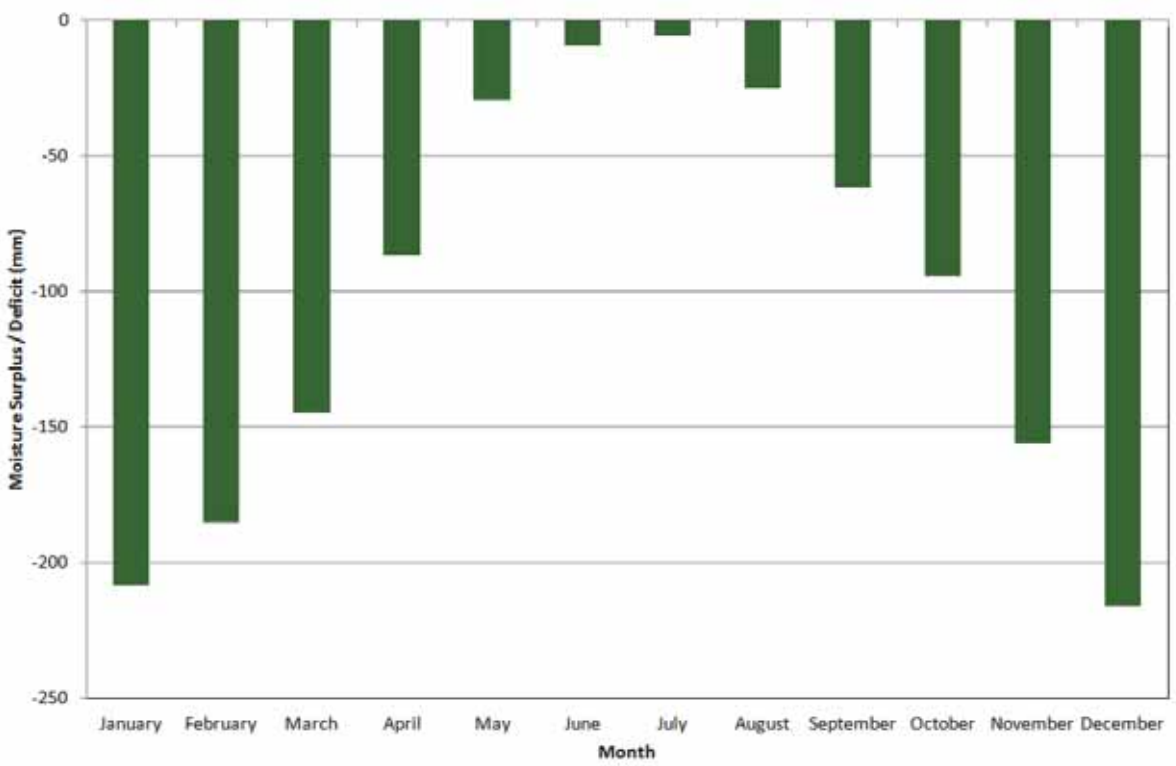

Figure 13: Monthly Variation in Moisture Deficit based on Rainfall and Evaporation Measurements from Wellington Research Centre (1965-2005)

4.7 Atmospheric Stability and Boundary Layer Depth

The atmospheric boundary layer constitutes the first few hundred metres of the atmosphere. This layer is directly affected by the earth's surface, either through the retardation of air flow due to the frictional drag of the earth's surface (mechanical mechanisms), or as result of the heat and moisture exchanges that take place at the surface (convective mixing) (Stull, 1997; Oke, 2003).

During the daytime, the atmospheric boundary layer is characterised by thermal turbulence due to the heating of the earth's surface and the extension of the mixing layer to the lowest elevated subsidence inversion. Elevated inversions may occur for a variety of reasons including anticyclonic subsidence and the passage of frontal systems. Due to radiative flux divergence, nights are typically characterised by weak vertical mixing and the predominance of stable conditions. These conditions are normally associated with low wind speeds and hence lower dilution potentials.

For low-level, non-buoyant, wind independent, continuous sources, the highest ground level air pollution concentrations tend to occur during stable, light wind, night-time conditions with pollutants accumulating close to the source. Air pollution emission sources characteristic of the proposed Project are mostly low level and wind dependent. Atmospheric conditions conducive to peak ground level concentrations from such sources are more complicated and best characterised through the application of dispersion modelling in which temporal variations in atmospheric conditions and source profiles are adequately represented.

Hourly-varying atmospheric boundary layer depths were generated for the Project Site by AERMET, the meteorological processor for the AERMOD dispersion model (see **Appendix B** for detailed discussion), using a combination of surface observations from MET01 and TAPM-predicted meteorology. The variation in average boundary layer depth by hour of the day for the Project Site is illustrated in **Figure 14**. As illustrated, greater boundary layer depths are experienced during the day time hours, peaking in the mid to late afternoon. Higher day-time wind velocities and the onset of incoming solar radiation increases the amount of mechanical and convective turbulence in the atmosphere respectively. As turbulence increases during the day-time, so too does the depth of the boundary layer, contributing to greater mixing depths and potential for atmospheric dispersion of pollutants.

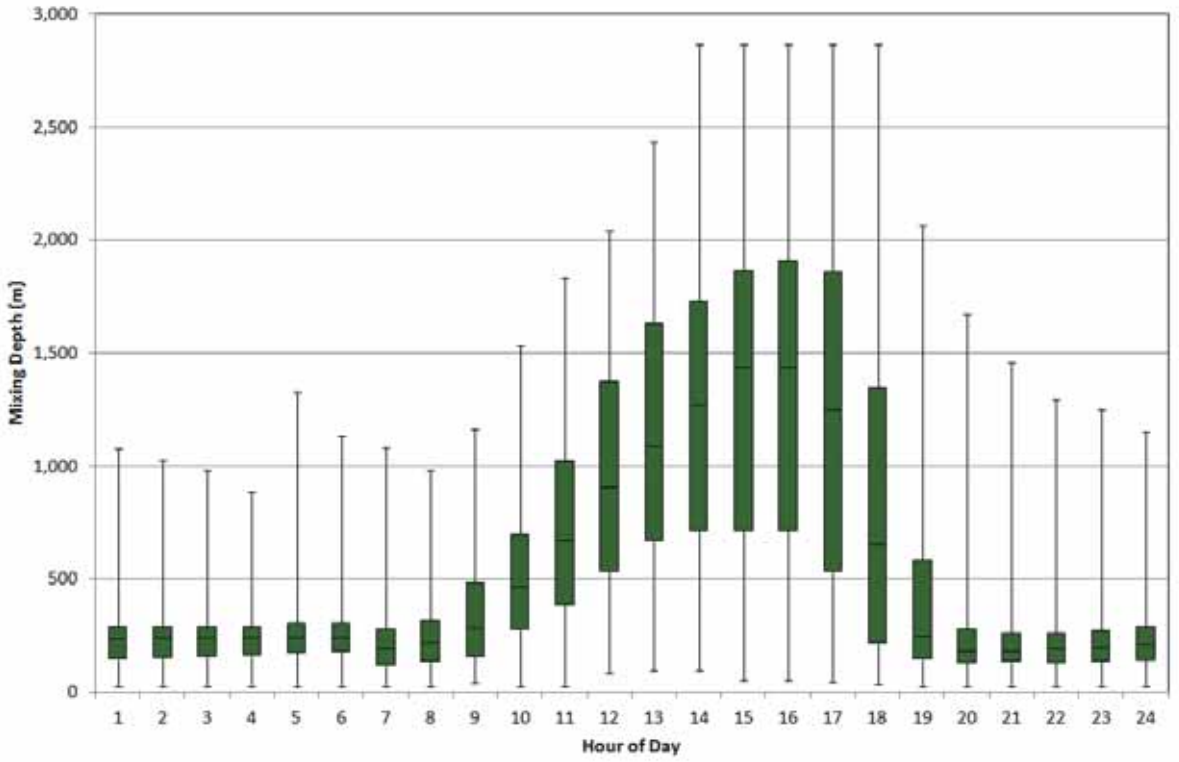

Figure 14: AERMET-Generated Diurnal Variations in Average Boundary Layer Depth – Project Site - November 2010 to November 2011

Note: Boxes indicate 25th percentile, Median and 75th percentile of AERMET-generated mixing height data while upper and lower whiskers indicate maximum and minimum values.

The Monin-Obukhov length (L) provides a measure of the stability of the surface layer (i.e. the layer above the ground in which vertical variation of heat and momentum flux is negligible; typically about 10% of the mixing height). Seinfeld and Pandis (2006) provide typical value ranges for L for widely referenced atmospheric stability classes, as listed within **Table 6**.

Table 6: Monin-Obukhov Length with Respect to Atmospheric Stability		
Monin-Obukhov Length (L)	**Range**	**Stability Class**
Very Large Negative	$L < -10^5$m	Neutral
Large Negative	-10^5m ≤ L ≤ -100m	Unstable
Small Negative	-100m < L < 0	Very Unstable
Small Positive	0 < L < 100m	Very Stable
Large Positive	100m ≤ L ≤ 10^5m	Stable
Very Large Positive	L > 10^5m	Neutral

Source: Table 16.2, Seinfeld and Pandis (2006)

Figure 15 illustrates the diurnal variation of atmospheric stability derived from the Monin-Obukhov length calculated by AERMET, with the meteorological modelling having been based on the data collected at the MET01 meteorological station between November 2010 and November 2011. The diurnal profile presented illustrates that atmospheric instability increases during daylight hours as convective energy increases, whereas stable atmospheric conditions prevail during the night-time. This profile indicates that the potential for atmospheric dispersion of emissions would be greatest during day time hours and lowest during evening through to early morning hours.

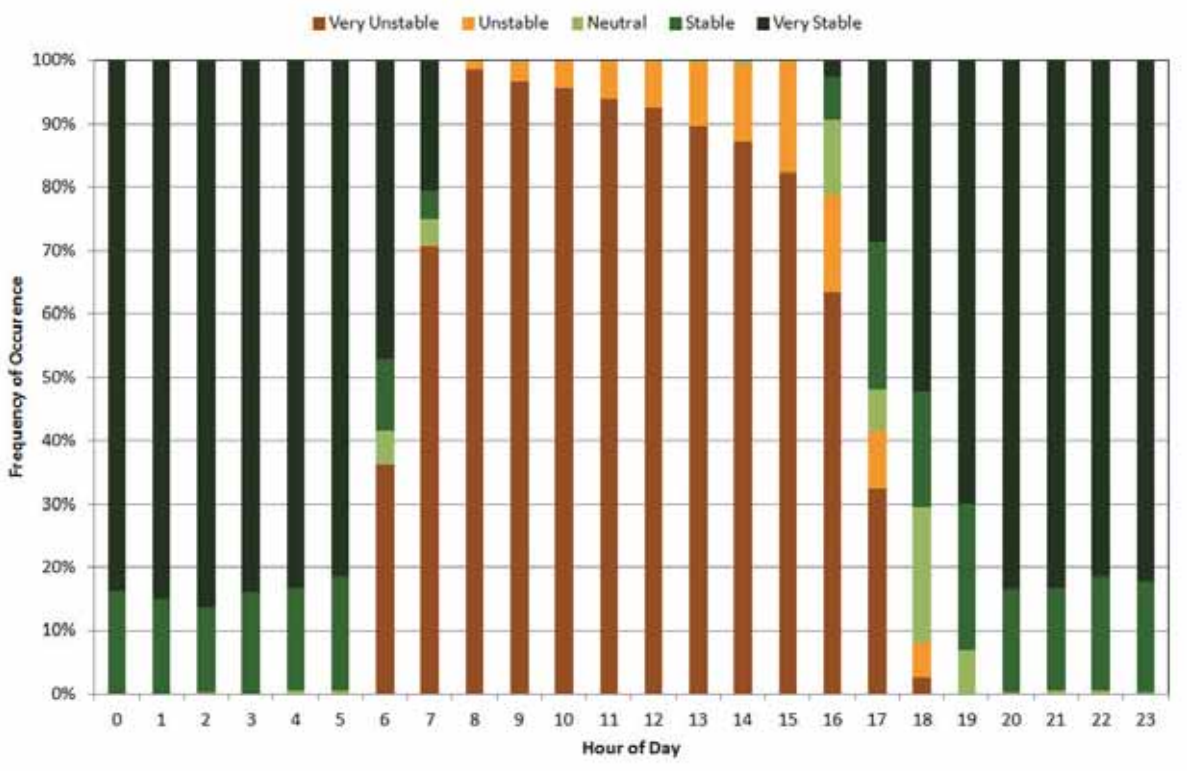

Figure 15: Diurnal Variations in AERMET-Generated Atmospheric Stability for the Project Site - November 2010 and November 2011

5 Baseline Air Quality Environment

The quantification of cumulative air pollution concentrations and the assessment of compliance with ambient air quality criteria necessitate the characterisation of baseline air quality. As particulate matter represents the primary emissions from the Project, it is pertinent that existing sources of such emissions and existing ambient suspended particulate concentrations and dust deposition levels be considered. It is also appropriate to consider possible changes to baseline air quality driven by approved future developments, including the scaling up of existing mining operations to approved production levels.

5.1 Existing Sources of Air Emissions

The National Pollutant Inventory (NPI) and NSW OEH Environment Protection Licence databases have been reviewed to identify significant existing sources of air pollutants in the surrounding region.

The Sibelco Tallawang Magnetite Mine is located approximately 3 km south of the rail spur crossing of the Castlereagh Highway and approximately 20 km east-southeast of the proposed CHPP. There are no other significant potential industrial sources of air pollutants located within 40 km of the Project Site.

Approximately 50km to 60km east-southeast of the Project CHPP are a number of existing coal mining operations, including the Ulan, Moolarben and Wilpinjong coal mines. Given that these operations are remote from the Project Site, it is not expected that emissions generated would contribute directly to the airborne particulate concentrations experienced at the Project Site on a day to day basis. These operations have not been explicitly included in the assessment of cumulative impacts with Project emissions.

Given the absence of significant industrial and extractive operations in the area surrounding the Project Site, it is considered that the dominant sources of particulate matter emissions in the vicinity of the Project include:

- Wind generated dust from exposed areas within the surrounding region;
- Dust and diesel emissions from agricultural activities at neighbouring properties;
- Dust entrainment due to vehicle movements along unsealed and sealed public roads with high silt loadings;
- Seasonal emissions from household wood burning fires; and
- Episodic emissions from vegetation (e.g. bush and grass) fires.

More remote sources which contribute episodically to suspended particulates in the region include dust storms and bushfires. Whereas dust storms predominately contribute primary particulates from mechanical attrition, bushfires are a source of fine particulates including both primary particulates and secondary particulates from atmospheric gas to particle conversion processes.

5.2 Review of Approved Developments

Whereas baseline air quality monitoring data reflects the contributions from existing sources, the potential exists for baseline air quality to be affected by future developments which are

unrelated to the Project. It is therefore appropriate to consider the potential impact of approved future developments on local air quality.

Reference was made to information and documentation posted on the Department of Planning's Major Project Assessment website (http://majorprojects.planning.nsw.gov.au/) to determine whether approval has been granted to any developments which may significantly affect local air quality in future years. Based on a search in March 2012, no approved developments likely to significantly influence local air quality were identified. The effect of approved developments situated farther afield on air quality at the Project Site is considered to be minimal (e.g. approved expanded operations at Ulan, Wilpinjong and Moolarben coal mines).

5.3 Monitoring Data Available for Baseline Air Quality Characterisation

Air quality monitoring has been conducted at the Project Site since September 2009. This monitoring includes the continuous measurement of ambient PM_{10} concentrations by a Tapered Element Oscillating Microbalance (TEOM) installed at the MET01 meteorological monitoring station and a network of six dust deposition gauges (DDGs) installed at various locations across the Project Site. **Figure 16** illustrates the location of on-site air quality and meteorological monitoring stations (as discussed in **Section** 4).

The data collected at the Project Site was used as the primary source for quantifying the baseline air quality environment.

To assess the extent to which fluctuations in PM_{10} concentrations recorded at the Cobbora TEOM station reflect regional trends in PM_{10} concentrations across the Central Tablelands of NSW, reference is made to a number of publically available PM_{10} monitoring datasets from the region.

These monitoring data sets are listed in **Table 7**.

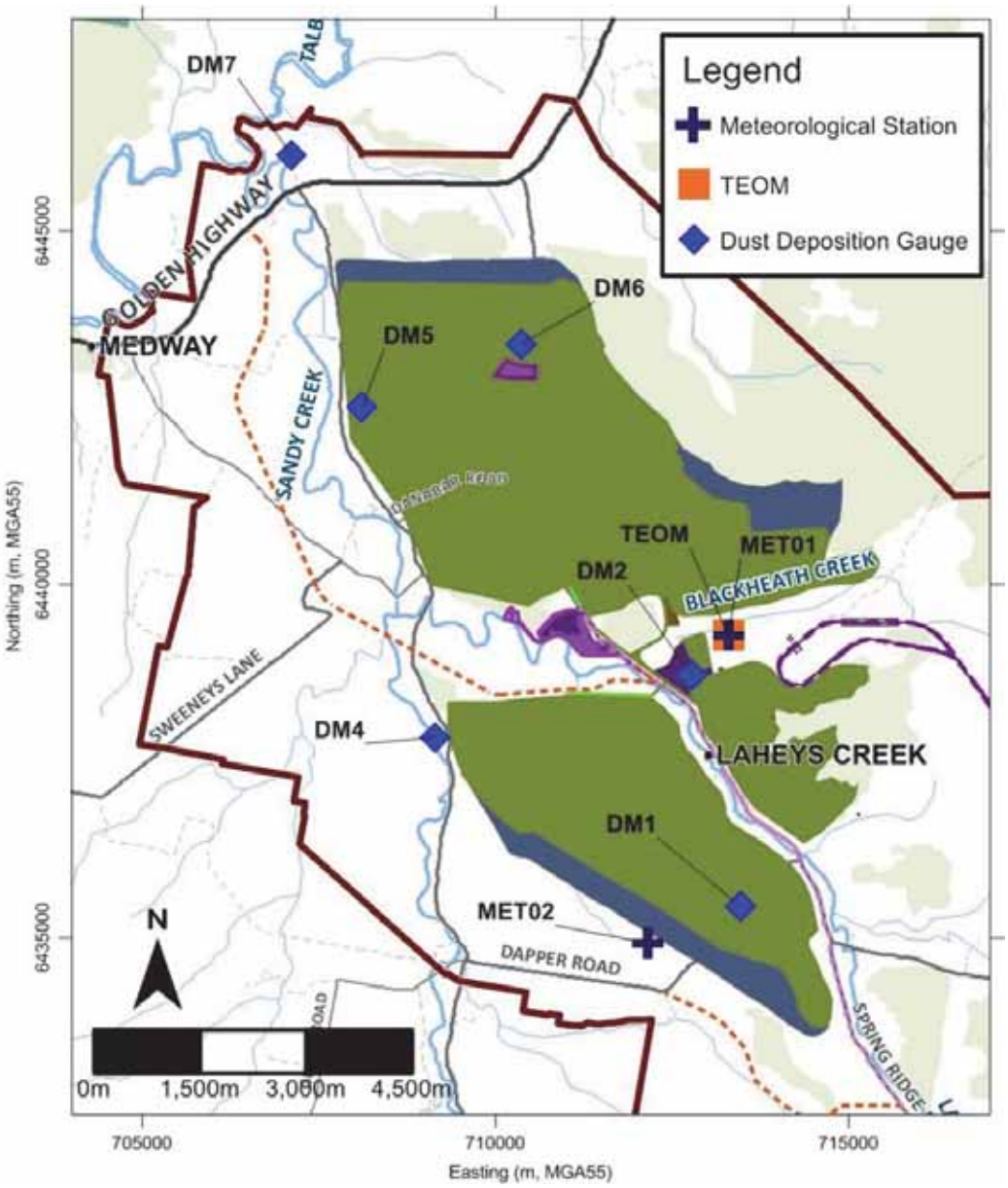

Figure 16: Air Quality and Meteorological Monitoring Locations – Project Site

Table 7: Sources of Air Quality Monitoring Data

Data Source	Monitor ID	Parameter Measured (Instrument)
CHC – Monitoring at Project Site from September 2009	MET01 TEOM	PM_{10} (TEOM)
	DM1	Dust Deposition (Dust Deposition Gauge)
	DM2	
	DM4	
	DM5	
	DM6	
	DM7	
Ulan Coal - AEMR 2009, 2010; Monitoring Reports 2010 to 2011	Ulan Coal Mine	PM_{10} (TEOM)
Moolarben Coal - AEMR 2008/2009, 2009/2010, 2010/2011	Mobile	PM_{10} (TEOM)
	Ulan School	
	Murragamba	
NSW OEH	Bathurst Monitoring Station	PM_{10} (TEOM)
	Tamworth Monitoring Station	

NOTE: TEOM – tapered element oscillating microbalance
HVAS – High Volume Air Sampler
AEMR – Annual Environmental Monitoring Report

5.3.1 Dust Deposition Monitoring Data

Dust deposition monitoring has been undertaken at the Project Site since September 2009. The monthly recorded dust deposition rates recorded at each location and the monthly average between September 2009 and September 2011 are presented within **Table 8**.

Table 8: Dust Deposition Monitoring Data – Project Site

Month	Monthly Dust Deposition (g/m^2/month) by Monitoring Location						
	DM1	DM2	DM4	DM5	DM6	DM7	Spatial Average
Sep 2009	9.5	6.0	6.7	6.1	6.6	8.1	**7.2**
Oct 2009	2.5	2.8	4.1	2.3	1.6	2.8	**2.7**
Nov 2009	2.2	1.9	1.2	1.1	2.3	1.9	**1.8**
Dec 2009	2.1	1.5	1.8	7.0	1.4	1.2	**2.5**
Jan 2010	2.9	1.3	2.6	2.4	1.2	2.7	**2.2**
Feb 2010	0.8	0.8	2.7	1.7	1.3	1.2	**1.4**
Mar 2010	0.5	1.0	2.9	1.3	0.9	1.2	**1.3**
Apr 2010	0.2	0.3	0.7	0.4	0.6	0.3	**0.4**
May 2010	0.6	0.5	6.0c	1.1	0.8	0.6	**0.7**
Jun 2010	0.4	0.2	5.1c	0.5	1.4	1.7	**0.8**
Jul 2010	0.4	0.3	11.9c	0.7	3.2	0.6	**1.0**
Aug 2010	0.4	0.5	0.3	0.3	0.5	0.3	**0.4**
Sep 2010	0.9	0.5	0.4	0.2	2.7	0.4	**0.9**
Oct 2010	0.4	0.7	0.6	0.5	1.4	0.3	**0.7**
Nov 2010	-	-	-	-	-	-	**-**
Dec 2010	1.0	1.1	1.0	1.5	2.6	1.9	**1.5**
Jan 2011	0.6	0.8	0.3	1	2.2	0.3	**0.9**
Feb 2011	0.8	0.8	1.6	0.7	2.1	2.3	**1.4**
Mar 2011	2.4	0.6	0.3	0.5	0.5	0.4	**0.8**
Apr 2011	0.3	0.4	1.0	0.2	6.5c	0.2	**0.4**
May 2011	3.2	0.2	7.6c	0.4	0.2	0.3	**0.9**
Jun 2011	0.1	0.2	36.2c	0.3	0.2	0.3	**0.2**
Jul 2011	4.0	0.2	10.4c	0.7	0.9	0.4	**1.2**
Aug 2011	0.3	0.4	0.4	0.4	0.5	0.2	**0.4**
Sep 2011	0.6	0.6	0.9	0.8	5.2	0.7	**1.5**

NOTE: NSW OEH Criteria - 4g/m^2/month annual average as insoluble solids
c – contaminated sample (bird droppings, excess biological matter, etc) – Sample excluded from calculated average
Due to flooding on site between November 2010 and December 2010, December 2010 accounts for two months
Elevated levels in September 2009 attributable to significant regional dust storm event which affected ambient particulate levels state-wide

It can be seen from the results presented within **Table 8** that the dust deposition rates across the Project Site varied both temporally and spatially throughout the monitoring period. A rolling 12 month average dust deposition rate was calculated for each monitoring location, and across all monitoring locations. Over the period between September 2009 and September 2011, the rolling 12-month average dust deposition rates across the Project Site ranged from 0.8g/m^2/month to 1.9g/m^2/month, with an overall dataset average deposition rate of 1.4g/m^2/month.

Dust deposition results are presented in terms of insoluble solids. Insoluble solids are the content of a collected dust deposition sample that does not dissolve in water.

5.3.2 PM_{10} Monitoring Data

As discussed previously in **Section 5.3**, a TEOM was established at the MET01 station (see **Figure 16**) and has recorded continuous concentrations of PM_{10} since September 2009, with the exception of three periods of equipment malfunction. The 24-hour average PM_{10} concentrations from the Cobbora TEOM are plotted in **Figure 17** to illustrate daily variations in such concentrations. A range of statistics for Cobbora TEOM monitoring dataset is presented within **Table 9**.

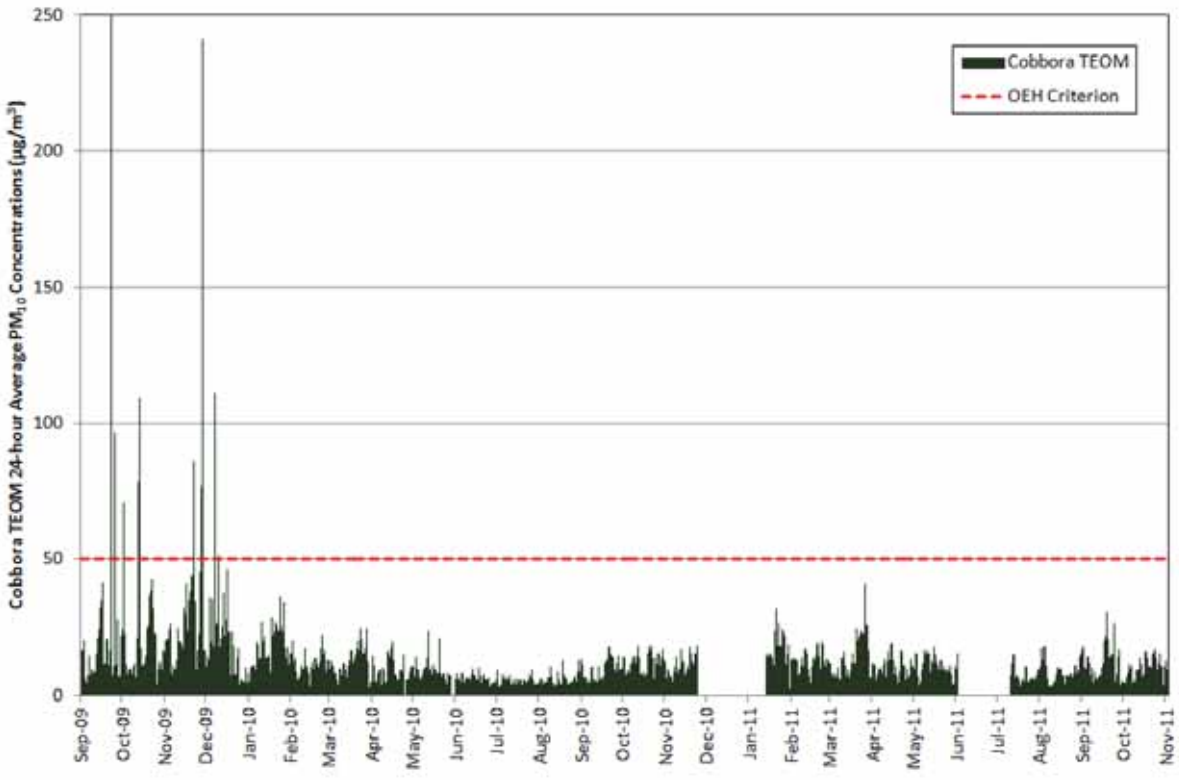

Figure 17: Daily-varying Recorded 24-hour Average PM_{10} Concentrations – Cobbora TEOM – September 2009 to November 2011

Note: Plot Y-axis cropped at 250µg/m^3 for visual purposes. Maximum of the dataset was 2,540.5µg/m^3 recorded on 23/09/2009 and was associated with the significant dust storm event that affected the east coast of Australia at that time. Breaks in dataset are associated with equipment malfunction.

Table 9: Cobbora TEOM Monitoring Dataset Statistics – September 2009 to November 2011

Monitoring Statistic	PM_{10} Monitoring Results
Number of Measurements	701
Data Completeness	88%
Minimum	2.5µg/m^3
Maximum	2,540.5µg/m^3
Average	16.8µg/m^3
25th Percentile	7.0µg/m^3
50th Percentile	10.3µg/m^3
75th Percentile	15.3µg/m^3
Inter-quartile Range	8.3µg/m^3
No. Days >50µg/m³	10

NOTE: NSW OEH Criterion – 24-hour Average 50µg/m^3; Annual Average - 30µg/m^3

It can be seen from **Figure 17** that the 24-hour average PM_{10} concentrations fluctuate throughout the presented period. The rolling 12-month average throughout the Cobbora TEOM dataset ranged from 9.8µg/m^3 to 21.9µg/m^3, with an overall dataset average of 16.8µg/m^3. The frequency distribution of 24-hour average PM_{10} concentrations recorded by the Cobbora TEOM is presented in **Figure 18**, which highlights that 24-hour average PM_{10} concentrations at Cobbora TEOM were less than 30µg/m^3, approximately 95% of the time between September 2009 and November 2011.

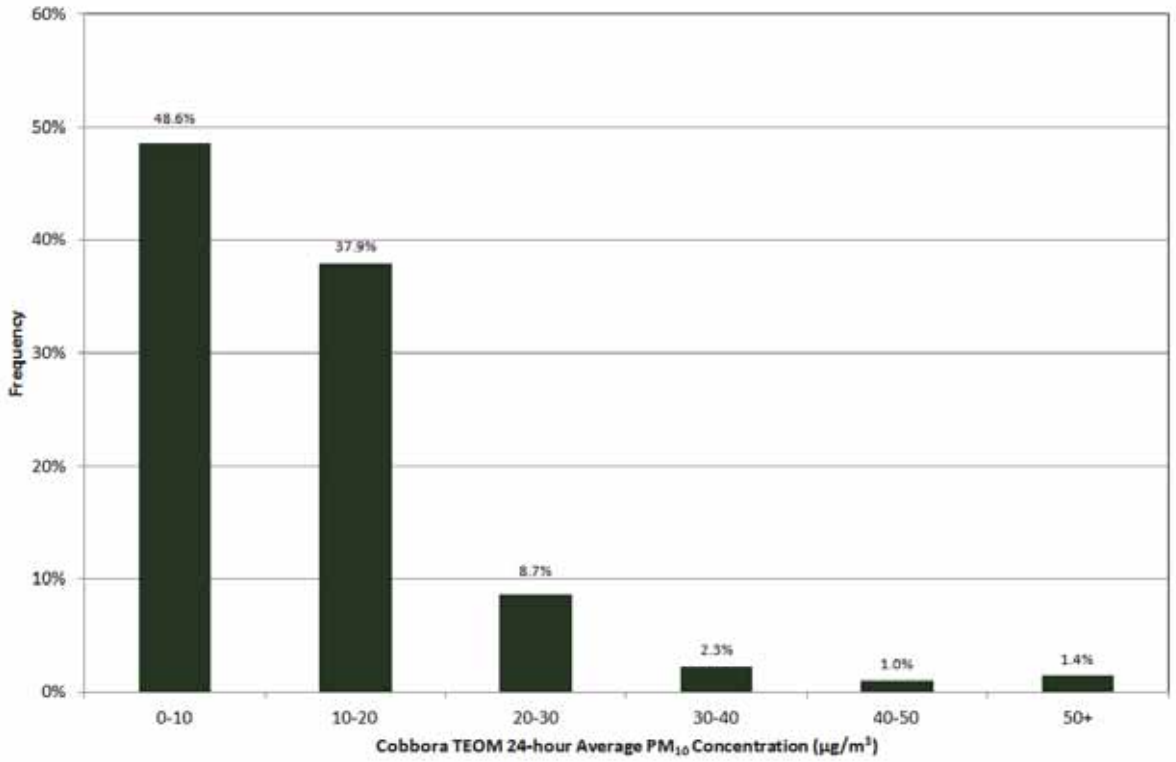

Figure 18: Distribution of 24-hour Average PM_{10} Concentrations – Cobbora TEOM – September 2009 to November 2011

The period between September 2009 and January 2010 experienced a number of elevated PM_{10} concentrations. The NSW Annual NEPM Compliance Report 2009 (DECC 2010) reported a large number of elevated PM_{10} concentrations throughout 2009 and in particular between September 2009 and January 2010. These concentrations were largely attributable to regional scale events, such as regional dust storms and bushfires.

To demonstrate fluctuations in PM_{10} concentrations across the Central Tablelands of NSW, reference is made to a number of publically available PM_{10} monitoring datasets from the region. These are the following:

- Continuous 24-hour average PM_{10} data from the three TEOM stations at the Moolarben Coal Mine (all located between approximately 50km and 60km east-southeast of the Project, about the village of Ulan);
- Continuous 24-hour average PM_{10} data from the Ulan Coal Mine TEOM (located approximately 50km east-southeast of the Project in the village of Ulan); and
- Continuous 24-hour average PM_{10} data from the NSW OEH TEOM monitoring station at Bathurst (located approximately 140km south-southeast of the Project) and Tamworth (located approximately 200km northeast of the Project).

While the stations referenced are geographically removed from the Project Site and located in areas with greater local particulate emissions (Ulan due to coal mining activities, Bathurst and Tamworth due to an urbanised setting), these datasets are referenced to provide an indication of regional trends in PM_{10} concentrations for comparison with concentrations measured at the Cobbora TEOM station.

Concurrent 24-hour average PM_{10} concentrations recorded between September 2009 and August 2011 were collected from the relevant AEMR documents for the Moolarben and Ulan Coal mines. Data between September 2009 and November 2011 was obtained from the NSW OEH Bathurst and Tamworth monitoring stations. A time-series plot, illustrating concurrent 24-hour average PM_{10} concentrations recorded at the Cobbora TEOM station and referenced regional monitoring stations, is presented in **Figure 19**.

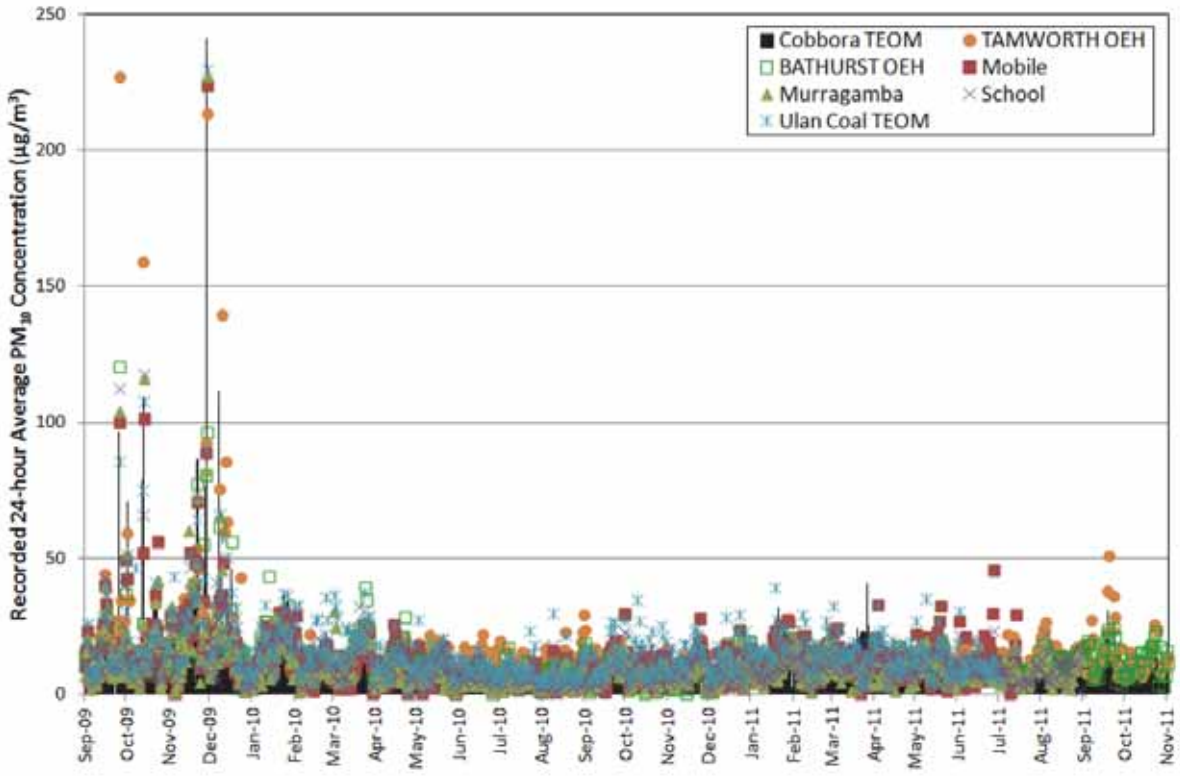

Figure 19: Timeseries Comparison of 24-hour Average PM_{10} Concentrations – Cobbora TEOM and Regional Datasets – September 2009 to November 2011

Note: Plot Y-Axis cropped at 250µg/m^3 for graphical purposes. Peak concentrations associated with 23 September 2009 dust storm extend to between approximately 2,000µg/m^3 and 3,000µg/m^3 across all stations.

It can be seen from **Figure 19** that each of the elevated 24-hour average PM_{10} concentrations recorded by the Cobbora TEOM between September 2009 and January 2010 coincided with elevated concentrations at the regional PM_{10} monitoring locations. This confirms that the elevated concentrations recorded by the Cobbora TEOM were attributable to regional scale events.

To illustrate common trends in PM_{10} concentrations recorded across the region, the Pearson product moment correlation coefficient, *r*, was calculated for each dataset pairing. A value of 1 for *r* indicates a significant linear relationship between two datasets. The calculated *r* for each PM_{10} dataset pairing is presented within **Table 10**. The September 2009 dust storm event, present in all datasets, was removed from the correlation analysis as the inclusion of these results returned misleading values for *r* (i.e. suggested that all datasets had a near perfect relationship).

Table 10: Relationship Between Cobbora TEOM Measurements and Other PM_{10} Monitoring Datasets – September 2009 to November 2011

Monitoring Station	Pearson Product Moment Correlation Coefficient (r) Calculated for Listed Monitoring Dataset and Cobbora TEOM Dataset
Mobile TEOM (Moolarben Coal Station)	0.88
Murragamba TEOM (Moolarben Coal Station)	0.91
Ulan School TEOM (Moolarben Coal Station)	0.79
Ulan Coal TEOM (Ulan Coal Station)	0.89
Tamworth TEOM (NSW OEH Station)	0.68
Bathurst TEOM (NSW OEH Station)	0.76

Note: r = 1 indicates significant linear relationship. September 2009 dust storm event removed before analysis conducted.

The results in **Table 10** show that PM_{10} concentrations recorded at the Cobbora Project Site, and PM_{10} concentrations measured at other monitoring stations in the region referenced in this assessment, are significantly influenced by regional trends in PM_{10} concentrations. This analysis indicates that PM_{10} concentrations in the region are significantly influenced by:

- regional variations in meteorological conditions conducive to elevated emissions and/or enhanced accumulation of airborne particulate matter; and
- regional-scale sources such as dust storms and bushfires.

To assess cumulative impacts for the Project, the Approved Methods for Modelling requires that at least one year of continuous measurements are used, contemporaneous with the input meteorological monitoring data. The PM_{10} dataset recorded at the Project Site for the period between November 2010 and November 2011 is approximately 75% complete. In order to generate a daily varying PM_{10} monitoring dataset with 100% completeness for the entire dispersion modelling period, data from the OEH Bathurst monitoring location (the most closely related OEH-maintained monitoring dataset in the above analysis) was inserted into the data gaps of the Cobbora TEOM dataset between November 2010 to November 2011.

The concurrent Cobbora TEOM and OEH Bathurst TEOM datasets are presented in **Figure 20**. Based on the close correlation of the daily fluctuation in 24-hour average PM_{10} concentrations in the two datasets, it is considered that the use of the OEH Bathurst monitoring data in place of periods of missing data in the Cobbora TEOM dataset is justified.

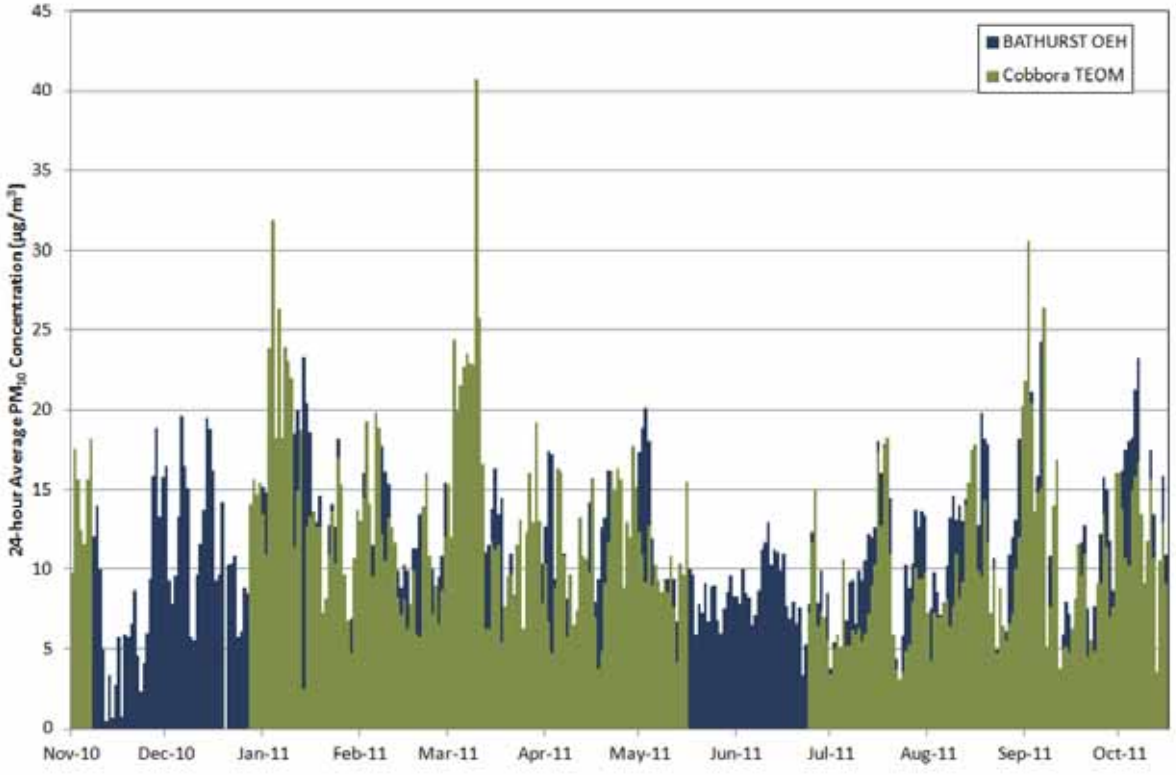

Figure 20: 24-hour Average PM_{10} Concentrations – Cobbora TEOM and OEH Bathurst – November 2010 to November 2011

The daily varying PM_{10} concentrations from this background dataset are illustrated in **Figure 21**. The maximum and average PM_{10} concentrations for the dataset between November 2010 and November 2011 are 40.7µg/m^3 and 11.8µg/m^3 respectively. This dataset was subsequently paired in time with model predictions to assess cumulative PM_{10} concentrations during the operation of the Project.

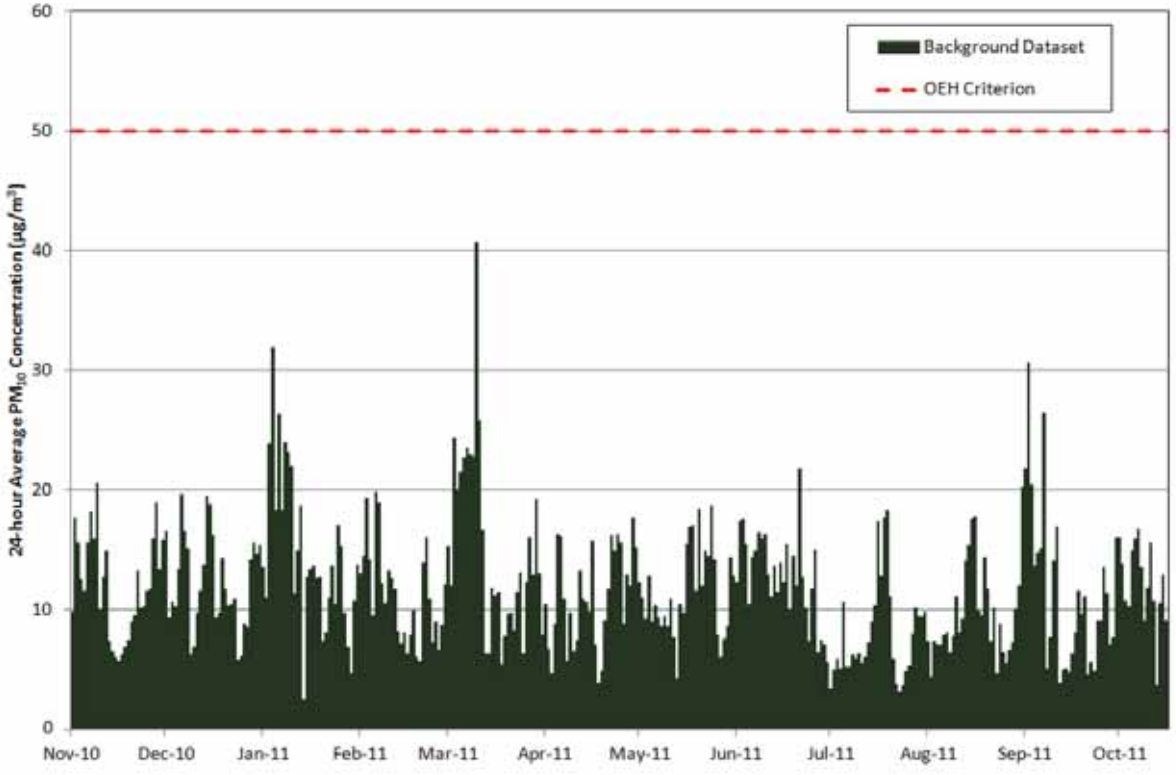

Figure 21: 24-hour Average PM_{10} Concentrations – Background Dataset for Use in Cumulative Assessment – November 2010 to November 2011

5.3.3 TSP Monitoring Data

There is currently no monitoring of ambient TSP concentrations conducted in the vicinity of the Project Site.

From ENVIRON experience of paired PM_{10} and TSP monitoring datasets in rurally-located mining areas (including the Hunter Valley and Ulan regions), the PM_{10} particle size mass fraction is typically of the order of 40% of the recorded TSP mass. On this basis, and in the absence of site-specific monitoring data for TSP, an annual average TSP concentration of 29.4µg/m^3, derived from the annual average PM_{10} concentration of 11.8µg/m^3 recorded by the Cobbora TEOM between September 2009 and November 2011, will be adopted as indicative of existing annual average TSP concentration at the Project Site.

5.3.4 $PM_{2.5}$ Concentrations

No site-specific $PM_{2.5}$ monitoring data was available for the Project Site. Based on ENVIRON experience of paired PM_{10} and $PM_{2.5}$ monitoring datasets from rural NSW, a typical $PM_{2.5}/PM_{10}$ ratio is on average approximately 0.4. However, it is noted that the ratio between concurrent 24-hour average PM_{10} and $PM_{2.5}$ concentrations is highly variable, with a general decrease in ratio observed as PM_{10} concentrations increase. Elevated PM_{10} concentrations often occur as a result of particulate matter generated by mechanical attrition (e.g. wind-blown dust or fugitive dust from mining operations) with such sources emitting a relatively small fraction of $PM_{2.5}$. Conversely, $PM_{2.5}$ can represent a more significant component of airborne PM_{10} during other periods less affected by local dust sources, due to

the longer atmospheric residence time, and associated greater transport distance, of fine particles. High $PM_{2.5}/PM_{10}$ ratios in rural areas are typically attributable to bushfires.

Due to the absence of site-specific monitoring data for $PM_{2.5}$, a background dataset was derived from the site specific PM_{10} monitoring dataset through the application of the 0.4 ratio. It is considered that this derived $PM_{2.5}$ monitoring dataset will be a conservative estimate of likely $PM_{2.5}$ concentrations in the vicinity of the Project Site, particularly in the higher concentration range based on the relationship between $PM_{2.5}$ and PM_{10} discussed above. Maximum 24-hour and annual average $PM_{2.5}$ concentrations from this derived dataset are thus 16.3µg/m^3 and 4.7µg/m^3 respectively.

5.3.5 Other Pollutants

Other than particulate matter, combustion emissions generated by the Project, as listed within **Section 3.4,** are also of interest within this assessment.

No measurements of such air quality indicators are available for the Project Site. Due to a lack of significant sources of such emissions, it is considered that existing ambient concentrations in the local air shed will be minimal. The modelling assessment therefore focuses on the incremental impact of emissions from the Project.

6 Air Quality Emissions Inventory

Sources of emissions to the atmosphere associated with the construction and operation of the Project were identified and quantified primarily through the application of United States Environmental Protection Agency (USEPA) AP-42 predictive emission factor equations. Referencing of AP-42 emission factors is a requirement within OEH's *Coal Mine Particulate Matter Control Best Practice, Site-specific determination guideline*, November 2011. Additionally, emissions were estimated using the NPI Emission Estimation Technique Manual for Mining (NPI, 2012).

Particulate emissions were quantified for various particle size fractions, with the TSP fraction being estimated and simulated to provide an indication of dust deposition rates. Fine particulates (PM_{10} and $PM_{2.5}$) were estimated using ratios for the different particle size fractions available within the literature (principally the USEPA AP-42). Gaseous products of combustion for which emissions were quantified were SO_2, NO_x, CO, benzene, toluene and total xylenes.

The quantitative assessment of combustion emissions focused primarily on routine releases from diesel-fuelled mobile plant, locomotives and blasts. Risks posed by emissions from possible incidents such as post-blast fumes and spontaneous combustion are further discussed in **Section** 8 and management measures are addressed in **Section** 9**.**

An overview of sources of emission are given in the sections below, with emissions quantified for selected mine development stages presented.

6.1 Construction Stage

A construction phase is required to establish the Project. This phase will involve the following activities:

- Preliminary topsoil stripping of initial mining areas;
- Construction of water supply infrastructure, electricity supply and rail spur;
- Construction and establishment of CHPP and Materials Handling Area;
- Realignment of various local roads surrounding the Project Site;
- Construction of temporary accommodation village; and
- Construction of assorted administration and infrastructure buildings.

Construction activities will have a total duration of approximately two years, with individual activities staged in shorter periods over this time. It is expected that the emissions intensity, both with regards to particulate matter and combustion related pollutants, will be lower than the operational mining years to be considered in this assessment.

The construction of the water pipeline (illustrated in **Figure 1**) is a low intensity cut and fill process, with the pipeline being laid less than a metre beneath the surface. There will be minimal emissions to air.

Finally, due to the distance of the proposed rail spur to the surrounding private receptors (a minimum of approximately 250 m as discussed in **Section 2.3**) it is considered that the

potential emissions from the construction of the rail spur are unlikely to cause an adverse impact.

Consequently, emissions generated during the construction phase of the Project have not been quantified within this assessment. Mitigation and management measures to be implemented during the construction stage are, however, addressed in **Section** 9.

It is noted that the stripping of topsoil, a construction stage activity listed above, is incorporated into the operational emissions for each of the assessed mine years.

6.2 Mine Operations and Emission Scenarios

Mine staging plans for each significant phase of the Project were provided by CHC, accounting for Years 1, 2, 4, 8, 12, 16 and 20. The amounts of material to be extracted and processed for each of these years are presented within **Table 11**.

Table 11: Material Handling by Year

Material Type	Year 1	Year 2	Year 4	Year 8	Year 12	Year 16	Year 20
Topsoil stripped (ha)	399.0	170.4	196.2	225.2	200.7	169.9	1.4
Waste (Mbcm)[1]	7.8	20.7	36.3	48.2	47.9	58.6	56.4
ROM Coal (Mtpa)	1.0	10.1	16.5	20.0	20.0	20.0	20.0
Product Coal (Mtpa)	0.7	7.1	11.2	12.0	12.0	12.0	12.0

Note 1: Mbcm – million bank cubic metre. A density of 2.5t/m^3 of waste has been assumed to calculate annual waste tonnage amounts.

Air emission sources associated with each operational mining stage were identified and quantified as documented in subsequent sections. Detailed source and emissions data are provided in **Appendix C** (source location maps) and **Appendix D** (emissions inventory).

6.3 Sources of Emissions from Operations

6.3.1 Particulate Matter Emissions

Air pollution emissions associated with the Project will primarily comprise of fugitive particulate matter releases. Sources of emissions during proposed operations were identified as follows:

- Wheel generated emissions from vehicle movements on unpaved roads;
- Loading and dumping of waste/topsoil material;
- Loading and dumping of Run-of-Mine (ROM) coal;
- ROM pad dumping direct and re-handle by front end loader (FEL) to hopper;
- Loading and dumping of rejects;
- Blasting;
- Drilling;

- Bulldozer operations on coal;
- Bulldozer operations on waste/topsoil;
- Coal crushing/screening;
- Coal stockpile loading;
- Coal conveying and transfer;
- Train wagon loading;
- Wind erosion of coal stockpiles;
- Wind erosion of active mining areas;
- Wind erosion of cleared areas;
- Wind erosion of waste dump/topsoil stockpile areas;
- Wind erosion of rehabilitated waste emplacement areas;
- Road maintenance by grader; and
- Wind-blown coal dust from rail wagons.

6.3.2 Sources of Combustion Emissions

Sources associated with combustion-related emissions during routine operations are as follows:

- Diesel-fuelled mobile plant;
- Diesel-fuelled rail locomotives; and
- Explosive detonation during blasts.

In addition to the above routine emissions, the potential exists for post-blast fumes and spontaneous combustion-related releases. Emissions from such abnormal events are highly site- and incident-specific and emission factors are not available for the accurate quantification of such releases. Risks posed by post-blast fumes and spontaneous combustion are further discussed in **Section** 8 and management measures are addressed in **Section** 9.

6.4 Emission Reduction Measures

6.4.1 Proposed Control Measures

A summary of all control measures proposed for the Project with quantifiable emission reduction factors based on published literature is provided in **Table 12**. These control efficiencies were taken into account in the quantification of Project-related emissions.

Table 12: Air Pollution Control Measures for the Project

Activity	Measure	Control Efficiency [a]
Wheel generated emissions from unpaved roads	Water application (75% Control Efficiency) Average vehicle travel speed on haul roads of 40 km/hr[b]	82.5% [c]
Wind erosion of waste rock and topsoil stockpiles	Progressive rehabilitation of emplacements	30% (New Rehabilitation Areas) 90% (Established Rehabilitation Area)
Trucks unloading coal to hopper	3-sided enclosure with a roof and water sprays	85% [d]
Drilling	Drill water sprays	70%
Crushing and screening	Enclosure	70%
Coal stockpiles	Water sprays	50%
Train wagon loading point	Telescopic chute	70%

(a) Sources of control efficiency information: NPI 2012; Katestone Environmental, 2011.

(b) The WRAP Fugitive Dust Handbook (Countess Environmental, 2006) specifies in Chapter 6 that an emission reduction of 44% can be achieved by limiting vehicle travel speed on unpaved roads to approximately 40 km/hr relative to 70km/hour. The emission estimation factor does not account for site specific vehicle travel speed and was based on travel speeds ranging up to 70km/hr (USEPA, 2006). While speeds may occasionally exceed 40 km/hr at the Project, CHC considers that the average travel speed will generally be lower than 40km/hr along all haul roads. On this basis, the WRAP emission reduction factor has been reduced to 30% for application in this assessment.

(c) Combined control efficiency based on the combination of Watering (75% control efficiency) and average vehicle travel speed of 40km/hr (30% control efficiency – as described in Point (b) above). Using approach of NPI (2012), the combined control factor derived for use in this assessment is 82.5% (i.e. (1-0.75) x (1-0.3) = 0.175 of uncontrolled emissions or 82.5% emission reduction factor.

(d) Combined control efficiency due to water sprays (control efficiency of 50%) and 3-sided enclosure with roof (control efficiency of 70%).

Additional emission mitigation measures that are associated with specific on-site operational and mine planning practices include:

- Not blasting during periods with unfavourable meteorological conditions;
- Ensuring all mobile plant travel paths (dozers, excavators, etc) are routinely watered to minimise particulate matter emissions;
- Ceasing operations or relocating operations to more sheltered areas during periods of dry, windy conditions where watering is not providing required mitigation;
- Minimising material drop height when loading and unloading haul trucks;
- Maintaining haul roads to ensure low silt-content within road surface material;
- Minimising double handling of material, wherever practicable;
- Disposing of rejects from the CHPP within the footprint of the mining area;
- Siting of CHPP and coal stockpiles within the centre of the Project Site, removed from surrounding receptors;
- Utilising empty coal haul trucks for backhauling of rejects wherever possible; and

- Progressively rehabilitating waste emplacement areas throughout the life of the Project to minimise the amount of erodible surfaces on site.

Certain of the above measures do not reduce emission but rather the impact potential of the associated activities (e.g. CHPP placement and blast controls). The effects of other measures are accounted for within the emission estimates, without necessitating control efficiencies being applied (e.g. backhauling reduces the vehicle activity rates used in the emission calculations). The control effectiveness of some of the aforementioned operational measures (e.g. ceasing or modifying operations during dry, windy conditions), could not be accurately quantified.

It is noted that at the time of assessment, a decision regarding the implementation of mitigation measures to reduce dust from rail wagons had not been made. Consequently, no emission reduction factors for rail wagons were applied in this assessment.

6.4.2 Best Management Practice Review

A best management practice (BMP) review was undertaken based on the guidance recommended by the OEH (2011). According to this guidance, NSW coal mines should aim to implement practicable best practice measures for the "top four" sources of TSP, PM_{10} and $PM_{2.5}$ emissions.

Following review of the calculated emissions from the Project, presented in **Section 6.5** of this report, the four most significant sources of particulate matter emissions across all assessed mining years are considered to be:

- The movement of vehicles along unpaved roads across the Project Site;
- The operation of bulldozers on coal (in-pit operations and stockpile management at CHPP);
- Loading of ROM coal in active mining areas; and
- Wind erosion of un-rehabilitated waste rock and topsoil emplacement areas.

The control measures proposed to be applied for each of these sources during the operation of the Project, along with the corresponding best practice measures, are listed in **Table 13**.

Table 13: Practicable Best Practice Controls for Top Sources

Highest Ranked Sources of PM Emissions	Control Method(s) Proposed	Practicable Best Practice Measures
Wheel generated emissions from unpaved roads	Water application (75% Control Efficiency) Average vehicle travel speed on haul roads of 40 km/hr Routine maintenance of haul roads to ensure low silt content within road surface material	Chemical suppression
Bulldozing of coal	Watering of travel route Ceasing/modifying operations during dry, windy conditions	Watering of travel route Ceasing/modifying operations during dry, windy conditions
Loading of coal	Drop height minimisation Cease/modify operations during dry, windy conditions	Drop height minimisation Cease/modify operations during dry, windy conditions
Wind erosion of waste and topsoil dumps	Progressive rehabilitation of emplacements	Progressive rehabilitation of emplacements

(a)Sources of Best Practice Measures: Katestone Environmental, 2011.

On the basis of the information presented within **Table 13**, the control measures proposed for implementation at the Project for the four top-ranked sources of particulate matter emissions are comparable to current best practise control measures. Whereas the application of chemical suppression to unpaved haul roads is not proposed for the Project, alternative management measures are planned to achieve a comparable control effectiveness. A high level of particulate matter emission control from unpaved road emissions will be achieved through the comprehensive management of unpaved roads, including:

- minimising the scale of the operating road network;
- application of watering at the specified rate;
- restricting vehicle travel speeds; and
- the continual upkeep of the road surfaces to a high standard,.

In the event that the expected outcomes are not achieved, chemical suppressants will be introduced.

The control efficiency achievable through the application of chemical suppression ranges significantly (20% to 99+%) across studies, sites, applications, products applied and particle size ranges. A typical control efficiency of approximately 80% is referenced within the USEPA *AP-42 Chapter 13.2.2 Unpaved Roads* (November 2006). It is noted that the emission reduction factor adopted for this assessment, accounting for the combined emission reductions from watering and reduced vehicle travel speed, is 82.5%.

6.5 Project-related Particulate Matter Emissions

The emissions inventory for the Project is comprehensively documented in **Appendix D**. A summary of Project-related emissions is given in **Table 14**, ordered by year of mine

development and source type. Total annual emissions ordered by year of mine development are illustrated in **Figure 22**. Proposed control measures, as documented in the previous section, have already been taken into account in the emission estimates. The highest emissions were estimated to occur during Year 16.

Table 14: Estimated Annual TSP Emissions for the Project by Source and Mining Year

Source	Annual TSP Emissions (tonnes/annum)						
	Year 1	Year 2	Year 4	Year 8	Year 12	Year 16	Year 20
Wheel generated (unpaved roads)	731.1	823.6	1,558.0	2,070.9	2,578.4	2,914.2	2,480.0
Loading/unloading of waste/topsoil	36.9	91.6	158.6	211.6	209.9	248.0	215.5
Loading/unloading of coal	50.2	482.1	786.9	956.6	956.6	956.6	956.6
ROM pad unloading/rehandle to hopper	19.3	185.6	303.0	368.3	368.3	368.3	368.3
Loading/unloading of rejects	4.4	40.7	71.5	109.7	109.7	109.7	35.1
Blasting	11.8	53.6	86.0	122.0	119.5	126.4	107.8
Drilling	5.6	29.1	50.7	73.3	76.4	75.6	67.7
Bulldozer - coal	234.8	823.2	1,332.7	1,472.9	1,528.0	1,528.0	1,528.0
Bulldozer - waste/topsoil	174.1	347.8	517.2	586.0	611.0	617.2	597.6
Coal crushing/screening	12.6	121.0	197.4	240.0	240.0	240.0	240.0
Coal stockpile loading	3.7	35.8	57.6	66.4	66.4	66.4	66.4
Coal conveying and transfer	0.9	7.0	11.2	13.1	13.1	13.1	12.9
Train loading	0.1	0.9	1.3	1.4	1.4	1.4	1.4
Wind erosion - coal stockpiles	195.8	195.8	195.8	195.8	195.8	195.8	195.8
Wind erosion - pit areas	42.5	142.0	251.2	418.9	478.1	428.5	376.4
Wind erosion - cleared areas	155.0	184.9	113.2	173.9	117.8	120.5	54.4
Wind erosion - waste emplacement/topsoil areas	315.2	486.6	571.6	932.0	811.8	913.5	817.5
Wind erosion - new rehabilitation areas	0.0	67.6	177.2	152.4	324.1	311.0	297.2
Wind erosion - established rehabilitation areas	0.0	0.0	9.7	35.0	56.8	103.1	147.5
Rail wagon coal dust	1.0	9.8	15.4	16.5	16.5	16.5	16.5
Rail locomotive emissions	0.2	0.6	0.8	1.0	1.0	1.0	1.0
Total	**1,995.3**	**4,129.1**	**6,467.1**	**8,217.7**	**8,880.5**	**9,354.6**	**8,583.7**

Table 15: Estimated Annual PM_{10} Emissions for the Project by Source and Mining Year

Source	Annual PM_{10} Emissions (tonnes/annum)						
	Year 1	Year 2	Year 4	Year 8	Year 12	Year 16	Year 20
Wheel generated (unpaved roads)	180.5	203.5	386.6	514.5	641.0	724.8	616.5
Loading/unloading of waste/topsoil	17.5	43.3	75.0	100.1	99.3	117.3	101.9
Loading/unloading of coal	7.2	69.3	113.2	137.6	137.6	137.6	137.6
ROM pad unloading/rehandle to hopper	2.8	26.7	43.6	53.0	53.0	53.0	53.0
Loading/unloading of rejects	0.9	8.7	15.3	23.4	23.4	23.4	7.5
Blasting	6.1	27.9	44.7	63.4	62.2	65.7	56.1
Drilling	3.0	15.3	26.7	38.5	40.1	39.7	35.6
Bulldozer - coal	74.1	258.8	418.9	463.1	480.6	480.6	480.6
Bulldozer - waste/topsoil	47.6	90.5	134.1	152.0	158.2	159.6	153.3
Coal crushing/screening	5.0	48.4	79.0	96.0	96.0	96.0	96.0
Coal stockpile loading	1.6	15.2	24.5	28.2	28.2	28.2	28.2
Coal conveying and transfer	0.4	3.3	5.3	6.2	6.2	6.2	6.1
Train loading	0.0	0.4	0.6	0.6	0.6	0.6	0.6
Wind erosion - coal stockpiles	97.9	97.9	97.9	97.9	97.9	97.9	97.9
Wind erosion - pit areas	21.3	71.0	125.6	209.5	239.0	214.3	188.2
Wind erosion - cleared areas	77.5	92.4	56.6	86.9	58.9	60.3	27.2
Wind erosion - waste emplacement/topsoil areas	157.6	243.3	285.8	466.0	405.9	456.7	408.7
Wind erosion - new rehabilitation areas	0.0	33.8	88.6	76.2	162.0	155.5	148.6
Wind erosion - established rehabilitation areas	0.0	0.0	4.8	17.5	28.4	51.5	73.7
Rail wagon coal dust	0.5	4.9	7.7	8.2	8.2	8.2	8.2
Rail locomotive emissions	0.2	0.2	0.2	0.2	1.0	1.0	1.0
Total	**701.8**	**1,354.8**	**2,034.7**	**2,639.1**	**2,827.8**	**2,978.0**	**2,726.6**

Table 16: Estimated Annual $PM_{2.5}$ Emissions for the Project by Source and Mining Year

Source	Annual $PM_{2.5}$ Emissions (tonnes/annum)						
	Year 1	Year 2	Year 4	Year 8	Year 12	Year 16	Year 20
Wheel generated (unpaved roads)	18.6	20.9	39.2	52.0	64.7	73.0	62.2
Loading/unloading of waste/topsoil	0.3	0.7	1.1	1.5	1.5	1.8	1.5
Loading/unloading of coal	1.0	9.2	15.0	18.2	18.2	18.2	18.2
ROM pad unloading/rehandle to hopper	0.4	3.5	5.8	7.0	7.0	7.0	7.0
Loading/unloading of rejects	0.1	0.8	1.4	2.1	2.1	2.1	0.7
Blasting	0.4	1.6	2.6	3.7	3.6	3.8	3.2
Drilling	0.2	0.9	1.5	2.2	2.3	2.3	2.0
Bulldozer - coal	5.2	18.1	29.3	32.4	33.6	33.6	33.6
Bulldozer - waste/topsoil	15.6	35.4	53.0	60.0	62.8	63.7	62.7
Coal crushing/screening	1.9	18.1	29.6	36.0	36.0	36.0	36.0
Coal stockpile loading	0.2	2.3	3.7	4.2	4.2	4.2	4.2
Coal conveying and transfer	0.0	0.1	0.1	0.1	0.1	0.1	0.1
Train loading	0.0	0.1	0.1	0.1	0.1	0.1	0.1
Wind erosion - coal stockpiles	14.7	14.7	14.7	14.7	14.7	14.7	14.7
Wind erosion - pit areas	1.6	5.3	9.4	15.7	17.9	16.1	14.1
Wind erosion - cleared areas	5.8	6.9	4.2	6.5	4.4	4.5	2.0
Wind erosion - waste emplacement/topsoil areas	11.8	18.2	21.4	35.0	30.4	34.3	30.7
Wind erosion - new rehabilitation areas	0.0	2.5	6.6	5.7	12.2	11.7	11.1
Wind erosion - established rehabilitation areas	0.0	0.0	0.4	1.3	2.1	3.9	5.5
Rail wagon coal dust	0.1	0.7	1.2	1.2	1.2	1.2	1.2
Rail locomotive emissions	0.2	0.2	0.2	0.2	1.0	1.0	1.0
Total	**77.9**	**160.2**	**240.4**	**299.8**	**320.1**	**333.1**	**312.0**

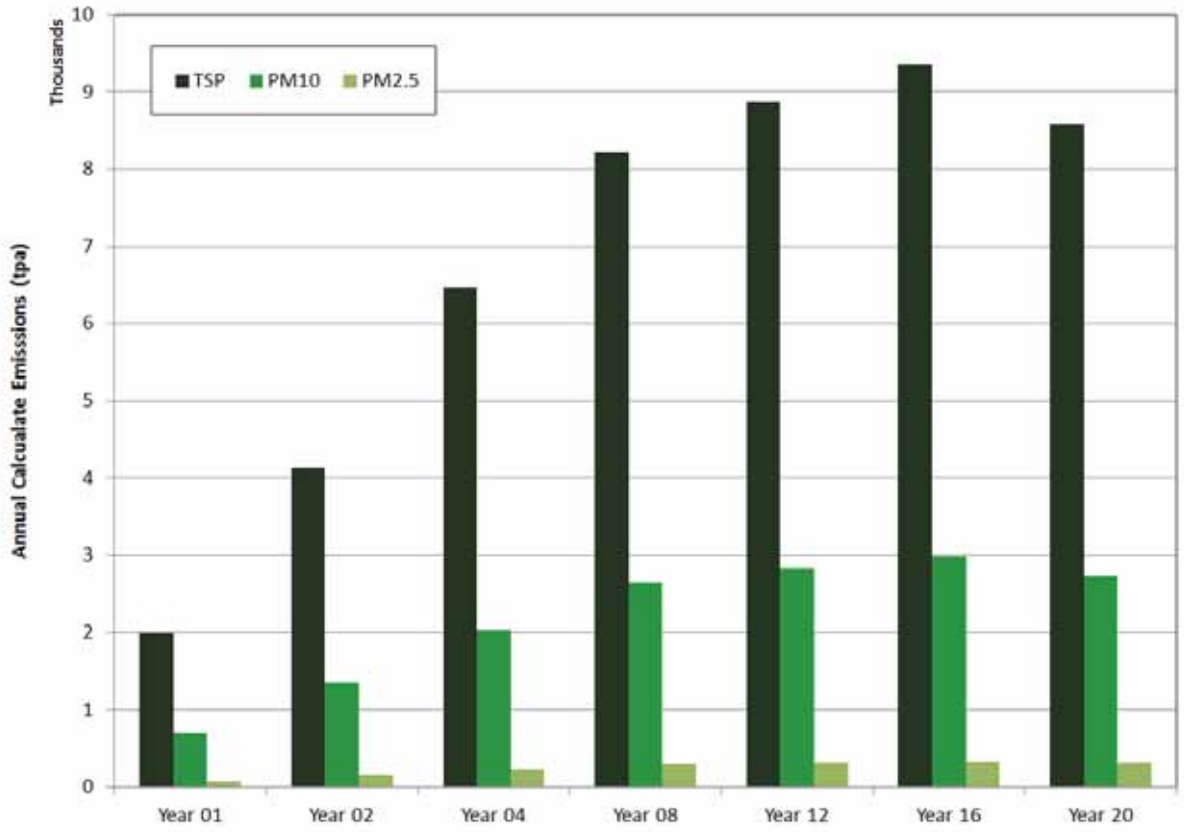

Figure 22: Estimated Annual Particulate Matter Emissions for the Project by Mine Year

6.6 Project-related Gaseous Emissions

The calculation of gaseous emissions generated by the operation of the Project is comprehensively documented in **Appendix D**. A summary of Project-related gaseous emissions is given in **Table 17**, ordered by mine year and source type.

Speciated VOC emissions were not estimated for blasts due to the absence of VOC speciation profiles applicable to such operations. Research is underway by CSIRO to further characterise the composition and impact of blast fumes (Australian Coal Association Research Program (ACARP) Project C18034). The ACARP Project C18034 comprises the sampling and analysis of VOC emissions from blasting to determine the range of compounds released.

Table 17: Estimated Annual Gaseous Emissions for the Project by Mine Year and Source Type

	Year 1				
	Units	Mobile Plant	Locomotives	Blasts	Total
CO	tonnes/year	252.2	3.1	157.4	**412.7**
NOx	tonnes/year	610.1	0.2	37.0	**647.3**
SO_2	tonnes/year	0.3	0.002	4.6	**4.9**
Benzene	kg/year	1,708.2	0.7	ND	**1,708.9**
Toluene	kg/year	854.1	1.1	ND	**855.2**
Xylenes	kg/year	512.5	1.6	ND	**514.1**
	Year 2				
	Units	Mobile Plant	Locomotives	Blasts	Total
CO	tonnes/year	667.9	9.4	451.8	**1,129.1**
NOx	tonnes/year	1,615.8	0.6	106.3	**1,722.7**
SO_2	tonnes/year	0.9	0.006	13.3	**14.2**
Benzene	kg/year	4,524.3	2.2	ND	**4,526.5**
Toluene	kg/year	2,262.2	3.2	ND	**2,265.4**
Xylenes	kg/year	1,357.3	4.8	ND	**1,362.1**
	Year 4				
	Units	Mobile Plant	Locomotives	Blasts	Total
CO	tonnes/year	1,088.3	12.6	779.8	**1,880.7**
NOx	tonnes/year	2,633.0	0.8	183.5	**2,817.3**
SO_2	tonnes/year	1.4	0.008	22.9	**24.3**
Benzene	kg/year	7,372.3	3.0	ND	**7,375.3**
Toluene	kg/year	3,686.1	4.3	ND	**3,690.4**
Xylenes	kg/year	2,211.7	6.4	ND	**2,218.1**
	Year 8				
	Units	Mobile Plant	Locomotives	Blasts	Total
CO	tonnes/year	1,258.3	15.7	1,062.2	**2,336.2**
NOx	tonnes/year	3,044.3	1.0	249.9	**3,295.2**
SO_2	tonnes/year	1.6	0.010	31.2	**32.8**
Benzene	kg/year	8,524.0	3.7	ND	**8,527.7**
Toluene	kg/year	4,262.0	5.4	ND	**4,267.4**
Xylenes	kg/year	2,557.2	8.1	ND	**2,565.3**
	Year 12				
	Units	Mobile Plant	Locomotives	Blasts	Total
CO	tonnes/year	1,376.3	15.7	1,027.3	**2,419.3**
NOx	tonnes/year	3,329.8	1.0	241.7	**3,572.5**
SO_2	tonnes/year	1.8	0.010	30.2	**32.0**
Benzene	kg/year	9,323.5	3.7	ND	**9,327.2**
Toluene	kg/year	4,661.7	5.4	ND	**4,667.1**
Xylenes	kg/year	2,797.0	8.1	ND	**2,805.1**
	Year 16				
	Units	Mobile Plant	Locomotives	Blasts	Total
CO	tonnes/year	1,390.6	15.7	1,256.6	**2,662.9**
NOx	tonnes/year	3,364.5	1.0	295.7	**3,661.2**
SO_2	tonnes/year	1.8	0.010	37.0	**38.8**

Table 17: Estimated Annual Gaseous Emissions for the Project by Mine Year and Source Type

Benzene	kg/year	9,420.5	3.7	ND	**9,424.2**
Toluene	kg/year	4,710.2	5.4	ND	**4,715.6**
Xylenes	kg/year	2,826.1	8.1	ND	**2,834.2**
	Year 20				
	Units	**Mobile Plant**	**Locomotives**	**Blasts**	**Total**
CO	tonnes/year	1,363.9	15.7	1,884.2	**3,263.8**
NOx	tonnes/year	3,299.8	1.0	443.3	**3,744.1**
SO_2	tonnes/year	1.8	0.010	55.4	**57.2**
Benzene	kg/year	9,239.5	3.7	ND	**9,243.2**
Toluene	kg/year	4,619.8	5.4	ND	**4,625.2**
Xylenes	kg/year	2,771.9	8.1	ND	**2,780.0**

ND – no data due to the unavailability of VOC-speciation profiles for blasting emissions.

7 Air Quality Modelling Method and Results

7.1 Dispersion Model Selection and Application

The atmospheric dispersion modelling carried out within this assessment utilises the USEPA regulatory AERMOD model.

AERMOD is designed to handle a variety of pollutant source types, including surface and buoyant elevated sources, in a wide variety of settings such as rural and urban as well as flat and complex terrain.

AERMOD replaced the Industrial Source Complex (ISC) model for regulatory purposes in the US in December 2006 as it provides more realistic results, with concentrations that are generally lower and more representative of actual concentrations compared to the conservative ISC model. Ausplume, a steady-state Gaussian plume dispersion model developed by the Victorian EPA and frequently used in Australia for simple near-field applications, is largely based on the ISC model.

Compared to ISC and Ausplume, AERMOD represents an advanced new-generation model which requires additional meteorological and land-use inputs to provide more refined predictions.

AERMOD was identified as the most suitable model for application for the Project due to the source types (predominately surface based, non-buoyant fugitive releases) and the observed low spatial variability of the meteorological conditions, notably in relation to wind direction (as discussed in **Section 4.2**). The nearest receptors are also noted to be located in relative proximity to the Project Site. The use of AERMOD within this assessment was discussed with OEH (pers. comm. Andrew Mattes, Air Quality Technical Policy, November 2011), with use approved pending demonstration of adequate implementation.

A detailed account of the model selection and modelling methodology is presented in **Appendix B**.

The dispersion of pollutants was modelled for an area covering 24 km by 24 km centred over the CHPP. Gridded receptor points were specified at intervals of 350m. The model simulated ground-level concentrations for each point in the gridded modelling domain for each hour of meteorological data.

Spatial allocation of model sources in each scenario is presented in **Appendix C**. The location of sources, including haul roads, coal and waste loading/unloading activities, dozer operations and wind erosion, were selected based on the indicative equipment locations provided by CHC.

For locomotive operations, emissions from diesel combustion and fugitive dust from open wagons have been quantified and included in the AERMOD modelling. The initial 16km of the private rail spur extending from the train loading facility has been included in the model runs as this represents the area where cumulative impacts of locomotive-related emissions with those generated by the other operations at the Project Site are most likely. Coal dust emissions from open rail wagons have also been assessed within **Appendix I**.

As discussed in **Section** 4, the period between November 2010 and November 2011 was selected for dispersion modelling so as to coincide with available meteorological and baseline air quality monitoring data.

7.2 Unit Emission Rate Modelling

Given the time-intensity associated with multiple complex model runs, and that several iterations of the model runs were required during the validation process, a 'unit emission rate' approach was adopted for modelling.

This approach, also termed "Chi-over-Q" modelling, assigns a nominal unit emission rate to each source (e.g. 1g/s). Model outputs are then created for each individual source, providing concentration data for every hour of the model run, from gridded receptors spaced at 350m intervals across the modelling domain.

Using in-house software, each source-specific concentration prediction is able to be scaled to be representative of the actual emission rate. The premise is that the predicted source concentrations are directly proportional to the emission rate which is the case where the other emission characteristics have not changed.

For example, if the actual emission rate for a given source is 0.5g/s, model outputs for this source may be scaled post-process such that the original predicted ground level concentration is multiplied by this value (0.5). This methodology is based on the assumption that there is no chemical transformation between source and receptor. Since modelling is being conducted in relative proximity of the Project, and not within a regional context, this assumption is deemed valid for most species modelled.

The exception to this is the case of NO_x, where significant chemical transformation may be expected in the vicinity of the Project due to more rapid transformation rates. This is discussed further in **Section 7.4**.

In-house software was subsequently applied with source outputs aggregated, and relevant statistics (e.g. 99.9th Percentile 1-hour average) extracted for all (scaled) source contributions.

The time-intensity to conduct such a scaling exercise is many orders of magnitude lower than having to run the model multiple times and allows greater flexibility for combining sources and identifying the major contributors to the predicted Project impacts. In this manner, several iterations were conducted for validation purposes, and emission scenarios explored in a more straightforward manner.

7.3 Source and Emissions Data

The methodology and results of the emissions inventory developed for the study are presented in **Section** 6. Detailed source configurations and emission rates used in the dispersion modelling are presented in **Appendix C** and **Appendix D**.

7.4 Modelling of NO_x Emissions

NO_x emissions associated with fuel combustion are primarily emitted as NO. The transformation in the atmosphere of NO to NO_2 was accounted for using the USEPA's ozone limiting method (OLM) which requires ambient ozone (O_3) data, as per the Approved Methods for Modelling.

No monitoring for ambient concentrations of O_3 is available for the Cobbora area. The NSW OEH has historically recorded ambient concentrations of O_3 at the air quality monitoring station at Bathurst. Available O_3 concentrations recorded at Bathurst between 2001 and 2007 (the most recent available data from Bathurst) were collated and analysed. The average 1-hour concentration O_3 over this period at Bathurst was 36µg/m^3. This concentration was taken to be indicative of the background O_3 concentration within the Cobbora region.

The equation used to calculate NO_2 concentrations from predicted NO_X concentrations, as presented within the Approved Methods for Modelling, is as follows:

$$[NO_2]_{TOTAL}=\{0.1 \times [NO_x]_{PRED}\} + MIN\{(0.9) \times [NO_x]_{PRED} \text{ or } (46/48) \times [O_3]_{BKGD}\}$$

Where:

$[NO_2]_{TOTAL}$ = The predicted concentration of NO_2

$[NO_x]_{PRED}$ = The AERMOD prediction of ground level NO_X concentrations

MIN = The minimum of the two quantities within the braces

$[O_3]_{BKGD}$ = The assumed background ambient O_3 concentration from Bathurst is 36µg/m^3

46/48 = the molecular weight of NO_2 divided by the molecular weight of O_3

The USEPA's OLM assumes that all of the available O_3 in the atmosphere will react with NO until either all of the O_3, or all of the NO has reacted. A major assumption of this method is that the reaction is instantaneous. In reality, this reaction takes place over a number of hours and over distance. Furthermore, the method assumes that the complete mixing of the plume NO and ambient ozone, down to the level of molecular contact, will have occurred by the time the plume reaches the ground level receiver of the maximum ground level NO_X concentration. Consequently, concentrations of the NO_2 reported within this assessment should be viewed as conservative, providing an upper bound estimate of NO_2 concentrations.

7.5 Presentation of Model Results

7.5.1 Results for Particulate Matter

Airborne particulate matter dispersion simulations were undertaken and results analysed for TSP, PM_{10}, $PM_{2.5}$ and dust deposition. Incremental Project-related particulate matter concentrations and dust deposition rates occurring due to the emissions associated with Mine Years 1, 2, 4, 8, 12, 16 and 20 were simulated. It is considered that the assessment of each of these mine years provides a comprehensive analysis of the potential spatial extent of impact on the surrounding environment throughout the life of the Project.

Model results are expressed as the maximum predicted concentration/deposition for each averaging period at the selected assessment receptor locations over the November 2010 to November 2011 modelling period. Results are provided in the following formats:

- Summary of key modelling results for each mine year presented in **Section 8**;

- Tabulated results of particulate concentrations and dust deposition rates at the closest private and CHC-owned residential receptors locations are presented in **Appendix E**. Tabulated results include Project-only increments, and cumulative concentrations/deposition (i.e. Project-only increment + measured background concentrations/deposition);
- Isopleth plots, illustrating spatial variations in Project-related incremental TSP, PM_{10}, $PM_{2.5}$ and dust deposition are provided in **Appendix F**; and
- Isopleth plots, illustrating spatial variations in Project-related cumulative (Project + background) TSP, PM_{10}, $PM_{2.5}$ and dust deposition are provided in **Appendix G**.

The receptors selected within this assessment for reporting of results represent the closest private and CHC-owned residences to the proposed mining areas. Due to the nature of the majority of emission releases from the Project (ground to low level, fugitive releases with limited thermal buoyancy), it is considered that these receptors represent the locations most likely to experience impact from Project-related emissions.

Isopleth plots of the maximum 24-hour average concentrations presented in **Appendix F** and **Appendix G** do not reflect the dispersion pattern on any individual day, but rather illustrate the maximum daily concentration simulated at each grid intercept given the range of meteorological conditions occurring over the modelling period.

7.5.2 Results for Gaseous Pollutants

Dispersion simulations were undertaken and results analysed for SO_2, NO_2, CO, benzene, toluene and xylenes. Results of gaseous pollutant concentrations at the surrounding receptor locations are discussed in **Section 8**, with the maximum predicted concentrations for each receptor location across all mine years presented in **Appendix E**.

7.5.3 Rail Wagon Emissions

In addition to the inclusion of emissions from rail wagons within the AERMOD modelling conducted for the Project, a stand-alone modelling exercise to investigate the near-field dispersion of coal dust from rail wagons has been conducted. The methodology and results of this investigation are presented in **Appendix I**.

8 Air Quality Assessment

Air quality assessments undertaken in accordance with the Approved Methods for Modelling generally provide a conservative (upper bound) estimate of the potential for air quality impacts occurring due to a project.

During this assessment modelling scenarios were established for the Project to provide an upper bound assessment of Project-related air emissions and related risks, taking into account existing air quality. Whereas existing PM_{10} concentrations measured at the Cobbora Project Site are within the OEH 24-hour impact assessment criterion on most days (including all days during the assessment year), concentrations may approach or exceed this criterion due to regional events such as dust storms and bushfires. Such occurrences are infrequent and typical of broader regional trends in PM_{10} concentrations, as recorded at OEH regional air quality monitoring stations.

The Approved Methods for Modelling provides guidance for dealing with elevated background concentrations when assessing cumulative impacts associated with proposed developments. In accordance with the Approved Methods for Modelling, the likelihood of exceedances of the impact assessment criterion occurring due to the Project is conservatively evaluated. Additionally, the extent to which the Project applies best management practices to minimise air emissions is reviewed and demonstrated in **Section 6.4** and **Section** 9.

Emission reductions due to the best practice management measures to be implemented by the Project were accounted for in the assessment where it was possible to quantify the control effectiveness of measures. The control effectiveness of real-time operational dust management, through the implementation of a reactive/predictive air quality control system (as documented in **Section** 9), could not accurately be quantified. Reduced risks due to the implementation of this measure are therefore not accounted for in the predicted risks presented in this section.

8.1 Assessment of Particulate Matter

Incremental and cumulative TSP, PM_{10} and $PM_{2.5}$ concentrations and dust deposition rates predicted to occur due to the operational emissions generated by the Project are presented in **Appendix E** for each assessed mining year.

A summary of the results for each mining year, with discussion regarding potential predicted exceedance of the applicable assessment criteria, is provided below.

8.1.1 Year 1

The results for Year 1 are presented within **Table E1** in **Appendix E**. There were no exceedances of any OEH and NEPM criteria predicted for the assessed particulate matter pollutants across all surrounding private residence locations during Year 1 operations.

8.1.2 Year 2

The results for Year 2 are presented within **Table E2** in **Appendix E**. Air pollutant concentrations and dust deposition rates due solely to the Project were predicted to be within OEH and NEPM criteria. The following criteria exceedances were predicted to occur

due to cumulative concentrations during proposed Year 2 operations, accounting for existing air quality:

- One exceedance of the 24-hour average PM_{10} criterion at each of the following residences: Residences 1223 and 3224.

No other exceedances were predicted across the remaining private receptors for all particulate matter pollutants assessed during Year 2.

8.1.3 Year 4

The results for Year 4 are presented within **Table E3** in **Appendix E**. Air pollutant concentrations and dust deposition rates due solely to the Project were predicted to be within OEH and NEPM criteria. The following criteria exceedances were predicted to occur due to cumulative concentrations during proposed Year 4 operations, taking existing air quality into account:

- One exceedance of the 24-hour average PM_{10} criterion at each of the following residences: Residences 1222 and 3224.

No other exceedances were predicted across the remaining private receptors for all particulate matter pollutants assessed during Year 4.

8.1.4 Year 8

The results for Year 8 are presented within **Table E4** in **Appendix E**. Air pollutant concentrations and dust deposition rates due solely to the Project were predicted to be within OEH and NEPM criteria. The following criteria exceedances were predicted to occur due to cumulative concentrations during proposed Year 8 operations, taking existing air quality into account:

- One exceedance of the 24-hour average PM_{10} criterion at each of the following residences: Residences 1222, 1223, 3224 and 5025; and
- Exceedance of the annual average $PM_{2.5}$ Advisory Reporting Standard at each of the following residences: Residences 1222, 1223 and 3224.

No other exceedances were predicted across the remaining private receptors for all particulate matter pollutants assessed during Year 8.

8.1.5 Year 12

The results for Year 12 are presented within **Table E5** in **Appendix E**. Air pollutant concentrations and dust deposition rates due solely to the Project were predicted to be within OEH and NEPM criteria. The following criteria exceedances were predicted to occur due to cumulative concentrations during proposed Year 12 operations, taking existing air quality into account:

- Two exceedances of the 24-hour average PM_{10} criterion at each of the following residences: Residence 3224;
- One exceedance of the 24-hour average PM_{10} criterion at each of the following residences: Residences 1222 and 1223; and
- Exceedance of the annual average $PM_{2.5}$ Advisory Reporting Standard at Residences 1222, 1223 and 3224.

No other exceedances were predicted across the remaining private receptors for all particulate matter pollutants assessed during Year 12.

8.1.6 Year 16

The results for Year 16 are presented within **Table E6** in **Appendix E**. Air pollutant concentrations and dust deposition rates due solely to the Project were predicted to be within OEH and NEPM criteria. The following criteria exceedances were predicted to occur due to cumulative concentrations during proposed Year 16 operations, taking existing air quality into account:

- One exceedance of the 24-hour average PM_{10} criterion at each of the following residences: Residences 1222, 1223 and 3224; and
- Exceedance of the annual average $PM_{2.5}$ Advisory Reporting Standard at Residences 1222, 1223, and 3224.

No other exceedances were predicted across the remaining private receptors for all particulate matter pollutants assessed during Year 12.

8.1.7 Year 20

The results for Year 20 are presented within **Table E7** in **Appendix E**. Air pollutant concentrations and dust deposition rates due solely to the Project were predicted to be within OEH and NEPM criteria. The following criteria exceedances were predicted to occur due to cumulative concentrations during proposed Year 20 operations of the Project, taking existing air quality into account:

- One exceedance of the 24-hour average PM_{10} criterion at each of the following residences: Residences 1222, 1223, 1230, 1232, 3224 and 5025;
- One exceedance of the 24-hour average $PM_{2.5}$ Advisory Reporting Standard at each of the following residences: Residences 1222, 1223 and 3224; and
- Exceedance of the annual average $PM_{2.5}$ Advisory Reporting Standard at Residences 1222, 1223, and 3224.

No other exceedances were predicted across the remaining private receptors for all particulate matter pollutants assessed during Year 20.

8.1.8 Modification to the Mine Plan

In August 2012, the mine plan was revised for Year 16 and Year 20 operations to improve rehabilitation of the final voids. The primary changes were as follows:

- Year 16:
  - Removal of the Pit C waste dump extension to the east of the Project Site; and
  - Dumping of waste rock into the northern area of the Pit B void.
- Year 20:
  - Removal of the Pit C waste dump extension to the east of the Project Site, as per Year 16;
  - Further dumping of waste rock into Pit B void; and

- Dumping of waste rock into the Pit A and Pit C voids.

CHC has advised that there would be negligible change in annual amounts of material (run-of-mine coal, waste rock, etc.) extracted and dumped as a result of these changes.

Furthermore, the updated layout relocates a number of haul road alignments and waste rock dumping points from those marked in Appendix C to more sheltered locations and/or locations further removed from the boundary of the operations. As a result there will be only minor changes in the emissions calculated for Year 16 and Year 20, while the discussed relocation of emission sources would result in a reduction in the spatial extent of predicted ground level concentrations.

Consequently, it is considered that the modelling for the Year 16 and Year 20 in this report are a conservative representation of ground level pollutant concentrations likely to be experienced for the modified Year 16 and Year 20 layouts.

8.1.9 Discussion of Results

Incremental air pollutant concentrations and dust deposition rates associated with all mining years were predicted to be within OEH and NEPM criteria.

Taking elevated background airborne particulate matter concentrations into account, resultant cumulative concentrations were predicted to result in infrequent exceedances of the OEH 24-hour PM_{10} criterion at a few private residences on days when background concentrations are high.

No OEH or NEPM criteria exceedances were predicted to occur due to cumulative concentrations during Year 1. One to three exceedances of the OEH 24-hour average PM_{10} criterion is predicted to occur at up to six of the surrounding private residences over the remaining mining years.

A conservative (upper bound) estimate of background $PM_{2.5}$ concentrations was derived from the site-specific PM_{10} dataset for use in the assessment. The derived annual average $PM_{2.5}$ concentrations of 4.7µg/m^3, comprises over 50% of the annual average $PM_{2.5}$ Advisory Reporting Standard of 8µg/m^3, and is considered a potential over-estimate of background concentrations. Using this upper bound estimate of background concentrations, annual average cumulative concentrations were predicted to be higher than the NEPM Advisory Reporting Standard at three surrounding private residences between Year 8 and Year 20. During Year 20 operations, one predicted exceedance of the 24-hour average $PM_{2.5}$ Advisory Reporting Standard is predicted at three private residences.

Given the easterly airflow which prevails in the region (as discussed in **Section** 4), the potential exceedances were predicted to occur primarily at private residences located immediately west of mining areas.

Exceedances were predicted at up to 28 of the CHC-owned properties across the assessed mine years. It is noted that residents and mine employees renting CHC-owned properties will be protected from health impacts by managing mining operations. Houses will not be leased as residences if health based criteria are likely to be exceeded.

Risk reductions due to the implementation of a reactive/predictive air quality control system (as documented in **Section** 9), were not accounted for in the predictions discussed in this section. Given that OEH criteria exceedances are predicted to occur infrequently at private residences, and that such exceedances tend to coincide with elevated background concentrations, the reactive/predictive system is considered to address the risks identified. The acquisition of nearby private land and dwellings represents a further measure to minimise the likelihood of air quality-related impacts on the surrounding environment.

8.1.10 Vacant Land Impact Assessment

As discussed in **Section 3.3**, the Department of Planning often place within the conditions of consent for a project that particulate emissions do not exceed the NSW OEH assessment criteria for particulate matter (TSP, PM_{10} and dust deposition) on more than 25 percent of privately-owned vacant land. In order to provide an indication of performance against this requirement, the maximum cumulative footprint of 24-hour average PM_{10} associated with all assessed mine years was overlayed over land ownership information provided by EMM/CHC. The 24-hour average PM_{10} footprint had the greatest spatial extent of the assessed particulate matter pollutants and averaging periods.

Based on the review of the maximum 24-hour cumulative PM_{10} impact footprint, 33 privately-owned properties (owned by eight different land owners) were predicted to experience a maximum 24-hour average PM_{10} concentration greater than the 50µg/m^3 across more than 25% of the lot area.

A list of these properties, along with the spatial extent of the maximum 24-hour average PM_{10} concentration footprint and the location of the affected properties, is presented in **Appendix H**.

It is noted that the exceedances over private land are predicted for a limited number of days (between one and four) during a given mine year, as with the predictions at individual receptor locations listed earlier in **Section 8.1**. CHC is currently negotiating the purchase of 18 of these lots.

8.2 Assessment of Gaseous Pollutants

The maximum predicted incremental concentrations of NO_2, SO_2, CO, benzene, toluene and xylenes at each private and CHC-owned receptor location across all mining years combined is presented within **Table E9** in **Appendix E**. Applicable impact assessment criteria are provided in the table.

Concentrations are predicted to be less than the relevant impact assessment criteria for all gaseous pollutants and averaging periods assessed across all assessed mining years.

8.3 Potential for Spontaneous Combustion

Spontaneous combustion can occur within coal stockpiles, emplacement areas, coal outcrops, shallow seams and tailings impoundments. It can be a significant source of combustion-related products including CO, NO_x, SO_2, total hydrocarbons and hydrogen sulphide (H_2S). The potential for spontaneous combustion is, however, site-specific, being influenced by factors such as coal characteristics, climate characteristics, stockpile compaction, and emplacement consolidation.

Based on the proposed Project operations, it is considered that risks of spontaneous combustion are mainly due to reject being emplaced together with overburden within mining voids. To adequately quantitatively assess the risk the potential spontaneous combustion, the properties of emplaced materials is required. There is no simple method of estimating the propensity for material to spontaneously combust. Methods range from direct observation and monitoring of in-situ materials to laboratory testing of materials (e.g. self-heating tests). Laboratory testing results may indicate that spontaneous combustion is unlikely, whereas in the field, spontaneous combustion events may occur. It is therefore often necessary for coal mines to undertake ongoing assessments of carbonaceous materials, with ongoing collection of samples for analysis to track the propensity for spontaneous combustion and use made of in-situ temperature probes.

Spontaneous combustion considerations and preventative measures will need to be integrated within the mine design. Monitoring and management measures to address spontaneous combustion risks are documented in **Section 10**. With preventative measures in place, it is considered that the residual risk of spontaneous combustion occurring in the spoil and rejects emplacements and coal stockpiles is best quantified during the early stages of mining. It is therefore recommended that quantitative measurement methods, sampling and testing programs, and guidelines for in-pit identification of high-risk materials be established for documentation within a Spontaneous Combustion Management Plan for the Project. However given the proposed methods of mining, any spontaneous combustion event will be able to be quickly extinguished, through burying the burning material.

8.4 Risks Related to Post-blast Fume

Emissions of NO_x, SO_2 and CO from routine blasting operations were assessed, with the resulting air quality impacts included within the assessment of gaseous emissions from the Project (**Section 8.2**)

It is noted, however, that non-ideal blast conditions increase the amount of trace air pollutants emitted. The generation of blast fume is not uncommon in the commercial explosives industry, with the occurrence of such post-detonation fumes being historically associated with wet conditions and not generally viewed with alarm due to the rapid dispersion of the gas into the air. However, large-scale blasts within some surface coal mining operations, where hundreds of tonnes of explosives are detonated, have resulted in the periodic occurrence of orange/red clouds. Blast fumes represent a potential safety issue for on-site personnel, with community health concerns being raised due to the migration of some blast fumes off the mine property (Sapka et al, 2002).

Several factors have been identified as contributing to blast formation due to non-ideal detonation behaviour observed in some large mine blasts including (Sapka et al, 2002; Attalla et al, 2005):

- Weak overburden which reduces the necessary explosive confinement;
- Significant water infiltration during long intervals between loading and firing, which changes the explosive composition;
- Long explosive columns that produce bottom hole hydrostatic pressures resulting in a decrease in the probability of successful detonation propagation;
- Explosive composition and its homogeneity;

- Velocity of detonation;
- Charge diameter; and
- Explosive re-compression caused by hole-to-hole shock propagation due to wet overburden and clay veins.

Management measures that can be implemented during the operation of the Project to reduce the potential for post-blast fume are addressed in **Section** 9.

9 Mitigation and Monitoring

9.1 Mitigation Measures During Construction

Mitigation measures that can be implemented during the construction stages of the Project to minimise dust generation potentials are as follows:

- Minimise the extent of exposed areas as far as practical throughout the construction phase;
- Stabilise exposed areas (through revegetation, hydromulching, chemical stabilisers) as practical;
- Apply watering to roads and other trafficked areas. Consider the application of water extenders to improve the control effectiveness of wet suppression;
- Consider the prevailing wind direction and speed in short term planning of construction operations, particularly when such operations are close to receptors;
- Cease or modify operations under adverse meteorological conditions (dry, wind conditions) when receptors are located downwind of the construction activities;
- Minimise double handling of material; and
- Locate stockpiles in sheltered areas where possible.

9.2 Mitigation Measures during Operations

Section 6.4.1 highlights the mitigation measures and practices proposed for implementation during the operation of the Project to minimise the level of impact on the surrounding environment. These controls were incorporated into the modelling wherever an appropriate emission reduction factor was available.

Based on the best management practice review conducted for the Project, the control measures applied by the 'top four' activities were closely aligned with practicable best practice measures.

The likelihood of air quality related risk can be further reduced through the implementation of real-time air quality and meteorological monitoring and an associated reactive/predictive air quality control system, as documented in **Section 9.5** and **Section 9.6** respectively.

9.3 Management and Monitoring of Spontaneous Combustion

A bulk washed coal sample from the Project Site was submitted to the Australian Coal Industry Research Laboratory for an initial analysis of spontaneous combustion potential. The results of this analysis indicated that there is a low to moderate propensity for the occurrence of spontaneous combustion within the target seam. Nevertheless, CHC intends to manage any potential risk of spontaneous combustion for the Project through the implementation of the following measures, as appropriate:

- Undertake a spontaneous combustion risk assessment for coal, rejects, overburden and coal seams, and develop and implement a Spontaneous Combustion Management Plan;
- Integrate controls developed to manage spontaneous combustion within operational procedures;

- Progressively emplace wastes containing carbonaceous material to avoid the accumulation such materials on site awaiting emplacement;
- Place the rejects in layers and compact, particularly on the edges of the dump, so that infiltration of oxygen is minimised;
- Sequence overburden emplacement to ensure that accumulations of coal material, particularly if pyritic, are buried under inert spoil;
- For coal stockpiles where the risk of spontaneous combustion is high, track coal moisture levels, coal sulphur content and the residence time of the coal within the stockpile;
- Ensure product stockpiles and coal inventory in the open cut are not left longer than the incipient heating period;
- Visually monitor all coal storage facilities for signs of spontaneous combustion;
- Conduct routine monitoring of high risk coal storage facilities using a temperature probe or infrared scanning device;
- Implement contingency measures in the event of visual signs of spontaneous combustion or temperature measurements of over 50°C such as early washing, dispatch, recycling or excavation;
- Record any spontaneous combustion incidences in a register and identify and record causal factors; and
- Consider safeguarding longer-term stockpiles, particularly of product coal, by spraying the surfaces with a thin (bituminous) coating to exclude air.

Provision should be made within the Spontaneous Combustion Management Plan for quantitative measurement methods, sampling and testing programs, and guidelines for in-pit identification of high risk materials.

9.4 Measures to Reduce Post-blast Fume Potential

It is recommended that the risk of post-blast fume is mitigated through the implementation of the following measures, as appropriate:

- Identify the key risk factors for blast fume at the site, and establish and implement site-specific measures to reduce blast fume events;
- Prior to blasts, conduct a blast fume risk assessment, taking into account ground conditions, occurrence of water (wet holes and depth of water), explosives products and their applications and prevailing and forecast meteorology;
- Reduce the potential for fume by:
  - Delaying blasting to avoid unfavourable weather conditions that are likely to cause or spread a blast fume, including unfavourable ground moisture conditions;
  - Selecting an explosive product that is correct for the conditions;
  - Monitoring the amount of hydrocarbon (diesel) in the product;
  - Preventing water ingress into blast holes;
  - Dewatering holes before loading;

  - Keeping sleep time (the amount of time between charging and firing of a blast) to a minimum, well within manufacturer recommended times;
  - Keeping ammonium nitrate dry;
  - Providing effective stemming; and
  - Loading the product using the appropriate techniques.
- Restrict the blast area and the quantity of explosives to be used in areas prone to blast fume; and
- Investigate and record causal factors for post-blast fume events.

9.5 Air Quality and Meteorological Monitoring Network

CHC has been proactive in establishing air quality and meteorological monitoring at the Cobbora Project Site for baseline characterisation purposes and to support the current air quality impact assessment. As described in **Section** 4 and **Section** 5, two meteorological monitoring stations, one continuous PM_{10} TEOM station and 6 dust deposition gauges are currently installed at the Project Site.

Furthermore, CHC has stated a commitment to implementing ongoing real-time air quality and meteorological monitoring for the duration of the mine to track changes in air quality and support operational dust management.

The monitoring network will comprise a network of continuous PM_{10} and meteorological monitors situated in the vicinity of the Project Site. This network will continuously record short-term PM_{10} concentrations (e.g. 15-minute averages; 1-hour averages), with measured concentrations being communicated to mine operations in real-time via telemetry to inform operational dust management, as discussed further in **Section 9.6**.

In establishing the network, the siting of existing monitoring equipment will be reviewed and additional monitoring stations installed. The location of the monitoring stations may change over the life of the mine to account for spatial progression of the Project.

The detailed air quality and meteorological monitoring network design and documented monitoring program will be finalised prior to the commencement of mine construction. In selecting monitoring station locations a range of factors will be taken into account, including: monitoring objectives (e.g. compliance demonstration; operational dust management), location of active mining areas, location of remaining nearby private residences and the prevailing meteorology. Site access and power and safety requirements will also need to be taken into account in establishing the monitoring stations.

9.6 Reactive/Predictive Air Quality Control System

Daily decisions regarding the need to cease or modify operations due to adverse meteorological conditions or elevated air pollution concentrations will be supported through the application of a reactive/predictive air quality control system (AQCS) (**Figure 23**). This will comprise of real-time predictive and reactive systems.

The reactive system will use real-time meteorological and PM_{10} concentration data to identify adverse meteorological conditions and/or elevated PM_{10} concentrations. This system will be fully automated incorporating trigger alarms, automated reports, SMS and email alarms.

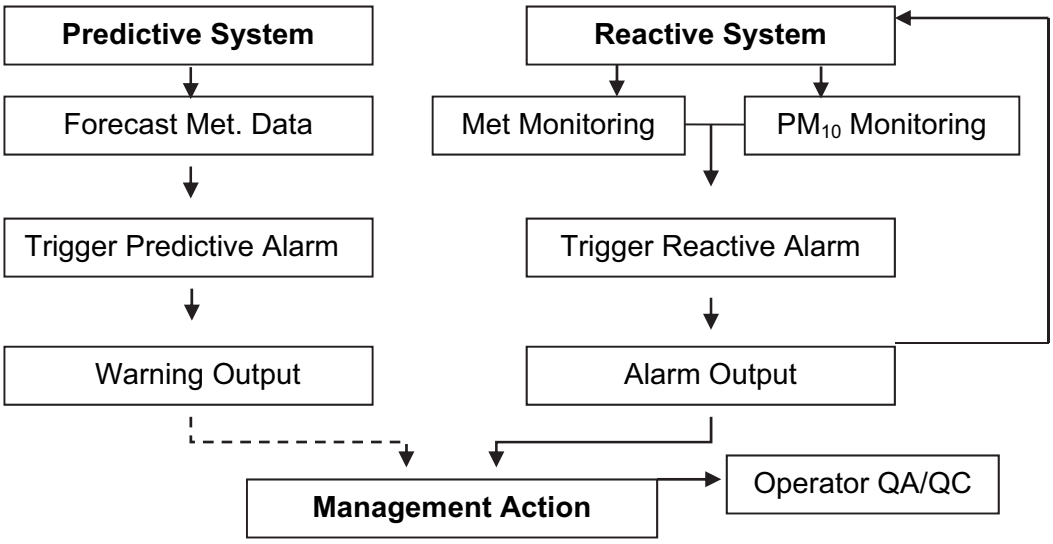

Figure 23: Integrated reactive/predictive air quality control system

The predictive component of the AQCS uses forecast meteorological data to provide early warning of adverse meteorological conditions that could give rise to air pollution episodes. Use may be made of the Bureau of Meteorology ACCESS Numerical Weather Prediction system forecast data, downloadable twice a day via a File Transfer Protocol (FTP) Pull System, to provide the forecast data input. Alternatively, a site-specific meteorological and air quality forecasting system may be developed.

Suitable triggers to be applied and the most suitable forecast system to be integrated will be established during the detailed design of the reactive/predictive system.

10 Greenhouse Gas Assessment

The operation of the Project has the potential to generate greenhouse gas (GHG) emissions. This section of report provides an introduction to greenhouse gases and the legislative framework addressing the emission of GHGs, and presents results from the quantification of GHG emissions from a range of sources related to the Project. The extent of such emissions are presented relative to total NSW, Australian and global GHG emissions, and the implications of such emissions qualitatively considered.

10.1 Greenhouse Gases and Climate Change

GHGs are gases present in the atmosphere that have the ability to absorb long-wave radiation reflected from the Earth's surface, adding heat to the atmosphere. GHGs include water vapour, carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF_6).

With the exception of water vapour, atmospheric concentrations of GHGs are influenced by human activities. The Intergovernmental Panel on Climate Change (IPCC, 2007) states that over the past 250 years, atmospheric concentrations of CO_2, CH_4, N_2O and other GHGs have notably increased and are attributable to human activities since the Industrial Revolution. The extra heat absorbed by increasing quantities of GHGs in the atmosphere has been linked by the IPCC to observed changes in the climate system over recent decades.

10.2 Methodology Adopted

This section sets out the boundaries for the Project, both organisational and operational and provides methodology adopted to derive Scope 1, 2 and 3 GHG emissions for the Project and the types of GHG emissions reported in this assessment.

10.2.1 Organisational Boundary

The organisational boundary for this assessment has been defined using the Operational Control approach, which is defined in the NGERS Act (Australian Government, 2007). In the case of the Project, CHC will account for 100% of GHG emissions over which it has operational control. It will not account for emissions in which it owns an interest but does not have operational control.

Section 11 of the NGERS Act defines Operational Control as follows:

A corporate group member has operational control of a facility if it has the authority to introduce and implement any or all of the operating, health and safety and environmental policies for the facility. Only one corporation or group member can have operational control of a facility at a time.

If there is uncertainty as to which corporation or member has operational control of a facility, the corporation or member deemed to have operational control will be the one with the greatest authority to introduce and implement operating and environmental policies.

The operation of the Project will rely on a number of contractors. CHC will account for emissions associated with its major contractors under its own Scope 1 and 2 emissions (as defined below), since it has authority to implement OHS and environmental policies in relation to the activity of these contractors at the project area.

10.2.2 Operational Boundary (Emission Scopes)

Direct and indirect GHG emissions are defined by the DCCEE within the NGAF 2011 workbook (DCCEE, 2011a), as the following:

Direct emissions *are produced from sources within the boundary of an organisation and as a result of that organisation's activities. These emissions mainly arise from the following activities:*

- *generation of energy, heat, steam and electricity, including carbon dioxide and products of incomplete combustion (methane and nitrous oxide);*
- *manufacturing processes which produce emissions (for example, cement, aluminium and ammonia production);*
- *transportation of materials, products, waste and people (for example, use of vehicles owned and operated by the reporting organisation);*
- *fugitive emissions: intentional or unintentional GHG releases (such as methane emissions from coal mines, natural gas leaks from joints and seals); and*
- *on-site waste management, such as emissions from landfill sites.*

Indirect emissions *are emissions generated in the wider economy as a consequence of an organisation's activities (particularly from its demand for goods and services), but which are physically produced by the activities of another organisation. Examples of indirect emission sources include:*

- *consumption of purchased electricity;*
- *upstream emissions generated in the extraction and production of fossil fuels;*
- *downstream emissions from transport of an organisation's product to customers; and*
- *emissions from contracted/outsourced activities.*

On the basis of the above definitions, the NGAF 2011 workbook prescribes a range of emission factors to estimate associated GHG emissions. These emissions factors are activity-specific, with the scope of the activity determining the emission factor used. Specifically, the scope that emissions are reported under is determined by whether the activity is within the organisational boundary (direct—Scope 1) or outside it (indirect—Scope 2 and Scope 3). The NGAF 2011 workbook defines the scope of emissions through the following:

- ***Direct (or point-source) emission factors*** *give the kilograms of carbon dioxide equivalent (CO_2-e) emitted per unit of activity at the point of emission release (i.e. fuel use, energy use, manufacturing process activity, mining activity, on-site waste disposal, etc.). These factors are used to calculate* ***Scope 1 emissions****.*
- ***Indirect emission factors*** *are used to calculate* ***Scope 2 emissions*** *from the generation of the electricity purchased and consumed by an organisation as kilograms of CO_2-e per unit of electricity consumed. Scope 2 emissions are physically produced by the burning of fuels (coal, natural gas, etc.) at the power station.*
- *Various emission factors can be used to calculate* ***Scope 3 emissions****. For ease of use, the workbook reports specific 'Scope 3' emission factors for organisations that:*

– *burn fossil fuels: to estimate their indirect emissions attributable to the extraction, production and transport of those fuels; or*

– *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 transmission and distribution network.*

Figure 24 shows the relationship between the three emission scopes as defined in the NGAF 2011 workbook.

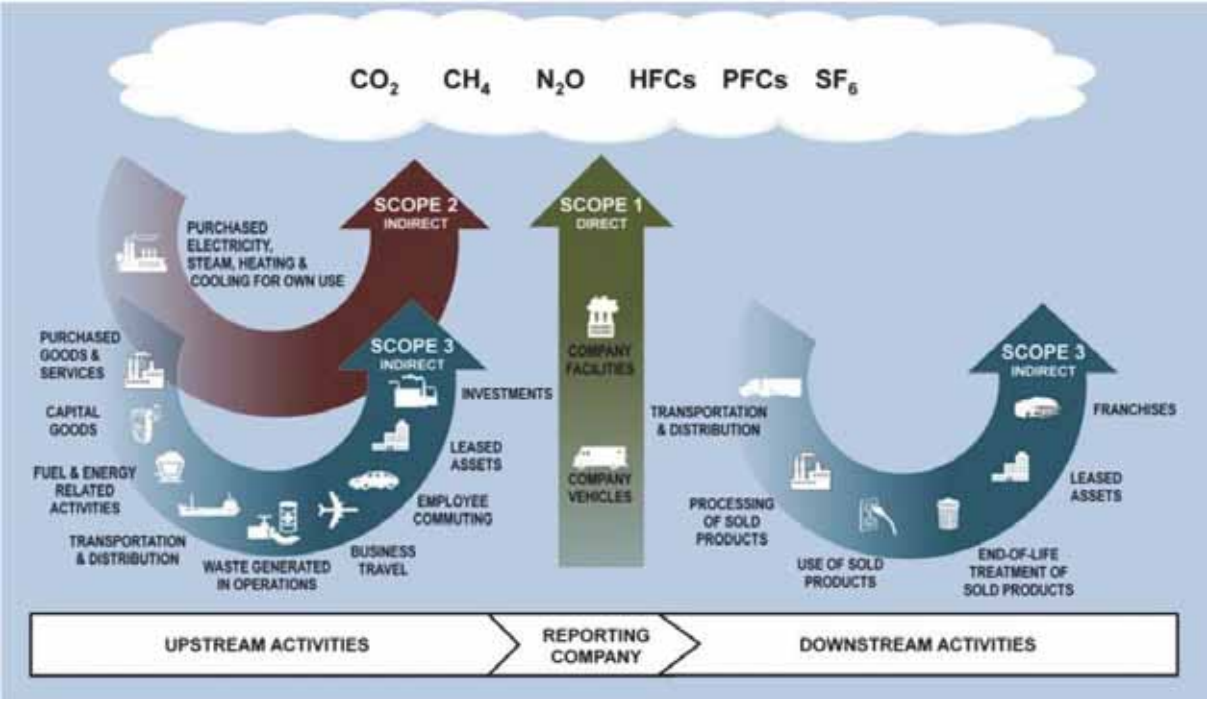

Figure 24: GHG Emission Scopes and Sources across the Value Chain (WBCSD and WRI, 2010)

10.3 Emission Sources

Based on the project description and the operational boundary, direct (Scope 1) and indirect emissions (Scope 2 and 3) have been defined for the project and are shown in **Table 18.**

It is considered that the emissions sources listed within **Table 18** represent the most significant GHG associated with the Project. Other minor sources of GHG emissions may be associated with the Project, including those generated by waste disposal and fugitive leaks from high voltage switch gear. These emissions are anticipated to be relatively negligible in comparison with the emission sources listed in **Table 18** and have therefore not been considered further in this assessment.

Table 18: Scope 1, 2 and 3 Emission Sources Identified for the Project

Scope 1 (Direct)	Scope 2 (Indirect)	Scope 3 (Indirect)
Fuel combustion on site for stationary and non-stationary purpose Blasting conducted on site Fugitive methane (CH_4) emissions from coal seams	Consumption of purchased electricity	Upstream emissions generated from supply of raw materials Downstream emissions generated from off-site transportation of final product Combustion of product coal by end customers – Australia Combustion of product coal by end customers – international Off-site commutation of work personnel (business and personal)

10.4 Reporting of GHG

The assessment will calculate annual emissions for the following GHGs, emitted by the emission sources identified in **Table 18** for the Project:

- CO_2;
- CH_4; and
- N_2O

The relative importance of a GHG is measured in terms of its Global Warming Potential (GWP). The GWP is an index used to convert relevant non-CO_2 gases to a carbon dioxide equivalent (CO_2-e) by multiplying the quantity of the gas by its GWP. The GWP for each type of GHG has been taken from the NGAF workbook – July 2011. The GWPs of relevance to this assessment are:

- CH_4: GWP of 21 (21 times more effective as a GHG than CO_2); and
- N_2O: GWP of 310 (310 times more effective as a GHG than CO_2).

Emissions from each of the assessed GHG have been reported in units of tonnes of carbon dioxide equivalents (t CO_2-e).

10.5 Operational Details

GHG emissions generated by the Project have been calculated for each individual operational year within this assessment. The indicative annual variation in relevant materials extraction and use is presented within **Table 19**.

Table 19: Indicative Yearly Production and Consumption

Mine Year	ROM Coal (Mt)	Product Coal - Domestic (Mt)	Product Coal - International (Mt)	Diesel Consumption (ML)	Explosives Amounts (kt)	Electricity Consumed (MWh)
Year 1	1.0	-	0.3	13.6	4.6	87,600
Year 2	10.1	5.5	1.6	35.9	13.3	175,200
Year 3	13.1	6.8	2.3	54.2	16.7	175,200
Year 4	16.5	8.4	2.9	58.5	22.9	175,200
Year 5	20.0	8.4	3.6	58.7	24.7	175,200
Year 6	20.0	8.4	3.6	62.5	25.8	175,200
Year 7	20.0	8.4	3.6	63.4	30.7	175,200
Year 8	20.0	9.5	2.5	67.7	31.2	175,200
Year 9	20.0	9.5	2.5	67.7	31.7	175,200
Year 10	20.0	9.5	2.5	70.2	30.1	175,200
Year 11	20.0	9.5	2.5	70.0	30.5	175,200
Year 12	20.0	9.5	2.5	74.0	30.2	175,200
Year 13	20.0	9.5	2.5	74.4	31.5	175,200
Year 14	20.0	9.5	2.5	74.6	31.1	175,200
Year 15	20.0	9.5	2.5	74.7	36.6	175,200
Year 16	20.0	9.5	2.5	74.8	37.0	175,200
Year 17	20.0	9.5	2.5	74.6	34.8	175,200
Year 18	20.0	9.5	2.5	74.4	53.5	175,200
Year 19	20.0	9.5	2.5	73.8	53.5	175,200
Year 20	20.0	9.5	2.5	73.5	54.6	175,200
Year 21	20.0	9.5	2.5	73.3	55.4	175,200

Note: Year 1 not complete 12 month period

10.6 Scope 1 Emissions

10.6.1 Onsite Combustion of Diesel Fuel

The principal use of diesel fuel during the life of the Project is for mobile mining equipment. There are no significant stationary sources of diesel fuel combustion associated with the operation of the Project.

Emissions from fuel consumption have been calculated based on equations provided in NGAF 2011 workbook.

The following equation is used to calculate fuel-related emissions for solid, liquid and gaseous fuels.

$$GHG\ Emissions_{fuel} = (Fuel\ Quantity \times Energy\ Content) \times (Emission\ Factor) / 1000$$

where,

GHG Emissions $_{fuel}$ is the emissions attributed to a particular GHG (CO_2, CH_4 or N_2O), in tonnes of carbon dioxide equivalent (t CO_2-e), due to the combustion of a particular fuel;

Fuel Quantity is the quantity of fuel combusted in one year, (kL/yr) as shown in **Table 19**;

Energy Content is the energy content of the fuel combusted, (GJ/kL)

Emission Factor is the GHG emission factor (kg CO_2-e/GJ) for the relevant GHG (CO_2, CH_4 or N_2O), emitted due to fuel combustion

Table 20 shows the energy content and GHG emission factor for diesel fuel.

Table 20: Fuel Energy Content and GHG Emission Factors

Types of fuel combusted (Stationary and Non-Stationary)	Energy Content Factor (GJ/kL)	Emission Factor for GHG Assessed from Fuel Combustion (kg CO_2-e/GJ)		
		CO_2	CH_4	N_2O
Diesel	38.6	69.2	0.1	0.2

10.6.2 Emissions from Blasting

Extensive use of explosives will be required throughout the life of the Project. Expected annual totals of explosives used at the Project are listed within **Table 19**.

The NGAF 2011 workbook does not include GHG emission factors for the use of explosives; however, a historical version of this document, published in January 2008, provides emission factors for the use of ANFO, Heavy ANFO and emulsion explosive types.

It is noted that Heavy ANFO has the highest associated emission factor of the three explosives types listed in the NGAF 2008 workbook. While a mixture of explosives types will be used during the operation of the Project, for the purpose of conservatism all explosives are assumed to be Heavy ANFO.

The following equation is used to calculate GHG emissions generated by the use of onsite explosives at the Project Site.

$$GHG\ Emissions_{explosive\ blasting} = (Explosives\ Quantity \times Explosive\ Emission\ Factor_{type\ of\ explosive})$$

where,

GHG Emissions $_{explosive\ blasting}$ is the emissions attributed to blasting of a particular explosive, in tonnes of carbon dioxide equivalent (t CO_2-e);

Explosives Quantity is the amount of explosives blasted annually (tonnes/yr) as shown in **Table 19**; and

Explosive Emission Factor $_{type\ of\ explosive}$ is the emission factor (t CO_2-e/tonne of explosive) for each type of explosive used

Table 21 shows the emission factors for explosives used on site.

Table 21: NGAF-2008 Explosive Emission Factors for Explosives Used On Site

Type of Explosive	Explosive Emission Factors (t CO_2-e/tonne of explosive)
Heavy ANFO	0.18

10.6.3 Fugitive Coal Seam Emissions

Significant amounts of CH_4 can be generated during the long-term coal formation process. The CH_4 is trapped within coal seams and released fugitively into the atmosphere during coal extraction operations.

There are two primary methods available for calculating fugitive coal seam CH_4 emissions from an open cut coal mine, listed within the NGERS 2011 – Technical Guidelines:

- Method 1 – Emissions are estimated for a particular location of the mine by multiplying a (physical) quantity of run-of-mine coal extracted by an emission factor; and
- Method 2 – Emissions are estimated from the analysis of the gas content in the coal and non-coal strata to be extracted.

Method 1 is useful for application when site-specific coal seam gas content data is not available. Method 2 theoretically provides a more accurate estimate of likely fugitive CH_4 emissions from a specific site, assuming that the samples collected are representative of the entire resource being extracted.

Coal seam gas desorption data from the Project Site, obtained through the analysis of two individual drill core samples, have been provided by CHC for use in this assessment. Core sample analysis was conducted by Earth Data Pty Ltd (2010). Based on information provided by CHC, it is understood that core samples are representative of the coal seams to be accessed during the life of the Project. Data is available in terms of the total gas content (m^3/t) and percentages of CH_4 and CO_2 present in the desorbed samples.

The maximum gas content, measured as 0.73m^3/t, has been paired with the maximum CH_4 content, measured as 4.88%. While the maximum CH_4 content did not coincide with the

maximum measured gas content, the use of both in combination provides an upper bound (conservative) estimate of the methane emissions using Method 2. The remainder of the gas sample (95.12%) was assumed to comprise of CO_2.

Annual GHG releases due to fugitive coal bed emissions have also been estimated for the Project using Method 1. This was done to compare with the emission estimates derived based on Method 2, and for completeness.

Estimated Emissions Methodology (Method 1)

Fugitive coal seam emissions of CH_4 from the extraction of coal can be estimated using the equation shown below:

$$Emissions_{\ methane\ gas} = Q \times EF_{methane\ gas}$$

where,

Emissions $_{methane\ gas}$ is the amount of methane fugitively released from the extraction of coal from the mine during a given year (t CO_2-e/year);

Q refers to the quantity of ROM coal extracted from the mine during a given year (tonne/yr) as shown in **Table 19**; and

$EF_{methane}$ is the emission factor for methane (t CO_2-e/tonne of ROM coal mined).

The indicative total amount of ROM coal extracted annually during the operation of the Project is shown in **Table 19.**

The fugitive CH_4 emission factor for open cut mines in NSW is 0.045t CO_2-e/tonne of ROM coal as per NGAF 2011 workbook

Direct Measured Emission Methodology (Method 2)

Chapter 3, Section 3.21 of the NGER (measurement) determination 2008 technical guidelines details the method for estimating emissions from open cut mining which involves the estimation of a total stock of gas available for release as emissions from the mine extraction area.

Fugitive coal seam emissions of CH_4 from the extraction of coal can be quantified using the equation shown below:

$$Ej = \gamma_j \sum_z \left(Sj, z \right)$$

where:

Ej is the fugitive emissions of gas type (j) that result from the extraction of coal from the mine during the year, measured in CO_2-e tonnes;

γ_j is the factor for converting a quantity of gas type (j) from cubic meters at standard conditions of pressure and temperature to CO_2-e tonnes, as follows:

- For CH_4: 6.784 x 10^{-4} x 21
- For CO_2: 1.861 x 10^{-3}

$\sum_z$ (Sj, z) is the total of gas type (j) in all gas bearing strata (z) under the extraction area of the mine during the year, measured in cubic meters.

As discussed previously, a total strata gas content of 0.73m^3/t and a CH_4 / CO_2 split of 4.88% / 95.12% has been assumed, based on site specific monitoring conducted at the Project Site.

Comparison of Emission Estimation Methods

Based on the above equations, the fugitive coal bed emissions calculated for both Method 1 and Method 2 are presented within **Table 22**.

Table 22: Estimated and Measured Fugitive Coal Bed Emissions

Methodology	Average Annual Amount of GHG released (t CO_2-e/yr)
Estimated Emissions (Method 1)	799,185
Direct Measured Emissions (Method 2)	31,520

Based on results shown in **Table 22**, the annual average CO_2-e emissions per year from fugitive coal seam emissions estimated by Method 2 (site specific data) are approximately 4% of the emissions estimated by Method 1 (default emission factor).

Emissions estimated from Method 1, employ a generic emission factor, whereas, emissions derived using Method 2, are measured on-site. For the remainder of this assessment, only emission estimates derived from Method 2, the direct measured emissions, will be considered.

10.6.4 Scope 2 Sources and Emissions

10.6.4.1 Emissions from Purchased Electricity

Specific year-to-year variation in annual electricity requirements for the Project was not available at the time of assessment, however it has been estimated that the likely demand of all components of the Project would be 20MW. Assuming constant maximum demand throughout the years (a conservative assumption as 20MW represents peak energy consumption), this equates to an estimated annual electricity consumption rate of 175,200 MWh/annum, excluding Year 1 which is a shorter operational period.

Scope 2 emissions from purchased electricity can be quantified using the equation below:

$$GHG\ Emissions_{\ purchased\ electricity} = Amount\ of\ electricity\ purchased \times Emission\ factor / 1000$$

where,

GHG Emissions $_{purchased\ electricity}$ is the total amount of GHG emitted in tonnes of carbon dioxide equivalent per year (t CO_2-e/year), as a result of purchased electricity;

Amount of electricity purchased refers to the amount of electricity purchased from the grid annually (kWh/year) as shown in **Table 19**; and

Emission factor, factor applicable for estimating emissions from purchase of electricity (kg CO_2–e/ kWh). This emission factor is based on geographic location within Australia from where the electricity is purchased.

The applicable emission factor for the project is shown in **Table 23**.

Table 23: Applicable Emission Factor for Calculating Emissions from Purchased Electricity

Electricity purchased in NSW	0.89 (kg CO_2 –e/ kWh)

It is noted that a Scope 3 emission factor for consumed electricity is provided within the NGAF 2011 workbook. These are addressed separately from Scope 2 electricity emissions, within the following section.

10.6.5 Scope 3 Sources and Emissions

10.6.5.1 Scope 3 Emission Scenarios

It is noted that while indicative amounts of product coal sent to domestic and international markets on a year by year basis are presented in **Table 19**, the amount sent to either market through the life of the Project could vary. The potential exists for all coal produced to be consumed domestically. Changes in the split of product coal used domestically and internationally could alter the Scope 3 GHG emission estimates, particularly emissions associated with the transportation of product coal to the end user. Additionally, the significance of Project GHG emissions could vary relative to state and federal GHG emissions inventories due to changes in the spatial occurrence of emissions. Consequently, the following two Scope 3 emission scenarios have been developed for this assessment:

- Scenario A – Assumes a split of domestic-grade and export-grade product coal by year, as per the amounts listed in **Table 19** for the domestic and international market respectively; and
- Scenario B – Assumes all product coal (both domestic- and export-grade coal) from the Project is consumed domestically. For each mine year, this scenario assumes that all of the domestic and international market coal listed in **Table 19** will be consumed domestically.

For the purpose of this assessment, and based on Project-specific coal quality data, export-grade coal is taken to have an energy content of 25GJ/t, with an energy content of 21 GJ/t taken for domestic-grade coal.

10.6.5.2 Upstream and Downstream Activity Emissions

Upstream activities that would contribute towards Scope 3 emissions include the production and supply of various raw materials to site. A major contribution to upstream activities for the Project would be the supply of fuel (diesel oil) to site, principally for mobile mining equipment, and purchased electricity.

Scope 3 purchased electricity emissions are associated with the extraction, production and transport of fuel burned at point of electricity generation and the indirect emissions attributable to the electricity lost in delivery, which differs from Scope 2 purchased electricity emissions which are associated with the purchased electricity directly consumed by the Project.

Downstream activities that would contribute towards Scope 3 emissions include transport of the product coal from site to domestic power station customers and the Port of Newcastle for export onwards to the end customer.

Upstream Activities

Fuel Supply

In order to quantify emissions from upstream activities, the amount of fuel required was determined based on the amount of fuel consumed as shown in **Table 19**.

Emissions from upstream activities have been calculated based on equations provided in NGAF 2011 workbook.

The following equation is used to calculate emissions for upstream activities

$$GHG\ Emissions_{upstream\ activities} = (Fuel\ Quantity \times Energy\ Content) \times (Emission\ Factor) / 1000$$

where,

GHG Emissions $_{upstream\ activities}$ is the emissions in tonnes of carbon dioxide equivalent (t CO_2-e), due to upstream activities;

Fuel Quantity is the quantity of fuel supplied annually, (kL/yr) as shown in **Table 19**;

Energy Content is the energy content for each fuel supplied in gigajoules per kiloliter (GJ/kL); and

Emission Factor is the GHG emission factor (kg CO_2–e/ GJ) for relevant fuel supplied.

The applicable emission factor for the project is shown in **Table 25**.

Table 24: Applicable Emission Factor for Calculating Scope 3 Emissions from Diesel Fuel Consumption

Diesel	5.3 (kg CO_2 –e/ GJ)

Purchased Electricity

A Scope 3 emission factor for consumed electricity is provided within the NGAF 2011 workbook, which accounts for emissions associated with the extraction, production and transport of fuels used in the production of the purchased electricity and emissions associated with the electricity lost in transmission and distribution on route to the end consumer.

Scope 3 emissions from purchased electricity can be quantified using the equation below:

$$GHG\ Emissions_{\ purchased\ electricity} = Amount\ of\ electricity\ purchased \times Emission\ factor$$

where,

GHG Emissions $_{purchased\ electricity}$ is the total amount of GHG emitted in tonnes of carbon dioxide equivalent per year (t CO_2-e/year), as a result of purchased electricity;

Amount of electricity purchased refers to the amount of electricity purchased from the grid annually (kWh/year) as shown in **Table 19**; and

Emission factor is the factor applicable for estimating emissions from purchase of electricity (kg CO_2–e/ kWh). This emission factor is based on geographic location within Australia from where the electricity is purchased.

The applicable emission factor for the project is shown in **Table 25**.

Table 25: Applicable Emission Factor for Calculating Scope 3 Emissions from Purchased Electricity

Electricity purchased in NSW	0.17 (kg CO_2–e/ KWh)

Downstream Activities

Coal produced by the Project will be transported by rail to the various customers, including Bayswater and Liddell power stations in the Upper Hunter Valley and Eraring, Vales Point and Munmorah power stations on Lake Macquarie on the NSW Central Coast. Coal may also be transported to other domestic customers or to a ship loading facility in Newcastle for export.

In estimating GHG emissions from downstream activities, the following assumptions are made:

- Domestic product coal is assumed to be distributed to Bayswater/Liddell Power Stations, Eraring Power Station and Vales Point/Munmorah Power Stations at a rate of 20%, 40% and 40% respectively. The distances for each trip are approximately 205 km, 345 km and 360 km in the same order;
- Rail transport of export coal from the Project to the Port of Newcastle is assumed to cover a distance of 300km;

- All transportation of product coal will be via diesel-electric freight trains;
- For exporting product coal via bulk carriers to the international market, it has been assumed that all coal would be transported to India (most likely purchaser based on current market and coal quality) from the Port of Newcastle, a distance of 11,400 km (one-way); and
- Information related to the number of train trips per year was based on the existing rail haulage capabilities and the expected minimum train movements required to meet the contracted tonnages to be supplied to the power stations. The nominal carrying capacity of coal wagons is 97 tonnes per wagon. For bulk carriers, the average payload capacity has been referenced from the IMO-GHG Study.

Rail Transport – Domestic Market and Port of Newcastle (Scenario A only)

Emissions have been calculated from the AGO National GHG Inventory.

In order to derive the GHG emissions, an annual tonne-kilometres (tonne-km) was determined by multiplying the distance for coal transport by rail to relevant end destination by the corresponding amount of product coal transported by rail per year.

The estimated tonne-kilometre was then multiplied by the GHG indicator for freight rail activity of 20g CO_2/t-km, obtained from the AGO National GHG Inventory, to estimate downstream emissions from rail transport.

$$GHG\ Emissions_{Rail\ Transport} = (Weighted\ average\ distance \times Maximum\ amount\ of\ product\ material) \times (GHG\ indicator_{Rail\ Transport}) / 1{,}000{,}000$$

where,

GHG Emissions $_{Rail\ Transport}$ is the emissions in tonnes of carbon dioxide equivalent (t CO_2-e), due to freight rail transport;

Weighted average distance is the distance (km) based on breakdown of amount of product coal shipped to a specific terminal and the distance between the site and the terminal;

Maximum amount of product material (tonne /year) is the amount of product material transported per year via freight trains to assorted destinations; and

GHG indicator $_{Rail\ Transport}$ is the GHG indicator for freight rail activity: 20g CO_2/tonne-km.

Transport via Bulk Carriers to International Market (Scenario B only)

Emissions from bulk carriers have been estimated from the IMO-GHG Study.

GHG emissions from bulk carriers have been classified based on the carrying capacity, (measured in dead weight tonnes) of the carriers.

Based on estimates made in previous GHG assessments in regards to product transport via bulk carriers, it has been assumed that the average cargo capacity through which product

coal would be shipped would equate to 163,000 tonnes (IMO-GHG Study). Based on the cargo capacity and the maximum amount of product coal that is to be transported via bulk carriers, the total number of trips required was established.

In order to derive the GHG emissions, an annual tonne-kilometre (tonne-km) was determined by multiplying distance of travel from the Port of Newcastle to India by the total number of trips required to transport the product coal.

The estimated tonne-kilometre was then multiplied by a total efficiency factor (g CO_2/tonne-km) obtained from the IMO-GHG Study, based on the carrying capacity of the bulk carrier, to estimate downstream emissions from bulk carrier transport.

For the assessment, as per the IMO-GHG Study, a total efficiency factor of 3g CO_2/tonne-km was applied based on an average cargo capacity of 163,000 tonnes.

The equation, applicable for deriving downstream emissions from bulk carriers is as follows:

$$GHG\ Emissions_{Bulk\ Carrier\ Transport} = (Weighted\ average\ distance \times Average\ Cargo\ Capacity \times Max\ number\ of\ trips\ per\ year) \times (Total\ efficiency\ factor_{Bulk\ Carriers}) / 1{,}000{,}000$$

where,

GHG Emissions $_{Bulk\ Carrier\ Transport}$ is the emissions in tonnes of carbon dioxide equivalent (t CO_2-e), due to bulk carrier transport;

Weighted average distance is the distance (km) based on breakdown of amount of product coal shipped to a specific terminal and the distance between the site and the terminal;

Average cargo capacity: Average cargo capacity in which product coal would be shipped (163,000 tonne); and

Total efficiency factor $_{Bulk\ Carriers}$ *is* the GHG efficiency factor for bulk carrier activity, based on cargo capacity: 3g CO_2/tonne-km.

10.6.5.3 Product Coal Combustion

For the purpose of quantifying GHG emissions, it has been assumed that the 'black coal' would be transported from the Project for thermal combustion.

Emissions from product coal combustion have been calculated based on equations provided in NGAF 2011 workbook.

The following equation is used to calculate product coal combustion related emissions for black coal.

$$GHG\ Emissions_{Black\ Coal} = (Shipped\ Quantity_{Black\ Coal} \times Energy\ Content_{Black\ Coal}) \times (Emission\ Factor_{Black\ Coal}) / 1{,}000$$

where,

GHG Emissions $_{Black\ Coal}$ is the emissions attributed to a particular GHG (CO_2, CH_4 or N_2O), in tonnes of carbon dioxide equivalent (t CO_2-e), due to the combustion of black coal;

Shipped Quantity $_{Black\ Coal}$ is the quantity of black coal that has been shipped to end-customers for combustion purpose, (Mtpa) as shown in **Table 19**;

Energy Content $_{Black\ Coal}$ is the energy content of black coal (GJ/t). Based on Project-specific data the energy content was taken to be 21GJ/t for domestic-grade product coal and 25GJ/t for export-grade coal; and

Emission Factor $_{Black\ Coal}$ is the GHG emission factor (kg CO_2-e/GJ) for the relevant GHG (CO_2, CH_4 or N_2O), emitted due to combustion of black coal.

Table 26 shows the energy content and GHG emission factor for black coal (thermal) combustion.

Table 26: Black Coal (Thermal) Energy Content and GHG Emission Factors

Coal Type	Energy Content Factor (GJ/t)	Emission factor for GHG assessed from fuel combustion (kg CO_2-e/GJ)		
		CO_2	CH_4	N_2O
Black coal (thermal only)	21 – Domestic–grade 25 – Export-Grade	88.2	0.03	0.2

10.6.5.4 Emissions Generated from Personnel Commutation

Emissions will be generated from transporting personnel within and beyond the site boundary. Emissions from transport within the site have already been factored in Scope 1 emissions through fuel combustion.

As there is no mine accommodation camp proposed for the operation of the Project, it is assumed that the majority of mine personnel will travel from the surrounding region, principally Dubbo, Wellington and Dunedoo. To estimate GHG emissions associated with the travel of mine personnel, annual vehicle kilometres travelled projections for all personnel per year have been provided by EMM.

It has been assumed that all personnel transport is made in gasoline-fuelled light motor vehicles, with a constant fuel consumption rate of 10 L/100km adopted.

The following equation is used to calculate emissions for upstream activities

GHG Emissions $_{off\text{-}site\ transport}$ = *(Fuel Quantity x Energy Content) x (Emission Factor) / 1000*

where,

GHG Emissions $_{off\text{-}site\ transport}$ is the emissions in tonnes of carbon dioxide equivalent (t CO_2-e), due to downstream activities;

Fuel Quantity is the quantity of fuel consumed in off-site personnel transport annually (kL/yr);

Energy Content is the energy content for fuel consumed (GJ/kL); and

Emission Factor is the GHG emission factor (kg CO_2–e/ GJ) for relevant fuel consumed

Table 27 shows the energy content and GHG emission factor for gasoline.

Table 27: Gasoline Energy Content and GHG Emission Factors

Types of fuel combusted	Energy Content Factor (GJ/kL)	Scope 3 Emission factor for GHG assessed from fuel combustion (kg CO_2-e/GJ)
Gasoline	34.2	5.3

10.7 GHG Emissions Inventory and Environmental Impact

10.7.1 Emissions Inventory

This section details the Scope 1, 2, 3 and the total GHG emissions for the Project.

Table 28 details the annual Scope 1 and 2 GHG emissions by source type for each mine year. **Table 29** lists the annual Scope 3 GHG emissions by mine year and source for Scenario A – product coal to both the domestic and international markets, while **Table 30** lists the annual Scope 3 GHG emissions by mine year and source for Scenario B – product coal to the domestic market only. **Table 31** and **Table 32** show the cumulative Scope 1, 2 and 3 emissions and the total GHG emissions for each year of the Project for Scenario A and B respectively. All results are expressed in tonnes of carbon dioxide equivalent per year (t CO_2-e/yr).

Table 28: Cobbora Coal Project – Calculated Annual GHG Emissions – Scope 1 and 2

Mine Year	Scope 1 Emissions (t CO_2-e/yr) by Source			Scope 2 Emissions (t CO_2-e/yr)
	Onsite Diesel Combustion	Explosives Detonation	Fugitive Coal Seam Gas	Purchased Electricity Consumption
Year 1	36,369	834	1,863	77,964
Year 2	96,329	2,392	17,889	155,928
Year 3	145,474	3,011	23,308	155,928
Year 4	156,966	4,129	29,198	155,928
Year 5	157,396	4,450	35,496	155,928
Year 6	167,772	4,652	35,496	155,928
Year 7	170,184	5,534	35,496	155,928
Year 8	181,486	5,623	35,496	155,928
Year 9	181,539	5,701	35,496	155,928
Year 10	188,232	5,421	35,496	155,928
Year 11	187,714	5,498	35,496	155,928
Year 12	198,509	5,439	35,496	155,928
Year 13	199,590	5,662	35,496	155,928
Year 14	200,128	5,592	35,496	155,928
Year 15	200,335	6,582	35,496	155,928
Year 16	200,574	6,652	35,496	155,928
Year 17	200,014	6,269	35,496	155,928
Year 18	199,587	9,637	35,496	155,928
Year 19	197,888	9,632	35,496	155,928
Year 20	197,083	9,819	35,496	155,928
Year 21	196,721	9,975	35,496	155,928

Note: Fugitive Coal Seam Emissions calculated by Method 2 – Direct Onsite Measurements.

Table 29: Cobbora Coal Project – Calculated Annual GHG Emissions – Scope 3 – Scenario A

Mine Year	Scope 3 Emissions (t CO_2-e/yr) by Source						
	Upstream Emissions	Transport to Domestic Market	Transport to International Market	Coal Combustion - Domestic	Coal Combustion - International	Employee Travel	Electricity Use
Year 1	2,773	3,924	22,367	-	722,918	70	14,892
Year 2	7,346	90,547	110,401	10,213,665	3,568,261	89	29,784
Year 3	11,094	115,555	155,707	12,661,568	5,032,606	94	29,784
Year 4	11,970	142,679	196,307	15,531,524	6,344,809	114	29,784
Year 5	12,003	151,875	248,727	15,531,524	8,039,091	121	29,784
Year 6	12,794	151,875	248,727	15,531,524	8,039,091	121	29,784
Year 7	12,978	151,875	248,727	15,531,524	8,039,091	125	29,784
Year 8	13,840	152,945	171,000	17,641,785	5,526,875	126	29,784
Year 9	13,844	152,945	171,000	17,641,785	5,526,875	134	29,784
Year 10	14,354	152,945	171,000	17,641,785	5,526,875	134	29,784
Year 11	14,315	152,945	171,000	17,641,785	5,526,875	138	29,784
Year 12	15,138	152,945	171,000	17,641,785	5,526,875	138	29,784
Year 13	15,221	152,945	171,000	17,641,785	5,526,875	140	29,784
Year 14	15,262	152,945	171,000	17,641,785	5,526,875	140	29,784
Year 15	15,277	152,945	171,000	17,641,785	5,526,875	140	29,784
Year 16	15,296	152,945	171,000	17,641,785	5,526,875	140	29,784
Year 17	15,253	152,945	171,000	17,641,785	5,526,875	138	29,784
Year 18	15,220	152,945	171,000	17,641,785	5,526,875	138	29,784
Year 19	15,091	152,945	171,000	17,641,785	5,526,875	137	29,784
Year 20	15,029	152,945	171,000	17,641,785	5,526,875	137	29,784
Year 21	15,002	152,945	171,000	17,641,785	5,526,875	137	29,784

Table 30: Cobbora Coal Project – Calculated Annual GHG Emissions – Scope 3 – Scenario B

Mine Year	Scope 3 Emissions (t CO_2-e/yr) by Source						
	Upstream Emissions	Transport to Domestic Market	Transport to International Market	Coal Combustion - Domestic	Coal Combustion - International	Employee Travel	Electricity Use
Year 1	2,773	4,232	-	722,918	-	70	14,892
Year 2	7,346	92,067	-	13,781,926	-	89	29,784
Year 3	11,094	117,699	-	17,694,174	-	94	29,784
Year 4	11,970	145,381	-	21,876,333	-	114	29,784
Year 5	12,003	155,299	-	23,570,615	-	121	29,784
Year 6	12,794	155,299	-	23,570,615	-	121	29,784
Year 7	12,978	155,299	-	23,570,615	-	125	29,784
Year 8	13,840	155,299	-	23,168,660	-	126	29,784
Year 9	13,844	155,299	-	23,168,660	-	134	29,784
Year 10	14,354	155,299	-	23,168,660	-	134	29,784
Year 11	14,315	155,299	-	23,168,660	-	138	29,784
Year 12	15,138	155,299	-	23,168,660	-	138	29,784
Year 13	15,221	155,299	-	23,168,660	-	140	29,784
Year 14	15,262	155,299	-	23,168,660	-	140	29,784
Year 15	15,277	155,299	-	23,168,660	-	140	29,784
Year 16	15,296	155,299	-	23,168,660	-	140	29,784
Year 17	15,253	155,299	-	23,168,660	-	138	29,784
Year 18	15,220	155,299	-	23,168,660	-	138	29,784
Year 19	15,091	155,299	-	23,168,660	-	137	29,784
Year 20	15,029	155,299	-	23,168,660	-	137	29,784
Year 21	15,002	155,299	-	23,168,660	-	137	29,784

Table 31: Cobbora Coal Project – Calculated Annual GHG Emissions – Scenario A

Mine Year	Annual GHG Emissions (t CO_2-e/yr) by Scope			Total Annual GHG Emissions (t CO_2-e/yr)
	Scope 1	Scope 2	Scope 3	
Year 1	39,065	77,964	766,945	883,974
Year 2	116,610	155,928	14,020,094	14,292,631
Year 3	171,794	155,928	18,006,408	18,334,130
Year 4	190,292	155,928	22,257,187	22,603,406
Year 5	197,343	155,928	24,013,125	24,366,395
Year 6	207,921	155,928	24,013,916	24,377,764
Year 7	211,214	155,928	24,014,105	24,381,247
Year 8	222,606	155,928	23,536,356	23,914,890
Year 9	222,736	155,928	23,536,367	23,915,030
Year 10	229,150	155,928	23,536,877	23,921,955
Year 11	228,708	155,928	23,536,842	23,921,478
Year 12	239,443	155,928	23,537,665	23,933,037
Year 13	240,748	155,928	23,537,750	23,934,426
Year 14	241,217	155,928	23,537,791	23,934,936
Year 15	242,413	155,928	23,537,807	23,936,147
Year 16	242,723	155,928	23,537,825	23,936,476
Year 17	241,779	155,928	23,537,780	23,935,487
Year 18	244,720	155,928	23,537,748	23,938,396
Year 19	243,017	155,928	23,537,617	23,936,562
Year 20	242,399	155,928	23,537,556	23,935,882
Year 21	242,192	155,928	23,537,528	23,935,648

Table 32: Cobbora Coal Project – Calculated Annual GHG Emissions – Scenario B

Mine Year	Annual GHG Emissions (t CO_2-e/yr) by Scope			Total Annual GHG Emissions (t CO_2-e/yr)
	Scope 1	Scope 2	Scope 3	
Year 1	39,065	77,964	744,886	861,915
Year 2	116,610	155,928	13,911,212	14,183,750
Year 3	171,794	155,928	17,852,844	18,180,566
Year 4	190,292	155,928	22,063,582	22,409,802
Year 5	197,343	155,928	23,767,821	24,121,092
Year 6	207,921	155,928	23,768,613	24,132,461
Year 7	211,214	155,928	23,768,801	24,135,943
Year 8	222,606	155,928	23,367,710	23,746,244
Year 9	222,736	155,928	23,367,721	23,746,384
Year 10	229,150	155,928	23,368,231	23,753,309
Year 11	228,708	155,928	23,368,196	23,752,832
Year 12	239,443	155,928	23,369,019	23,764,391
Year 13	240,748	155,928	23,369,104	23,765,780
Year 14	241,217	155,928	23,369,145	23,766,290
Year 15	242,413	155,928	23,369,161	23,767,501
Year 16	242,723	155,928	23,369,179	23,767,830
Year 17	241,779	155,928	23,369,134	23,766,841
Year 18	244,720	155,928	23,369,102	23,769,750
Year 19	243,017	155,928	23,368,971	23,767,916
Year 20	242,399	155,928	23,368,910	23,767,236
Year 21	242,192	155,928	23,368,882	23,767,002

The total Scope 1, 2 and 3 for all sources of the Project for each mine year are presented within **Figure 25** and **Figure 26** for Scenario A and B respectively. The significance of each emissions source type to annual emissions, average across all years of the Project, is illustrated within **Figure 27** and **Figure 28** for Scenario A and B respectively.

From the estimated GHG emissions, the following can be observed:

- As shown in the results of the GHG emission calculations and as illustrated within **Figure 25** and **Figure 26**, the major contributor towards the Project-related GHG emissions are Scope 3 emissions, followed by Scope 1 and Scope 2 emissions. It is reiterated that Scope 3 emissions are those generated beyond the operational control of CHC and are not directly attributable to the operation of the Project.
- It is observed that Scope 3 emissions contribute between 86% (Year 1) and 99% (peaking from Year 5 to Year 21) of the GHG emissions generated by the Project for both Scenario A and B.
- Based on analysis of the Scope 3 emissions by source type, transportation to and combustion of product coal by domestic and international customers contributes between approximately 96% (Year 1) and 99% (all other years) of the Scope 3 emissions for the Project, both for Scenario A and B.
- Of calculated Scope 1 emissions, the combustion of diesel fuel represents the most significant source, contributing between 80% and 93% to total annual Scope 1 emissions across the mine years.
- Scope 2 emissions associated with the consumption of purchased electricity contribute between 1% and 9% (Year 1) to annual GHG emissions.

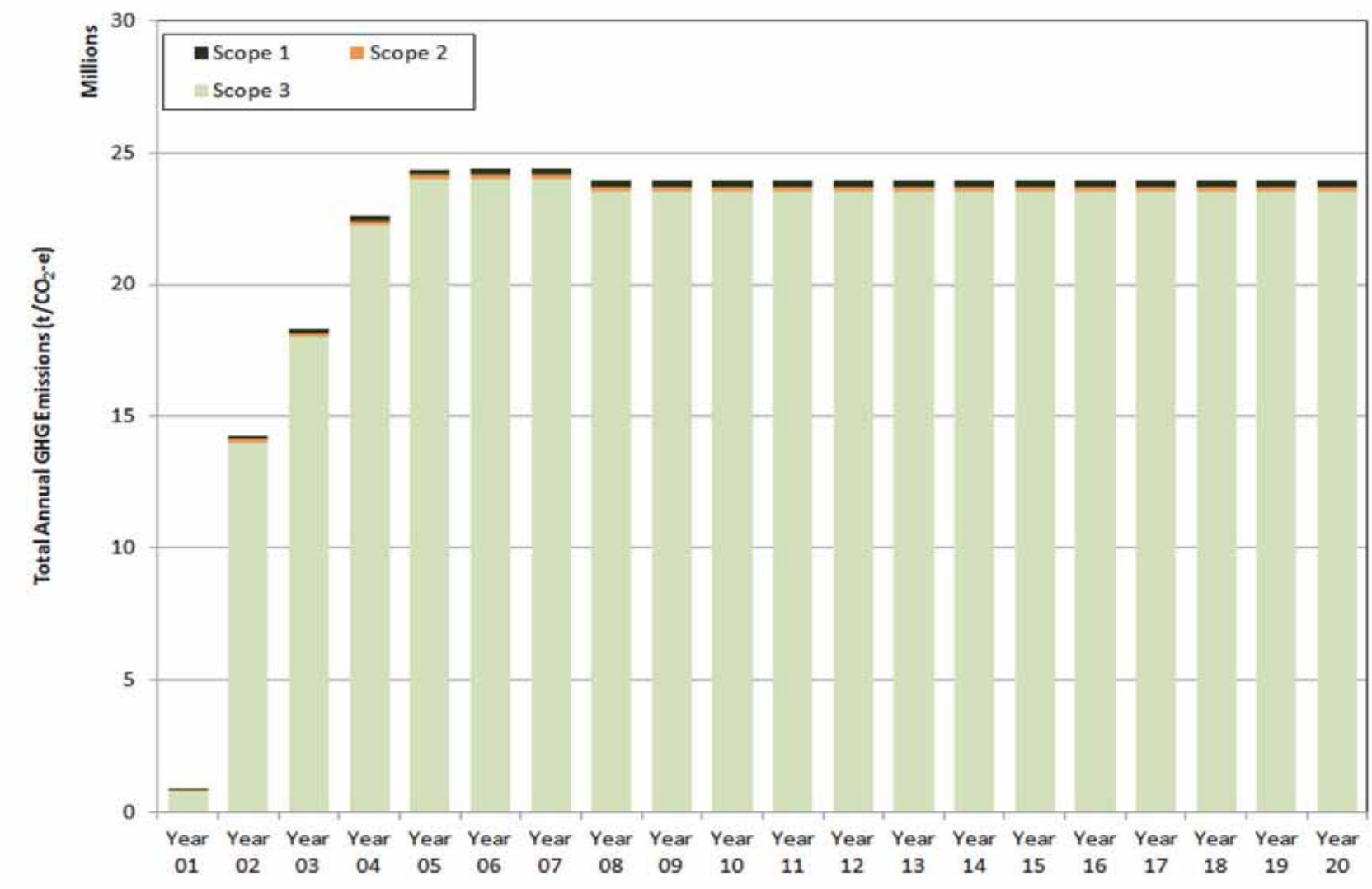

Figure 25: Total Annual Scope 1, 2 and 3 GHG Emissions by Mine Year – Scenario A

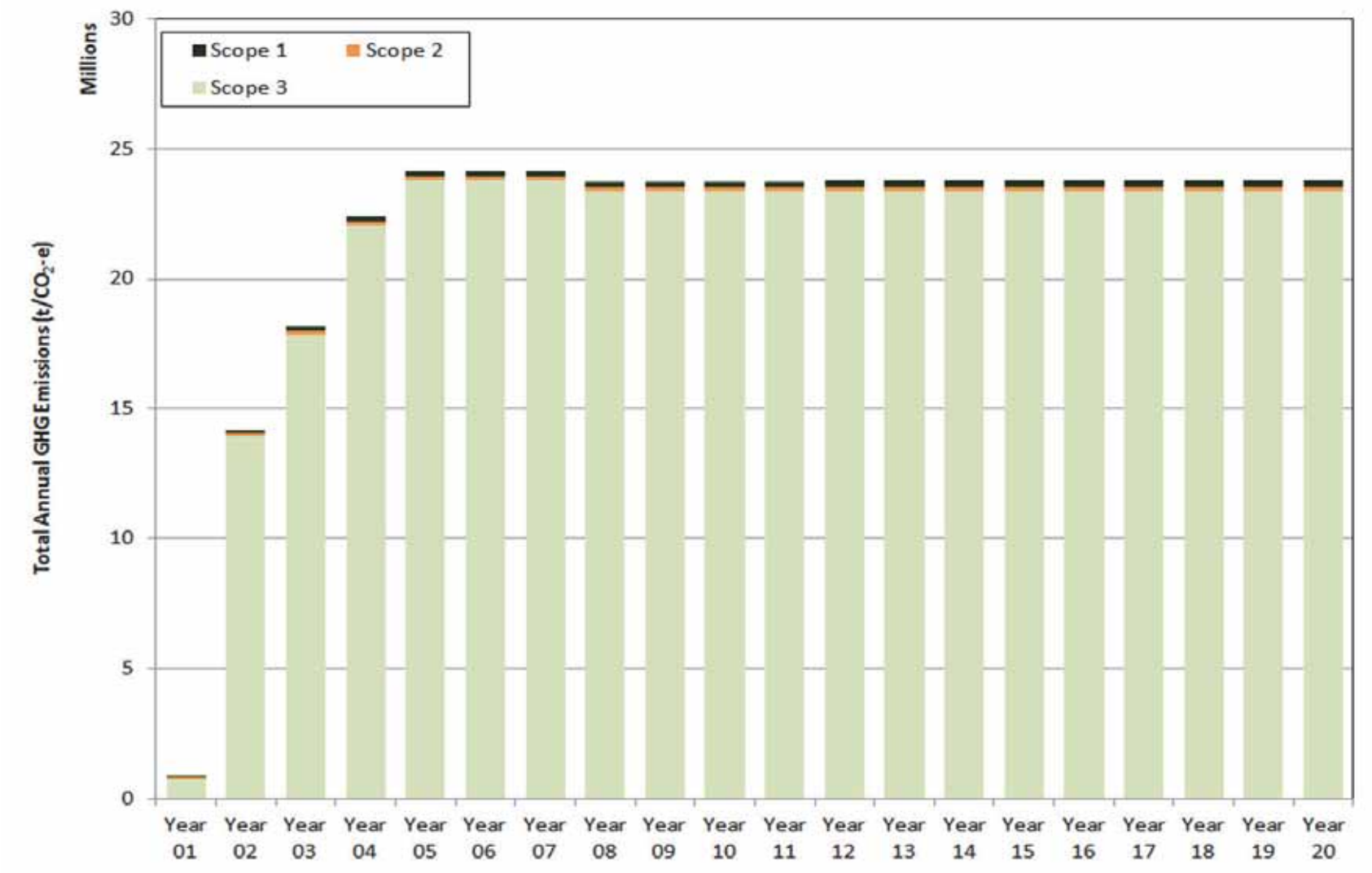

Figure 26: Total Annual Scope 1, 2 and 3 GHG Emissions by Mine Year – Scenario B

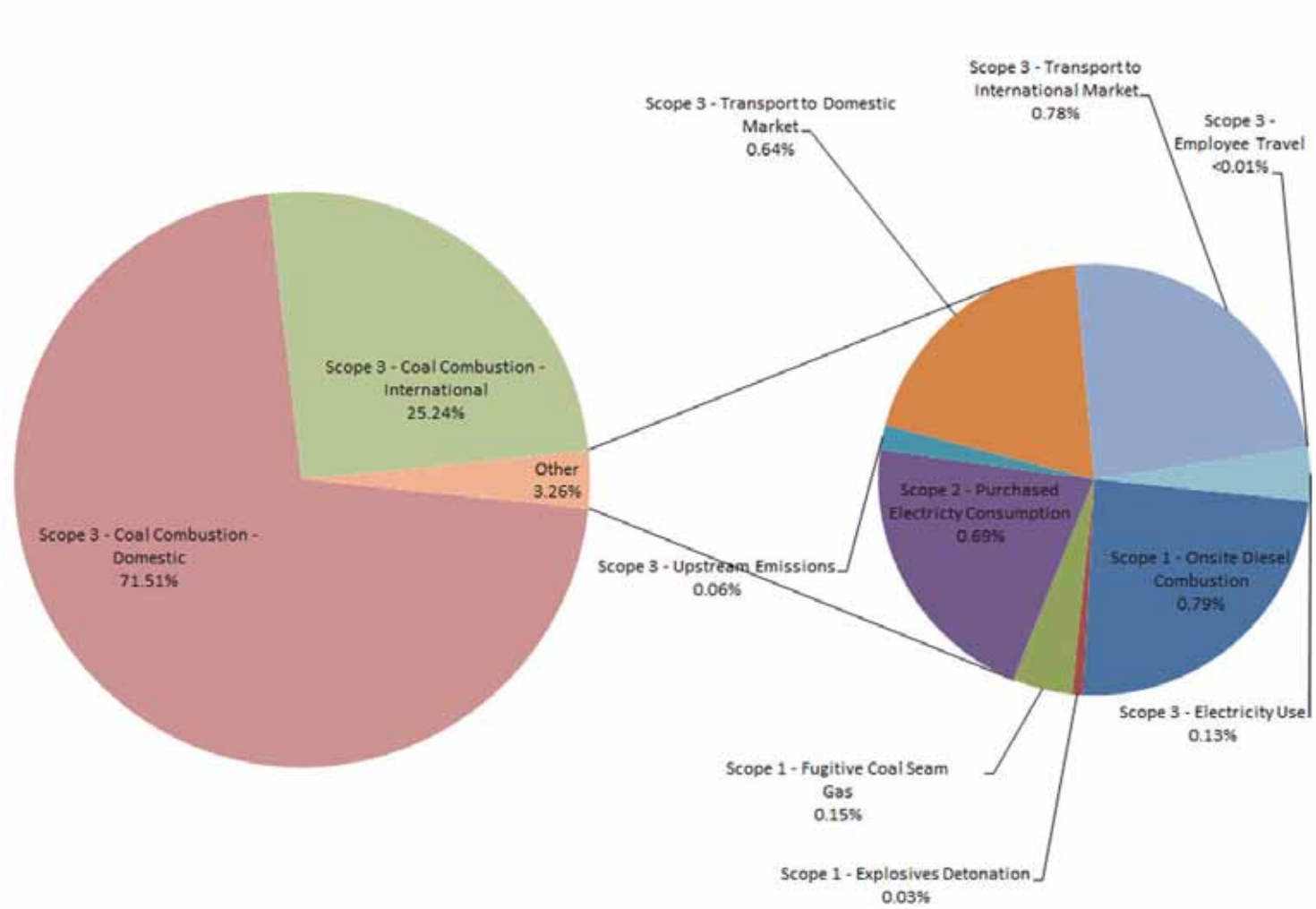

Figure 27: Speciated Annual Scope 1, 2 and 3 GHG Emissions – Average Across Project Life – Scenario A

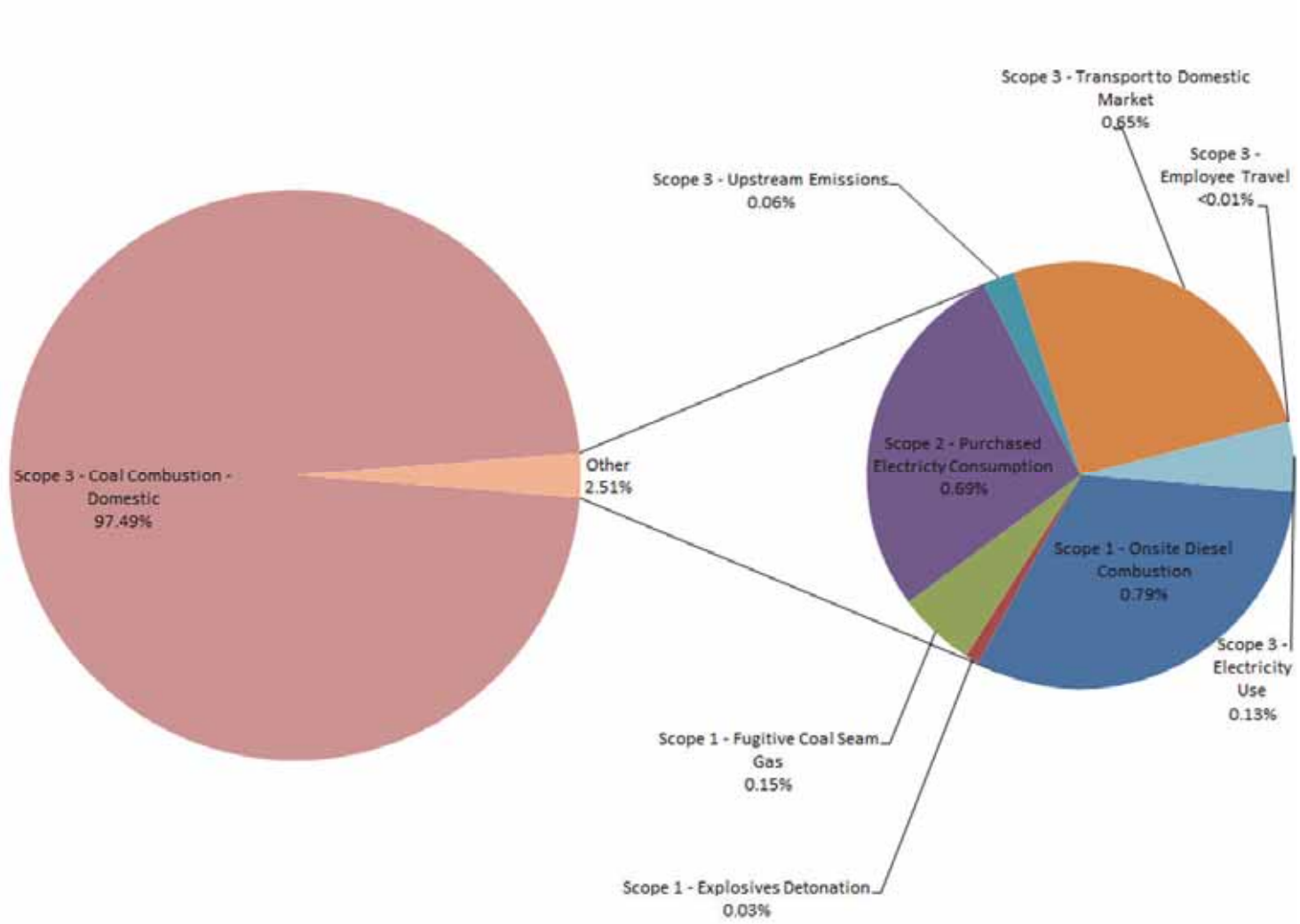

Figure 28: Speciated Annual Scope 1, 2 and 3 GHG Emissions – Average Across Project Life – Scenario B

10.7.2 Impacts of GHG Emissions on the Environment

The extent of the warming produced by a given rise in GHG concentrations depends on 'feedback' processes in the climate system, which can either amplify or dampen a change (CSIRO, 2011, p.15). According to the CSIRO (2011) the net effect of all climate feedbacks, given global GHG emissions, is to amplify the warming caused by increasing CO_2 and other GHGs of human origin. The best estimate of annual average warming by 2030 (above 1990 temperatures) is given as being around 1.0ºC across Australia, with warming of 0.7°C to 0.9ºC in coastal areas and 1°C to 1.2ºC inland (CSIRO, 2011, p. 35). In regard to rainfall, the CSIRO notes that drying is likely in southern areas of Australia, especially in winter, and in southern and eastern areas in spring. This is due to a contraction in the rainfall belt towards the higher latitudes of the southern hemisphere. More extreme rainfall events are predicted for most locations, with the drying and increased evaporation resulting in a decline in soil moisture over parts of Australia. An increase in fire-weather risk is given as being likely with warmer and drier conditions (CSIRO, 2011).

Potential environmental effects in Australia associated with climate change due to global GHG emissions, are documented to include loss of biodiversity, water security issues in parts of Australia, increased drought and fire incidents, and risks of sea level rise and coastal flooding (IPCC, 2007).

Given the complexity of climate feedback processes, the non-linear relationship between GHG emissions and climate changes, and uncertainties in climate change projections, the specific impact of GHG emissions from the Project on the climate system, and as a consequence the broader environment, cannot be quantified with any certainty. The relative significance of GHG emissions from the Project may however be qualitatively evaluated by considering the magnitude of such emissions compared to total GHG emissions released within NSW, nationally and globally.

The most recently published annual GHG emissions for NSW and Australia have been resourced from the Australia National Greenhouse Accounts – State and Territory Greenhouse Gas Inventories 2009 (DCCEE, 2011b). According to this inventory, annual GHG emissions for NSW and Australia in 2009 totalled 160.5 Mt and 564.5 Mt CO_2-e/yr respectively. Global annual GHG emissions for 2004 totalled 49,000 Mt according to the Climate Change 2007: Synthesis Report, compiled by the Intergovernmental Panel on Climate Change (IPCC, 2007). At the time of undertaking this assessment, this estimate comprised the latest global GHG emissions data available.

The significance of Project-related GHG emissions in comparison to NSW, Australian and global annual GHG emissions is presented within **Table 33** for Scenario A and **Table 34** for Scenario B. Emissions have been compared in terms of GHG emissions directly generated by the operation of the Project (Scope 1) and beyond the operational boundary of the Project (Scope 2 and 3). Further, in comparing Project GHG emissions with NSW and Australian annual totals, only emissions generated in Australia have been incorporated into calculations. Downstream emissions generated from off-shore product transport and the combustion of product coal by international end customers (Scenario A only) have been included in the comparison with global emissions only.

It can be seen from the results within **Table 33** and **Table 34** that direct emissions (Scope 1) generated by the Project represent between 0.024% and 0.152% of annual NSW emissions,

0.007% to 0.045% of Australian emissions and between 0.0001% and 0.0005% of global emissions for Scenario A and B.

10.8 Greenhouse Gas Mitigation Measures

The following provides a discussion of the potential mitigation measures and strategies that could be implemented by CHC to reduce both direct and indirect GHG emissions from the Project.

10.8.1 Direct Emissions (Scope 1)

As discussed previously, the most significant contributor to direct emissions from the Project is the consumption of diesel fuel by mobile plant and equipment. Fugitive coal seam emissions and blasting emissions represent less significant sources. The following recommendations are made for direct emission reductions:

- Use mining equipment which is regularly maintained and serviced to maximise efficiency;
- Use lower emission fuels (biodiesel, natural gas) where practical;
- Reduce fuel consumption by minimising the vehicle kilometres travelled on site;
- Plan operations well in advance in order to minimise resource non-utilisation and wastage; and
- Investigate practical and feasible reduction in the amount of explosives used for blasting.

10.8.2 Indirect Emissions (Scope 2 and 3)

As highlighted, indirect emissions (Scope 2 and 3) contribute, on average, approximately 99% of annual Project GHG emissions. Of the indirect emissions, the major contributions are from downstream product transport and combustion of product by end-customers, which constitute approximately 99% of indirect emissions for the Project. The remaining contributors are: electricity consumption (Scope 2 and 3), product upstream emissions and personnel commutation.

In order to minimise the indirect emissions, the following recommendations are made:

- Adopt the use of energy efficient lighting technologies and hot water and air conditioning systems wherever practical;
- Use of alternative energy sources where practical such as solar power and green power;
- Progressively review and implement energy efficiency measures throughout the life of the Project;
- Conduct periodic audits and reviews on the amounts of materials used, amount of mine waste and non-mine waste generated and disposed; and
- Source materials locally where feasible to minimise emissions generated from upstream activities.

Table 33: Comparison of Annual Project GHG Emissions with NSW and Australian (2009) and Global (2004) GHG Emissions – Scenario A

Mine Year	Significance of Direct Project Emissions (Scope 1)			Significance of Indirect Project Emissions (Scope 2 and 3)		
	vs NSW	vs Australia	vs Global	vs NSW	vs Australia	vs Global
Year 1	0.024%	0.0071%	0.0001%	0.1%	0.02%	0.002%
Year 2	0.073%	0.0213%	0.0002%	6.5%	1.92%	0.029%
Year 3	0.107%	0.0314%	0.0004%	8.1%	2.37%	0.037%
Year 4	0.118%	0.0348%	0.0004%	9.9%	2.90%	0.046%
Year 5	0.123%	0.0361%	0.0004%	9.9%	2.91%	0.049%
Year 6	0.129%	0.0380%	0.0004%	9.9%	2.91%	0.049%
Year 7	0.132%	0.0386%	0.0004%	9.9%	2.91%	0.049%
Year 8	0.139%	0.0407%	0.0005%	11.2%	3.29%	0.048%
Year 9	0.139%	0.0408%	0.0005%	11.2%	3.29%	0.048%
Year 10	0.143%	0.0419%	0.0005%	11.2%	3.29%	0.048%
Year 11	0.142%	0.0418%	0.0005%	11.2%	3.29%	0.048%
Year 12	0.149%	0.0438%	0.0005%	11.2%	3.29%	0.048%
Year 13	0.150%	0.0441%	0.0005%	11.2%	3.29%	0.048%
Year 14	0.150%	0.0441%	0.0005%	11.2%	3.29%	0.048%
Year 15	0.151%	0.0444%	0.0005%	11.2%	3.29%	0.048%
Year 16	0.151%	0.0444%	0.0005%	11.2%	3.29%	0.048%
Year 17	0.151%	0.0442%	0.0005%	11.2%	3.29%	0.048%
Year 18	0.152%	0.0448%	0.0005%	11.2%	3.29%	0.048%
Year 19	0.151%	0.0445%	0.0005%	11.2%	3.29%	0.048%
Year 20	0.151%	0.0444%	0.0005%	11.2%	3.29%	0.048%
Year 21	0.151%	0.0443%	0.0005%	11.2%	3.29%	0.048%

Note: Only emissions generated in Australia are compared against NSW and Australian emission totals

Table 34: Comparison of Annual Project GHG Emissions with NSW and Australian (2009) and Global (2004) GHG Emissions – Scenario B

Mine Year	Significance of Direct Project Emissions (Scope 1)			Significance of Indirect Project Emissions (Scope 2 and 3)		
	vs NSW	vs Australia	vs Global	vs NSW	vs Australia	vs Global
Year 1	0.024%	0.0071%	0.0001%	0.5%	0.15%	0.002%
Year 2	0.073%	0.0213%	0.0002%	8.8%	2.57%	0.029%
Year 3	0.107%	0.0314%	0.0004%	11.2%	3.30%	0.037%
Year 4	0.118%	0.0348%	0.0004%	13.8%	4.07%	0.046%
Year 5	0.123%	0.0361%	0.0004%	14.9%	4.38%	0.049%
Year 6	0.129%	0.0380%	0.0004%	14.9%	4.38%	0.049%
Year 7	0.132%	0.0386%	0.0004%	14.9%	4.38%	0.049%
Year 8	0.139%	0.0407%	0.0005%	14.6%	4.30%	0.048%
Year 9	0.139%	0.0408%	0.0005%	14.6%	4.30%	0.048%
Year 10	0.143%	0.0419%	0.0005%	14.6%	4.30%	0.048%
Year 11	0.142%	0.0418%	0.0005%	14.6%	4.30%	0.048%
Year 12	0.149%	0.0438%	0.0005%	14.6%	4.30%	0.048%
Year 13	0.150%	0.0441%	0.0005%	14.6%	4.30%	0.048%
Year 14	0.150%	0.0441%	0.0005%	14.6%	4.30%	0.048%
Year 15	0.151%	0.0444%	0.0005%	14.6%	4.30%	0.048%
Year 16	0.151%	0.0444%	0.0005%	14.6%	4.30%	0.048%
Year 17	0.151%	0.0442%	0.0005%	14.6%	4.30%	0.048%
Year 18	0.152%	0.0448%	0.0005%	14.6%	4.30%	0.048%
Year 19	0.151%	0.0445%	0.0005%	14.6%	4.30%	0.048%
Year 20	0.151%	0.0444%	0.0005%	14.6%	4.30%	0.048%
Year 21	0.151%	0.0443%	0.0005%	14.6%	4.30%	0.048%

Note: Only emissions generated in Australia are compared against NSW and Australian emission totals

11 Conclusions

11.1 Air Quality Assessment

An air quality assessment was undertaken for the Project. The assessment was undertaken in accordance with the DGRs issued for the Project. Emissions of TSP, PM_{10}, $PM_{2.5}$ and assorted gaseous pollutants were quantified for proposed Year 1, Year 2, Year 4, Year 8, Year 12, Year 16 and Year 20 operational mine plans in order to assess the spatial variation of potential impacts on the surrounding environment from the operation of the Project.

The air quality assessment, undertaken in accordance with the Approved Methods for Modelling, provides a conservative (upper bound) estimate of the potential for air quality impacts occurring due to the Project. Emission reductions due to the best practice management measures to be implemented by the Project were accounted for where the control effectiveness of measures could be quantified. Real-time operational dust management, informed by the proposed reactive/predictive air quality control system, could however not be accounted for in the model predictions. Reduced risks due to the implementation of this measure were therefore not accounted for in the model predictions.

Despite the conservative approach adopted, it was predicted that air pollutants will remain below the applicable air quality criteria and standards at all but a small number of privately-owned residences. Incremental air pollutant concentrations and dust deposition rates associated with all mining years were predicted to be within OEH criteria. However, taking background concentrations into account, resultant cumulative concentrations were predicted to result in infrequent 24-hour PM_{10} criterion exceedances at nearby private residences on days when background concentrations are elevated. Given the easterly airflow which prevails in the region, the potential exceedances were predicted to occur primarily at private residences located immediately west of mining areas.

Across all assessed mine years combined, exceedances were predicted as follows:

- 24-hour Average PM_{10} – at receptors 1222, 1223, 1230, 1232, 3224 and 5025;
- 24-hour Average $PM_{2.5}$ – at receptors 1222, 1223 and 3224; and
- Annual Average $PM_{2.5}$ – at receptors 1222, 1223 and 3224;

Predicted exceedances of the 24-hour average PM_{10} criterion were generally restricted to one or two occurrences in most cases.

A conservative (upper bound) estimate of background $PM_{2.5}$ concentrations was derived from the site-specific PM_{10} dataset for use in the assessment. The derived annual average $PM_{2.5}$ concentrations of 4.7µg/m^3, comprises over 50% of the annual average $PM_{2.5}$ Advisory Reporting Standard of 8µg/m^3, and is considered a potential over-estimate of background concentrations.

It is noted that at the time of reporting, CHC was in the process of negotiating the acquisition of these properties with the relevant owners. It is understood that the owner of residence 3224 is seeking to stay and enter an amenity arrangement with CHC.

During mining operations, measures will be put in place to protect residents renting CHC properties from health impacts. Houses will not be leased if health-based criteria are likely to be exceeded.

In order to address the potential for exceedances in the surrounding environment, real time dust and meteorological monitoring will be undertaken. This will allow proactive management of potential dust impacts during unusual wind or weather events.

Gaseous emissions associated with fuel combustion by mobile plant and rail locomotives, and routine blasting operations were quantified and assessed. Constituents assessed were sulphur dioxide (SO_2), nitrogen dioxide (NO_2), carbon monoxide (CO and volatile organic compounds (VOCs); benzene, toluene, and toluene. Combustion emissions were predicted to be in compliance with all applicable criteria across all assessed years.

Risks posed by abnormal emissions related to post-blast fume and spontaneous combustion were addressed and management and monitoring measures recommended to reduce the risks of such events throughout the life of mine.

The proposed construction stage activities will have a lower emissions intensity and spatial footprint than the operational mining stage of the Project. It is considered that emissions from these activities are unlikely to adversely impact upon the surrounding environment as long as sufficient emission reduction measures are applied.

Generally, the predictions presented in this report incorporate a level of conservatism due to worst case assumptions and the inherent conservative nature of dispersion modelling. As a result, it is expected that actual ground level concentrations would be lower during the normal operation of the Project. Notwithstanding, it is proposed that the emissions would be managed day-to-day using a best practice real-time dust management system.

Risk reductions due to the implementation of a reactive/predictive air quality control system were not accounted for in the quantitative assessment. Given that OEH criteria exceedances are predicted to occur infrequently at private residences, and that such exceedances tend to coincide with elevated background concentrations, the reactive/predictive system will address the risks identified.

It is considered that through the implementation of proposed particulate matter emission control techniques, including the real-time monitoring network and reactive/predictive air quality control system, and the acquisition of nearby private land and dwellings, the air quality-related impact of the Project on the surrounding environment will be minimised.

11.2 Greenhouse Gas Assessment

To evaluate the Project's GHG emissions and determine the Project's contribution to NSW and Australian annual GHG emissions, emissions were estimated based on information provided by the client and relevant GHG emission factors.

The assessment's key findings were as follows:

- Annual Project GHG emissions (from direct and indirect sources) were estimated to be between 0.9 Mt and 24 Mt of CO_2–e/yr;

- Indirect emissions (Scope 2 and 3) are the major contributor towards the Project's GHG emissions;
- Of the indirect emissions, downstream product transport and combustion of product by end-customers constitutes approximately 99% of the emissions; and
- Direct emissions generated by the Project represent between 0.024% and 0.152% of annual NSW emissions, 0.007% to 0.045% of Australian emissions and between 0.0001% and 0.0005% of global emissions.

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Appendix A
Annual, Seasonal and Diurnal Wind Roses - Cobbora MET01 Monitoring Station – and Inter-annual Regional Wind Analysis

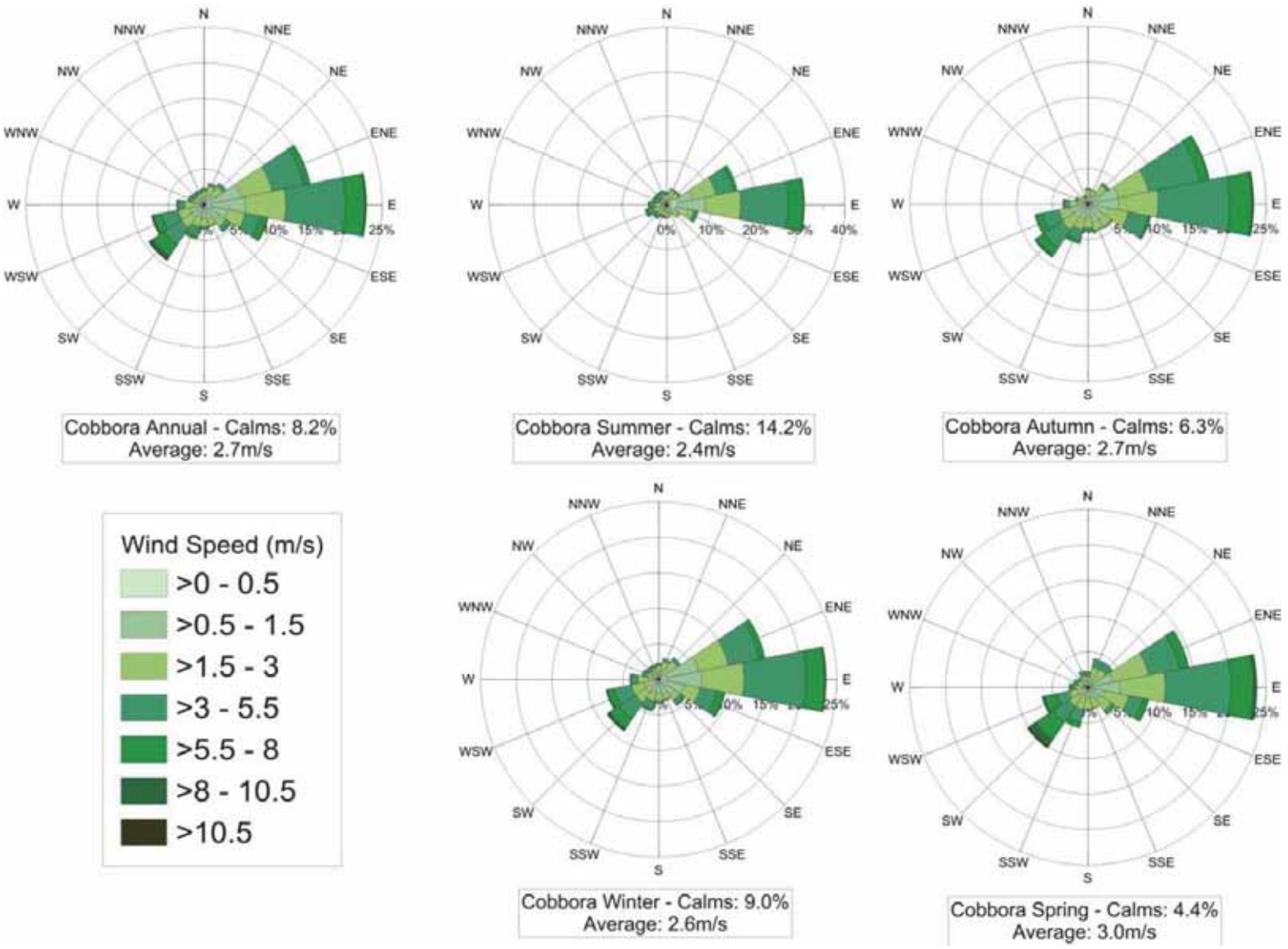

Figure A1 – Seasonal Wind Roses – Cobbora MET01 – November 2010 to November 2011

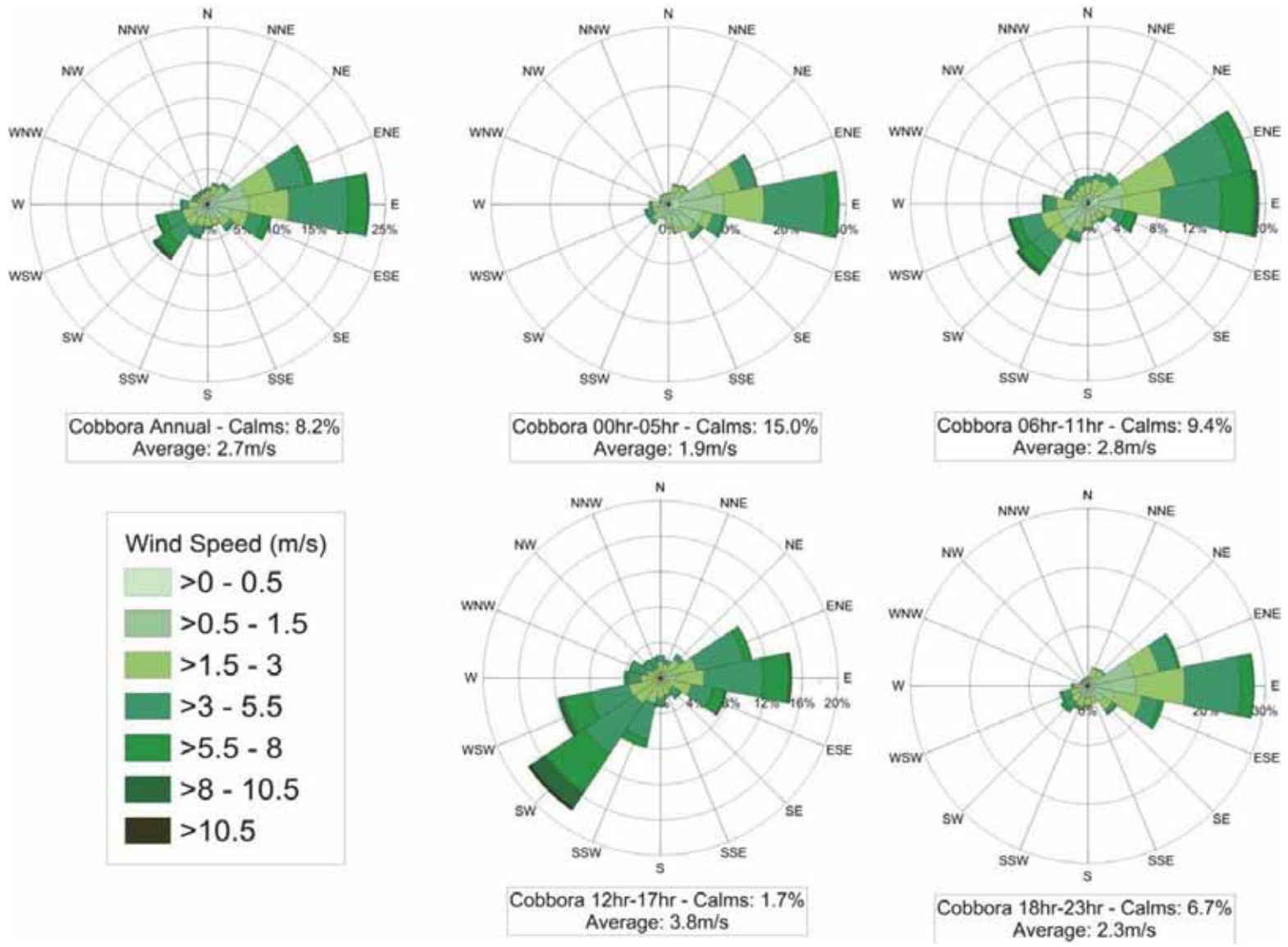

Figure A2 – Diurnal Wind Roses – Cobbora MET01 – November 2010 to November 2011

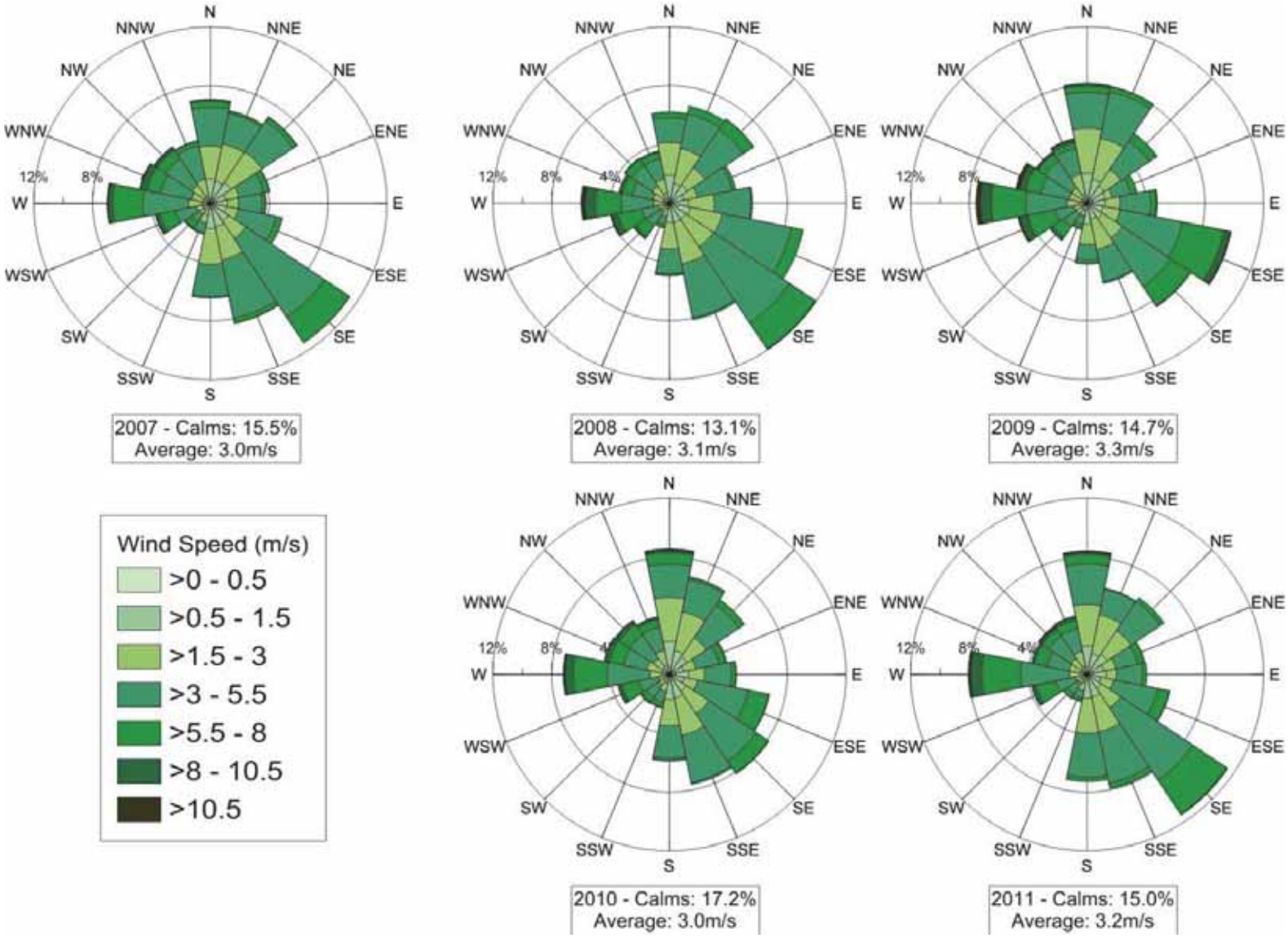

Figure A3 – Annual Wind Roses – BoM Mudgee Airport – 2007 to 2011

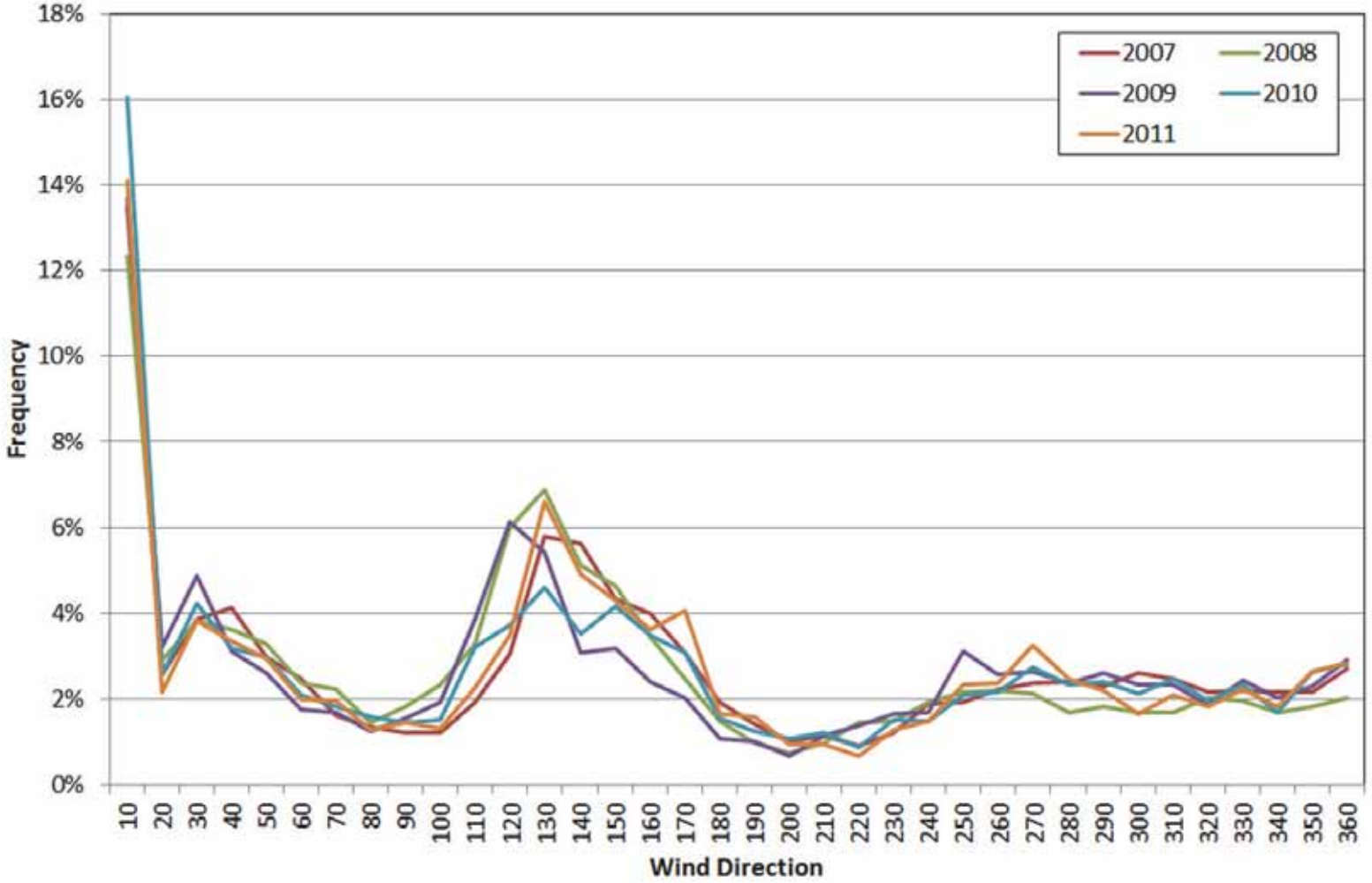

Figure A4 – Wind Direction Comparison – BoM Mudgee Airport – 2007 to 2011

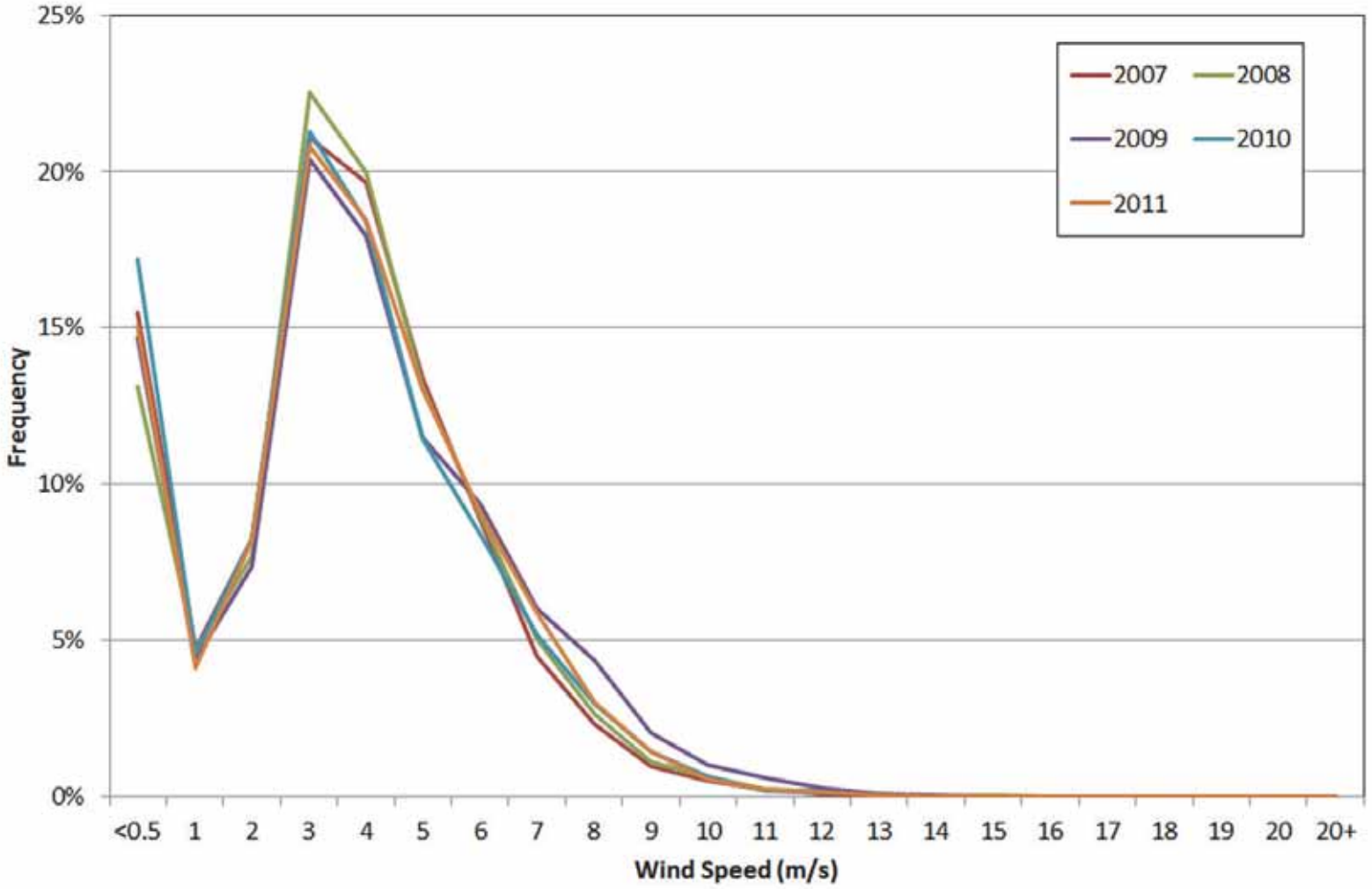

Figure A5 – Wind Speed Comparison – BoM Mudgee Airport – 2007 to 2011

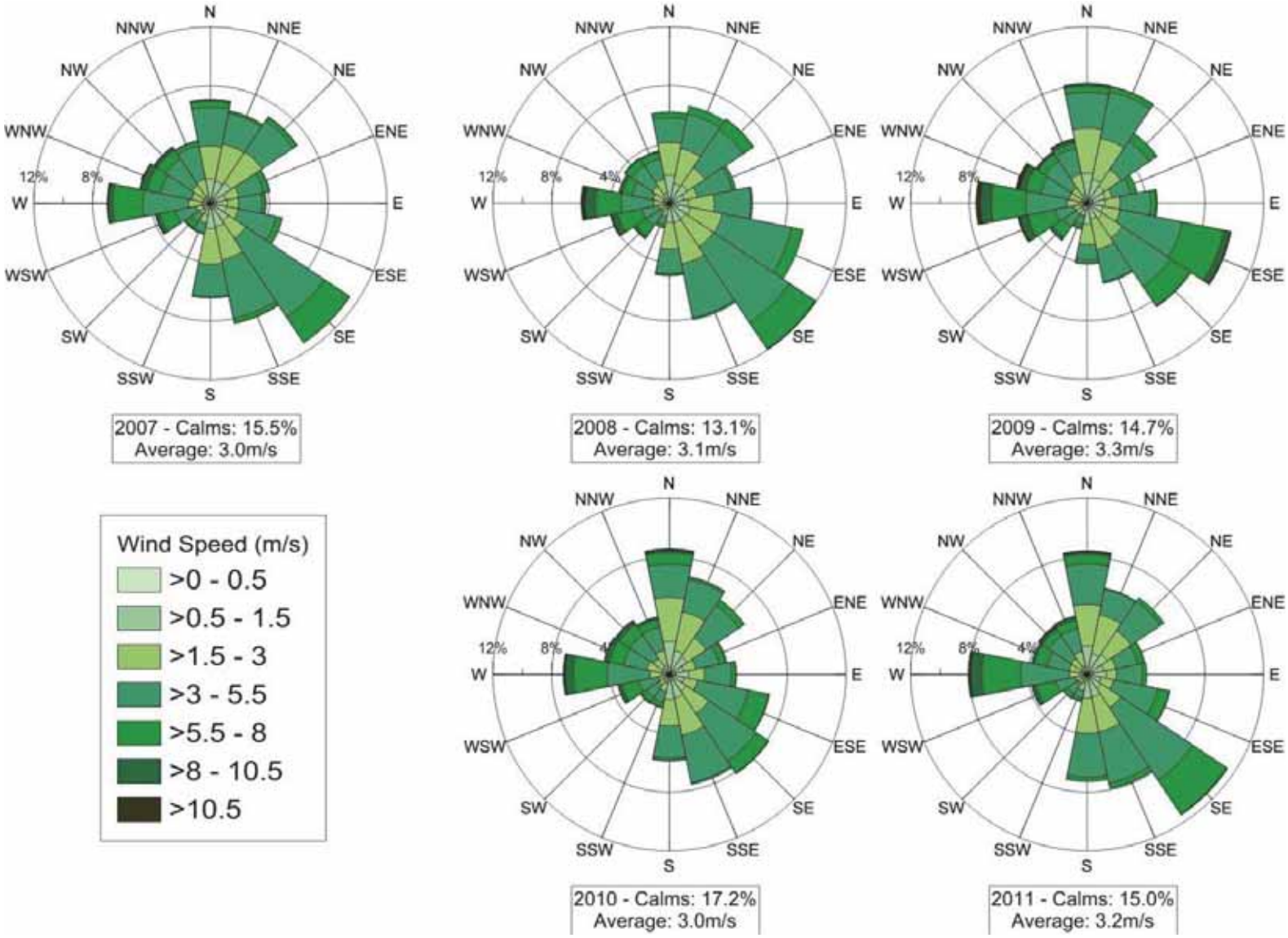

Figure A6 – Annual Wind Roses – BoM Dubbo Airport – 2007 to 2011

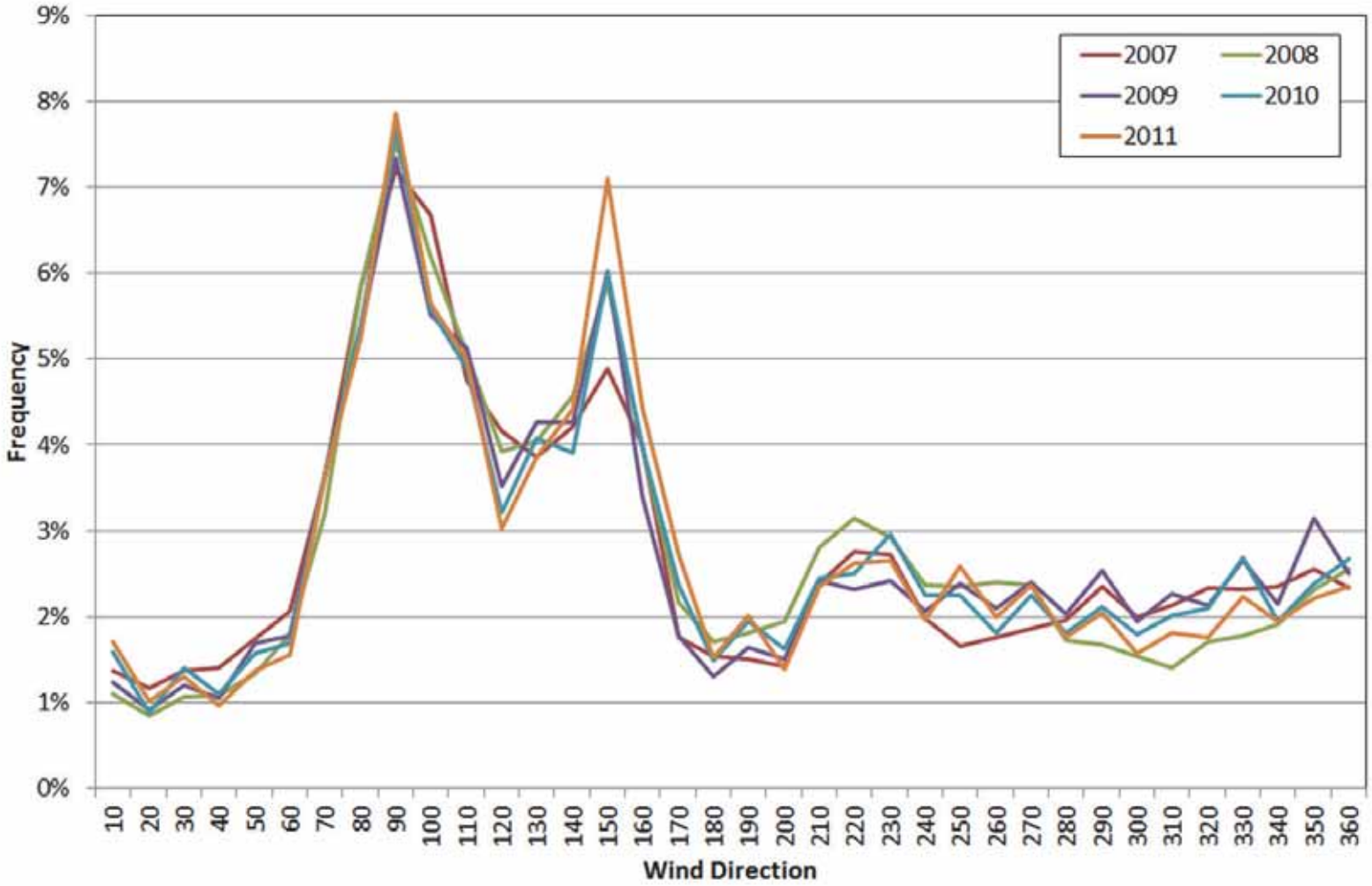

Figure A7 – Wind Direction Comparison – BoM Dubbo Airport – 2007 to 2011

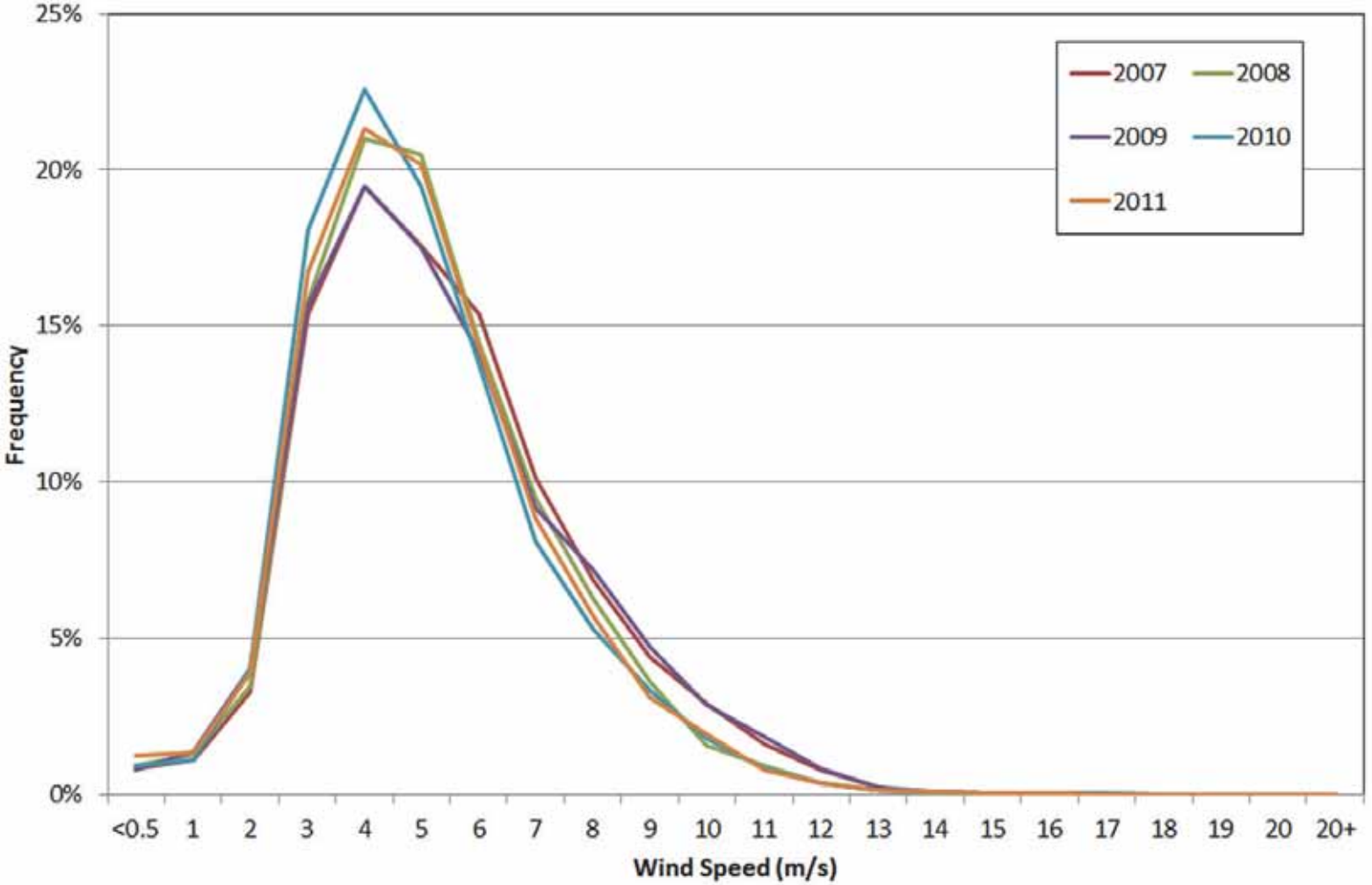

Figure A8 – Wind Speed Comparison – BoM Dubbo Airport – 2007 to 2011

Appendix B
Dispersion Modelling Methodology and Data Input

Dispersion Model Selection and Application

Dispersion models compute ambient concentrations and deposition rates as a function of source configurations, emission strengths and meteorological characteristics. They provide a useful tool to ascertain the spatial and temporal patterns in the ground level concentrations. Knowledge of spatial and temporal variations in pollutant concentrations is essential for the assessment of the potential for non-compliance with ambient air quality criteria and assessment of potential impacts on human health and the biophysical environment.

Given the nature of the sources and the local environment, AERMOD was used to predict ambient particulate and combustion-related concentrations and dust deposition rates resulting from the operation of the Project. AERMOD is the USEPA's recommended steady-state plume dispersion model for US regulatory purposes. AERMOD is designed to handle a variety of pollutant source types, including surface and buoyant elevated sources, in a wide variety of settings such as rural and urban as well as flat and complex terrain[(1)]. AERMOD is able to predict pollutant concentrations from point, area and volume sources in addition to 'open pit' sources.

AERMOD replaced the Industrial Source Complex (ISC) model for regulatory purposes in the US in December 2006 as it provides more realistic results with concentrations that are generally lower and more representatives of actual concentrations compared to the conservative ISC model. Ausplume, a steady state Gaussian plume dispersion model developed by the Victorian EPA and frequently used in Australia for simple near-field applications, is largely based on the ISC model.

Compared to ISC and Ausplume, AERMOD represents an advanced new-generation model which requires additional meteorological and land use inputs to provide more refined predictions. The most important feature of AERMOD, compared to ISC and Ausplume, is its modification of the basic dispersion model to account more effectively for a variety of meteorological factors and surface characteristics. In particular it uses the Monin-Obukhov length scale rather than Pasquill-Gifford stability categories to account for the effects of atmospheric stratification. Whereas Ausplume and ISC parameterise dispersion based on semi-empirical fits to field observations and meteorological extrapolations, AERMOD uses surface-layer and boundary-layer theory for improved characterisation of the planetary boundary layer turbulence structure.

Verification studies have been undertaken for AERMOD both locally and abroad (Hanna *et al.,* 2001*;* Perry *et al*., 2005; Hurley 2006). Hanna *et al.* (2001) concluded that AERMOD performed better than ISC with predictions generally within a factor of two of actual values. It was noted that AERMOD did tend to under-predict actual concentrations by 20% to 40%, with predictions more accurate for short-term averaging periods. Perry *et al.* (2005) summarises the performance of AERMOD across 17 field study databases placing emphasis on statistics that demonstrate the model's abilities to reproduce the upper end of the concentration distribution which are of importance in terms of regulatory modelling. The field

1 Under complex wind conditions and for regional applications, CALPUFF is the USEPA's recommended model for regulatory purposes.

studies include flat and complex terrain cases, urban and rural conditions and elevated and surface releases with and without building wake effects. Perry et al. (2005) concludes that, with few exceptions AERMOD's performance was superior to that of the other applied models tested.

Hurley (2006) compared the performance of Ausplume, AERMOD and TAPM across several case studies including flat terrain, flat terrain with building downwash, in complex terrain and coastal terrain. AERMOD was determined to perform acceptably for all of the datasets but was found unable to simulate shoreline fumigation in the case of the Kwinana case study. This potential limitation of AERMOD is not relevant to this Project due to the inland setting of Cobbora.

AERMET Meteorological Modelling

The AERMOD system is composed of two pre-processors that generate the input files required by the AERMOD dispersion model: AERMET (for the preparation of meteorological data) and AERMAP (for the preparation of terrain data). Terrain data for the modelling domain was sourced from a combination of CHC-generated mine year land form data and NASA's Shuttle Radar Topography Mission (SRTM) data. This data set provided high-resolution topography at 3 arc-second (~90m) grid spacings.

By using the CHC-generated mine area topography data, the actual pit depths were able to be incorporated into the dispersion modelling process. An example of this local terrain is presented within **Figure B1**.

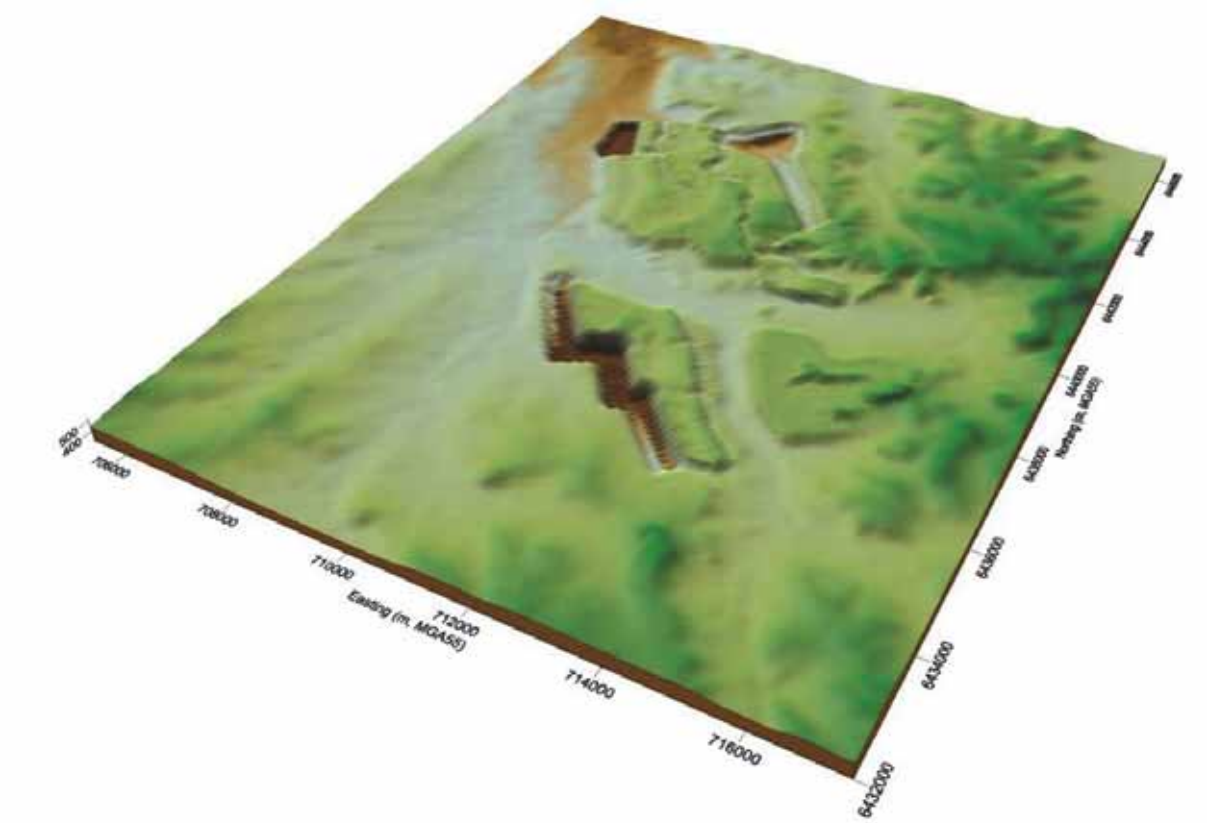

Figure B1 – Three Dimensional Topography for Year 12 – as Input into AERMOD

AERMET produces data characterising the planet boundary layer (PBL) such as friction velocity and mixing height. Inputs in the AERMET modelling are described below.

Surface Characteristics

In applying the AERMET meteorological processor to prepare the meteorological data for the AERMOD model, appropriate values for three surface characteristics need to be determined: surface roughness length, albedo, and Bowen ratio. Surface roughness length is related to the height of obstacles in the path of wind flow and is, in principle, the height at which the mean horizontal wind speed is zero based on a logarithmic profile. The surface roughness length influences the surface shear stress and is an important factor in determining the magnitude of mechanical turbulence and the stability of the boundary layer. The albedo is the fraction of total incident solar radiation reflected by the surface back to space without absorption. The daytime Bowen ratio, an indicator of surface moisture, is the ratio of sensible heat flux to latent heat flux and is used for determining planetary boundary layer parameters for convective conditions driven by the surface sensible heat flux.

Aerial photographs and site observations were used to define the land use and associated effective surface roughness on a sector-by-sector basis within a 1 km radius around the MET01 meteorological station. Values of Bowen ratio and albedo were determined over a greater domain (10 km by 10 km) centered on the MET01 meteorological monitoring station. A mixture of forested land and cultivated land dominated the surrounding area. Reference was made to the AERMET user's guide (EPA, 2004) and to Sturman and Tapper (2006) in

assigning surface roughness, Bowen ratio and albedo values to designated land cover categories.

Meteorological Inputs

Hourly data recorded by the MET01 meteorological monitoring station between November 2010 and November 2011 was input into AERMET, including hourly-varying values of wind speed, direction, temperature (2 m and 10 m height), relative humidity, standard deviation in wind direction and atmospheric pressure. TAPM was used to generate parameters not measured by the MET01 station, yet required by AERMET, specifically mixing height and net radiation flux.

AERMOD Dispersion Modelling

Input data types required for the AERMOD model include: meteorological data (from AERMET), source data (from the compiled emissions inventory), and information on the nature of the receptor grid.

Meteorological Inputs

The AERMET generated meteorological files were used as input in the dispersion simulations.

Source and Emissions

Emissions estimated for the Project, as documented in **Section 6** and **Appendix D**, were simulated using a range of sources. Hourly varying TSP, PM_{10} and $PM_{2.5}$ emission data generated from the emissions inventory were input in the dispersion modelling to facilitate dust deposition rates (in the case of TSP emissions), suspended PM_{10} and $PM_{2.5}$ concentrations and assorted gaseous pollutants concentrations.

Dispersion Modelling Domain

The dispersion of pollutants was modelled for an area covering 24 km by 24 km centred over the mining areas of the Project. Gridded receptor points were specified at intervals of 350m. The model simulates ground-level concentrations for each point in the gridded modelling domain for each hour of meteorological data.

Particulate Size Distribution

Particle dry deposition and depletion were modelled in the AERMOD dispersion modelling conducted. AERMOD requires the input of particle size distribution in order to calculate the settling and deposition velocity values for different particle size categories. Where possible, site specific particle size analysis data was integrated into the particulate matter dispersion modelling undertaken for the Project. Samples of topsoil and coal from drill core samples taken from the site were analysed for particle size distribution, in particular for content less than 75 μm, 30 μm, 10 μm and 2.5 μm. This particle size distribution data for these material types was applied to all relevant emission sources in the AERMOD modelling.

No samples were available for waste material due to the consolidated nature of the material within the core samples. In this instance, and for haul road emission sources, relevant particle size distribution data reported within the SPCC (1986) were adopted.

A particle density of 1g/cm^3 was applied for all particle size fractions and material types. Site specific particle size distribution data was also incorporated into the emission estimation process for the Project wherever possible.

Model Results

Dispersion simulations were undertaken and results analysed for annual average TSP and dust deposition and highest 24-hour and annual average PM_{10} and $PM_{2.5}$ concentrations. Relevant averaging periods for assorted gaseous pollutants were also assessed. Results were presented as contour plots (**Appendix F**), illustrating spatial variations in particulate concentrations and dust deposition, and tabulated results for discrete receptor points (**Appendix E**).

Appendix C
Dispersion Modelling Source Locations

Introduction

As discussed in **Appendix B**, emissions from the Project were represented within AERMOD through a range of volume sources. The following Appendix illustrates the spatial distribution of sources by each of the assessed mine years.

Indicative equipment locations for extractive operations and haul road activities were provided by CHC prior to the commencement of this assessment. These locations were adhered to as closely as possible in the allocation of emission sources within the modelling.

The following figures illustrate the distribution of sources. For each mine year, two figures are presented:

- Mine plan as provided by CHC, illustrating the various land use categories for each year, the location of the CHPP and associated stockpiles and the alignment of the rail spur; and
- A sketch map indicating the location of haul roads between load and dump points for coal, waste rock, topsoil and CHPP rejects.

With regards to the mine plan figures, the distribution of land category (ie active dump, rehabilitated dump, cleared area, etc) represents the location of wind erosion sources. Each land category type was represented in each mine year through a series of volume sources across the indicated area.

The rail spur was represented by a series of volume sources along the extent of the alignment within the modelling domain. This equates to a length of 16km of the total 20km rail spur. The CHPP was represented by a series of volume sources at all key transfer points.

With regards to the sketch maps, a volume source for loading/dozer operations was assumed at one end of each haul road source and a volume source for dumping/dozer operations (as applicable) at the other. The following colour code is applied to all haul road figures:

- Blue line – coal haulage from pit to ROM pad;
- Brown line – Waste Rock Haulage from pit to emplacement areas;
- Red line – Topsoil haulage from point of removal to stockpile/emplacement areas; and
- Green line – CHPP reject haulage from loading point to emplacement areas.

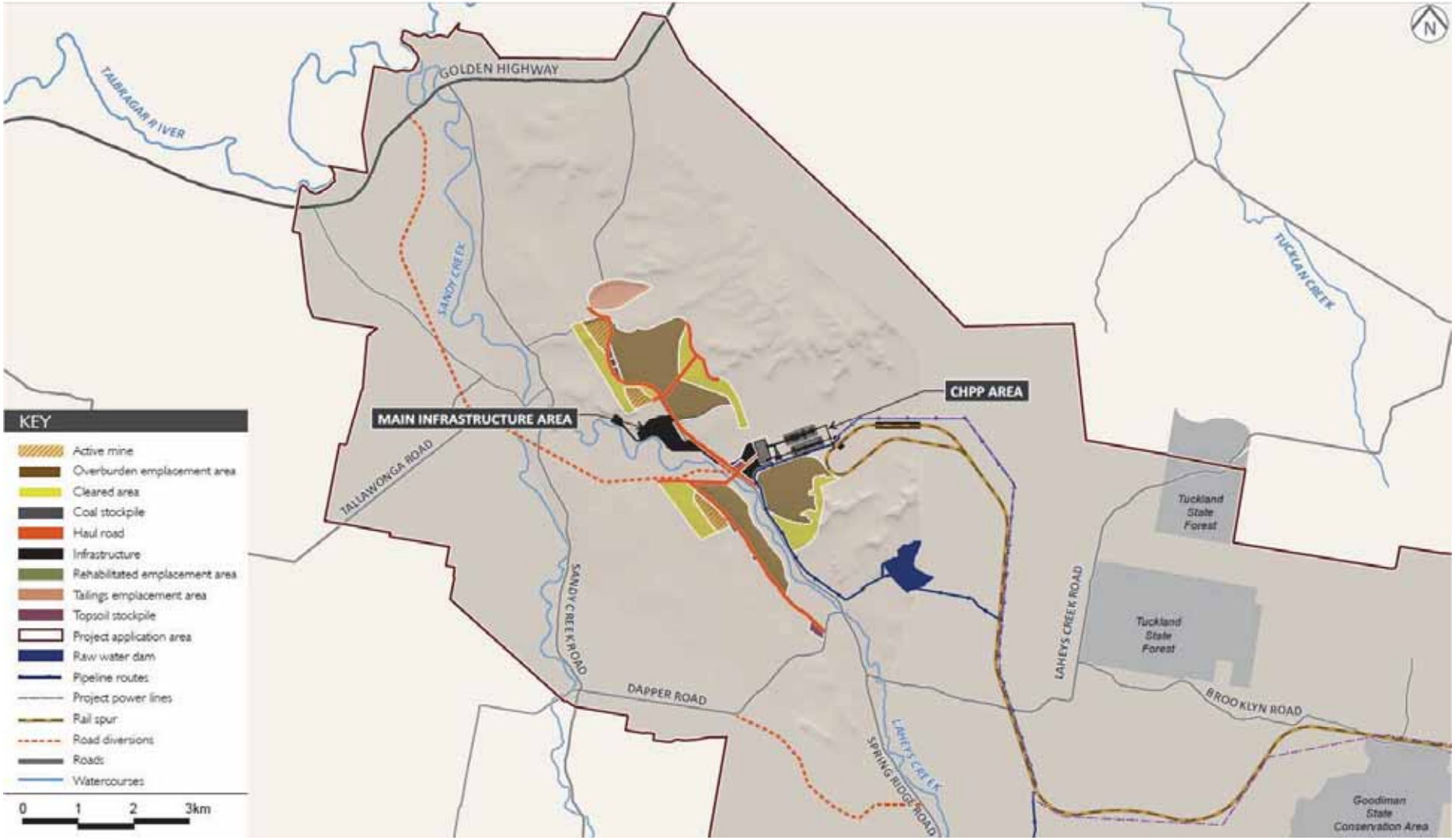

Figure C1 – Year 1 Mine Plan

Figure C2 – Year 1 Haul Road Sources

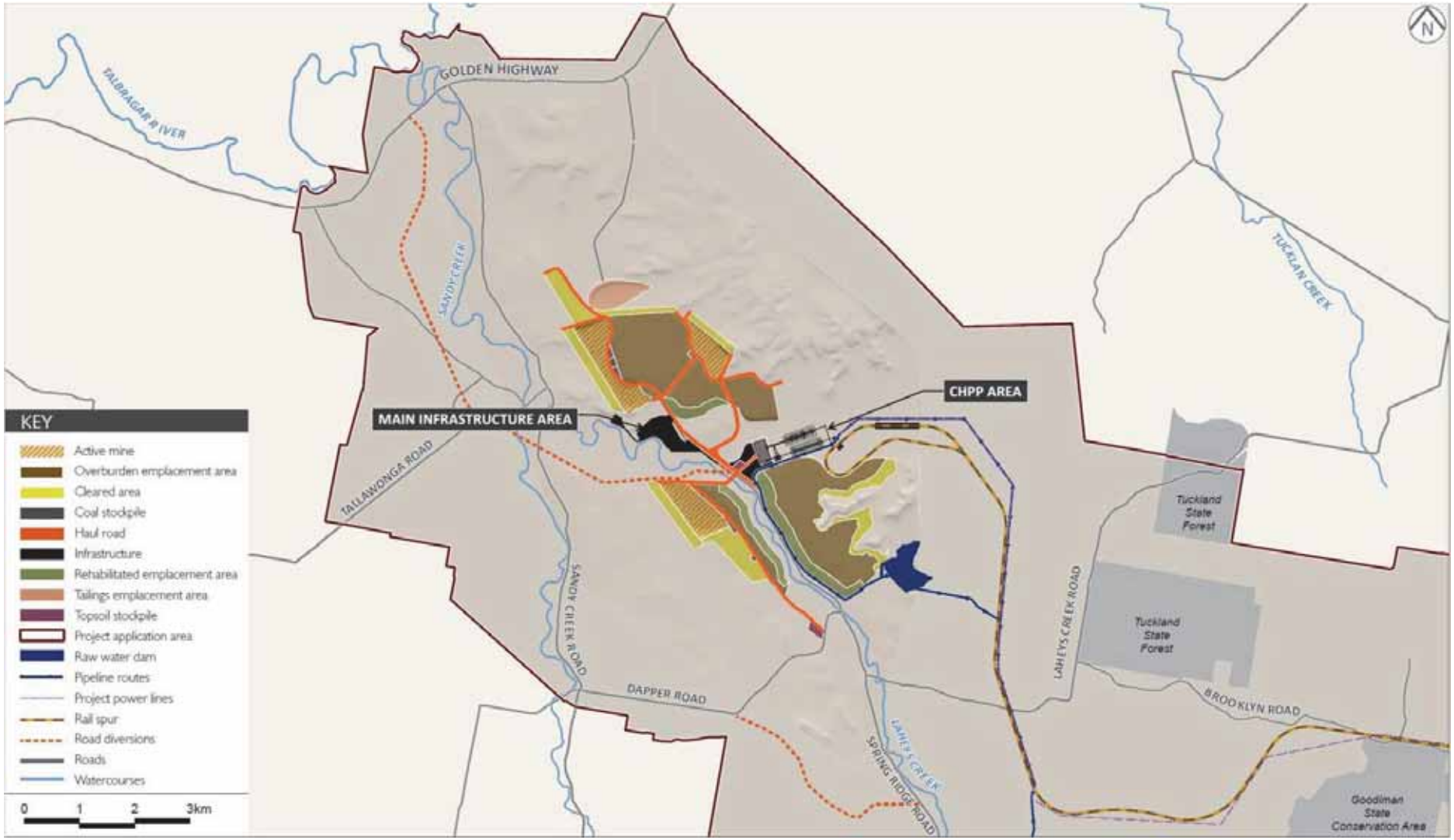

Figure C3 – Year 2 Mine Plan

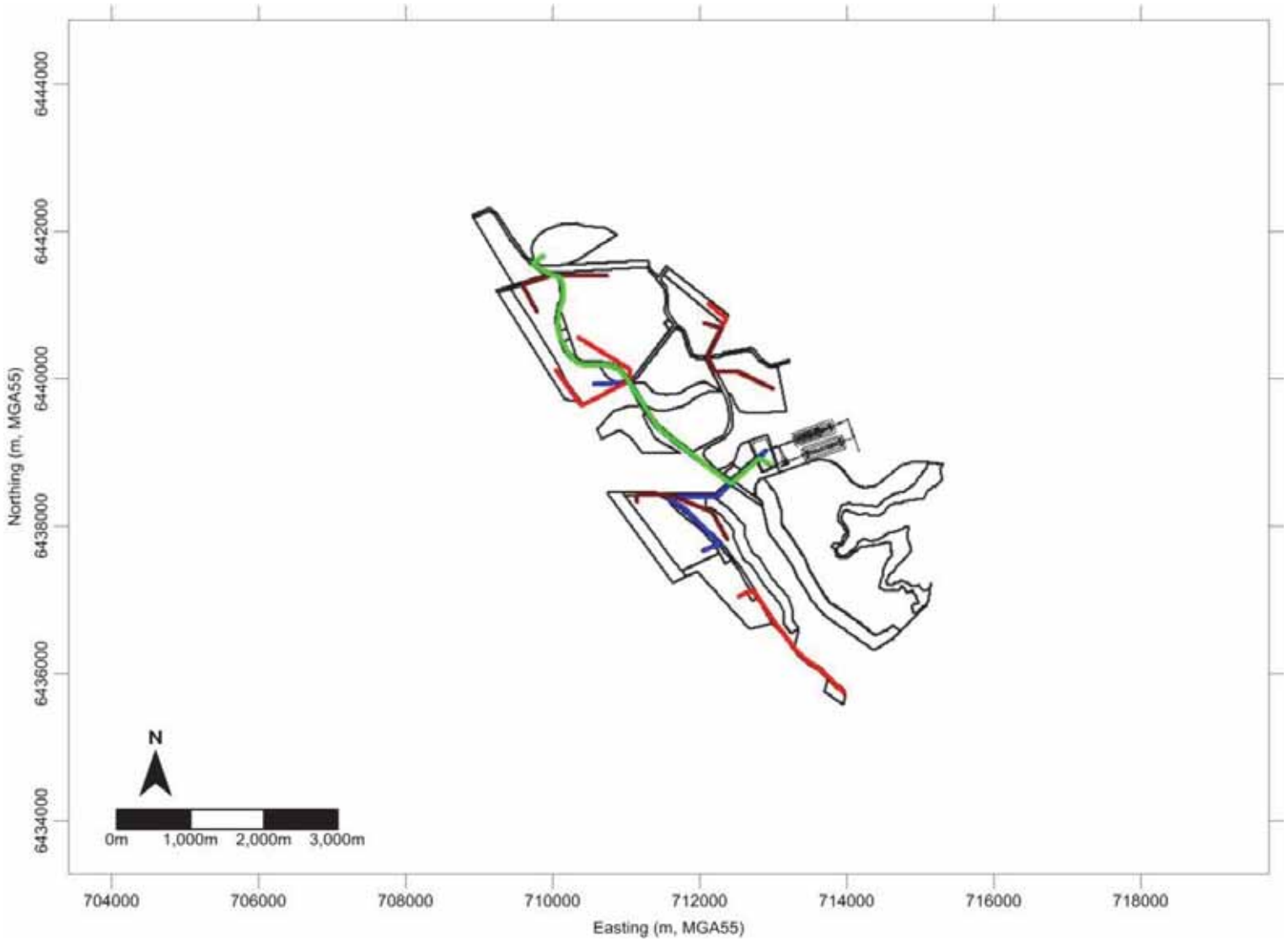

Figure C4 – Year 2 Haul Road Sources

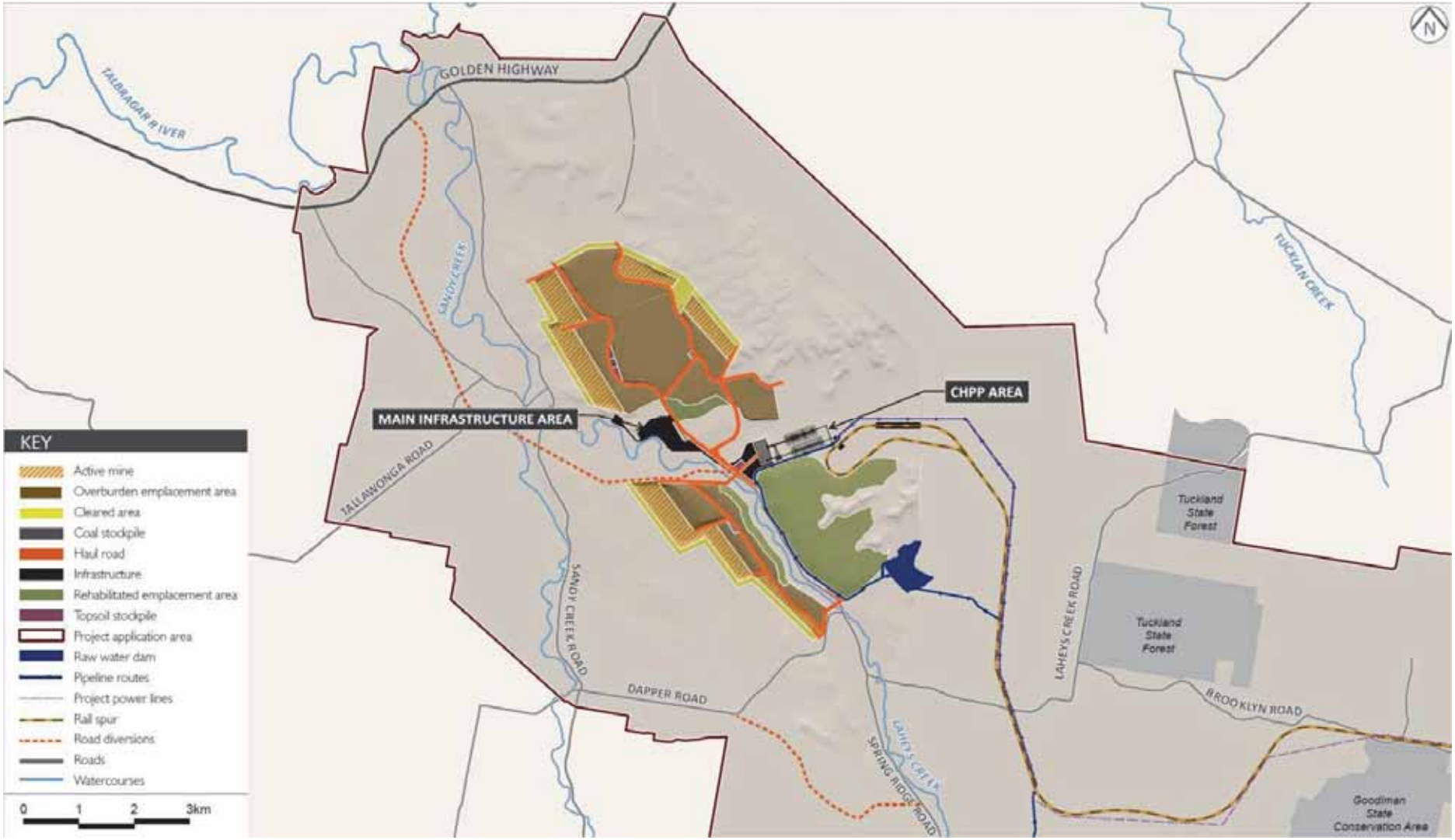

Figure C5 – Year 4 Mine Plan

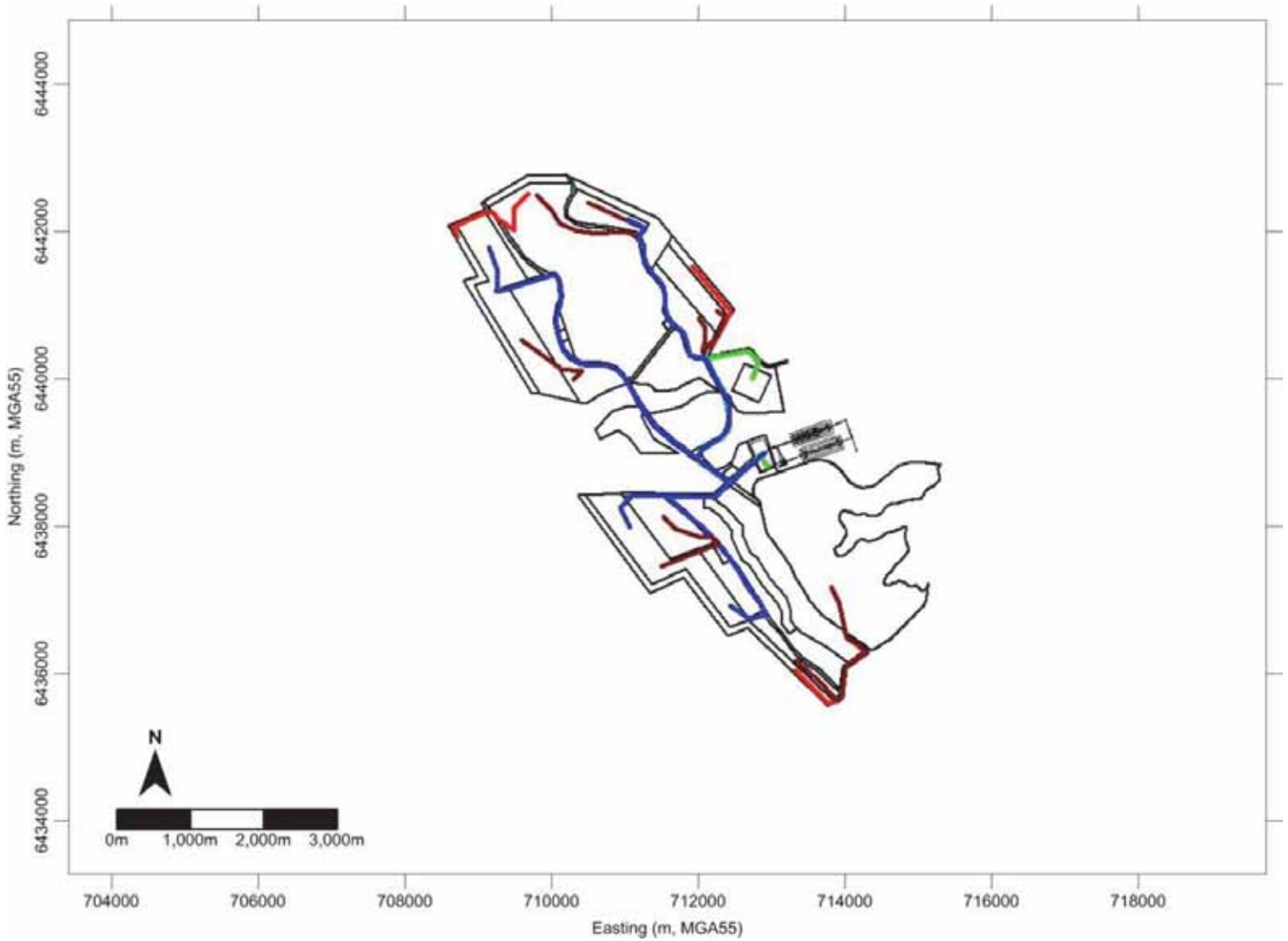

Figure C6 – Year 4 Haul Road Sources

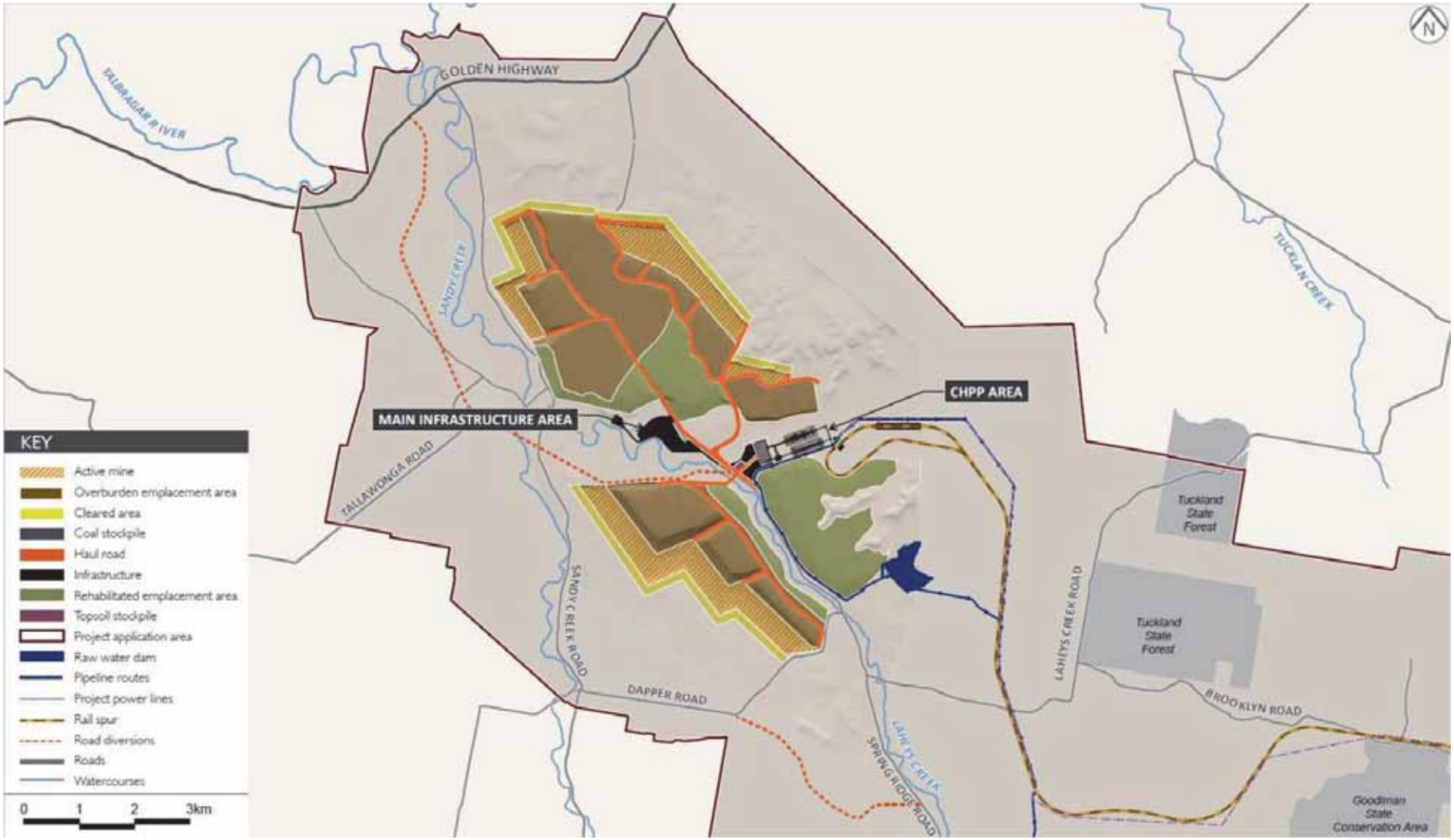

Figure C7 – Year 8 Mine Plan

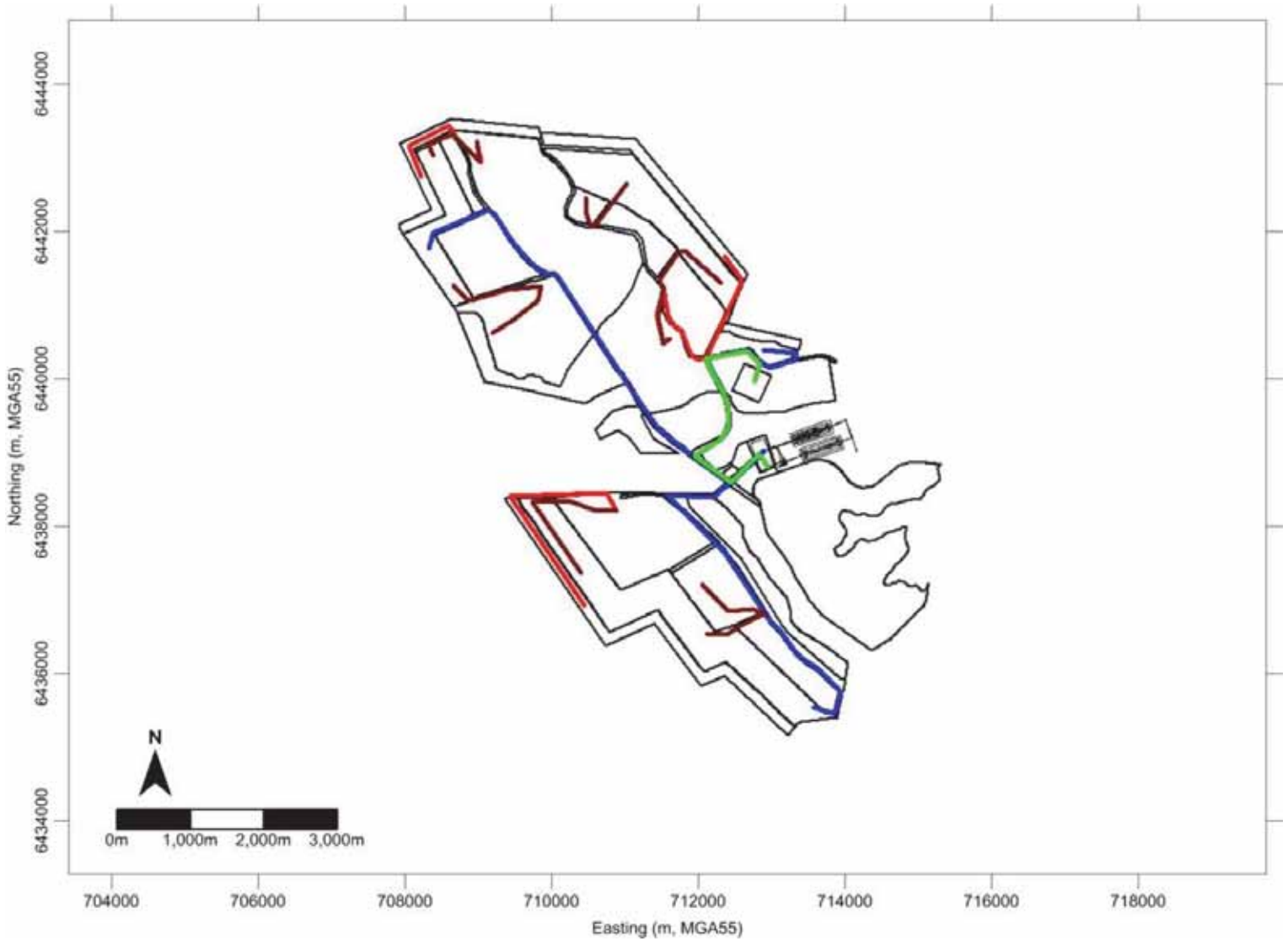

Figure C8 – Year 8 Haul Road Sources

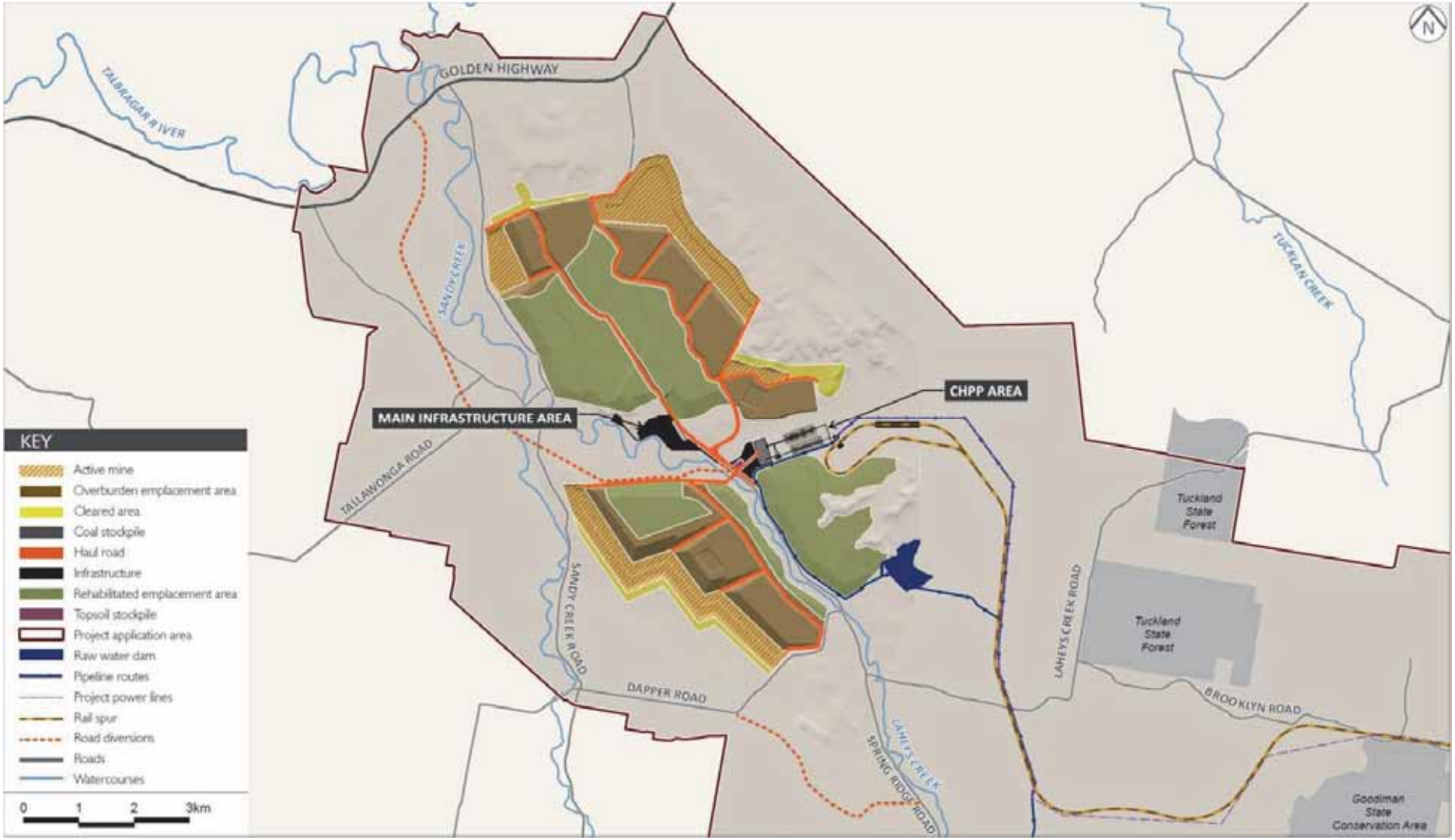

Figure C9 – Year 12 Mine Plan

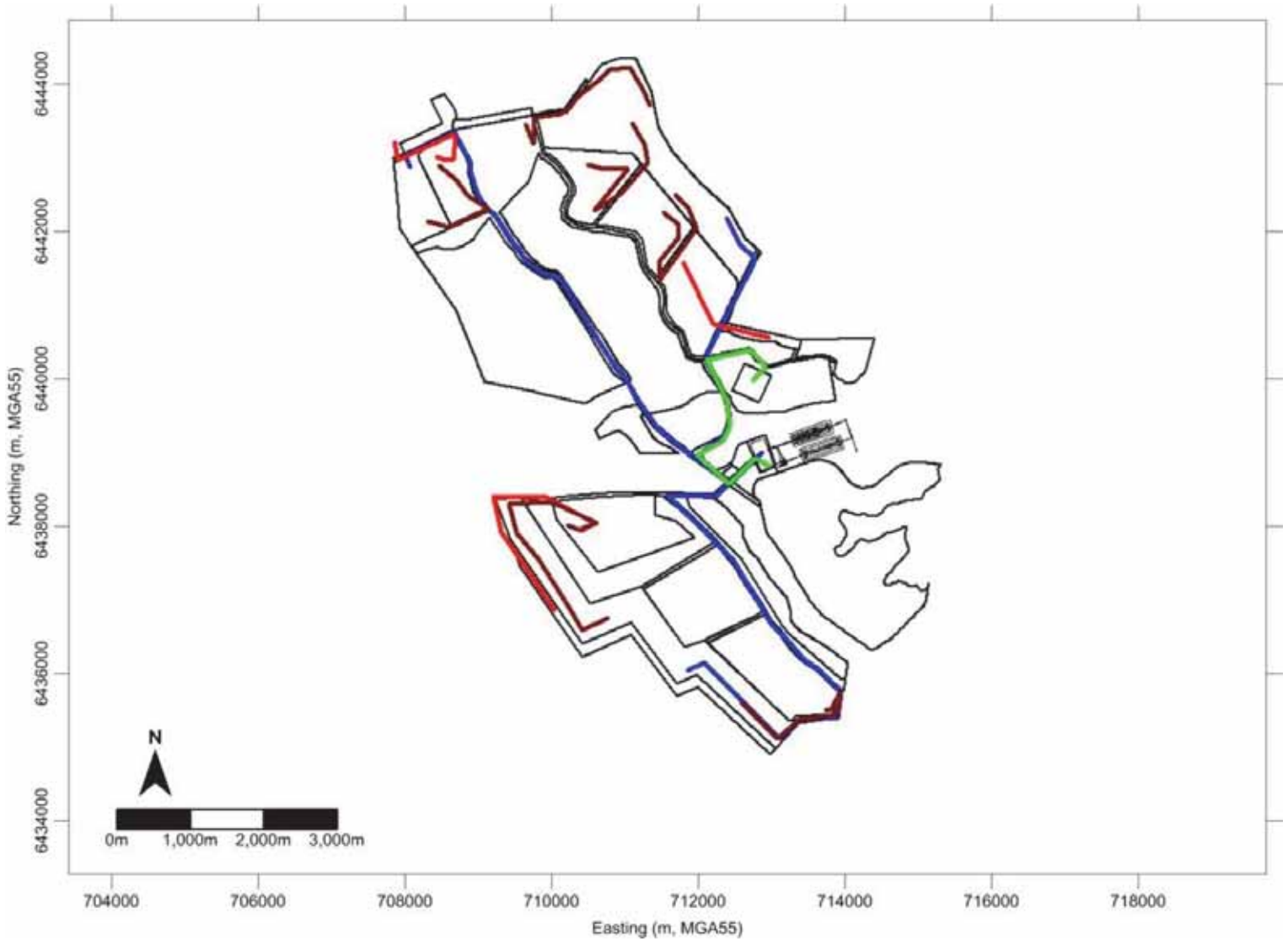

Figure C10 – Year 12 Haul Road Sources

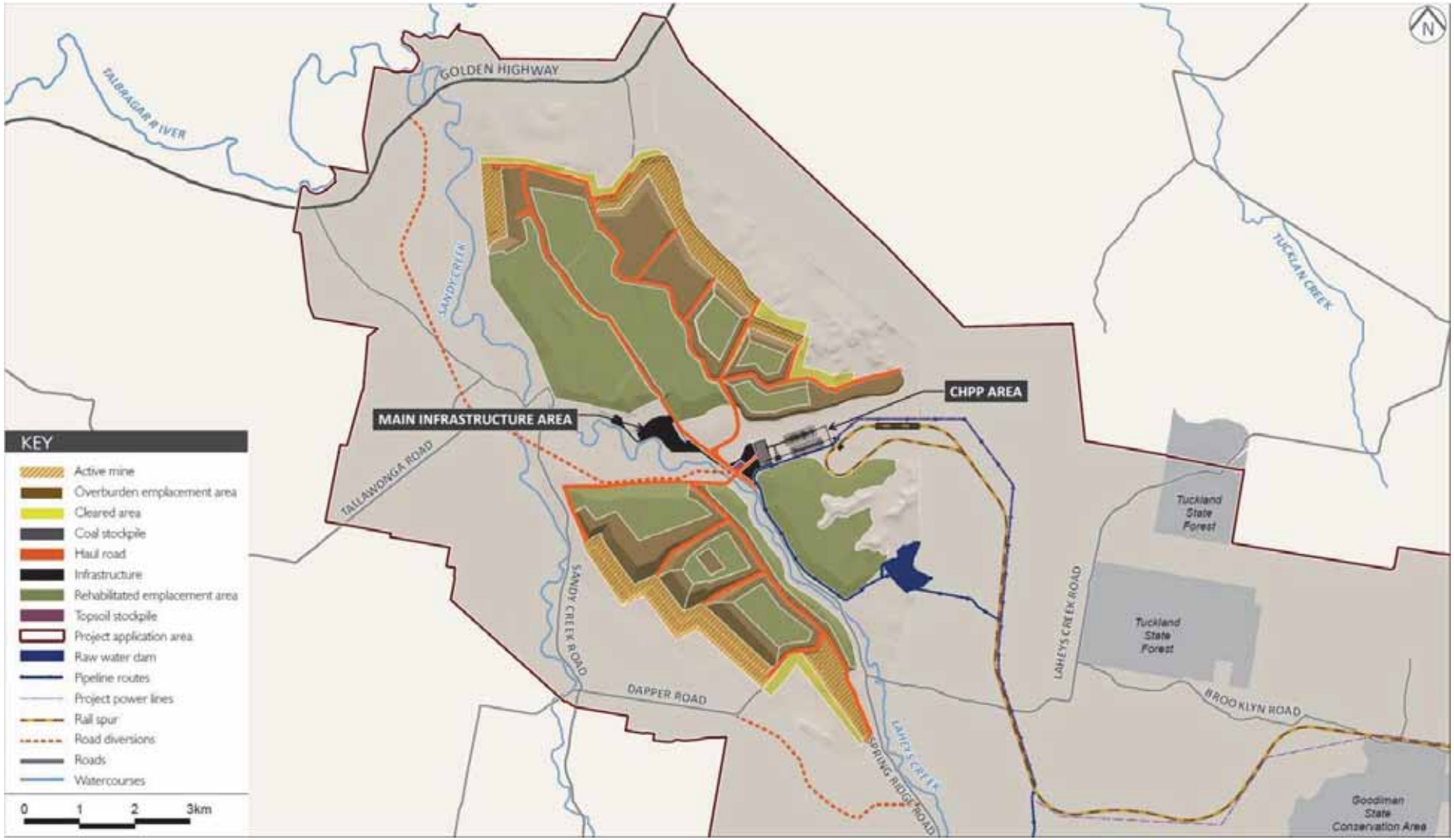

Figure C11 – Year 16 Mine Plan

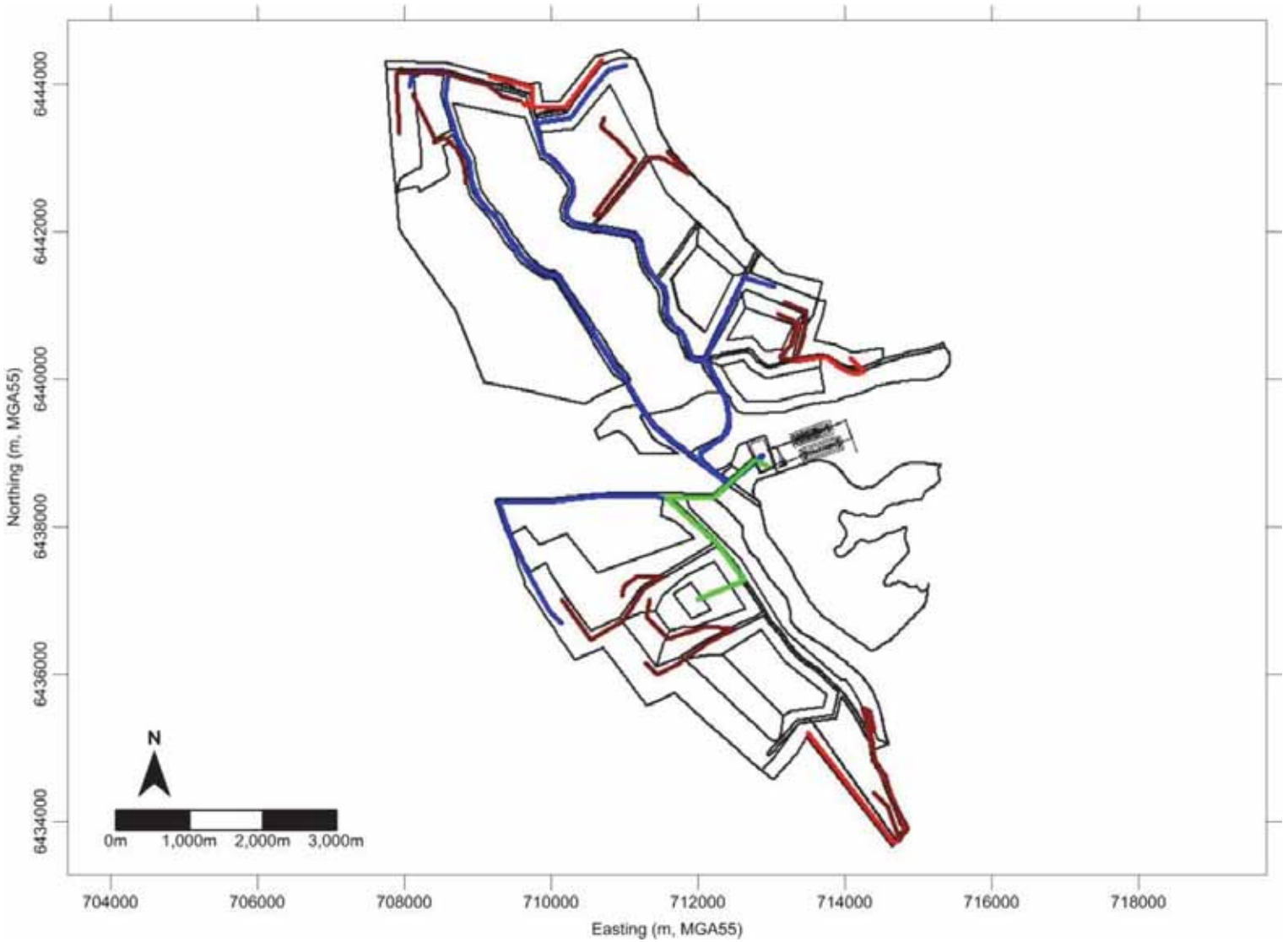

Figure C12 – Year 16 Haul Road Sources

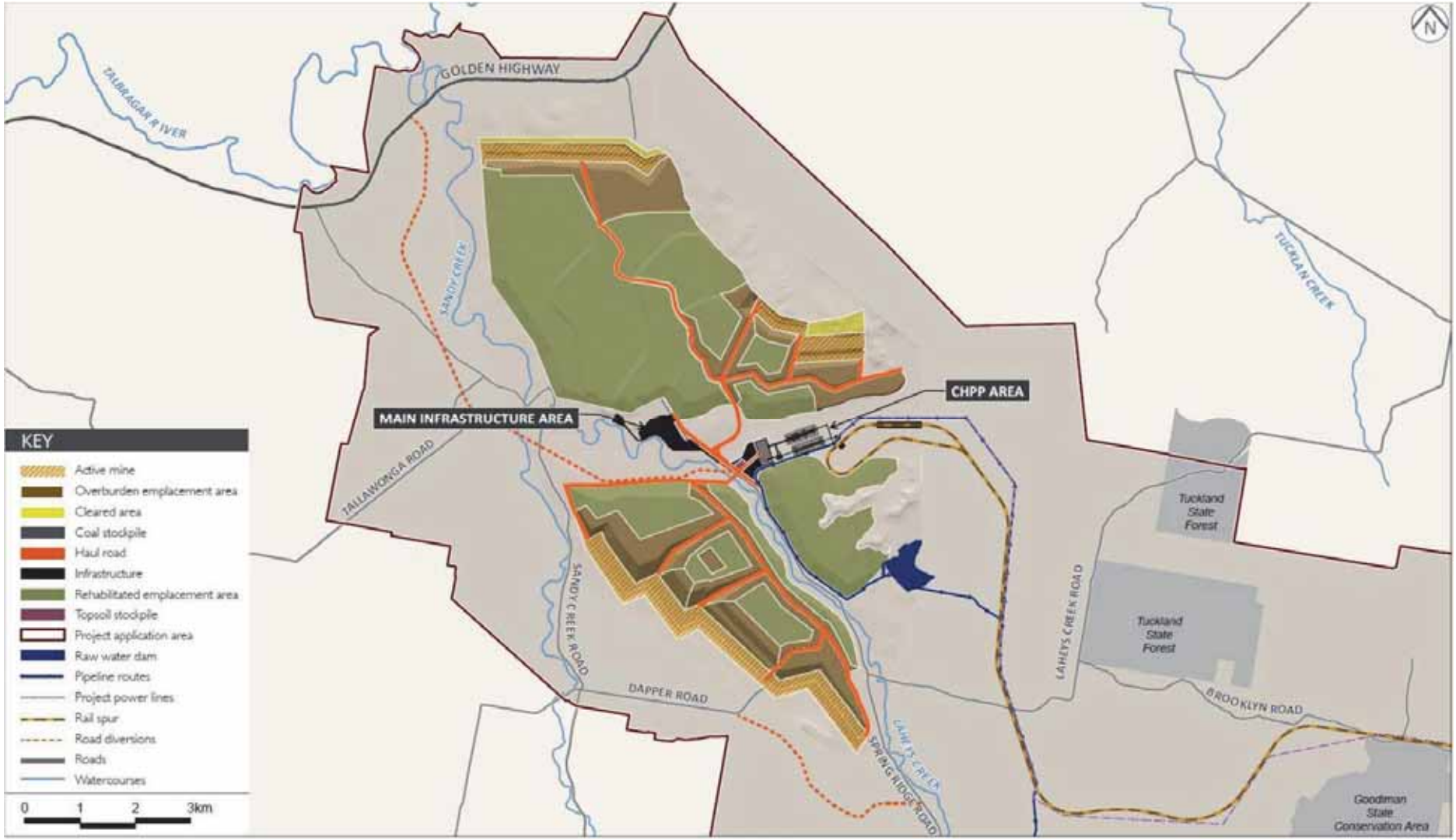

Figure C13 – Year 20 Mine Plan

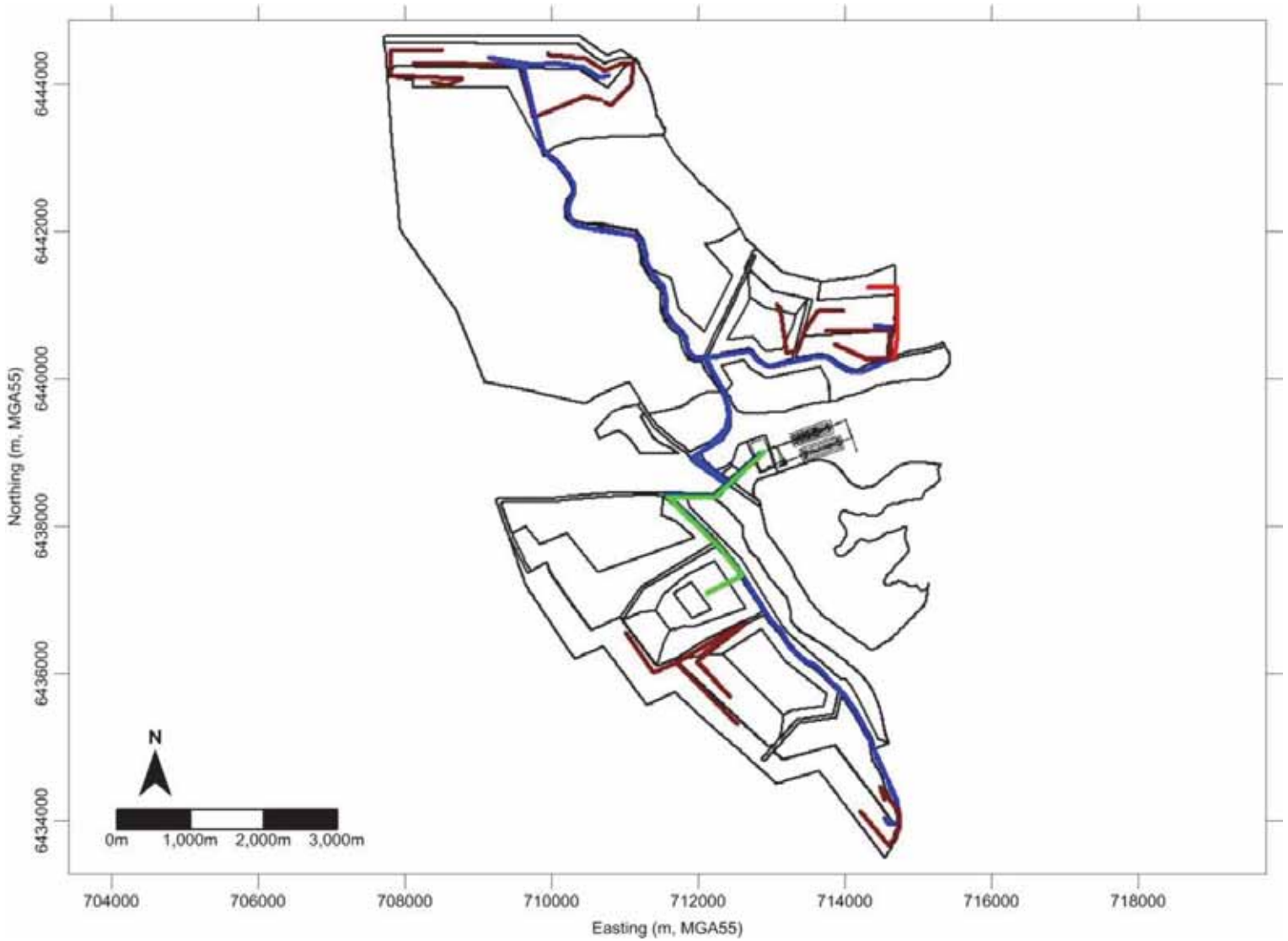

Figure C14 – Year 20 Haul Road Sources

Appendix D
Project Emissions Inventory for Air Quality Assessment

Introduction

Air emission sources associated with the Project were identified and quantified primarily through the application of United States Environmental Protection Agency (USEPA) AP-42 predictive emission factor equations. Referencing of AP-42 emission factors is a requirement within OEH's *Coal Mine Particulate Matter Control Best Practice, Site-specific determination guideline*, November 2011.

Particulate releases were quantified for various particle size fractions, with the TSP fraction being estimated and simulated to provide an indication of dust deposition rates. Fine particulates (PM_{10} and $PM_{2.5}$) were estimated using ratios for the different particle size fractions available within the literature (principally the USEPA AP-42).

Gaseous emissions from the Project due to fuel combustion by mobile plant, locomotives and blasting operations were also quantified.

Mine Progression Years for Emission Scenarios

Mine staging plans for each significant phase of the Project were provided by CHC, accounting for Years 1, 2, 4, 8, 12, 16 and 20. The amount of material to be extracted and processed for each of these years is presented within **Table D1**.

Table D1. Material Handling by Key Operational Years

Material Type	Year 1	Year 2	Year 4	Year 8	Year 12	Year 16	Year 20
Topsoil stripped (ha)	399.0	170.4	196.2	225.2	200.7	169.9	1.4
Waste (MBCM)[1]	7.8	20.7	36.3	48.2	47.9	58.6	56.4
ROM Coal (Mtpa)	1.0	10.1	16.5	20.0	20.0	20.0	20.0
Product Coal (Mtpa)	0.7	7.1	11.2	12.0	12.0	12.0	12.0

Note 1: MBCM – million bank cubic metre. A density of 2.5t/m^3 of waste has been assumed to calculate annual waste tonnage amounts.

Sources of Particulate Matter Emissions

Air emissions associated with the Project will primarily comprise of fugitive particulate matter releases. Sources of emission were identified as follows:

- Wheel generated emissions from vehicle movements on unpaved roads;
- Loading and dumping of waste/topsoil material;
- Loading and dumping of Run-of-Mine (ROM) coal;
- ROM pad dumping direct and rehandle by front end loader (FEL) to hopper;
- Loading and dumping of rejects;
- Blasting;
- Drilling;

- Bulldozer operations on coal;
- Bulldozer operations on waste/topsoil;
- Coal crushing/screening;
- Coal stockpile loading;
- Coal conveying and transfer;
- Train wagon loading;
- Wind erosion of coal stockpiles;
- Wind erosion of active mining areas;
- Wind erosion of cleared areas;
- Wind erosion of waste dump/topsoil stockpile areas;
- Wind erosion of rehabilitated waste emplacement areas;
- Road maintenance by grader; and
- Wind-blown coal dust from rail wagons.

Sources of Combustion Emissions

Sources associated with combustion-related emissions given routine operations are as follows:

- Diesel-fuelled mobile plant;
- Diesel-fuelled rail locomotives; and
- Explosive detonation during blasts

In addition to the above routine emissions, the potential exists for post-blast fume and spontaneous combustion-related releases. Emissions from such abnormal events are highly site- and incident-specific and emission factors are not available for the accurate quantification of such releases. Risks associated with such events are evaluated within the main body of the report, and management and monitoring measures identified to reduce the likelihood of such events occurring.

Particulate Matter Emission Factors Applied

The emission factor equations applied within the assessment are documented in this subsection. Project-specific inputs applied, including material properties, activity rates, meteorological data (rainfall, wind speed) and particulate matter control efficiencies, are documented in the subsequent subsection.

Unpaved Roads

The emissions factors for unpaved roads, as documented within AP-42 Chapter 13.2.2 “Unpaved Roads” November 2006, was applied as follows:

$$E = k\ (s/12)^a (W/3)^b$$

Where:
E = emissions factor (lb/Vehicle Mile Travelled)
s = surface material silt content (%)
W = mean vehicle weight (short ton)

The following constants are applicable:

Constant	TSP (assumed from PM_{30})	PM_{10}	$PM_{2.5}$
K (lb/VMT)	4.9	1.5	0.15
a	0.7	0.9	0.9
b	0.45	0.45	0.45

Note: PM_{30} is particulate matter less than 30 µm in aerodynamic diameter

The mean vehicle weight is converted from metric tonnes to short tons (as required by USEPA Equation) by a factor of 1.1023.

The metric conversion from lb/VMT to g/VKT is as follows:

1 lb/VMT = 0.2819 kg/VKT

This emission factor was applied to the following sources:

- Movement of haul trucks for waste rock, topsoil, ROM coal and CHPP rejects; and
- Movement of light vehicles across haul road network.

Topsoil Scraping Activities

Emissions factors for topsoil scraping activities are taken from AP-42 Chapter 11.9 entitled "Western Surface Coal Mining" dated October 1998. Given that no $PM_{2.5}$ factors are defined in this workbook, the $PM_{2.5}$ ratios used in the OEH's 2008 Greater Metropolitan Region Emissions Inventory were applied.

Material	Units	TSP	PM_{10}	$PM_{2.5}$
Waste rock	kg/tonne	0.029	0.0093	TSP x 0.0468

Bulldozing

The emissions factors for bulldozing operations were taken from AP-42 Chapter 11.9 "Western Surface Coal Mining" October 1998.

Material	Units	TSP	PM_{10}	$PM_{2.5}$
Coal	kg/hr	$\frac{35.6(s)^{1.2}}{(M)^{1.5}}$	$\frac{8.44(s)^{1.5}}{(M)^{1.4}} \times 0.75$	$\frac{35.6(s)^{1.2}}{(M)^{1.4}} \times 0.022$
Waste rock	kg/hr	$\frac{2.6(s)^{1.2}}{(M)^{1.3}}$	$\frac{0.45(s)^{1.5}}{(M)^{1.4}} \times 0.75$	$\frac{2.6(s)^{1.2}}{(M)^{1.3}} \times 0.105$

Where: s = material silt content (%)
M = material moisture content (%)

These emissions factors were applied to the following sources:

- Operation of bulldozers on coal in pit (coal factor);
- Operation of bulldozers on coal stockpiles in CHPP (coal factor);
- Operation of bulldozers on waste rock material in pit (waste rock factor); and
- Operation of bulldozers in rehabilitation areas (waste rock factor).

Drilling

The emissions factor for drilling operations was taken from AP-42 Chapter 11.9 entitled "Western Surface Coal Mining" dated October 1998. There are no PM_{10} and $PM_{2.5}$ emission factors for drilling, with the PM_{10} to TSP and $PM_{2.5}$ to TSP ratio for blasting used for PM_{10} and $PM_{2.5}$ respectively.

Material	Units	TSP	PM_{10}	$PM_{2.5}$
waste rock and Coal	kg/hole	0.59	TSP x 0.52	TSP x 0.03

These emission factors were applied to the following sources:

- Pre-blast drilling of waste rock and ROM coal in operational pits.

Blasting

The emission factors for blasting were taken from AP-42 Chapter 11.9 "Western Surface Coal Mining" October 1998.

Material	Units	TSP	PM_{10}	$PM_{2.5}$
Coal or waste rock	kg/blast	$0.00022(A)^{1.5}$	TSP x 0.52	TSP x 0.03

Where: A= horizontal area (m^2) with blasting depth ≤ 21 m.

These emission factors were applied to the following sources:

- Blasting of waste rock and ROM coal in operational pits.

Trucks Loading

The emissions factors for coal loading to haul trucks were taken from AP-42 Chapter 11.9 "Western Surface Coal Mining" October 1998.

Material	Units	TSP	PM_{10}	$PM_{2.5}$
Coal	kg/t	$\frac{0.58}{(M)^{1.2}}$	$\frac{0.0596}{(M)^{0.9}} \times 0.75$	TSP x 0.019
Waste rock	kg/t	Refer to Material Handling Emission Factor		

Where: M = material moisture content (%)

The coal emission factors were applied to the following sources:

- Extraction and loading of coal to haul trucks;
- Loading of CHPP rejects to haul trucks.

Trucks Dumping

The emission factors for unloading of coal by haul trucks were taken from AP-42 Chapter 11.9 "Western Surface Coal Mining" October 1998.

Material	Units	TSP	PM_{10}	$PM_{2.5}$
Coal	kg/t	$\frac{0.58}{(M)^{1.2}}$	$\frac{0.0596}{(M)^{0.9}} \times 0.75$	TSP x 0.019
Waste rock	kg/t	Refer to Material Handling Emission Factor		

Where: M = material moisture content (%)

The coal emission factors were applied to the following sources:

- Unloading of coal from haul trucks to ROM pad and hopper.

Grading

The emissions factors for grading were taken from AP-42 Chapter 11.9 “Western Surface Coal Mining” October 1998.

Units	TSP	PM_{10}	$PM_{2.5}$
kg/VKT	0.0034 $(S)^{2.5}$	0.0056 $(S)^{2.0}$ x 0.6	TSP x 0.031

Where: VKT= Vehicles kilometres travelled
S = mean vehicle speed (km/h)

These emission factors were applied to the following sources:

- Routine maintenance of haul roads.

Materials Handling

Particulate matter emissions from material transfer operations were calculated through the application of the USEPA predictive emission factor equation for continuous and batch drop loading and tipping operations (AP-42, Section 13.2.4), given as follows:

$$E = k(0.0016) * \left(\frac{\left(\frac{U}{2.2}\right)^{1.3}}{\left(\frac{M}{2}\right)^{1.4}} \right)$$

where,

E = Emissions (kg/tonne transferred)

U = mean wind speed (m/s)

M = material moisture content (%)

k = 0.74 for TSP, 0.35 for PM_{10} and 0.053 for $PM_{2.5}$

Emission rates were calculated on an hourly basis to reflect hourly variations in wind speed.

These emission factors were applied to the following sources:

- Extraction and loading of waste rock/topsoil to haul trucks;
- Unloading of waste rock/top soil to emplacement areas;
- Various transfer points about the processing and CHPP area (conveyor points, loading to transfer bins, etc).

It is noted that as this equation is applicable for a batch drop process. When applied for the waste extraction and truck loading process (i.e. two processes), the factor has been doubled.

Front End Loaders

The USEPA does not provide emissions factors for front end loading and so the truck loading by batch loading factors from AP-42 Chapter 11.9 "Western Surface Coal Mining" October 1998 were adopted for use in the assessment.

Material	Units	TSP	PM_{10}	$PM_{2.5}$
Coal	kg/t	$\frac{0.58}{(M)^{1.2}}$	$\frac{0.596}{(M)^{0.9}} \times 0.75$	TSP x 0.019

Where: M = material moisture content (%)

These emission factors were applied to the following sources:

- Rehandle of coal from ROM pad to hopper (5% of total ROM coal);

Crushing and Screening

No emission factors are available for coal crushing and screening operations. An upper bound approach was adopted with reference made to emissions factors for crushing and screening contained within AP-42 Chapter 11.24 "Metallic Minerals Processing" dated January 1995. The emissions factors presented in this document offer a high moisture and low moisture content factor with high moisture defined as a moisture content greater than 4%. As the moisture content of coal is typically above 4%, the high moisture content values were applied.

There were no $PM_{2.5}$ factors defined in Chapter 11.24 and so the $PM_{2.5}$ ratios outlined in Category 3 of AP-42 Appendix B.2 "Generalized Particle Size Distribution" were applied. Category 3 covers material handling and processing of aggregate and unprocessed ore. This includes emissions from milling, grinding, crushing, screening, conveying, cooling and drying of material.

The TSP and PM_{10} screening emissions factors were obtained from AP-42 Chapter 11.19.2 "Crushed Stone Processing and Pulverized Mineral Processing" dated August 2004. There were no $PM_{2.5}$ factors defined in this chapter, with $PM_{2.5}$ fractions from Category 3 of AP-42 Appendix B.2 "Generalized Particle Size Distribution" applied.

Activity	Units	TSP	PM_{10}	$PM_{2.5}$
High moisture primary crushing	kg/t	0.01	0.004	TSP x 0.15
High moisture secondary crushing	kg/t	0.03	0.012	TSP x 0.15

These emission factors were applied to the following sources:

- Primary and secondary screening of ROM coal before CHPP.

Wind Erosion from Active Coal Stockpiles

Wind-blown dust from coal stockpiles was estimated by applying the complex, predictive emission estimation procedure documented within AP-42 Chapter 13.2.5 “Industrial Wind Erosion” November 2006, as described below.

The predictive emission factor equation for industrial wind erosion is given as follows:

$$E = k \sum_{i=1}^{N} Pi$$

Where,

k = particle size multiplier (k = 1 for TSP, 0.5 for PM_{10} and 0.075 for $PM_{2.5}$)

N = number of disturbances per year

Pi = erosion potential corresponding to the observed (or probable) fastest mile of wind for the i^{th} period between disturbances (g/m²), calculated by:

$$P = 58(u^* - ut^*) + 25(u^* - ut^*)$$

$$P = 0 \text{ for } u^* \leq ut^*$$

Where,

u* = friction velocity (m/s)

ut* = threshold friction velocity (m/s)

The following steps were followed in applying this equation:

Step 1 – The fastest mile of wind was determined between disturbances.

The coal stockpiles were conservatively assumed to be subject to disturbance on a continuous (hourly) basis to provide an upper bound estimate of emissions (i.e. N=8760).

Emissions were calculated on an hourly basis for the base case emission inventory year based on measured site-specific wind speed data for this year.

The fastest mile of wind, required for this methodology, was calculated from the hourly average wind speed based on the gust factor range documented by Pitts (2005). Fastest mile wind speeds are given by Pitts (2005) as being in the range of approximately 1.18 to 1.27 times the hourly wind speed. A factor of 1.27 was used to provide an upper bound estimate of emissions.

Step 2 – The friction velocity was derived for several stockpile sub-areas to account for different wind exposures.

Given that coal stockpiles typically penetrate the surface wind layer (i.e. piles with height-to-base ratios exceeding 0.2), it is necessary to consider that different areas of a stockpile have different exposures to the wind. The friction velocity (u*) must therefore be calculated taking into account the surface wind speed distribution (u_s^+) which is estimated as follows:

$$u_s^+ = \frac{u_s}{u_r} u_{10}^+$$

where,

u_s^+ = surface wind speed distribution (m/s)

u_s = surface wind speed (m/s), measured at 25 cm from the pile's surface

u_r = approach wind speed (m/s), or reference wind speed measured at a height of 10 m.

u_{10}^+= gust wind speed at reference height of 10 m for periods between disturbances (m/s)

The shape of the pile and its orientation to the prevailing wind determine wind exposure patterns (u_s/u_r ratios) at the pile surface. AP-42 Chapter 13.2.5 "Industrial Wind Erosion" November 2006" documents wind exposure patterns for two coal stockpile configurations based on wind tunnel studies undertaken. The two pile shapes are a conical pile and an oval pile with a flat top, both with 37 degree side slopes. The percentage of the pile surface areas represented by normalised surface wind speeds (u_s/u_r) ratio, as listed within the AP-42 Chapter 13.2.5, is given in the table below.

Pile Sub-area (u_s/u_r)	Percent of Pile Surface Area				
	Pile A	Pile B1	Pile B2	Pile B3	Generic
0.2	40%	36%	31%	28%	27%
0.6	48%	50%	51%	54%	54%
0.9	12%	14%	15%	14%	15%
1.1	0%	0%	3%	4%	4%

Note: Values are adopted from AP-42 Chapter 13.2.5 Industrial Wind Erosion

Allowing for variations in actual stockpile shapes, a generic set of pile surface areas was established for application in the emission estimates (as shown in above table). In deriving this generic set, reference was made to the maximum areas across stockpile types covered by sub-areas with higher u_s/u_r ratios.

Based on the surface wind speed distribution (u_s+), the friction velocity (u*) was calculated for each pile sub-area, taking into account the non-uniform wind exposure of stockpiles, by applying the following equation (USEPA, 2006):

$$u^* = \frac{0.4u_s^+}{(\frac{25}{\ln 0.5})} = 0.10u_s^+$$

Step 3 – A threshold friction velocity was determined.

Reference was made to the literature to identify threshold friction velocities for use in the erosion potential calculations. The threshold friction velocity for coal piles is listed by AP-42 Chapter 13.2.5 as 1.12 m/s, which was adopted in this assessment.

Step 4 – Calculation of annual erosion potential for the entire pile

The erosion potential (P) was calculated for each stockpile sub-area, for each hour, based on the calculated friction velocity (u*) and the selected threshold friction velocity (ut*) as follows:

$$P = 58(u^* - ut^*)^2 + 25(u^* - ut^*)$$

$$P = 0 \text{ for } u^* \leq ut^*$$

The erosion potentials were then summed across stockpile sub-areas and across hours to give the total annual erosion potential for the entire pile.

This emission factor derived from the above approach was applied to the following sources:

- ROM, product and emergency stockpiles; and
- ROM pad area.

Wind Erosion of Overburden Emplacement Areas and Other Exposed Areas

The TSP emissions factor taken from the USEPA AP-42 Chapter 11.9 "Western Surface Coal mining" October 1998 was applied in the quantification of wind-blown dust from overburden emplacement areas and other exposed areas (but excluding coal stockpiles). In designating PM_{10} and $PM_{2.5}$ emission factors, reference was made to the PM_{10}/TSP and $PM_{2.5}$/TSP ratios specified within AP-42 Chapter 13.2.5 "Industrial Wind Erosion" November 2006. Emission factors, expressed in metric tonnes per hectare of exposed area per year (t/ha/yr), are given in the table below.

Units	TSP	PM_{10}	$PM_{2.5}$
t/ha/year	0.85	TSP x 0.5	TSP x 0.075

The TSP emission factor is specified for use with seeded land, stripped overburden and graded overburden. This factor was derived based on upwind downwind sampling of exposed areas at coal mines in the US. Pitts (2005) noted that these coal mines, documented within the background document to AP-42 Chapter 11.9 "Western Surface Coal Mining" October 1998, are located within reasonably dry areas (rainfall in the range of 280 to 430 mm/year) characterised by relatively high wind speeds (four sites with average wind speeds of 4.8 to 6 m/s, and one with 2.3 m/s). Pitts (2005) therefore concluded that the equation appears to be based on reasonably dry and windy sites. As the Cobbora area experiences a mean rainfall of 590 mm per year, the application of this emission factor is considered conservative.

The annual emissions calculated by this method were divided up across the modelling period and scaled proportionally according to hourly wind speed. The wind erosion potential equation listed within the USEPA Industrial Wind Erosion method was drawn upon to distribute the annual wind erosion emissions by wind speed.

These emission factors were applied to the following sources:

- Wind erosion from stripped areas, waste rock emplacement areas, topsoil stockpiles and active mining areas; and
- Freshly rehabilitated and fully rehabilitated waste emplacement areas (30% and 90% control efficiency factors applied respectively).

Loading of Stockpiles and Train Wagons

The National Pollution Inventory (NPI) Emission Estimation Technique Manual for Mining (NPI, 2012), provides emission estimation factors for the loading of coal to stockpiles and train wagons. These factors were adopted for use in the assessment. $PM_{2.5}$ emissions were assumed to be 15% of the PM_{10} emission factor

Source	Units	TSP	PM_{10}	$PM_{2.5}$
Loading stockpiles	kg/t	0.004	0.0017	PM_{10} x 0.15
Loading train wagons	kg/t	0.0004	0.00017	PM_{10} x 0.15

Where: M = material moisture content (%)

These emission factors were applied to the following sources:

- Loading of coal to ROM, emergency and product Stockpiles; and
- Loading of coal to train wagons.

Coal Dust from Rail Wagons

Queensland Rail Limited (QR) recently commissioned a comprehensive study into fugitive dust emissions from a number of their coal rail transportation systems in the Queensland coal fields. This study comprised a literature review, a network of air quality monitoring equipment and atmospheric dispersion and numerical modelling. During this assessment conducted by Connell Hatch (2008), reference was made to a paper by Ferreira *et al.* (2003) which focused on the release of coal dust from train wagons. The study by Ferreira *et al.* (2003) conducted measurement of TSP emissions from coal wagons over a 350 km journey, and found that for such a distance, a 60t semi-covered wagon would lose approximately 0.001% of its load. (Semi-covered wagons were defined as wagons having 0.5 m wide automatic doors running the length of the wagon. When in the closed position, there is a gap of about 1 m wide between the two doors.) Further testing by Ferreira *et al.* (2003) showed that if the wagon was uncovered, emissions could be increased by up to five times that of a semi-covered wagon. Based on the specifics of the study conducted by Ferreira *et al.*, emission factors of 1.7g/km/wagon and 8.6g/km/wagon were derived for semi-covered and uncovered wagons respectively.

The findings of Ferreira *et al.* (2003) were used to derive emission factors for the dispersion modelling assessment conducted for the QR study. The resulting predicted concentrations paired well with the track-side air quality monitoring conducted during the QR study, suggesting that the conclusions of the Ferreira *et al.* (2003) study were acceptable for estimating the fugitive coal dust emissions from rail wagons.

Connell Hatch (2008) estimated that almost 90% of coal dust emissions from rail wagons was emitted from the wagon surface with parasitic loads from sills and bodies, door leakage and residual coal in unloaded wagons representing more minor sources. It is therefore pertinent to focus on dust emissions from rail wagons in this assessment.

In the absence of AP-42 emissions estimation methods, the findings of Ferreira *et al.* have been adopted to estimate coal dust emissions from trains transporting coal from the Project. To provide an upper bound estimate of emissions, a TSP emission factor of 8.57g/km/wagon was applied. PM_{10} and $PM_{2.5}$ ratios from the USEPA AP-42 predictive emission factor equation for industrial wind erosion (Section 13.2.5) were applied, i.e. TSP x 0.5 for PM_{10} and TSP x 0.075 for $PM_{2.5}$. Emissions were estimated for the first 16 km of the Rail spur to address cumulative impacts with other Project emissions.

Project Related Input Data and Particulate Matter Emission Estimates

Material property inputs used in the emission estimates are summarised in **Table D.2**. Project-related activity data is provided in **Table D.3**, with particulate matter control efficiencies given in **Table D.4**.

Table D2. Material Property Inputs for Emission Estimation (All Years)			
Material Properties	**Units**	**Value**	**Source of Information**
Moisture content of ROM coal	%	8	Provided by CHC
Moisture content of product coal	%	10	Provided by CHC
Moisture content of topsoil	%	4	Assumed
Moisture content of road material	%	2	Assumed
Moisture content of overburden	%	4	Assumed
Moisture content of reject	%	30	Assumed
Silt content of ROM coal	%	13.7	Site specific sampling data
Silt content of product coal	%	13.7	Assumed same as ROM coal (conservative assumption)
Silt content of topsoil	%	23.9	Site specific sampling data
Silt content of road material	%	4.3	Average default value from USEPA AP-42 for coal mining
Silt content of waste rock	%	15	Assumed
Density of waste rock	tonnes/m^3	2.5	Assumed

Table D3. Project Activity Data by Mine Progression Year									
Activity	**Mine Area**	**Parameter (Unit)**	**Year 1**	**Year 2**	**Year 4**	**Year 8**	**Year 12**	**Year 16**	**Year 20**
Topsoil removal/	Mining Area A	Amount of topsoil (tonnes)	910,457	263,867	237,320	155,247	104,668	52,057	-
	Mining Area B		685,543	297,784	350,137	581,884	535,816	384,660	-
	Mining Area C		-	120,129	197,408	163,556	162,189	242,697	5,513
Waste extraction/unloading	Mining Area A	Amount of waste rock (tonnes)	11,575,385	18,452,191	21,018,783	19,517,314	17,349,192	15,885,945	35,234,375
	Mining Area B		8,015,241	27,365,516	53,930,643	84,594,294	82,029,491	78,269,184	35,234,375
	Mining Area C		-	6,037,852	15,866,643	16,406,906	20,269,394	52,243,555	70,468,750
ROM coal extraction/unloading	Mining Area A	Amount of ROM coal (tonnes)	1,049,439	5,719,424	6,083,026	5,605,533	2,607,245	3,241,765	3,000,000
	Mining Area B		-	4,359,949	8,030,857	10,947,554	11,918,068	8,793,932	5,000,000
	Mining Area C		-	-	2,337,198	3,446,913	5,474,688	7,964,304	12,000,000
Dozer on waste rock	Mining Area A	Total dozer hours	3,221	5,210	4,971	4,276	2,828	2,596	5,988
	Mining Area B		1,464	6,277	11,100	14,822	16,404	14,034	5,988
	Mining Area C		-	1,157	4,100	3,594	4,721	7,324	11,977
Dozer on ROM coal	Mining Area A	Total dozer hours	3,403	5,220	5,602	4,618	2,756	2,992	2,846
	Mining Area B		308	4,570	8,292	10,513	11,453	7,997	4,743
	Mining Area C		-	224	2,081	2,840	4,761	7,982	11,382
Dozer on rehabilitation area	All Mine	Total hours	2,190	4,380	4,380	5,256	5,256	6,132	6,132
Haulage of topsoil	Mining Area A	Annual VKT (total)	12,415	2,759	1,834	1,411	809	237	-
	Mining Area B		13,711	2,842	4,138	8,993	8,768	7,518	-
	Mining Area C		-	1,092	1,795	2,751	1,253	1,544	55
Haulage of waste rock	Mining Area A	Annual VKT (total)	165,738	134,198	105,094	159,687	141,948	151,639	336,328
	Mining Area B		342,469	199,022	539,306	807,491	1,193,156	1,031,730	480,469
	Mining Area C		-	49,401	176,637	126,781	253,367	766,357	629,414
Haulage of ROM coal	Mining Area A	Annual VKT (total)	48,974	197,002	412,294	417,301	225,961	298,963	343,333

Table D3. Project Activity Data by Mine Progression Year									
Activity	**Mine Area**	**Parameter (Unit)**	**Year 1**	**Year 2**	**Year 4**	**Year 8**	**Year 12**	**Year 16**	**Year 20**
	Mining Area B		-	67,821	149,463	352,755	536,313	278,475	208,333
	Mining Area C		-	-	51,938	90,003	149,033	337,098	504,444
Haulage of rejects	Variable by Year	Annual VKT (total)	13,041	59,965	81,161	124,444	124,444	118,222	37,826
Grader on roads	All Roads	Annual VKT (total)	41,856	152,467	202,700	253,375	253,375	253,375	253,375
Light vehicle travel	All Roads	Annual VKT (total)	595,000	855,000	1,135,000	1,225,000	1,415,000	1,415,000	1,415,000
Blast size	Mining Area A	Average blast size (m^2)	9,291	8,006	8,508	7,536	7,538	7,937	7,761
	Mining Area B		5,595	8,454	7,702	8,162	7,664	8,156	7,731
	Mining Area C		-	3,231	6,663	3,338	3,588	7,013	5,097
Explosives use	Mining Area A	Total explosives use (tonnes)	3,609	30,292	52,956	82,698	47,543	73,373	149,136
	Mining Area B		1,022	31,660	110,971	234,311	233,717	232,076	333,315
	Mining Area C		-	2,541	26,647	50,997	87,977	159,247	190,699
Drill holes	Mining Area A	Number of drill holes per blast	532	477	503	494	499	537	490
	Mining Area B		242	537	537	549	535	539	538
	Mining Area C		-	280	683	407	489	909	630
Blasts	Mining Area A	Number of blasts per year (total)	53	155	157	180	107	135	183
	Mining Area B		15	162	329	510	526	427	409
	Mining Area C		-	13	79	111	198	293	234
Product coal produced	CHPP	Amount of product coal (tonnes)	727,001	7,114,050	11,233,617	12,000,000	12,000,000	12,000,000	12,000,000
Coarse rejects from CHPP	CHPP	Amount of coarse reject (tonnes)	225,707	2,075,726	3,652,225	5,600,000	5,600,000	5,600,000	1,791,772
Wind erosion areas	Cleared	Total area (ha)	182.3	217.5	133.2	204.6	138.5	141.8	64.0
	Active mining		50.0	167.0	295.6	492.8	562.5	504.2	442.8
	Active waste dump		360.4	562.1	666.4	1,094.3	952.8	1,072.5	959.5

Table D3. Project Activity Data by Mine Progression Year									
Activity	**Mine Area**	**Parameter (Unit)**	**Year 1**	**Year 2**	**Year 4**	**Year 8**	**Year 12**	**Year 16**	**Year 20**
	Rehabilitated dump (new)		-	113.7	297.9	256.2	544.6	522.7	499.6
	Rehabilitated dump (established)		-	-	113.7	411.6	667.8	1,212.4	1,735.1
	Reject area		44.1	44.1	16.0	16.0	16.0	12.2	12.2
	Topsoil stockpiles		10.4	10.4	6.0	2.2	2.2	2.2	2.2
	ROM pad		8.0	8.0	8.0	8.0	8.0	8.0	8.0
	Product coal stockpile		6.5	6.5	6.5	6.5	6.5	6.5	6.5
	ROM coal stockpile		4.0	4.0	4.0	4.0	4.0	4.0	4.0
	Emergency coal stockpile		2.5	2.5	2.5	2.5	2.5	2.5	2.5

Table D4. Particulate Matter Control Efficiencies Applied (All Years)				
Mining Activity	**Material**	**Source**	**Control Efficiency (%)**	**Details**
Topsoil removal and stockpiling	Topsoil	Topsoil removal	0%	
	Topsoil	Excavator loading topsoil	0%	
	Topsoil	Trucks unloading topsoil	0%	
Drilling	Overburden	Drilling	70%	Drill water sprays
Blasting of overburden	Overburden	Blasting	0%	Blasting assumed to occur during daylight hours – preferable dispersion conditions
Overburden extraction and unloading	Overburden	Excavators/shovels extracting overburden	0%	
	Overburden	Dozers on Overburden	0%	
	Overburden	Excavators/shovels loading overburden to trucks	0%	
	Overburden	Trucks unloading overburden	0%	
ROM coal extraction	ROM coal	Dozers on ROM coal	0%	
	ROM coal	Front end loaders loading coal to trucks	0%	
	ROM coal	Loading ROM coal dump station (hopper)	70%	Partial enclosure (3 sides and roof)
Vehicle movements	Road material	Wheel generated dust - light vehicles	75%	Level 2 watering
	Road material	Wheel generated dust – haul trucks	75% 30%	Level 2 watering Average vehicle travel speed of 40km/hr
Grading	Road material	Graders on roads	75%	Level 2 watering
CHPP	ROM coal	Primary crusher	70%	Enclosure
	ROM coal	Secondary crusher	70%	Enclosure
	ROM coal	Assorted transfer points	0%	
	ROM coal	Coal stockpiles	50%	Water sprays
	Product	Coal stockpiles	50%	Water sprays

Table D4. Particulate Matter Control Efficiencies Applied (All Years)

Mining Activity	Material	Source	Control Efficiency (%)	Details
	coal			
	Product coal	Loading coal to trains	70%	Telescopic chute
Rehabilitation	Topsoil	Dozers - shaping	0%	
Exposed areas	Topsoil	Topsoil Stockpile	0%	
	Open cut	Open cut area	0%	
	Overburden	Waste dump active	0%	
	Overburden	Rehabilitated waste dump (new)	50%	Primary rehabilitation
	Overburden	Rehabilitated waste dump (established)	90%	Vegetation
	ROM coal	ROM coal stockpile	50%	Water sprays
	Product coal	Product coal stockpile	50%	Water sprays
Rail transport	Product coal	Coal dust from rail wagons	0%	

Combustion Emissions from Mobile Plant

Oxides of nitrogen (NO_x), sulphur dioxide (SO_2), carbon monoxide (CO) and volatile organic compounds (VOC) emissions were estimated for diesel fuel combustion during the Project. Annual diesel consumption across the Project was provided for each mining year by CHC.

In order to assess the potential impact on the surrounding environment, emission factors sourced from Table 35 of the NPI Emission Estimation Manual for Combustion Engines (NPI, 2008), corresponding to Diesel Industrial Vehicle (Miscellaneous). The adopted emission factors are presented within **Table D5**. Benzene, toluene and xylenes have been adopted as indicators of VOC emissions. The speciation of each of these individual air toxics from total VOCs was calculated using the Profile Number 8774 (USEPA, 2010) – Pre-2007 Heavy Duty Diesel Trucks (uncontrolled) from USEPA Speciate V4.3 (notably, 3%, 1.5% and 0.9% of total VOCs respectively).

Table D5. Combustion Emission Factors for Diesel Combustion – Mobile Plant

Pollutant	Diesel Combustion Emission Factors (kg/L)[(a)]
NO_x	0.0186
CO	0.045
SO_2	0.000024
VOC	0.0042
Benzene[(b)]	0.000126
Toluene[(b)]	0.000063
Xylenes[(b)]	0.0000378

(a) Factors reported in kg/L are derived from NPI Emission Estimation Technique Manual for Combustion Engines factors originally in kg/kWh by multiplying by 3. This is in accordance with NPI manual guidance.

(b) Estimated from calculated VOC emissions, based on the Profile Number 8774 (USEPA, 2010) – Pre-2007 Heavy Duty Diesel Trucks (uncontrolled) from USEPA Speciate V4.3.

In applying calculated emissions to the modelling conducted, annual emissions of each pollutant were allocated along the haul road sources for each mine year model. The proportion of annual emissions allocated to each road source in each scenario was based on the rate of activity derived in the particulate modelling.

Emissions for all years and pollutants are given in the main body of the report.

Rail Locomotives Combustion Emissions

Combustion emissions for locomotives transporting coal from the Project Site were calculated for each year of the selected mine years. For the purpose of this assessment the following input data was derived for use in the estimation of combustion emissions from locomotives:

Capacity of train (t)	9,000
Capacity of wagon (t)	100
No. of locomotives per train	3
Hours on-site per train (assumed)	2
Average Load Factor (fraction of available power)	0.28
Average power rating (hp)	4000

Emission factors drawn from ICF (2009) and the *NPI EETM for Railway Yard Operations V2.0 June 2008* to derive combustion emissions from locomotives are presented within **Table D6**. Annual emissions by mine year are presented within **Table D7**.

Table D6. Combustion Emission Factors from Rail Locomotives

	Emission Rates for Line-Haul Locomotives (g/bhp-hr)(a)
NO_x	4.95
CO	1.28
VOC	0.13
$PM_{2.5}$	0.0776
PM_{10}	0.08
SO_2 [(b)]	0.000828
Benzene[(c)]	0.03802% of PM_{10}
Toluene[(c)]	0.32% of VOC
Xylenes[(c)]	0.48% of VOC

(a) ICF International (2009). *Current Methodologies in Preparing Mobile Source Port-Related Emission Inventories, Final Report*, Report Prepared for the U.S. Environmental Protection Agency, April 2009.

(b) Adjusted to reflect sulphur content of local fuel, based on NPI *EETM for Railway Yard Operations V2.0* June 2008.

(c) Estimated from Emission Profile from Table 3-1 of *Documentation for Locomotive Component of the National Emissions Inventory Methodology* (Eastern Research Group, 2011).

Table D7. Gaseous Emissions from Locomotive Operations							
Pollutant	Annual Locomotive Emissions (kg per year)						
	Year 1	Year 2	Year 4	Year 8	Year 12	Year 16	Year 20
CO	3,139.6	9,418.8	12,558.3	15,697.9	15,697.9	15,697.9	15,697.9
NO_x	12,141.4	36,424.1	48,565.4	60,706.8	60,706.8	60,706.8	60,706.8
SO_2	2.0	6.1	8.1	10.2	10.2	10.2	10.2
Benzene	0.7	2.2	3.0	3.7	3.7	3.7	3.7
Toluene	1.1	3.2	4.3	5.4	5.4	5.4	5.4
Xylenes	1.6	4.8	6.4	8.1	8.1	8.1	8.1

Gaseous Emissions from Blasting

Ammonium nitrate explosives are widely used in NSW open cut coal mines, and are proposed for use by the Project. Ammonium nitrate fuel oil (ANFO) blasts release primarily carbon dioxide, water and nitrogen. Air pollutants released from blasts include a range of gases such as CO, nitric oxide (NO), hydrocarbons (HC) and lesser amounts of NO_2 and SO_2. The extent of the latter depends on the sulphur content of the fuel oil used. Particulates are also produced by blasts, but due to the large quantities of particulate generated in the shattering of rock and earth in the explosion, the quantity of particulates from the explosive charge cannot be distinguished.

NO_2 is a direct product of the detonation process. It is also produced post-detonation by secondary oxidation of NO to NO_2 as the cloud mixes with air. NO_2 has a greater potential to impact on human health, compared to NO, in the event that exposure occurs. While NO and CO are not visible, NO_2 appears as a yellow to reddish-brown gas.

Emission factors for explosives detonation are published within USEPA *AP-42 Emission Factors for Explosives Detonation 1995*. The extent to which such emission factors account for Australian blast practices has been assessed by Attalla *et al.* (2007). Maximum and average emission rates derived by Attalla *et al.* (2007) are compared to the AP-42 emission factors for blasting within **Table D.8**.

Table D8. Comparison of Emission Rates Projected by Attalla et al. (2007) with USEPA AP-42 Emission Factors						
Source		Emission Rates (kg pollutant per t of Explosives)				
		CO	NO	NO_2	NO_x	SO_2
USEPA AP-42 1995 Emission Factors		34	Not given	Not given	8	1
Attalla *et al.* (2007)[(a)]	Maximum	97.2	5.0	0.32	5.3	2.4
	Average	19.2	0.9	0.06	0.9	0.4

(a) Emission rates back-estimated using dispersion modelling based on measurements undertaken at Mt Arthur Coal where both ANFO and 'heavy ANFO' were in use.

Given that AP-42 emission factors fell within the range of the emission rates derived by Attalla *et al.* (2007) for CO and SO_2, and were higher (more conservative) for NOx,

preference was given to the AP-42 emission factors for CO, NO_x and SO_2 in this assessment.

A summary of gaseous emissions from blasts for each mine progression year is provided in **Table D9**.

Table D9. Gaseous Emissions from Blasts by Mine

Pollutant	Annual Blasting Emissions (t)						
	Year 1	Year 2	Year 4	Year 8	Year 12	Year 16	Year 20
CO	157.4	451.8	779.8	1,062.2	1,027.3	1,256.6	1,884.2
NO_x	37.0	106.3	183.5	249.9	241.7	295.7	443.3
SO_2	4.6	13.3	22.9	31.2	30.2	37.0	55.4

Appendix E
Tabular Results of Dispersion Modelling – All Scenarios

Introduction

Incremental and cumulative TSP, PM_{10} and $PM_{2.5}$ concentrations and dust deposition rates predicted to occur due to the operational emissions generated by the Project are presented in **Table E1** through to **Table E7** for each assessed mining year at each of the surrounding private and CHC-owned receptor locations. The CHC-owned receptors are marked by grey shaded cells.

Criteria applicable for the assessment of the predicted concentration are given in the tables. Such criteria are primarily applicable to cumulative concentrations, with criteria for deposition being issued for both incremental and cumulative dust deposition. In the absence of air quality standards for $PM_{2.5}$, reference is made to the NEPM Advisory Reporting Standard for $PM_{2.5}$ to facilitate a screening assessment of predicted $PM_{2.5}$ concentrations. Exceedances of the relevant air quality criteria are highlighted in the tables as red text in red boxes.

Table E1. Year 1 – Incremental and Cumulative Particulate Matter Concentration/Deposition Results for Project (CHC-owned receptors are marked by grey shaded cells)

Residence ID	Incremental Concentration/Deposition due to Project						Cumulative Concentration/Deposition due to Project + Background Air Quality							
	TSP Annual Average µg/m³	PM_{10} Maximum 24-hr µg/m³	PM_{10} Annual Average µg/m³	$PM_{2.5}$ Maximum 24-hr µg/m³	$PM_{2.5}$ Annual Average µg/m³	Deposition Annual Average g/m²/month	TSP Annual Average µg/m³	PM_{10} Maximum 24-hr µg/m³(b)	PM_{10} No. Of Days >50 µg/m³	PM_{10} Annual Average µg/m³	$PM_{2.5}$ Maximum 24-hr µg/m³(b)	$PM_{2.5}$ No. Of Days >25µg/m³	$PM_{2.5}$ Annual Average µg/m³	Deposition Annual Average g/m²/month
Criteria	**NA**	**NA**	**NA**	**NA**	**NA**	**2**	**90**	**50**	**NA**	**30**	**25[a]**	**NA**	**8[a]**	**4**
1088	0.7	2.1	0.4	0.7	0.2	0.0	30.1	40.7	0	12.2	16.3	0	4.9	1.4
1089	0.7	2.1	0.4	0.7	0.2	0.0	30.1	40.7	0	12.2	16.3	0	4.9	1.4
1094	0.1	1.0	0.0	0.1	0.0	0.0	29.5	40.7	0	11.8	16.3	0	4.7	1.4
1122	0.1	0.7	0.0	0.1	0.0	0.0	29.5	40.7	0	11.8	16.3	0	4.7	1.4
1133	0.8	1.5	0.4	0.6	0.2	0.0	30.2	40.7	0	12.2	16.3	0	4.9	1.4
1143	0.7	1.4	0.4	0.6	0.2	0.0	30.1	40.7	0	12.2	16.3	0	4.9	1.4
1144	0.7	1.4	0.4	0.6	0.2	0.0	30.1	40.7	0	12.2	16.3	0	4.9	1.4
1145	0.7	1.4	0.4	0.6	0.2	0.0	30.1	40.7	0	12.2	16.3	0	4.9	1.4
1147	0.8	1.6	0.4	0.6	0.2	0.0	30.2	40.7	0	12.2	16.3	0	4.9	1.4
1149	0.9	1.8	0.4	0.7	0.2	0.0	30.3	40.7	0	12.2	16.3	0	4.9	1.4
1158	0.2	1.0	0.1	0.2	0.0	0.0	29.6	40.7	0	11.9	16.3	0	4.7	1.4
1166	0.7	1.3	0.4	0.6	0.2	0.0	30.1	40.7	0	12.2	16.3	0	4.9	1.4
1170	0.8	1.5	0.4	0.6	0.2	0.0	30.2	40.7	0	12.2	16.3	0	4.9	1.4
1171	0.8	1.6	0.4	0.6	0.2	0.0	30.2	40.7	0	12.2	16.3	0	4.9	1.4
1172	1.1	2.3	0.6	0.9	0.2	0.0	30.5	40.7	0	12.4	16.3	0	4.9	1.4
1178	0.7	2.4	0.3	0.6	0.1	0.0	30.1	40.7	0	12.1	16.3	0	4.8	1.4
1179	0.2	1.0	0.1	0.2	0.0	0.0	29.6	40.7	0	11.9	16.3	0	4.7	1.4
1198	1.5	4.9	0.7	1.4	0.3	0.0	30.9	40.7	0	12.5	16.3	0	5.0	1.4
1199	1.5	4.7	0.7	1.4	0.3	0.0	30.9	40.7	0	12.5	16.3	0	5.0	1.4
1200	0.4	2.2	0.2	0.4	0.0	0.0	29.8	40.7	0	12.0	16.3	0	4.7	1.4
1201	0.1	0.9	0.1	0.1	0.0	0.0	29.5	40.7	0	11.9	16.3	0	4.7	1.4

Table E1. Year 1 – Incremental and Cumulative Particulate Matter Concentration/Deposition Results for Project (CHC-owned receptors are marked by grey shaded cells)

Residence ID	Incremental Concentration/Deposition due to Project						Cumulative Concentration/Deposition due to Project + Background Air Quality							
	TSP Annual Average µg/m³	PM_{10} Maximum 24-hr µg/m³	PM_{10} Annual Average µg/m³	$PM_{2.5}$ Maximum 24-hr µg/m³	$PM_{2.5}$ Annual Average µg/m³	Deposition Annual Average g/m²/month	TSP Annual Average µg/m³	PM_{10} Maximum 24-hr µg/m³(b)	PM_{10} No. Of Days >50 µg/m³	PM_{10} Annual Average µg/m³	$PM_{2.5}$ Maximum 24-hr µg/m³[(b)]	$PM_{2.5}$ No. Of Days >25µg/m³	$PM_{2.5}$ Annual Average µg/m³	Deposition Annual Average g/m²/month
Criteria	**NA**	**NA**	**NA**	**NA**	**NA**	**2**	**90**	**50**	**NA**	**30**	**25[(a)]**	**NA**	**8[(a)]**	**4**
1213	1.4	4.9	0.6	1.2	0.2	0.0	30.8	40.8	0	12.4	16.3	0	4.9	1.4
1215	0.5	3.2	0.2	0.6	0.0	0.0	29.9	40.7	0	12.0	16.3	0	4.7	1.4
1222	6.7	13.6	3.1	3.7	1.0	0.1	36.1	43.5	0	14.9	16.6	0	5.7	1.5
1223	6.9	12.6	3.1	3.8	1.0	0.1	36.3	43.3	0	14.9	16.7	0	5.7	1.5
1225	2.0	5.8	0.8	0.9	0.1	0.1	31.4	41.3	0	12.6	16.4	0	4.8	1.5
1230	2.0	6.9	1.0	2.5	0.4	0.0	31.4	40.7	0	12.8	16.3	0	5.1	1.4
1232	2.2	5.3	1.1	2.6	0.4	0.0	31.6	40.9	0	12.9	16.3	0	5.1	1.4
1233	1.5	5.4	0.7	1.7	0.3	0.0	30.9	40.7	0	12.5	16.3	0	5.0	1.4
1234	1.4	5.0	0.7	1.6	0.2	0.0	30.8	40.7	0	12.5	16.3	0	4.9	1.4
1240	1.0	3.5	0.5	1.0	0.2	0.1	30.4	40.7	0	12.3	16.3	0	4.9	1.5
1243	1.0	3.1	0.5	1.0	0.2	0.1	30.4	40.7	0	12.3	16.3	0	4.9	1.5
1252	1.1	6.5	0.5	1.0	0.1	0.1	30.5	40.7	0	12.3	16.3	0	4.8	1.5
1253	1.1	6.8	0.5	1.1	0.2	0.1	30.5	40.7	0	12.3	16.3	0	4.9	1.5
3086	0.2	1.2	0.1	0.2	0.0	0.0	29.6	40.7	0	11.9	16.3	0	4.7	1.4
3108	0.3	2.9	0.1	0.5	0.0	0.0	29.7	40.7	0	11.9	16.3	0	4.7	1.4
3224	7.6	11.8	3.4	4.4	1.1	0.2	37.0	43.2	0	15.2	17.2	0	5.8	1.6
5001	0.2	1.8	0.1	0.3	0.0	0.0	29.6	40.7	0	11.9	16.3	0	4.7	1.4
5003	0.1	1.4	0.0	0.2	0.0	0.0	29.5	40.7	0	11.8	16.3	0	4.7	1.4
5006	0.9	2.6	0.5	0.8	0.2	0.0	30.3	40.7	0	12.3	16.3	0	4.9	1.4
5024	3.8	8.3	1.8	2.6	0.6	0.1	33.2	42.2	0	13.6	16.5	0	5.3	1.5
5025	4.8	9.2	2.1	3.1	0.7	0.1	34.2	42.6	0	13.9	16.5	0	5.4	1.5

Table E1. Year 1 – Incremental and Cumulative Particulate Matter Concentration/Deposition Results for Project (CHC-owned receptors are marked by grey shaded cells)

Residence ID	Incremental Concentration/Deposition due to Project						Cumulative Concentration/Deposition due to Project + Background Air Quality							
	TSP Annual Average µg/m³	PM_{10} Maximum 24-hr µg/m³	PM_{10} Annual Average µg/m³	$PM_{2.5}$ Maximum 24-hr µg/m³	$PM_{2.5}$ Annual Average µg/m³	Deposition Annual Average g/m²/month	TSP Annual Average µg/m³	PM_{10} Maximum 24-hr µg/m³(b)	PM_{10} No. Of Days >50 µg/m³	PM_{10} Annual Average µg/m³	$PM_{2.5}$ Maximum 24-hr µg/m³(b)	$PM_{2.5}$ No. Of Days >25µg/m³	$PM_{2.5}$ Annual Average µg/m³	Deposition Annual Average g/m²/month
Criteria	**NA**	**NA**	**NA**	**NA**	**NA**	**2**	**90**	**50**	**NA**	**30**	**25(a)**	**NA**	**8(a)**	**4**
1083	0.1	1.3	0.0	0.1	0.0	0.0	29.5	40.7	0	11.8	16.3	0	4.7	1.4
1093	0.1	1.0	0.0	0.1	0.0	0.0	29.5	40.7	0	11.8	16.3	0	4.7	1.4
1180	2.2	5.7	1.1	1.9	0.5	0.0	31.6	40.7	0	12.9	16.3	0	5.2	1.4
1203	0.5	2.9	0.2	0.6	0.0	0.0	29.9	40.7	0	12.0	16.3	0	4.7	1.4
1228	2.0	10.1	1.0	2.4	0.4	0.0	31.4	40.7	0	12.8	16.3	0	5.1	1.4
2087	0.6	3.3	0.3	0.4	0.0	0.1	30.0	40.7	0	12.1	16.3	0	4.7	1.5
2128	0.9	3.4	0.4	0.8	0.1	0.1	30.3	40.7	0	12.2	16.3	0	4.8	1.5
2174	1.4	2.9	0.7	1.1	0.3	0.0	30.8	40.7	0	12.5	16.3	0	5.0	1.4
2176	1.5	4.0	0.7	1.3	0.3	0.0	30.9	40.7	0	12.5	16.3	0	5.0	1.4
2189	1.3	2.4	0.7	1.2	0.3	0.0	30.7	40.7	0	12.5	16.3	0	5.0	1.4
2208	1.5	3.3	0.8	1.2	0.3	0.0	30.9	40.7	0	12.6	16.3	0	5.0	1.4
2209	2.0	3.9	1.0	1.5	0.4	0.0	31.4	40.7	0	12.8	16.3	0	5.1	1.4
2221	2.0	8.3	1.0	2.7	0.4	0.0	31.4	40.7	0	12.8	16.3	0	5.1	1.4
3098	0.1	1.3	0.0	0.1	0.0	0.0	29.5	40.7	0	11.8	16.3	0	4.7	1.4
3099	0.1	1.2	0.0	0.1	0.0	0.0	29.5	40.7	0	11.8	16.3	0	4.7	1.4
3100	0.1	1.4	0.0	0.2	0.0	0.0	29.5	40.7	0	11.8	16.3	0	4.7	1.4
3107	0.2	2.4	0.1	0.4	0.0	0.0	29.6	40.7	0	11.9	16.3	0	4.7	1.4
3113	0.3	3.9	0.1	0.8	0.0	0.0	29.7	40.7	0	11.9	16.3	0	4.7	1.4
3115	0.2	3.0	0.1	0.5	0.0	0.0	29.6	40.7	0	11.9	16.3	0	4.7	1.4
3117	0.2	2.8	0.1	0.5	0.0	0.0	29.6	40.7	0	11.9	16.3	0	4.7	1.4
3118	0.2	2.5	0.1	0.4	0.0	0.0	29.6	40.7	0	11.9	16.3	0	4.7	1.4

Table E1. Year 1 – Incremental and Cumulative Particulate Matter Concentration/Deposition Results for Project (CHC-owned receptors are marked by grey shaded cells)

Residence ID	Incremental Concentration/Deposition due to Project						Cumulative Concentration/Deposition due to Project + Background Air Quality							
	TSP Annual Average µg/m³	PM_{10} Maximum 24-hr µg/m³	PM_{10} Annual Average µg/m³	$PM_{2.5}$ Maximum 24-hr µg/m³	$PM_{2.5}$ Annual Average µg/m³	Deposition Annual Average g/m²/month	TSP Annual Average µg/m³	PM_{10} Maximum 24-hr µg/m³(b)	PM_{10} No. Of Days >50 µg/m³	PM_{10} Annual Average µg/m³	$PM_{2.5}$ Maximum 24-hr µg/m³(b)	$PM_{2.5}$ No. Of Days >25µg/m³	$PM_{2.5}$ Annual Average µg/m³	Deposition Annual Average g/m²/month
Criteria	**NA**	**NA**	**NA**	**NA**	**NA**	**2**	**90**	**50**	**NA**	**30**	**25[a]**	**NA**	**8[a]**	**4**
3126	4.9	15.0	2.3	5.2	1.1	0.1	34.3	40.9	0	14.1	16.3	0	5.8	1.5
3177	0.8	3.1	0.3	0.5	0.1	0.0	30.2	40.7	0	12.1	16.3	0	4.8	1.4
3218	4.6	8.5	2.1	3.0	0.7	0.1	34.0	41.4	0	13.9	16.4	0	5.4	1.5
3219	7.4	12.0	3.2	4.4	1.0	0.2	36.8	43.1	0	15.0	16.7	0	5.7	1.6
4081	0.1	0.8	0.0	0.1	0.0	0.0	29.5	40.7	0	11.8	16.3	0	4.7	1.4
4084	0.1	1.1	0.0	0.1	0.0	0.0	29.5	40.7	0	11.8	16.3	0	4.7	1.4
4085	0.2	1.2	0.1	0.2	0.0	0.0	29.6	40.7	0	11.9	16.3	0	4.7	1.4
4090	0.3	2.1	0.1	0.4	0.0	0.0	29.7	40.7	0	11.9	16.3	0	4.7	1.4
4101	0.1	1.5	0.0	0.2	0.0	0.0	29.5	40.7	0	11.8	16.3	0	4.7	1.4
4102	0.1	1.5	0.0	0.2	0.0	0.0	29.5	40.7	0	11.8	16.3	0	4.7	1.4
4103	0.1	1.7	0.1	0.2	0.0	0.0	29.5	40.7	0	11.9	16.3	0	4.7	1.4
4104	0.2	1.7	0.1	0.3	0.0	0.0	29.6	40.7	0	11.9	16.3	0	4.7	1.4
4105	0.2	2.0	0.1	0.4	0.0	0.0	29.6	40.7	0	11.9	16.3	0	4.7	1.4
4106	0.2	1.9	0.1	0.3	0.0	0.0	29.6	40.7	0	11.9	16.3	0	4.7	1.4
4109	0.7	3.9	0.3	1.1	0.1	0.0	30.1	40.7	0	12.1	16.3	0	4.8	1.4
4116	0.2	2.4	0.1	0.4	0.0	0.0	29.6	40.7	0	11.9	16.3	0	4.7	1.4
4123	1.5	10.4	0.7	2.6	0.3	0.0	30.9	40.7	0	12.5	16.3	0	5.0	1.4
4125	1.6	8.3	0.8	2.1	0.3	0.0	31.0	40.7	0	12.6	16.3	0	5.0	1.4
4150	34.3	100.8	15.1	20.5	3.7	3.7	63.7	111.2	39	26.9	26.0	1	8.4	5.1
4151	18.6	28.4	8.1	11.5	3.1	0.8	48.0	44.5	0	19.9	18.2	0	7.8	2.2
4161	0.7	3.3	0.3	0.7	0.1	0.0	30.1	40.7	0	12.1	16.3	0	4.8	1.4

Table E1. Year 1 – Incremental and Cumulative Particulate Matter Concentration/Deposition Results for Project (CHC-owned receptors are marked by grey shaded cells)

Residence ID	Incremental Concentration/Deposition due to Project						Cumulative Concentration/Deposition due to Project + Background Air Quality							
	TSP Annual Average µg/m³	PM_{10} Maximum 24-hr µg/m³	PM_{10} Annual Average µg/m³	$PM_{2.5}$ Maximum 24-hr µg/m³	$PM_{2.5}$ Annual Average µg/m³	Deposition Annual Average g/m²/month	TSP Annual Average µg/m³	PM_{10} Maximum 24-hr µg/m³(b)	PM_{10} No. Of Days >50 µg/m³	PM_{10} Annual Average µg/m³	$PM_{2.5}$ Maximum 24-hr µg/m³(b)	$PM_{2.5}$ No. Of Days >25µg/m³	$PM_{2.5}$ Annual Average µg/m³	Deposition Annual Average g/m²/month
Criteria	**NA**	**NA**	**NA**	**NA**	**NA**	**2**	**90**	**50**	**NA**	**30**	**25(a)**	**NA**	**8(a)**	**4**
4163	23.4	43.1	10.0	18.3	4.1	0.7	52.8	55.7	2	21.8	23.2	0	8.8	2.1
4182	3.1	8.5	1.5	2.7	0.7	0.0	32.5	40.7	0	13.3	16.3	0	5.4	1.4
4183	5.3	13.5	2.5	3.3	0.9	0.1	34.7	40.7	0	14.3	16.3	0	5.6	1.5
4190	44.7	79.5	20.2	17.8	5.0	0.7	74.1	95.9	44	32.0	26.5	1	9.7	2.1
4191	42.9	75.7	19.5	17.4	5.0	0.7	72.3	93.4	44	31.3	26.5	1	9.7	2.1
4193	26.4	31.6	12.0	14.5	4.0	0.5	55.8	57.3	1	23.8	23.1	0	8.7	1.9
4194	20.4	23.3	9.3	11.6	3.3	0.3	49.8	48.6	0	21.1	18.5	0	8.0	1.7
4196	4.9	10.1	2.4	4.0	1.1	0.1	34.3	40.9	0	14.2	16.3	0	5.8	1.5
4205	33.5	55.7	15.4	14.4	4.3	0.6	62.9	79.1	12	27.2	25.1	1	9.0	2.0
5002	5.0	10.0	2.5	4.1	1.1	0.1	34.4	41.0	0	14.3	16.3	0	5.8	1.5
5007	4.5	16.2	2.2	5.7	0.9	0.0	33.9	40.7	0	14.0	16.3	0	5.6	1.4
5008	6.1	21.6	3.0	6.2	1.1	0.1	35.5	40.7	0	14.8	16.3	0	5.8	1.5
5009	23.4	27.0	10.5	12.2	3.5	0.4	52.8	48.5	0	22.3	18.7	0	8.2	1.8
5010	0.8	5.4	0.3	0.7	0.1	0.1	30.2	40.7	0	12.1	16.3	0	4.8	1.5

NA – Not applicable. Criteria are applicable to cumulative concentrations.

(a) The NEPM Advisory Reporting Standards for $PM_{2.5}$ are referenced for screening assessment purposes.

(b) The maximum cumulative value is not a sum of the maximum increment and the maximum baseline concentrations, since these maximums may occur on different days. Rather the maximum 24-hour cumulative concentrations reflect days on which background levels plus the concurrent Project-related increment were highest.

Table E2. Year 2 – Incremental and Cumulative Particulate Matter Concentration/Deposition Results for Project (CHC-owned receptors are marked by grey shaded cells)

Residence ID	Incremental Concentration/Deposition due to Project						Cumulative Concentration/Deposition due to Project + Background Air Quality							
	TSP Annual Average µg/m³	PM_{10} Maximum 24-hr µg/m³	PM_{10} Annual Average µg/m³	$PM_{2.5}$ Maximum 24-hr µg/m³	$PM_{2.5}$ Annual Average µg/m³	Deposition Annual Average g/m²/month	TSP Annual Average µg/m³	PM_{10} Maximum 24-hr µg/m³(b)	PM_{10} No. Of Days >50 µg/m³	PM_{10} Annual Average µg/m³	$PM_{2.5}$ Maximum 24-hr µg/m³(b)	$PM_{2.5}$ No. Of Days >25µg/m³	$PM_{2.5}$ Annual Average µg/m³	Deposition Annual Average g/m²/month
Criteria	**NA**	**NA**	**NA**	**NA**	**NA**	**2**	**90**	**50**	**NA**	**30**	**25[a]**	**NA**	**8[a]**	**4**
1088	1.6	3.6	0.8	1.2	0.3	0.1	31.0	40.7	0	12.6	16.3	0	5.0	1.5
1089	1.6	3.6	0.8	1.2	0.3	0.1	31.0	40.7	0	12.6	16.3	0	5.0	1.5
1094	0.2	1.2	0.1	0.2	0.0	0.0	29.6	40.7	0	11.9	16.3	0	4.7	1.4
1122	0.3	1.4	0.1	0.3	0.0	0.0	29.7	40.7	0	11.9	16.3	0	4.7	1.4
1133	1.9	3.3	0.9	1.4	0.4	0.0	31.3	40.7	0	12.7	16.3	0	5.1	1.4
1143	1.7	3.0	0.8	1.3	0.4	0.0	31.1	40.7	0	12.6	16.3	0	5.1	1.4
1144	1.7	3.0	0.8	1.3	0.4	0.0	31.1	40.7	0	12.6	16.3	0	5.1	1.4
1145	1.7	3.0	0.8	1.4	0.4	0.0	31.1	40.7	0	12.6	16.3	0	5.1	1.4
1147	1.8	3.3	0.9	1.1	0.4	0.0	31.2	40.7	0	12.7	16.3	0	5.1	1.4
1149	2.0	3.7	1.0	1.4	0.4	0.0	31.4	40.7	0	12.8	16.3	0	5.1	1.4
1158	0.3	1.5	0.1	0.3	0.0	0.0	29.7	40.7	0	11.9	16.3	0	4.7	1.4
1166	1.7	2.9	0.9	1.5	0.4	0.0	31.1	40.7	0	12.7	16.3	0	5.1	1.4
1170	1.9	3.6	1.0	1.6	0.4	0.0	31.3	40.7	0	12.8	16.3	0	5.1	1.4
1171	1.9	3.7	1.0	1.7	0.4	0.0	31.3	40.7	0	12.8	16.3	0	5.1	1.4
1172	2.4	3.9	1.2	1.7	0.5	0.0	31.8	40.7	0	13.0	16.3	0	5.2	1.4
1178	2.1	7.2	0.9	2.0	0.3	0.0	31.5	40.7	0	12.7	16.3	0	5.0	1.4
1179	0.6	2.6	0.2	0.6	0.1	0.0	30.0	40.7	0	12.0	16.3	0	4.8	1.4
1198	3.4	13.9	1.6	3.1	0.6	0.0	32.8	40.7	0	13.4	16.3	0	5.3	1.4
1199	3.3	13.4	1.6	3.0	0.6	0.0	32.7	40.7	0	13.4	16.3	0	5.3	1.4
1200	1.1	6.3	0.5	1.3	0.1	0.0	30.5	40.7	0	12.3	16.3	0	4.8	1.4
1201	0.4	2.5	0.1	0.4	0.0	0.0	29.8	40.7	0	11.9	16.3	0	4.7	1.4

Table E2. Year 2 – Incremental and Cumulative Particulate Matter Concentration/Deposition Results for Project (CHC-owned receptors are marked by grey shaded cells)

Residence ID	Incremental Concentration/Deposition due to Project						Cumulative Concentration/Deposition due to Project + Background Air Quality							
	TSP Annual Average µg/m³	PM_{10} Maximum 24-hr µg/m³	PM_{10} Annual Average µg/m³	$PM_{2.5}$ Maximum 24-hr µg/m³	$PM_{2.5}$ Annual Average µg/m³	Deposition Annual Average g/m²/month	TSP Annual Average µg/m³	PM_{10} Maximum 24-hr µg/m³(b)	PM_{10} No. Of Days >50 µg/m³	PM_{10} Annual Average µg/m³	$PM_{2.5}$ Maximum 24-hr µg/m³(b)	$PM_{2.5}$ No. Of Days >25µg/m³	$PM_{2.5}$ Annual Average µg/m³	Deposition Annual Average g/m²/month
Criteria	**NA**	**NA**	**NA**	**NA**	**NA**	**2**	**90**	**50**	**NA**	**30**	**25[a]**	**NA**	**8[a]**	**4**
1213	4.1	9.2	1.8	2.8	0.6	0.1	33.5	40.9	0	13.6	16.3	0	5.3	1.5
1215	1.6	4.9	0.7	1.3	0.2	0.0	31.0	40.7	0	12.5	16.3	0	4.9	1.4
1222	12.6	23.4	5.4	5.8	1.6	0.2	42.0	49.5	1	17.2	18.2	0	6.3	1.6
1223	13.0	24.3	5.6	6.0	1.6	0.2	42.4	50.6	1	17.4	18.6	0	6.3	1.6
1225	5.0	12.4	2.0	2.3	0.4	0.2	34.4	42.7	0	13.8	16.5	0	5.1	1.6
1230	4.2	11.2	2.0	5.0	0.8	0.1	33.6	40.7	0	13.8	16.3	0	5.5	1.5
1232	4.6	11.2	2.2	5.1	0.8	0.1	34.0	40.9	0	14.0	16.3	0	5.5	1.5
1233	3.2	8.2	1.5	3.6	0.6	0.0	32.6	40.7	0	13.3	16.3	0	5.3	1.4
1234	3.0	7.9	1.5	3.4	0.6	0.0	32.4	40.7	0	13.3	16.3	0	5.3	1.4
1240	2.1	5.6	1.0	1.6	0.4	0.1	31.5	40.7	0	12.8	16.3	0	5.1	1.5
1243	2.2	7.5	1.0	1.8	0.4	0.1	31.6	40.7	0	12.8	16.3	0	5.1	1.5
1252	2.5	9.7	1.1	2.1	0.4	0.1	31.9	40.7	0	12.9	16.3	0	5.1	1.5
1253	2.5	8.6	1.1	2.0	0.4	0.1	31.9	40.7	0	12.9	16.3	0	5.1	1.5
3086	0.6	4.1	0.2	0.6	0.0	0.0	30.0	40.7	0	12.0	16.3	0	4.7	1.4
3108	1.3	7.6	0.6	1.8	0.2	0.0	30.7	40.7	0	12.4	16.3	0	4.9	1.4
3224	13.9	25.0	6.0	6.3	1.8	0.3	43.3	52.2	1	17.8	19.0	0	6.5	1.7
5001	0.7	4.5	0.3	1.0	0.1	0.0	30.1	40.7	0	12.1	16.3	0	4.8	1.4
5003	0.2	1.2	0.1	0.2	0.0	0.0	29.6	40.7	0	11.9	16.3	0	4.7	1.4
5006	2.1	4.1	1.0	1.4	0.4	0.0	31.5	40.7	0	12.8	16.3	0	5.1	1.4
5024	3.8	15.8	3.4	4.3	1.0	0.1	37.2	45.8	0	15.2	17.1	0	5.7	1.5
5025	4.8	18.4	3.9	4.9	1.2	0.2	38.5	47.0	0	15.7	17.7	0	5.9	1.6

Table E2. Year 2 – Incremental and Cumulative Particulate Matter Concentration/Deposition Results for Project (CHC-owned receptors are marked by grey shaded cells)

Residence ID	Incremental Concentration/Deposition due to Project						Cumulative Concentration/Deposition due to Project + Background Air Quality							
	TSP Annual Average µg/m³	PM_{10} Maximum 24-hr µg/m³	PM_{10} Annual Average µg/m³	$PM_{2.5}$ Maximum 24-hr µg/m³	$PM_{2.5}$ Annual Average µg/m³	Deposition Annual Average g/m²/month	TSP Annual Average µg/m³	PM_{10} Maximum 24-hr µg/m³(b)	PM_{10} No. Of Days >50 µg/m³	PM_{10} Annual Average µg/m³	$PM_{2.5}$ Maximum 24-hr µg/m³(b)	$PM_{2.5}$ No. Of Days >25µg/m³	$PM_{2.5}$ Annual Average µg/m³	Deposition Annual Average g/m²/month
Criteria	**NA**	**NA**	**NA**	**NA**	**NA**	**2**	**90**	**50**	**NA**	**30**	**25(a)**	**NA**	**8(a)**	**4**
1083	0.2	1.2	0.1	0.2	0.0	0.0	29.6	40.7	0	11.9	16.3	0	4.7	1.4
1093	0.2	1.2	0.1	0.2	0.0	0.0	29.6	40.7	0	11.9	16.3	0	4.7	1.4
1180	5.0	17.5	2.3	4.1	0.9	0.0	34.4	40.8	0	14.1	16.3	0	5.6	1.4
1203	1.2	7.1	0.5	1.4	0.1	0.0	30.6	40.7	0	12.3	16.3	0	4.8	1.4
1228	4.4	13.4	2.2	4.8	0.9	0.1	33.8	40.7	0	14.0	16.3	0	5.6	1.5
2087	1.7	7.9	0.7	1.3	0.1	0.1	31.1	40.7	0	12.5	16.3	0	4.8	1.5
2128	2.0	6.2	0.9	1.6	0.3	0.1	31.4	40.7	0	12.7	16.3	0	5.0	1.5
2174	2.9	4.9	1.4	1.9	0.6	0.0	32.3	40.7	0	13.2	16.3	0	5.3	1.4
2176	3.0	7.6	1.5	2.9	0.6	0.0	32.4	40.7	0	13.3	16.3	0	5.3	1.4
2189	2.9	4.9	1.5	2.4	0.7	0.0	32.3	40.7	0	13.3	16.3	0	5.4	1.4
2208	3.5	7.0	1.8	3.3	0.8	0.0	32.9	40.7	0	13.6	16.3	0	5.5	1.4
2209	4.4	8.8	2.2	4.1	1.0	0.0	33.8	40.7	0	14.0	16.3	0	5.7	1.4
2221	4.2	11.3	2.1	5.2	0.9	0.0	33.6	40.7	0	13.9	16.3	0	5.6	1.4
3098	0.2	1.3	0.1	0.2	0.0	0.0	29.6	40.7	0	11.9	16.3	0	4.7	1.4
3099	0.2	1.5	0.1	0.2	0.0	0.0	29.6	40.7	0	11.9	16.3	0	4.7	1.4
3100	0.2	1.7	0.1	0.3	0.0	0.0	29.6	40.7	0	11.9	16.3	0	4.7	1.4
3107	0.9	6.1	0.4	1.4	0.1	0.0	30.3	40.7	0	12.2	16.3	0	4.8	1.4
3113	1.1	8.8	0.5	1.8	0.2	0.0	30.5	40.7	0	12.3	16.3	0	4.9	1.4
3115	0.6	6.4	0.3	1.1	0.1	0.0	30.0	40.7	0	12.1	16.3	0	4.8	1.4
3117	0.6	6.0	0.2	1.0	0.1	0.0	30.0	40.7	0	12.0	16.3	0	4.8	1.4
3118	0.5	5.4	0.2	0.9	0.0	0.0	29.9	40.7	0	12.0	16.3	0	4.7	1.4

Table E2. Year 2 – Incremental and Cumulative Particulate Matter Concentration/Deposition Results for Project (CHC-owned receptors are marked by grey shaded cells)

Residence ID	Incremental Concentration/Deposition due to Project						Cumulative Concentration/Deposition due to Project + Background Air Quality							
	TSP Annual Average µg/m³	PM_{10} Maximum 24-hr µg/m³	PM_{10} Annual Average µg/m³	$PM_{2.5}$ Maximum 24-hr µg/m³	$PM_{2.5}$ Annual Average µg/m³	Deposition Annual Average g/m²/month	TSP Annual Average µg/m³	PM_{10} Maximum 24-hr µg/m³(b)	PM_{10} No. Of Days >50 µg/m³	PM_{10} Annual Average µg/m³	$PM_{2.5}$ Maximum 24-hr µg/m³(b)	$PM_{2.5}$ No. Of Days >25µg/m³	$PM_{2.5}$ Annual Average µg/m³	Deposition Annual Average g/m²/month
Criteria	**NA**	**NA**	**NA**	**NA**	**NA**	**2**	**90**	**50**	**NA**	**30**	**25[a]**	**NA**	**8[a]**	**4**
3126	41.7	70.1	17.3	34.7	7.7	0.6	71.1	84.3	1	29.1	39.2	1	12.4	2.0
3177	2.8	10.5	1.2	2.3	0.4	0.1	32.2	40.7	0	13.0	16.3	0	5.1	1.5
3218	10.8	19.2	4.8	7.0	1.6	0.3	40.2	42.8	0	16.6	16.5	0	6.3	1.7
3219	13.2	21.0	5.7	5.9	1.8	0.3	42.6	50.4	1	17.5	18.7	0	6.5	1.7
4081	0.3	1.1	0.1	0.2	0.0	0.0	29.7	40.7	0	11.9	16.3	0	4.7	1.4
4084	0.2	1.0	0.1	0.1	0.0	0.0	29.6	40.7	0	11.9	16.3	0	4.7	1.4
4085	0.7	3.7	0.2	0.6	0.0	0.0	30.1	40.7	0	12.0	16.3	0	4.7	1.4
4090	1.1	6.7	0.4	1.5	0.1	0.0	30.5	40.7	0	12.2	16.3	0	4.8	1.4
4101	0.3	2.1	0.1	0.4	0.0	0.0	29.7	40.7	0	11.9	16.3	0	4.7	1.4
4102	0.3	2.2	0.1	0.4	0.0	0.0	29.7	40.7	0	11.9	16.3	0	4.7	1.4
4103	0.3	2.5	0.1	0.5	0.0	0.0	29.7	40.7	0	11.9	16.3	0	4.7	1.4
4104	0.4	3.0	0.1	0.6	0.0	0.0	29.8	40.7	0	11.9	16.3	0	4.7	1.4
4105	0.4	3.9	0.2	0.7	0.0	0.0	29.8	40.7	0	12.0	16.3	0	4.7	1.4
4106	0.5	4.4	0.2	1.0	0.0	0.0	29.9	40.7	0	12.0	16.3	0	4.7	1.4
4109	2.8	12.1	1.3	3.3	0.5	0.0	32.2	40.7	0	13.1	16.3	0	5.2	1.4
4116	0.5	5.2	0.2	0.9	0.0	0.0	29.9	40.7	0	12.0	16.3	0	4.7	1.4
4123	6.3	23.0	2.9	5.2	1.1	0.1	35.7	41.0	0	14.7	16.3	0	5.8	1.5
4125	7.0	23.7	3.2	7.1	1.3	0.1	36.4	41.3	0	15.0	16.4	0	6.0	1.5
4150	180.8	219.3	79.2	58.8	18.1	9.5	210.2	231.8	302	91.0	64.2	201	22.8	10.9
4151	35.8	62.5	16.1	19.3	5.6	1.3	65.2	76.1	20	27.9	25.1	2	10.3	2.7
4161	2.7	7.2	1.1	2.1	0.4	0.0	32.1	40.7	0	12.9	16.3	0	5.1	1.4

Table E2. Year 2 – Incremental and Cumulative Particulate Matter Concentration/Deposition Results for Project (CHC-owned receptors are marked by grey shaded cells)

Residence ID	Incremental Concentration/Deposition due to Project						Cumulative Concentration/Deposition due to Project + Background Air Quality							
	TSP Annual Average µg/m³	PM_{10} Maximum 24-hr µg/m³	PM_{10} Annual Average µg/m³	$PM_{2.5}$ Maximum 24-hr µg/m³	$PM_{2.5}$ Annual Average µg/m³	Deposition Annual Average g/m²/month	TSP Annual Average µg/m³	PM_{10} Maximum 24-hr µg/m³(b)	PM_{10} No. Of Days >50 µg/m³	PM_{10} Annual Average µg/m³	$PM_{2.5}$ Maximum 24-hr µg/m³(b)	$PM_{2.5}$ No. Of Days >25µg/m³	$PM_{2.5}$ Annual Average µg/m³	Deposition Annual Average g/m²/month
Criteria	**NA**	**NA**	**NA**	**NA**	**NA**	**2**	**90**	**50**	**NA**	**30**	**25(a)**	**NA**	**8(a)**	**4**
4163	35.6	69.9	15.7	21.8	5.6	0.8	65.0	84.8	11	27.5	26.9	1	10.3	2.2
4182	8.5	27.4	3.8	5.8	1.4	0.1	37.9	46.5	1	15.6	16.3	0	6.1	1.5
4183	10.4	17.8	4.7	5.7	1.7	0.2	39.8	40.8	0	16.5	16.3	0	6.4	1.6
4190	52.3	77.3	22.8	28.0	7.3	0.9	81.7	90.1	72	34.6	33.3	23	12.0	2.3
4191	53.3	81.6	23.7	30.3	7.8	0.9	82.7	93.3	72	35.5	35.8	23	12.5	2.3
4193	60.7	95.0	25.4	23.0	6.9	0.9	90.1	113.1	65	37.2	30.9	4	11.6	2.3
4194	48.6	69.5	20.6	20.0	5.7	0.7	78.0	82.1	36	32.4	26.8	1	10.4	2.1
4196	16.0	30.9	7.0	9.4	2.2	0.2	45.4	48.3	1	18.8	17.0	0	6.9	1.6
4205	48.7	79.3	22.1	29.8	7.6	0.7	78.1	91.5	57	33.9	37.3	20	12.3	2.1
5002	16.0	31.0	7.0	9.7	2.2	0.2	45.4	47.9	1	18.8	17.2	0	6.9	1.6
5007	8.2	20.1	4.0	9.4	1.7	0.1	37.6	40.7	0	15.8	16.5	0	6.4	1.5
5008	11.1	29.1	5.3	11.0	2.1	0.1	40.5	42.5	0	17.1	17.1	0	6.8	1.5
5009	56.1	81.8	23.7	22.9	6.5	0.7	85.5	95.2	72	35.5	28.6	5	11.2	2.1
5010	1.8	8.5	0.7	1.6	0.2	0.2	31.2	40.7	0	12.5	16.3	0	4.9	1.6

NA – Not applicable. Criteria are applicable to cumulative concentrations.

(a) The NEPM Advisory Reporting Standards for $PM_{2.5}$ are referenced for screening assessment purposes.

(b) The maximum cumulative value is not a sum of the maximum increment and the maximum baseline concentrations, since these maximums may occur on different days. Rather the maximum 24-hour cumulative concentrations reflect days on which background levels plus the concurrent Project-related increment were highest.

Table E3. Year 4 – Incremental and Cumulative Particulate Matter Concentration/Deposition Results for Project (CHC-owned receptors are marked by grey shaded cells)

Residence ID	Incremental Concentration/Deposition due to Project						Cumulative Concentration/Deposition due to Project + Background Air Quality							
	TSP Annual Average µg/m³	PM_{10} Maximum 24-hr µg/m³	PM_{10} Annual Average µg/m³	$PM_{2.5}$ Maximum 24-hr µg/m³	$PM_{2.5}$ Annual Average µg/m³	Deposition Annual Average g/m²/month	TSP Annual Average µg/m³	PM_{10} Maximum 24-hr µg/m³(b)	PM_{10} No. Of Days >50 µg/m³	PM_{10} Annual Average µg/m³	$PM_{2.5}$ Maximum 24-hr µg/m³(b)	$PM_{2.5}$ No. Of Days >25µg/m³	$PM_{2.5}$ Annual Average µg/m³	Deposition Annual Average g/m²/month
Criteria	**NA**	**NA**	**NA**	**NA**	**NA**	**2**	**90**	**50**	**NA**	**30**	**25[a]**	**NA**	**8[a]**	**4**
1088	2.6	5.2	1.3	2.0	0.6	0.1	32.0	40.7	0	13.1	16.3	0	5.3	1.5
1089	2.6	5.2	1.3	2.0	0.6	0.1	32.0	40.7	0	13.1	16.3	0	5.3	1.5
1094	0.3	2.4	0.1	0.4	0.0	0.0	29.7	40.7	0	11.9	16.3	0	4.7	1.4
1122	0.6	2.8	0.2	0.5	0.0	0.0	30.0	40.7	0	12.0	16.3	0	4.7	1.4
1133	3.0	4.9	1.5	2.3	0.7	0.1	32.4	40.7	0	13.3	16.3	0	5.4	1.5
1143	2.8	5.3	1.4	2.2	0.6	0.0	32.2	40.7	0	13.2	16.3	0	5.3	1.4
1144	2.8	5.2	1.4	2.3	0.6	0.0	32.2	40.7	0	13.2	16.3	0	5.3	1.4
1145	2.8	5.5	1.4	2.3	0.6	0.0	32.2	40.7	0	13.2	16.3	0	5.3	1.4
1147	2.8	6.4	1.4	1.9	0.6	0.0	32.2	40.7	0	13.2	16.3	0	5.3	1.4
1149	3.0	6.9	1.5	2.4	0.7	0.0	32.4	40.7	0	13.3	16.3	0	5.4	1.4
1158	0.7	2.9	0.3	0.6	0.1	0.0	30.1	40.7	0	12.1	16.3	0	4.8	1.4
1166	2.9	6.2	1.4	2.4	0.6	0.0	32.3	40.7	0	13.2	16.3	0	5.3	1.4
1170	3.6	6.2	1.8	2.6	0.8	0.0	33.0	40.7	0	13.6	16.3	0	5.5	1.4
1171	3.6	5.7	1.8	2.6	0.8	0.0	33.0	40.7	0	13.6	16.3	0	5.5	1.4
1172	3.8	8.4	1.9	3.1	0.9	0.0	33.2	40.7	0	13.7	16.3	0	5.6	1.4
1178	3.5	12.5	1.5	3.0	0.5	0.0	32.9	40.7	0	13.3	16.3	0	5.2	1.4
1179	1.1	4.6	0.5	1.0	0.1	0.0	30.5	40.7	0	12.3	16.3	0	4.8	1.4
1198	5.6	18.9	2.6	4.6	1.1	0.1	35.0	40.7	0	14.4	16.3	0	5.8	1.5
1199	5.5	19.5	2.6	4.7	1.0	0.1	34.9	40.7	0	14.4	16.3	0	5.7	1.5
1200	1.9	8.6	0.8	1.7	0.2	0.0	31.3	40.7	0	12.6	16.3	0	4.9	1.4
1201	0.6	3.6	0.2	0.7	0.0	0.0	30.0	40.7	0	12.0	16.3	0	4.7	1.4

Table E3. Year 4 – Incremental and Cumulative Particulate Matter Concentration/Deposition Results for Project (CHC-owned receptors are marked by grey shaded cells)

Residence ID	Incremental Concentration/Deposition due to Project						Cumulative Concentration/Deposition due to Project + Background Air Quality							
	TSP Annual Average µg/m³	PM_{10} Maximum 24-hr µg/m³	PM_{10} Annual Average µg/m³	$PM_{2.5}$ Maximum 24-hr µg/m³	$PM_{2.5}$ Annual Average µg/m³	Deposition Annual Average g/m²/month	TSP Annual Average µg/m³	PM_{10} Maximum 24-hr µg/m³(b)	PM_{10} No. Of Days >50 µg/m³	PM_{10} Annual Average µg/m³	$PM_{2.5}$ Maximum 24-hr µg/m³(b)	$PM_{2.5}$ No. Of Days >25µg/m³	$PM_{2.5}$ Annual Average µg/m³	Deposition Annual Average g/m²/month
Criteria	**NA**	**NA**	**NA**	**NA**	**NA**	**2**	**90**	**50**	**NA**	**30**	**25[a]**	**NA**	**8[a]**	**4**
1213	7.3	13.7	3.3	4.8	1.1	0.1	36.7	41.1	0	15.1	16.3	0	5.8	1.5
1215	3.1	7.9	1.3	2.0	0.4	0.1	32.5	40.8	0	13.1	16.3	0	5.1	1.5
1222	17.7	26.7	7.9	10.3	2.8	0.4	47.1	50.2	1	19.7	18.2	0	7.5	1.8
1223	17.4	25.6	7.8	9.9	2.8	0.4	46.8	49.6	0	19.6	18.3	0	7.5	1.8
1225	8.3	14.5	3.4	3.2	0.8	0.3	37.7	43.8	0	15.2	16.8	0	5.5	1.7
1230	8.5	19.4	4.0	7.2	1.5	0.1	37.9	41.3	0	15.8	16.4	0	6.2	1.5
1232	9.2	19.3	4.3	7.8	1.6	0.1	38.6	43.0	0	16.1	16.6	0	6.3	1.5
1233	6.2	15.3	2.9	6.0	1.1	0.1	35.6	40.8	0	14.7	16.3	0	5.8	1.5
1234	6.0	15.1	2.8	6.0	1.1	0.1	35.4	40.8	0	14.6	16.3	0	5.8	1.5
1240	3.3	7.0	1.6	2.5	0.7	0.2	32.7	40.7	0	13.4	16.3	0	5.4	1.6
1243	3.5	13.4	1.6	3.5	0.6	0.2	32.9	40.7	0	13.4	16.3	0	5.3	1.6
1252	3.9	12.7	1.7	2.8	0.5	0.2	33.3	40.7	0	13.5	16.3	0	5.2	1.6
1253	3.9	11.2	1.8	3.0	0.6	0.1	33.3	40.7	0	13.6	16.3	0	5.3	1.5
3086	1.0	7.0	0.4	1.0	0.1	0.1	30.4	40.7	0	12.2	16.3	0	4.8	1.5
3108	2.3	12.1	1.0	2.7	0.3	0.0	31.7	40.8	0	12.8	16.3	0	5.0	1.4
3224	17.8	27.0	7.9	8.8	2.7	0.4	47.2	53.3	1	19.7	20.1	0	7.4	1.8
5001	1.3	7.2	0.6	1.4	0.2	0.0	30.7	40.7	0	12.4	16.3	0	4.9	1.4
5003	0.3	2.1	0.1	0.3	0.0	0.0	29.7	40.7	0	11.9	16.3	0	4.7	1.4
5006	3.1	5.6	1.6	2.4	0.7	0.1	32.5	40.7	0	13.4	16.3	0	5.4	1.5
5024	10.8	15.2	4.9	6.4	1.7	0.2	40.2	45.6	0	16.7	16.8	0	6.4	1.6
5025	12.5	19.2	5.5	6.6	1.8	0.3	41.9	48.3	0	17.3	18.0	0	6.5	1.7

Table E3. Year 4 – Incremental and Cumulative Particulate Matter Concentration/Deposition Results for Project (CHC-owned receptors are marked by grey shaded cells)

Residence ID	Incremental Concentration/Deposition due to Project						Cumulative Concentration/Deposition due to Project + Background Air Quality							
	TSP Annual Average µg/m³	PM_{10} Maximum 24-hr µg/m³	PM_{10} Annual Average µg/m³	$PM_{2.5}$ Maximum 24-hr µg/m³	$PM_{2.5}$ Annual Average µg/m³	Deposition Annual Average g/m²/month	TSP Annual Average µg/m³	PM_{10} Maximum 24-hr µg/m³(b)	PM_{10} No. Of Days >50 µg/m³	PM_{10} Annual Average µg/m³	$PM_{2.5}$ Maximum 24-hr µg/m³(b)	$PM_{2.5}$ No. Of Days >25µg/m³	$PM_{2.5}$ Annual Average µg/m³	Deposition Annual Average g/m²/month
Criteria	**NA**	**NA**	**NA**	**NA**	**NA**	**2**	**90**	**50**	**NA**	**30**	**25[a]**	**NA**	**8[a]**	**4**
1083	0.3	1.9	0.1	0.3	0.0	0.0	29.7	40.7	0	11.9	16.3	0	4.7	1.4
1093	0.4	2.8	0.1	0.5	0.0	0.0	29.8	40.7	0	11.9	16.3	0	4.7	1.4
1180	8.9	21.0	4.2	7.1	1.7	0.1	38.3	42.0	0	16.0	16.3	0	6.4	1.5
1203	2.0	9.4	0.9	2.1	0.3	0.0	31.4	40.7	0	12.7	16.3	0	5.0	1.4
1228	8.9	18.4	4.2	8.3	1.7	0.1	38.3	40.7	0	16.0	16.3	0	6.4	1.5
2087	2.7	11.7	1.1	1.9	0.2	0.2	32.1	40.7	0	12.9	16.3	0	4.9	1.6
2128	3.5	7.4	1.6	2.1	0.5	0.2	32.9	40.7	0	13.4	16.3	0	5.2	1.6
2174	4.4	8.9	2.2	3.5	1.1	0.0	33.8	40.7	0	14.0	16.3	0	5.8	1.4
2176	5.3	11.0	2.5	4.9	1.1	0.1	34.7	40.7	0	14.3	16.3	0	5.8	1.5
2189	5.8	9.8	2.8	4.5	1.3	0.0	35.2	40.7	0	14.6	16.3	0	6.0	1.4
2208	7.5	16.8	3.7	7.2	1.6	0.0	36.9	40.7	0	15.5	16.3	0	6.3	1.4
2209	11.0	23.1	5.3	11.2	2.3	0.1	40.4	40.7	0	17.1	16.9	0	7.0	1.5
2221	9.3	22.0	4.4	8.3	1.8	0.1	38.7	40.8	0	16.2	16.3	0	6.5	1.5
3098	0.4	2.7	0.1	0.5	0.0	0.0	29.8	40.7	0	11.9	16.3	0	4.7	1.4
3099	0.4	3.2	0.2	0.6	0.0	0.0	29.8	40.7	0	12.0	16.3	0	4.7	1.4
3100	0.4	3.4	0.2	0.6	0.0	0.0	29.8	40.7	0	12.0	16.3	0	4.7	1.4
3107	1.7	9.4	0.8	2.0	0.2	0.0	31.1	40.7	0	12.6	16.3	0	4.9	1.4
3113	2.0	14.8	0.9	3.1	0.3	0.0	31.4	40.7	0	12.7	16.3	0	5.0	1.4
3115	1.1	10.5	0.5	2.0	0.1	0.0	30.5	40.7	0	12.3	16.3	0	4.8	1.4
3117	1.0	9.8	0.4	1.9	0.1	0.0	30.4	40.7	0	12.2	16.3	0	4.8	1.4
3118	1.0	9.1	0.4	1.7	0.1	0.0	30.4	40.7	0	12.2	16.3	0	4.8	1.4

Table E3. Year 4 – Incremental and Cumulative Particulate Matter Concentration/Deposition Results for Project (CHC-owned receptors are marked by grey shaded cells)

Residence ID	Incremental Concentration/Deposition due to Project						Cumulative Concentration/Deposition due to Project + Background Air Quality							
	TSP Annual Average µg/m³	PM_{10} Maximum 24-hr µg/m³	PM_{10} Annual Average µg/m³	$PM_{2.5}$ Maximum 24-hr µg/m³	$PM_{2.5}$ Annual Average µg/m³	Deposition Annual Average g/m²/month	TSP Annual Average µg/m³	PM_{10} Maximum 24-hr µg/m³(b)	PM_{10} No. Of Days >50 µg/m³	PM_{10} Annual Average µg/m³	$PM_{2.5}$ Maximum 24-hr µg/m³(b)	$PM_{2.5}$ No. Of Days >25µg/m³	$PM_{2.5}$ Annual Average µg/m³	Deposition Annual Average g/m²/month
Criteria	**NA**	**NA**	**NA**	**NA**	**NA**	**2**	**90**	**50**	**NA**	**30**	**25[a]**	**NA**	**8[a]**	**4**
3126	44.5	90.1	19.6	30.3	7.4	1.2	73.9	100.8	46	31.4	34.1	17	12.1	2.6
3177	5.1	17.4	2.1	3.5	0.6	0.1	34.5	41.5	0	13.9	16.3	0	5.3	1.5
3218	17.0	27.4	7.6	11.6	2.5	0.4	46.4	44.8	0	19.4	17.4	0	7.2	1.8
3219	17.7	28.9	7.7	9.2	2.4	0.4	47.1	59.5	1	19.5	21.9	0	7.1	1.8
4081	0.6	1.9	0.3	0.3	0.0	0.0	30.0	40.7	0	12.1	16.3	0	4.7	1.4
4084	0.3	1.3	0.1	0.2	0.0	0.0	29.7	40.7	0	11.9	16.3	0	4.7	1.4
4085	1.2	7.0	0.4	1.1	0.1	0.1	30.6	40.7	0	12.2	16.3	0	4.8	1.5
4090	2.1	12.7	0.8	2.4	0.2	0.1	31.5	40.7	0	12.6	16.3	0	4.9	1.5
4101	0.5	4.2	0.2	0.8	0.0	0.0	29.9	40.7	0	12.0	16.3	0	4.7	1.4
4102	0.5	4.4	0.2	0.8	0.0	0.0	29.9	40.7	0	12.0	16.3	0	4.7	1.4
4103	0.5	4.8	0.2	0.9	0.0	0.0	29.9	40.7	0	12.0	16.3	0	4.7	1.4
4104	0.7	6.4	0.3	1.3	0.1	0.0	30.1	40.7	0	12.1	16.3	0	4.8	1.4
4105	0.8	7.6	0.3	1.5	0.1	0.0	30.2	40.7	0	12.1	16.3	0	4.8	1.4
4106	0.9	8.1	0.4	1.8	0.1	0.0	30.3	40.7	0	12.2	16.3	0	4.8	1.4
4109	5.0	18.8	2.3	4.4	0.8	0.1	34.4	40.9	0	14.1	16.3	0	5.5	1.5
4116	0.9	8.6	0.3	1.7	0.1	0.0	30.3	40.7	0	12.1	16.3	0	4.8	1.4
4123	10.6	40.7	4.7	9.1	1.6	0.1	40.0	57.2	1	16.5	16.4	0	6.3	1.5
4125	11.8	40.4	5.2	9.6	1.8	0.1	41.2	56.9	1	17.0	16.7	0	6.5	1.5
4150	292.7	354.3	127.4	93.5	28.3	10.7	322.1	366.7	329	139.2	98.8	251	33.0	12.1
4151	82.3	103.7	35.5	46.7	13.4	2.4	111.7	113.8	177	47.3	52.7	59	18.1	3.8
4161	5.2	13.3	2.2	4.1	0.8	0.1	34.6	40.8	0	14.0	16.3	0	5.5	1.5

Table E3. Year 4 – Incremental and Cumulative Particulate Matter Concentration/Deposition Results for Project (CHC-owned receptors are marked by grey shaded cells)

Residence ID	Incremental Concentration/Deposition due to Project						Cumulative Concentration/Deposition due to Project + Background Air Quality							
	TSP Annual Average µg/m³	PM_{10} Maximum 24-hr µg/m³	PM_{10} Annual Average µg/m³	$PM_{2.5}$ Maximum 24-hr µg/m³	$PM_{2.5}$ Annual Average µg/m³	Deposition Annual Average g/m²/month	TSP Annual Average µg/m³	PM_{10} Maximum 24-hr µg/m³(b)	PM_{10} No. Of Days >50 µg/m³	PM_{10} Annual Average µg/m³	$PM_{2.5}$ Maximum 24-hr µg/m³(b)	$PM_{2.5}$ No. Of Days >25µg/m³	$PM_{2.5}$ Annual Average µg/m³	Deposition Annual Average g/m²/month
Criteria	**NA**	**NA**	**NA**	**NA**	**NA**	**2**	**90**	**50**	**NA**	**30**	**25(a)**	**NA**	**8(a)**	**4**
4163	96.8	163.4	37.8	39.6	11.7	4.9	126.2	176.3	162	49.6	46.0	37	16.4	6.3
4182	15.1	27.6	7.4	15.9	3.3	0.2	44.5	42.5	0	19.2	20.9	0	8.0	1.6
4183	31.9	52.0	14.4	29.5	6.9	0.9	61.3	63.0	3	26.2	33.9	1	11.6	2.3
4190	73.7	115.7	30.8	32.9	8.9	1.6	103.1	127.1	154	42.6	37.6	21	13.6	3.0
4191	72.6	109.0	30.6	34.4	9.1	1.4	102.0	119.4	154	42.4	39.0	21	13.8	2.8
4193	50.0	56.4	22.0	21.1	7.4	0.9	79.4	78.8	95	33.8	29.7	3	12.1	2.3
4194	40.3	49.2	17.9	17.7	6.3	0.6	69.7	68.8	23	29.7	25.3	1	11.0	2.0
4196	23.2	31.5	10.9	17.8	4.4	0.4	52.6	52.2	1	22.7	25.3	1	9.1	1.8
4205	61.0	87.7	26.6	31.0	8.5	1.0	90.4	98.6	161	38.4	36.2	35	13.2	2.4
5002	23.1	31.6	10.8	17.1	4.3	0.4	52.5	51.6	1	22.6	24.4	0	9.0	1.8
5007	21.9	49.6	10.1	18.6	3.9	0.2	51.3	63.4	12	21.9	23.6	0	8.6	1.6
5008	28.4	70.0	12.8	18.3	4.7	0.3	57.8	80.0	27	24.6	23.5	0	9.4	1.7
5009	45.2	55.6	20.2	22.3	7.1	0.7	74.6	77.8	38	32.0	29.2	3	11.8	2.1
5010	2.8	11.4	1.2	2.1	0.3	0.2	32.2	40.7	0	13.0	16.3	0	5.0	1.6

NA – Not applicable. Criteria are applicable to cumulative concentrations.

(a) The NEPM Advisory Reporting Standards for $PM_{2.5}$ are referenced for screening assessment purposes.

(b) The maximum cumulative value is not a sum of the maximum increment and the maximum baseline concentrations, since these maximums may occur on different days. Rather the maximum 24-hour cumulative concentrations reflect days on which background levels plus the concurrent Project-related increment were highest.

Table E4. Year 8 – Incremental and Cumulative Particulate Matter Concentration/Deposition Results for Project (CHC-owned receptors are marked by grey shaded cells)

Residence ID	Incremental Concentration/Deposition due to Project						Cumulative Concentration/Deposition due to Project + Background Air Quality							
	TSP Annual Average µg/m³	PM_{10} Maximum 24-hr µg/m³	PM_{10} Annual Average µg/m³	$PM_{2.5}$ Maximum 24-hr µg/m³	$PM_{2.5}$ Annual Average µg/m³	Deposition Annual Average g/m²/month	TSP Annual Average µg/m³	PM_{10} Maximum 24-hr µg/m³(b)	PM_{10} No. Of Days >50 µg/m³	PM_{10} Annual Average µg/m³	$PM_{2.5}$ Maximum 24-hr µg/m³[(b)]	$PM_{2.5}$ No. Of Days >25µg/m³	$PM_{2.5}$ Annual Average µg/m³	Deposition Annual Average g/m²/month
Criteria	**NA**	**NA**	**NA**	**NA**	**NA**	**2**	**90**	**50**	**NA**	**30**	**25[(a)]**	**NA**	**8[(a)]**	**4**
1088	3.1	5.3	1.6	2.4	0.7	0.1	32.5	40.7	0	13.4	16.3	0	5.4	1.5
1089	3.1	5.4	1.6	2.4	0.7	0.1	32.5	40.7	0	13.4	16.3	0	5.4	1.5
1094	0.4	2.3	0.1	0.4	0.0	0.0	29.8	40.7	0	11.9	16.3	0	4.7	1.4
1122	0.7	3.5	0.3	0.6	0.0	0.0	30.1	40.7	0	12.1	16.3	0	4.7	1.4
1133	3.5	5.9	1.8	2.9	0.9	0.1	32.9	40.7	0	13.6	16.3	0	5.6	1.5
1143	3.0	5.6	1.6	2.6	0.8	0.0	32.4	40.7	0	13.4	16.3	0	5.5	1.4
1144	3.0	5.7	1.6	2.5	0.8	0.0	32.4	40.7	0	13.4	16.3	0	5.5	1.4
1145	3.0	5.8	1.6	2.6	0.8	0.0	32.4	40.7	0	13.4	16.3	0	5.5	1.4
1147	3.2	5.5	1.7	2.9	0.8	0.0	32.6	40.7	0	13.5	16.3	0	5.5	1.4
1149	3.5	6.6	1.8	3.1	0.9	0.0	32.9	40.7	0	13.6	16.3	0	5.6	1.4
1158	0.8	3.7	0.3	0.8	0.1	0.0	30.2	40.7	0	12.1	16.3	0	4.8	1.4
1166	3.0	6.3	1.6	2.5	0.8	0.0	32.4	40.7	0	13.4	16.3	0	5.5	1.4
1170	3.3	6.4	1.7	2.9	0.9	0.0	32.7	40.7	0	13.5	16.3	0	5.6	1.4
1171	3.3	6.5	1.7	2.9	0.9	0.0	32.7	40.7	0	13.5	16.3	0	5.6	1.4
1172	4.2	7.8	2.2	3.8	1.1	0.0	33.6	40.7	0	14.0	16.3	0	5.8	1.4
1178	4.5	15.6	2.0	3.8	0.7	0.0	33.9	41.5	0	13.8	16.3	0	5.4	1.4
1179	1.4	5.4	0.6	1.2	0.2	0.0	30.8	40.7	0	12.4	16.3	0	4.9	1.4
1198	7.7	22.6	3.6	6.3	1.5	0.1	37.1	41.9	0	15.4	16.3	0	6.2	1.5
1199	7.3	21.9	3.5	6.4	1.5	0.1	36.7	41.6	0	15.3	16.3	0	6.2	1.5
1200	2.6	12.6	1.1	2.7	0.4	0.0	32.0	40.7	0	12.9	16.3	0	5.1	1.4
1201	0.8	5.3	0.3	0.8	0.1	0.0	30.2	40.7	0	12.1	16.3	0	4.8	1.4

Table E4. Year 8 – Incremental and Cumulative Particulate Matter Concentration/Deposition Results for Project (CHC-owned receptors are marked by grey shaded cells)

Residence ID	Incremental Concentration/Deposition due to Project						Cumulative Concentration/Deposition due to Project + Background Air Quality							
	TSP Annual Average µg/m³	PM_{10} Maximum 24-hr µg/m³	PM_{10} Annual Average µg/m³	$PM_{2.5}$ Maximum 24-hr µg/m³	$PM_{2.5}$ Annual Average µg/m³	Deposition Annual Average g/m²/month	TSP Annual Average µg/m³	PM_{10} Maximum 24-hr µg/m³(b)	PM_{10} No. Of Days >50 µg/m³	PM_{10} Annual Average µg/m³	$PM_{2.5}$ Maximum 24-hr µg/m³(b)	$PM_{2.5}$ No. Of Days >25µg/m³	$PM_{2.5}$ Annual Average µg/m³	Deposition Annual Average g/m²/month
Criteria	**NA**	**NA**	**NA**	**NA**	**NA**	**2**	**90**	**50**	**NA**	**30**	**25[a]**	**NA**	**8[a]**	**4**
1213	9.8	17.5	4.3	5.5	1.5	0.1	39.2	41.4	0	16.1	16.3	0	6.2	1.5
1215	4.2	10.3	1.8	2.4	0.6	0.1	33.6	40.9	0	13.6	16.3	0	5.3	1.5
1222	19.1	28.7	8.9	10.2	3.4	0.4	48.5	55.0	1	20.7	21.5	0	8.1	1.8
1223	18.9	29.1	8.8	10.0	3.4	0.4	48.3	55.1	1	20.6	21.7	0	8.1	1.8
1225	10.9	19.4	4.6	5.1	1.3	0.3	40.3	46.0	0	16.4	17.0	0	6.0	1.7
1230	9.0	22.2	4.4	8.9	1.8	0.1	38.4	41.7	0	16.2	16.5	0	6.5	1.5
1232	8.7	14.8	4.2	7.3	1.7	0.1	38.1	42.2	0	16.0	16.5	0	6.4	1.5
1233	6.8	18.6	3.3	7.6	1.4	0.1	36.2	40.9	0	15.1	16.3	0	6.1	1.5
1234	6.6	19.0	3.3	7.6	1.4	0.1	36.0	40.9	0	15.1	16.3	0	6.1	1.5
1240	3.9	7.4	2.0	3.3	0.9	0.2	33.3	40.7	0	13.8	16.3	0	5.6	1.6
1243	4.4	12.3	2.1	4.3	0.9	0.2	33.8	40.7	0	13.9	16.3	0	5.6	1.6
1252	4.8	15.9	2.2	3.7	0.7	0.2	34.2	40.7	0	14.0	16.3	0	5.4	1.6
1253	4.8	14.1	2.2	3.9	0.8	0.1	34.2	40.7	0	14.0	16.3	0	5.5	1.5
3086	1.3	7.6	0.5	1.3	0.1	0.1	30.7	40.7	0	12.3	16.3	0	4.8	1.5
3108	2.7	13.3	1.2	3.0	0.4	0.0	32.1	40.8	0	13.0	16.3	0	5.1	1.4
3224	20.4	30.8	9.5	10.9	3.7	0.4	49.8	57.6	1	21.3	22.8	0	8.4	1.8
5001	1.5	8.1	0.7	1.7	0.2	0.0	30.9	40.7	0	12.5	16.3	0	4.9	1.4
5003	0.4	2.6	0.1	0.4	0.0	0.0	29.8	40.7	0	11.9	16.3	0	4.7	1.4
5006	3.9	6.8	2.0	3.1	0.9	0.1	33.3	40.7	0	13.8	16.3	0	5.6	1.5
5024	12.1	17.0	5.7	6.8	2.2	0.2	41.5	48.3	0	17.5	19.2	0	6.9	1.6
5025	14.4	22.6	6.7	7.9	2.5	0.3	43.8	52.4	1	18.5	20.6	0	7.2	1.7

Table E4. Year 8 – Incremental and Cumulative Particulate Matter Concentration/Deposition Results for Project (CHC-owned receptors are marked by grey shaded cells)

Residence ID	Incremental Concentration/Deposition due to Project						Cumulative Concentration/Deposition due to Project + Background Air Quality							
	TSP Annual Average µg/m³	PM_{10} Maximum 24-hr µg/m³	PM_{10} Annual Average µg/m³	$PM_{2.5}$ Maximum 24-hr µg/m³	$PM_{2.5}$ Annual Average µg/m³	Deposition Annual Average g/m²/month	TSP Annual Average µg/m³	PM_{10} Maximum 24-hr µg/m³(b)	PM_{10} No. Of Days >50 µg/m³	PM_{10} Annual Average µg/m³	$PM_{2.5}$ Maximum 24-hr µg/m³(b)	$PM_{2.5}$ No. Of Days >25µg/m³	$PM_{2.5}$ Annual Average µg/m³	Deposition Annual Average g/m²/month
Criteria	**NA**	**NA**	**NA**	**NA**	**NA**	**2**	**90**	**50**	**NA**	**30**	**25[a]**	**NA**	**8[a]**	**4**
1083	0.3	2.1	0.1	0.4	0.0	0.0	29.7	40.7	0	11.9	16.3	0	4.7	1.4
1093	0.4	2.4	0.2	0.5	0.0	0.0	29.8	40.7	0	12.0	16.3	0	4.7	1.4
1180	12.4	28.7	5.8	8.0	2.3	0.1	41.8	44.4	0	17.6	16.3	0	7.0	1.5
1203	2.8	11.3	1.2	2.7	0.4	0.0	32.2	40.7	0	13.0	16.3	0	5.1	1.4
1228	8.6	18.9	4.3	7.5	1.9	0.1	38.0	40.8	0	16.1	16.3	0	6.6	1.5
2087	3.2	13.4	1.3	2.5	0.3	0.2	32.6	40.7	0	13.1	16.3	0	5.0	1.6
2128	4.6	9.7	2.2	3.5	0.8	0.2	34.0	40.7	0	14.0	16.3	0	5.5	1.6
2174	5.0	8.9	2.6	4.5	1.3	0.0	34.4	40.7	0	14.4	16.3	0	6.0	1.4
2176	6.6	14.5	3.3	7.7	1.6	0.1	36.0	40.8	0	15.1	16.3	0	6.3	1.5
2189	5.0	8.7	2.6	4.5	1.3	0.0	34.4	40.7	0	14.4	16.3	0	6.0	1.4
2208	6.8	14.8	3.5	7.4	1.8	0.0	36.2	40.8	0	15.3	16.3	0	6.5	1.4
2209	9.2	21.0	4.7	10.0	2.3	0.1	38.6	40.7	0	16.5	16.3	0	7.0	1.5
2221	7.8	20.5	3.9	7.6	1.8	0.1	37.2	40.7	0	15.7	16.3	0	6.5	1.5
3098	0.5	2.6	0.2	0.4	0.0	0.0	29.9	40.7	0	12.0	16.3	0	4.7	1.4
3099	0.5	3.0	0.2	0.5	0.0	0.0	29.9	40.7	0	12.0	16.3	0	4.7	1.4
3100	0.5	3.3	0.2	0.6	0.0	0.0	29.9	40.7	0	12.0	16.3	0	4.7	1.4
3107	2.0	10.4	0.9	2.3	0.3	0.0	31.4	40.8	0	12.7	16.3	0	5.0	1.4
3113	2.4	15.9	1.1	3.5	0.4	0.0	31.8	40.7	0	12.9	16.3	0	5.1	1.4
3115	1.4	13.3	0.6	2.6	0.2	0.0	30.8	40.7	0	12.4	16.3	0	4.9	1.4
3117	1.3	12.3	0.5	2.4	0.2	0.0	30.7	40.7	0	12.3	16.3	0	4.9	1.4
3118	1.2	10.9	0.5	2.3	0.1	0.0	30.6	40.7	0	12.3	16.3	0	4.8	1.4

Table E4. Year 8 – Incremental and Cumulative Particulate Matter Concentration/Deposition Results for Project (CHC-owned receptors are marked by grey shaded cells)

Residence ID	Incremental Concentration/Deposition due to Project						Cumulative Concentration/Deposition due to Project + Background Air Quality							
	TSP Annual Average µg/m³	PM_{10} Maximum 24-hr µg/m³	PM_{10} Annual Average µg/m³	$PM_{2.5}$ Maximum 24-hr µg/m³	$PM_{2.5}$ Annual Average µg/m³	Deposition Annual Average g/m²/month	TSP Annual Average µg/m³	PM_{10} Maximum 24-hr µg/m³(b)	PM_{10} No. Of Days >50 µg/m³	PM_{10} Annual Average µg/m³	$PM_{2.5}$ Maximum 24-hr µg/m³(b)	$PM_{2.5}$ No. Of Days >25µg/m³	$PM_{2.5}$ Annual Average µg/m³	Deposition Annual Average g/m²/month
Criteria	**NA**	**NA**	**NA**	**NA**	**NA**	**2**	**90**	**50**	**NA**	**30**	**25[a]**	**NA**	**8[a]**	**4**
3126	33.4	61.6	14.5	20.2	4.8	1.2	62.8	71.0	21	26.3	24.0	0	9.5	2.6
3177	8.1	23.5	3.5	6.2	1.2	0.1	37.5	45.8	0	15.3	16.3	0	5.9	1.5
3218	23.9	38.8	10.9	18.5	3.9	0.4	53.3	52.3	2	22.7	22.1	0	8.6	1.8
3219	22.4	36.3	10.2	12.6	3.6	0.4	51.8	65.5	5	22.0	25.2	1	8.3	1.8
4081	0.7	2.4	0.3	0.4	0.1	0.0	30.1	40.7	0	12.1	16.3	0	4.8	1.4
4084	0.3	1.6	0.1	0.2	0.0	0.0	29.7	40.7	0	11.9	16.3	0	4.7	1.4
4085	1.4	8.0	0.5	1.3	0.1	0.1	30.8	40.7	0	12.3	16.3	0	4.8	1.5
4090	2.4	12.0	0.9	2.0	0.2	0.1	31.8	40.7	0	12.7	16.3	0	4.9	1.5
4101	0.6	4.1	0.2	0.8	0.0	0.0	30.0	40.7	0	12.0	16.3	0	4.7	1.4
4102	0.6	4.4	0.2	0.9	0.0	0.0	30.0	40.7	0	12.0	16.3	0	4.7	1.4
4103	0.6	5.1	0.2	1.1	0.0	0.0	30.0	40.7	0	12.0	16.3	0	4.7	1.4
4104	0.8	6.9	0.3	1.6	0.1	0.0	30.2	40.7	0	12.1	16.3	0	4.8	1.4
4105	1.0	8.7	0.4	1.9	0.1	0.0	30.4	40.7	0	12.2	16.3	0	4.8	1.4
4106	1.0	8.8	0.4	2.0	0.1	0.0	30.4	40.7	0	12.2	16.3	0	4.8	1.4
4109	5.5	22.9	2.5	5.3	0.9	0.1	34.9	41.0	0	14.3	16.3	0	5.6	1.5
4116	1.1	10.2	0.4	1.9	0.1	0.0	30.5	40.7	0	12.2	16.3	0	4.8	1.4
4123	10.5	38.1	4.7	9.0	1.7	0.1	39.9	53.8	1	16.5	16.5	0	6.4	1.5
4125	11.6	35.0	5.2	9.3	1.9	0.1	41.0	49.8	0	17.0	16.7	0	6.6	1.5
4150	347.1	419.8	151.5	116.9	35.4	10.7	376.5	432.5	336	163.3	122.3	259	40.1	12.1
4151	65.2	81.1	28.8	34.0	9.8	2.4	94.6	92.9	184	40.6	39.6	77	14.5	3.8
4161	6.4	17.3	2.8	3.9	1.0	0.1	35.8	41.0	0	14.6	16.3	0	5.7	1.5

Table E4. Year 8 – Incremental and Cumulative Particulate Matter Concentration/Deposition Results for Project (CHC-owned receptors are marked by grey shaded cells)

Residence ID	Incremental Concentration/Deposition due to Project						Cumulative Concentration/Deposition due to Project + Background Air Quality							
	TSP Annual Average µg/m³	PM_{10} Maximum 24-hr µg/m³	PM_{10} Annual Average µg/m³	$PM_{2.5}$ Maximum 24-hr µg/m³	$PM_{2.5}$ Annual Average µg/m³	Deposition Annual Average g/m²/month	TSP Annual Average µg/m³	PM_{10} Maximum 24-hr µg/m³(b)	PM_{10} No. Of Days >50 µg/m³	PM_{10} Annual Average µg/m³	$PM_{2.5}$ Maximum 24-hr µg/m³(b)	$PM_{2.5}$ No. Of Days >25µg/m³	$PM_{2.5}$ Annual Average µg/m³	Deposition Annual Average g/m²/month
Criteria	**NA**	**NA**	**NA**	**NA**	**NA**	**2**	**90**	**50**	**NA**	**30**	**25(a)**	**NA**	**8(a)**	**4**
4163	53.0	72.3	23.9	29.1	8.5	4.9	82.4	86.2	135	35.7	35.0	24	13.2	6.3
4182	23.4	39.4	10.4	11.8	3.5	0.2	52.8	55.3	5	22.2	19.2	0	8.2	1.6
4183	27.4	41.9	13.7	26.9	6.6	0.9	56.8	55.7	1	25.5	32.2	1	11.3	2.3
4190	125.6	152.9	48.3	44.4	15.2	1.6	155.0	166.1	136	60.1	50.0	48	19.9	3.0
4191	95.5	116.5	37.9	36.9	12.6	1.4	124.9	130.1	136	49.7	42.3	48	17.3	2.8
4193	47.6	60.2	22.5	26.0	9.2	0.9	77.0	80.3	77	34.3	31.5	35	13.9	2.3
4194	47.6	59.1	22.3	24.3	8.8	0.6	77.0	78.7	85	34.1	30.5	29	13.5	2.0
4196	38.4	50.0	16.8	18.0	5.6	0.4	67.8	65.8	36	28.6	24.1	0	10.3	1.8
4205	46.0	47.8	21.5	25.3	8.6	1.0	75.4	67.7	92	33.3	30.9	28	13.3	2.4
5002	37.5	48.4	16.5	18.2	5.5	0.4	66.9	64.4	36	28.3	24.3	0	10.2	1.8
5007	21.0	34.3	10.0	15.3	4.2	0.2	50.4	49.6	0	21.8	21.2	0	8.9	1.6
5008	28.6	37.8	13.3	16.9	5.4	0.3	58.0	51.9	10	25.1	22.3	0	10.1	1.7
5009	58.3	70.3	26.7	29.1	10.1	0.7	87.7	89.6	136	38.5	35.2	53	14.8	2.1
5010	3.4	13.4	1.4	2.7	0.4	0.2	32.8	40.7	0	13.2	16.3	0	5.1	1.6

NA – Not applicable. Criteria are applicable to cumulative concentrations.

(a) The NEPM Advisory Reporting Standards for $PM_{2.5}$ are referenced for screening assessment purposes.

(b) The maximum cumulative value is not a sum of the maximum increment and the maximum baseline concentrations, since these maximums may occur on different days. Rather the maximum 24-hour cumulative concentrations reflect days on which background levels plus the concurrent Project-related increment were highest.

Table E5. Year 12 – Incremental and Cumulative Particulate Matter Concentration/Deposition Results for Project (CHC-owned receptors are marked by grey shaded cells)

Residence ID	Incremental Concentration/Deposition due to Project						Cumulative Concentration/Deposition due to Project + Background Air Quality							
	TSP Annual Average µg/m³	PM_{10} Maximum 24-hr µg/m³	PM_{10} Annual Average µg/m³	$PM_{2.5}$ Maximum 24-hr µg/m³	$PM_{2.5}$ Annual Average µg/m³	Deposition Annual Average g/m²/month	TSP Annual Average µg/m³	PM_{10} Maximum 24-hr µg/m³(b)	PM_{10} No. Of Days >50 µg/m³	PM_{10} Annual Average µg/m³	$PM_{2.5}$ Maximum 24-hr µg/m³(b)	$PM_{2.5}$ No. Of Days >25µg/m³	$PM_{2.5}$ Annual Average µg/m³	Deposition Annual Average g/m²/month
Criteria	**NA**	**NA**	**NA**	**NA**	**NA**	**2**	**90**	**50**	**NA**	**30**	**25[a]**	**NA**	**8[a]**	**4**
1088	3.7	6.4	1.9	3.2	1.0	0.2	33.1	40.7	0	13.7	16.3	0	5.7	1.6
1089	3.8	6.4	2.0	3.2	1.0	0.2	33.2	40.7	0	13.8	16.3	0	5.7	1.6
1094	0.4	2.4	0.2	0.5	0.0	0.0	29.8	40.7	0	12.0	16.3	0	4.7	1.4
1122	0.8	3.6	0.3	0.8	0.1	0.0	30.2	40.7	0	12.1	16.3	0	4.8	1.4
1133	4.4	7.2	2.4	3.9	1.3	0.1	33.8	40.7	0	14.2	16.3	0	6.0	1.5
1143	3.8	7.5	2.1	4.6	1.1	0.1	33.2	40.7	0	13.9	16.3	0	5.8	1.5
1144	3.8	7.5	2.1	4.8	1.1	0.0	33.2	40.7	0	13.9	16.3	0	5.8	1.4
1145	3.8	7.6	2.1	4.8	1.2	0.0	33.2	40.7	0	13.9	16.3	0	5.9	1.4
1147	3.9	7.3	2.1	3.9	1.1	0.1	33.3	40.7	0	13.9	16.3	0	5.8	1.5
1149	4.3	8.4	2.3	4.9	1.3	0.1	33.7	40.7	0	14.1	16.3	0	6.0	1.5
1158	0.9	3.6	0.4	0.8	0.1	0.0	30.3	40.7	0	12.2	16.3	0	4.8	1.4
1166	3.8	7.5	2.1	4.3	1.2	0.0	33.2	40.7	0	13.9	16.3	0	5.9	1.4
1170	4.3	8.8	2.4	4.9	1.3	0.0	33.7	40.7	0	14.2	16.3	0	6.0	1.4
1171	4.4	8.7	2.4	5.0	1.3	0.0	33.8	40.7	0	14.2	16.3	0	6.0	1.4
1172	5.5	10.4	3.0	6.1	1.7	0.1	34.9	40.7	0	14.8	16.3	0	6.4	1.5
1178	5.4	17.4	2.4	4.5	0.9	0.1	34.8	41.1	0	14.2	16.3	0	5.6	1.5
1179	1.8	6.0	0.8	2.1	0.3	0.0	31.2	40.7	0	12.6	16.3	0	5.0	1.4
1198	8.9	20.5	4.2	7.0	1.8	0.1	38.3	41.4	0	16.0	16.3	0	6.5	1.5
1199	8.4	20.8	4.0	6.6	1.7	0.1	37.8	41.1	0	15.8	16.3	0	6.4	1.5
1200	2.9	11.4	1.3	2.6	0.5	0.0	32.3	40.8	0	13.1	16.3	0	5.2	1.4
1201	0.9	5.2	0.3	0.9	0.1	0.0	30.3	40.7	0	12.1	16.3	0	4.8	1.4

Table E5. Year 12 – Incremental and Cumulative Particulate Matter Concentration/Deposition Results for Project (CHC-owned receptors are marked by grey shaded cells)

Residence ID	Incremental Concentration/Deposition due to Project						Cumulative Concentration/Deposition due to Project + Background Air Quality							
	TSP Annual Average µg/m³	PM_{10} Maximum 24-hr µg/m³	PM_{10} Annual Average µg/m³	$PM_{2.5}$ Maximum 24-hr µg/m³	$PM_{2.5}$ Annual Average µg/m³	Deposition Annual Average g/m²/month	TSP Annual Average µg/m³	PM_{10} Maximum 24-hr µg/m³(b)	PM_{10} No. Of Days >50 µg/m³	PM_{10} Annual Average µg/m³	$PM_{2.5}$ Maximum 24-hr µg/m³(b)	$PM_{2.5}$ No. Of Days >25µg/m³	$PM_{2.5}$ Annual Average µg/m³	Deposition Annual Average g/m²/month
Criteria	**NA**	**NA**	**NA**	**NA**	**NA**	**2**	**90**	**50**	**NA**	**30**	**25[a]**	**NA**	**8[a]**	**4**
1213	12.4	17.9	5.4	6.0	1.9	0.3	41.8	42.3	0	17.2	16.6	0	6.6	1.7
1215	5.9	14.8	2.5	4.1	0.9	0.2	35.3	41.1	0	14.3	16.3	0	5.6	1.6
1222	18.3	27.9	8.8	11.2	3.7	0.3	47.7	51.5	1	20.6	20.1	0	8.4	1.7
1223	18.3	28.0	8.8	11.2	3.7	0.3	47.7	50.2	1	20.6	19.5	0	8.4	1.7
1225	11.5	18.6	4.9	5.7	1.5	0.4	40.9	45.8	0	16.7	17.2	0	6.2	1.8
1230	10.2	17.5	5.2	8.6	2.5	0.1	39.6	44.3	0	17.0	17.9	0	7.2	1.5
1232	10.5	18.4	5.3	9.0	2.4	0.2	39.9	44.8	0	17.1	19.2	0	7.1	1.6
1233	7.3	14.0	3.8	7.2	1.9	0.1	36.7	41.7	0	15.6	16.6	0	6.6	1.5
1234	7.0	13.7	3.7	7.2	1.8	0.1	36.4	41.6	0	15.5	16.6	0	6.5	1.5
1240	4.7	10.9	2.4	4.2	1.1	0.2	34.1	40.7	0	14.2	16.3	0	5.8	1.6
1243	4.8	16.2	2.4	4.5	1.0	0.2	34.2	40.7	0	14.2	16.3	0	5.7	1.6
1252	5.6	16.6	2.5	4.4	0.9	0.2	35.0	40.7	0	14.3	16.3	0	5.6	1.6
1253	5.3	14.5	2.5	4.3	0.9	0.2	34.7	40.7	0	14.3	16.3	0	5.6	1.6
3086	1.4	7.2	0.5	1.3	0.1	0.1	30.8	40.7	0	12.3	16.3	0	4.8	1.5
3108	3.8	14.8	1.8	3.7	0.7	0.1	33.2	40.8	0	13.6	16.3	0	5.4	1.5
3224	19.4	32.3	9.3	12.1	3.8	0.3	48.8	52.8	2	21.1	20.7	0	8.5	1.7
5001	1.9	10.5	0.9	2.6	0.3	0.0	31.3	40.7	0	12.7	16.3	0	5.0	1.4
5003	0.4	3.0	0.2	0.6	0.0	0.0	29.8	40.7	0	12.0	16.3	0	4.7	1.4
5006	4.8	8.3	2.5	4.3	1.3	0.1	34.2	40.7	0	14.3	16.3	0	6.0	1.5
5024	12.3	17.3	6.0	7.5	2.5	0.2	41.7	47.2	0	17.8	18.5	0	7.2	1.6
5025	14.2	21.4	6.1	8.4	2.6	0.3	43.6	49.0	0	17.9	19.0	0	7.3	1.7

Table E5. Year 12 – Incremental and Cumulative Particulate Matter Concentration/Deposition Results for Project (CHC-owned receptors are marked by grey shaded cells)

Residence ID	Incremental Concentration/Deposition due to Project						Cumulative Concentration/Deposition due to Project + Background Air Quality							
	TSP Annual Average µg/m³	PM_{10} Maximum 24-hr µg/m³	PM_{10} Annual Average µg/m³	$PM_{2.5}$ Maximum 24-hr µg/m³	$PM_{2.5}$ Annual Average µg/m³	Deposition Annual Average g/m²/month	TSP Annual Average µg/m³	PM_{10} Maximum 24-hr µg/m³(b)	PM_{10} No. Of Days >50 µg/m³	PM_{10} Annual Average µg/m³	$PM_{2.5}$ Maximum 24-hr µg/m³(b)	$PM_{2.5}$ No. Of Days >25µg/m³	$PM_{2.5}$ Annual Average µg/m³	Deposition Annual Average g/m²/month
Criteria	**NA**	**NA**	**NA**	**NA**	**NA**	**2**	**90**	**50**	**NA**	**30**	**25[a]**	**NA**	**8[a]**	**4**
1083	0.4	2.3	0.1	0.5	0.0	0.0	29.8	40.7	0	11.9	16.3	0	4.7	1.4
1093	0.5	2.8	0.2	0.5	0.0	0.0	29.9	40.7	0	12.0	16.3	0	4.7	1.4
1180	15.8	28.0	7.3	12.2	3.0	0.2	45.2	43.5	0	19.1	18.4	0	7.7	1.6
1203	3.5	12.6	1.6	3.2	0.6	0.1	32.9	40.7	0	13.4	16.3	0	5.3	1.5
1228	10.2	17.2	5.3	10.9	2.7	0.1	39.6	41.9	0	17.1	17.0	0	7.4	1.5
2087	3.3	14.6	1.4	3.0	0.4	0.2	32.7	40.7	0	13.2	16.3	0	5.1	1.6
2128	6.5	12.7	3.0	3.7	1.1	0.4	35.9	40.7	0	14.8	16.3	0	5.8	1.8
2174	6.7	12.5	3.6	7.9	2.0	0.1	36.1	40.8	0	15.4	16.3	0	6.7	1.5
2176	9.0	19.4	4.4	10.1	2.0	0.2	38.4	40.8	0	16.2	16.3	0	6.7	1.6
2189	6.7	12.2	3.7	7.5	2.1	0.0	36.1	40.8	0	15.5	16.3	0	6.8	1.4
2208	9.9	20.9	5.4	12.2	3.0	0.1	39.3	40.8	0	17.2	18.2	0	7.7	1.5
2209	13.5	25.5	7.2	16.3	3.8	0.2	42.9	41.2	0	19.0	21.6	0	8.5	1.6
2221	10.7	24.3	5.6	13.7	2.9	0.1	40.1	41.0	0	17.4	18.0	0	7.6	1.5
3098	0.5	3.0	0.2	0.5	0.0	0.0	29.9	40.7	0	12.0	16.3	0	4.7	1.4
3099	0.6	3.3	0.2	0.6	0.0	0.0	30.0	40.7	0	12.0	16.3	0	4.7	1.4
3100	0.6	3.7	0.2	0.6	0.0	0.0	30.0	40.7	0	12.0	16.3	0	4.7	1.4
3107	2.7	12.4	1.3	3.0	0.5	0.1	32.1	40.8	0	13.1	16.3	0	5.2	1.5
3113	3.4	21.1	1.6	4.8	0.7	0.1	32.8	40.8	0	13.4	16.3	0	5.4	1.5
3115	1.8	13.6	0.8	2.7	0.3	0.0	31.2	40.7	0	12.6	16.3	0	5.0	1.4
3117	1.6	12.7	0.7	2.5	0.2	0.0	31.0	40.7	0	12.5	16.3	0	4.9	1.4
3118	1.4	11.6	0.6	2.4	0.2	0.0	30.8	40.7	0	12.4	16.3	0	4.9	1.4

Table E5. Year 12 – Incremental and Cumulative Particulate Matter Concentration/Deposition Results for Project (CHC-owned receptors are marked by grey shaded cells)

Residence ID	Incremental Concentration/Deposition due to Project						Cumulative Concentration/Deposition due to Project + Background Air Quality							
	TSP Annual Average µg/m³	PM_{10} Maximum 24-hr µg/m³	PM_{10} Annual Average µg/m³	$PM_{2.5}$ Maximum 24-hr µg/m³	$PM_{2.5}$ Annual Average µg/m³	Deposition Annual Average g/m²/month	TSP Annual Average µg/m³	PM_{10} Maximum 24-hr µg/m³(b)	PM_{10} No. Of Days >50 µg/m³	PM_{10} Annual Average µg/m³	$PM_{2.5}$ Maximum 24-hr µg/m³(b)	$PM_{2.5}$ No. Of Days >25µg/m³	$PM_{2.5}$ Annual Average µg/m³	Deposition Annual Average g/m²/month
Criteria	**NA**	**NA**	**NA**	**NA**	**NA**	**2**	**90**	**50**	**NA**	**30**	**25[a]**	**NA**	**8[a]**	**4**
3126	53.9	76.9	23.0	30.4	8.2	1.9	83.3	88.1	136	34.8	34.5	29	12.9	3.3
3177	12.4	25.0	5.4	10.5	2.0	0.3	41.8	42.2	0	17.2	17.7	0	6.7	1.7
3218	23.6	39.0	10.8	18.8	3.9	0.5	53.0	52.4	2	22.6	22.5	0	8.6	1.9
3219	20.7	35.5	9.4	12.6	3.4	0.4	50.1	64.0	2	21.2	24.7	0	8.1	1.8
4081	0.8	3.0	0.3	0.6	0.1	0.0	30.2	40.7	0	12.1	16.3	0	4.8	1.4
4084	0.4	2.0	0.1	0.4	0.0	0.0	29.8	40.7	0	11.9	16.3	0	4.7	1.4
4085	1.7	8.3	0.6	1.6	0.1	0.1	31.1	40.7	0	12.4	16.3	0	4.8	1.5
4090	3.1	11.4	1.2	2.8	0.3	0.1	32.5	40.7	0	13.0	16.3	0	5.0	1.5
4101	0.7	4.3	0.3	0.9	0.1	0.0	30.1	40.7	0	12.1	16.3	0	4.8	1.4
4102	0.7	4.7	0.3	0.9	0.1	0.0	30.1	40.7	0	12.1	16.3	0	4.8	1.4
4103	0.7	5.7	0.3	1.4	0.1	0.0	30.1	40.7	0	12.1	16.3	0	4.8	1.4
4104	0.9	7.2	0.4	1.6	0.1	0.0	30.3	40.7	0	12.2	16.3	0	4.8	1.4
4105	1.1	9.2	0.5	2.0	0.1	0.0	30.5	40.7	0	12.3	16.3	0	4.8	1.4
4106	1.2	11.2	0.5	3.0	0.1	0.0	30.6	40.7	0	12.3	16.3	0	4.8	1.4
4109	8.2	28.1	3.8	7.0	1.5	0.1	37.6	41.4	0	15.6	16.3	0	6.2	1.5
4116	1.3	11.1	0.5	2.0	0.1	0.0	30.7	40.7	0	12.3	16.3	0	4.8	1.4
4123	18.9	50.1	8.4	14.3	3.2	0.2	48.3	66.2	2	20.2	20.6	0	7.9	1.6
4125	19.6	43.4	8.8	14.6	3.3	0.2	49.0	56.0	3	20.6	19.9	0	8.0	1.6
4150	337.8	412.0	148.2	115.5	35.2	11.7	367.2	424.8	336	160.0	120.8	261	39.9	13.1
4151	55.4	72.6	25.3	33.5	9.3	1.4	84.8	85.6	133	37.1	39.1	51	14.0	2.8
4161	10.7	30.8	4.8	10.0	1.9	0.2	40.1	47.7	0	16.6	16.6	0	6.6	1.6

Table E5. Year 12 – Incremental and Cumulative Particulate Matter Concentration/Deposition Results for Project (CHC-owned receptors are marked by grey shaded cells)

Residence ID	Incremental Concentration/Deposition due to Project						Cumulative Concentration/Deposition due to Project + Background Air Quality							
	TSP Annual Average µg/m³	PM_{10} Maximum 24-hr µg/m³	PM_{10} Annual Average µg/m³	$PM_{2.5}$ Maximum 24-hr µg/m³	$PM_{2.5}$ Annual Average µg/m³	Deposition Annual Average g/m²/month	TSP Annual Average µg/m³	PM_{10} Maximum 24-hr µg/m³(b)	PM_{10} No. Of Days >50 µg/m³	PM_{10} Annual Average µg/m³	$PM_{2.5}$ Maximum 24-hr µg/m³(b)	$PM_{2.5}$ No. Of Days >25µg/m³	$PM_{2.5}$ Annual Average µg/m³	Deposition Annual Average g/m²/month
Criteria	**NA**	**NA**	**NA**	**NA**	**NA**	**2**	**90**	**50**	**NA**	**30**	**25(a)**	**NA**	**8(a)**	**4**
4163	45.5	60.9	20.5	26.7	7.4	1.8	74.9	75.2	53	32.3	32.7	6	12.1	3.2
4182	28.2	41.6	12.5	14.3	4.5	0.6	57.6	55.5	9	24.3	21.8	0	9.2	2.0
4183	108.8	175.9	56.2	123.6	32.5	2.9	138.2	186.8	255	68.0	128.3	244	37.2	4.3
4190	41.2	47.7	19.7	25.1	8.2	0.8	70.6	64.5	36	31.5	31.3	30	12.9	2.2
4191	40.7	47.6	19.7	26.0	8.4	0.8	70.1	63.7	36	31.5	32.2	30	13.1	2.2
4193	39.2	54.8	18.9	25.3	8.0	0.5	68.6	71.1	18	30.7	30.8	9	12.7	1.9
4194	41.1	53.3	19.4	24.1	7.9	0.6	70.5	71.8	36	31.2	29.3	10	12.6	2.0
4196	39.7	57.6	17.3	18.4	5.9	0.9	69.1	69.4	18	29.1	24.7	0	10.6	2.3
4205	37.1	46.1	18.2	26.3	8.1	0.6	66.5	61.2	23	30.0	31.2	17	12.8	2.0
5002	38.8	55.0	16.9	17.8	5.8	0.9	68.2	68.0	18	28.7	24.2	0	10.5	2.3
5007	29.6	44.8	14.6	25.5	6.8	0.6	59.0	67.7	10	26.4	33.3	5	11.5	2.0
5008	41.4	52.6	19.4	26.1	8.2	1.2	70.8	82.5	42	31.2	37.2	26	12.9	2.6
5009	52.1	64.2	24.0	29.3	9.3	0.8	81.5	84.5	66	35.8	34.8	19	14.0	2.2
5010	3.9	14.5	1.7	3.1	0.5	0.3	33.3	40.7	0	13.5	16.3	0	5.2	1.7

NA – Not applicable. Criteria are applicable to cumulative concentrations.

(a) The NEPM Advisory Reporting Standards for $PM_{2.5}$ are referenced for screening assessment purposes.

(b) The maximum cumulative value is not a sum of the maximum increment and the maximum baseline concentrations, since these maximums may occur on different days. Rather the maximum 24-hour cumulative concentrations reflect days on which background levels plus the concurrent Project-related increment were highest.

Table E6. Year 16 – Incremental and Cumulative Particulate Matter Concentration/Deposition Results for Project (CHC-owned receptors are marked by grey shaded cells)

Residence ID	Incremental Concentration/Deposition due to Project						Cumulative Concentration/Deposition due to Project + Background Air Quality							
	TSP Annual Average µg/m³	PM_{10} Maximum 24-hr µg/m³	PM_{10} Annual Average µg/m³	$PM_{2.5}$ Maximum 24-hr µg/m³	$PM_{2.5}$ Annual Average µg/m³	Deposition Annual Average g/m²/month	TSP Annual Average µg/m³	PM_{10} Maximum 24-hr µg/m³(b)	PM_{10} No. Of Days >50 µg/m³	PM_{10} Annual Average µg/m³	$PM_{2.5}$ Maximum 24-hr µg/m³(b)	$PM_{2.5}$ No. Of Days >25µg/m³	$PM_{2.5}$ Annual Average µg/m³	Deposition Annual Average g/m²/month
Criteria	**NA**	**NA**	**NA**	**NA**	**NA**	**2**	**90**	**50**	**NA**	**30**	**25[a]**	**NA**	**8[a]**	**4**
1088	4.6	8.8	2.4	4.3	1.1	0.2	34.0	40.7	0	14.2	16.3	0	5.8	1.6
1089	4.6	9.0	2.4	4.4	1.1	0.2	34.0	40.7	0	14.2	16.3	0	5.8	1.6
1094	0.4	2.8	0.2	0.5	0.0	0.0	29.8	40.7	0	12.0	16.3	0	4.7	1.4
1122	0.9	4.1	0.3	0.8	0.1	0.0	30.3	40.7	0	12.1	16.3	0	4.8	1.4
1133	5.3	8.2	2.7	4.0	1.3	0.2	34.7	40.7	0	14.5	16.3	0	6.0	1.6
1143	4.4	7.9	2.2	3.6	1.1	0.1	33.8	40.7	0	14.0	16.3	0	5.8	1.5
1144	4.4	8.0	2.2	3.6	1.1	0.1	33.8	40.7	0	14.0	16.3	0	5.8	1.5
1145	4.5	7.9	2.3	3.6	1.1	0.1	33.9	40.7	0	14.1	16.3	0	5.8	1.5
1147	4.9	8.0	2.5	3.7	1.2	0.1	34.3	40.7	0	14.3	16.3	0	5.9	1.5
1149	5.5	9.3	2.8	4.4	1.3	0.1	34.9	40.7	0	14.6	16.3	0	6.0	1.5
1158	1.2	5.3	0.5	1.2	0.1	0.0	30.6	40.7	0	12.3	16.3	0	4.8	1.4
1166	4.4	7.1	2.2	3.5	1.1	0.1	33.8	40.7	0	14.0	16.3	0	5.8	1.5
1170	5.2	10.6	2.6	4.4	1.2	0.0	34.6	40.7	0	14.4	16.3	0	5.9	1.4
1171	5.3	10.5	2.7	4.4	1.2	0.0	34.7	40.7	0	14.5	16.3	0	5.9	1.4
1172	7.4	13.2	3.7	5.8	1.8	0.1	36.8	40.8	0	15.5	16.3	0	6.5	1.5
1178	6.3	15.2	2.9	4.6	1.1	0.1	35.7	41.2	0	14.7	16.3	0	5.8	1.5
1179	2.0	6.1	0.9	1.3	0.3	0.0	31.4	40.7	0	12.7	16.3	0	5.0	1.4
1198	11.5	22.7	5.7	10.0	2.5	0.1	40.9	42.5	0	17.5	16.5	0	7.2	1.5
1199	11.0	21.5	5.4	10.0	2.4	0.1	40.4	42.2	0	17.2	16.5	0	7.1	1.5
1200	3.6	11.6	1.6	2.9	0.6	0.1	33.0	40.7	0	13.4	16.3	0	5.3	1.5
1201	0.9	4.3	0.3	0.8	0.1	0.0	30.3	40.7	0	12.1	16.3	0	4.8	1.4

Table E6. Year 16 – Incremental and Cumulative Particulate Matter Concentration/Deposition Results for Project (CHC-owned receptors are marked by grey shaded cells)

Residence ID	Incremental Concentration/Deposition due to Project						Cumulative Concentration/Deposition due to Project + Background Air Quality							
	TSP Annual Average µg/m³	PM_{10} Maximum 24-hr µg/m³	PM_{10} Annual Average µg/m³	$PM_{2.5}$ Maximum 24-hr µg/m³	$PM_{2.5}$ Annual Average µg/m³	Deposition Annual Average g/m²/month	TSP Annual Average µg/m³	PM_{10} Maximum 24-hr µg/m³(b)	PM_{10} No. Of Days >50 µg/m³	PM_{10} Annual Average µg/m³	$PM_{2.5}$ Maximum 24-hr µg/m³(b)	$PM_{2.5}$ No. Of Days >25µg/m³	$PM_{2.5}$ Annual Average µg/m³	Deposition Annual Average g/m²/month
Criteria	**NA**	**NA**	**NA**	**NA**	**NA**	**2**	**90**	**50**	**NA**	**30**	**25[a]**	**NA**	**8[a]**	**4**
1213	11.9	21.0	5.5	7.2	2.0	0.3	41.3	42.2	0	17.3	16.7	0	6.7	1.7
1215	6.3	11.0	2.7	3.3	0.9	0.1	35.7	41.8	0	14.5	16.5	0	5.6	1.5
1222	19.0	27.4	9.2	15.8	4.0	0.3	48.4	51.1	1	21.0	21.8	0	8.7	1.7
1223	18.6	27.2	9.0	14.6	3.9	0.3	48.0	50.9	1	20.8	21.2	0	8.6	1.7
1225	11.8	17.9	4.9	4.9	1.4	0.4	41.2	46.5	0	16.7	17.2	0	6.1	1.8
1230	13.8	21.5	6.5	9.1	2.5	0.2	43.2	49.8	0	18.3	19.0	0	7.2	1.6
1232	13.4	19.7	6.2	8.2	2.3	0.2	42.8	48.8	0	18.0	19.9	0	7.0	1.6
1233	9.6	18.4	4.6	8.0	1.8	0.1	39.0	43.8	0	16.4	16.8	0	6.5	1.5
1234	9.1	16.3	4.4	8.0	1.8	0.1	38.5	43.4	0	16.2	16.7	0	6.5	1.5
1240	5.2	14.7	2.7	5.0	1.2	0.2	34.6	40.7	0	14.5	16.3	0	5.9	1.6
1243	5.1	12.4	2.6	4.5	1.2	0.2	34.5	40.7	0	14.4	16.3	0	5.9	1.6
1252	5.6	15.2	2.5	4.0	0.9	0.2	35.0	40.7	0	14.3	16.3	0	5.6	1.6
1253	5.4	14.0	2.6	4.3	1.0	0.2	34.8	40.7	0	14.4	16.3	0	5.7	1.6
3086	1.4	6.6	0.5	1.1	0.1	0.1	30.8	40.7	0	12.3	16.3	0	4.8	1.5
3108	5.2	16.5	2.3	4.0	0.8	0.1	34.6	40.7	0	14.1	16.3	0	5.5	1.5
3224	19.7	30.2	9.5	12.5	4.0	0.3	49.1	52.9	1	21.3	21.6	0	8.7	1.7
5001	2.4	11.2	1.0	2.7	0.3	0.1	31.8	40.7	0	12.8	16.3	0	5.0	1.5
5003	0.5	3.9	0.2	0.7	0.0	0.0	29.9	40.7	0	12.0	16.3	0	4.7	1.4
5006	6.0	10.0	3.1	4.9	1.5	0.2	35.4	40.7	0	14.9	16.3	0	6.2	1.6
5024	12.8	16.2	6.2	9.4	2.6	0.2	42.2	44.1	0	18.0	17.8	0	7.3	1.6
5025	14.5	21.4	6.9	9.7	2.8	0.3	43.9	47.5	0	18.7	19.2	0	7.5	1.7

Table E6. Year 16 – Incremental and Cumulative Particulate Matter Concentration/Deposition Results for Project (CHC-owned receptors are marked by grey shaded cells)

Residence ID	Incremental Concentration/Deposition due to Project						Cumulative Concentration/Deposition due to Project + Background Air Quality							
	TSP Annual Average µg/m³	PM_{10} Maximum 24-hr µg/m³	PM_{10} Annual Average µg/m³	$PM_{2.5}$ Maximum 24-hr µg/m³	$PM_{2.5}$ Annual Average µg/m³	Deposition Annual Average g/m²/month	TSP Annual Average µg/m³	PM_{10} Maximum 24-hr µg/m³(b)	PM_{10} No. Of Days >50 µg/m³	PM_{10} Annual Average µg/m³	$PM_{2.5}$ Maximum 24-hr µg/m³(b)	$PM_{2.5}$ No. Of Days >25µg/m³	$PM_{2.5}$ Annual Average µg/m³	Deposition Annual Average g/m²/month
Criteria	**NA**	**NA**	**NA**	**NA**	**NA**	**2**	**90**	**50**	**NA**	**30**	**25[a]**	**NA**	**8[a]**	**4**
1083	0.4	2.6	0.1	0.5	0.0	0.0	29.8	40.7	0	11.9	16.3	0	4.7	1.4
1093	0.5	3.7	0.2	0.6	0.0	0.0	29.9	40.7	0	12.0	16.3	0	4.7	1.4
1180	17.4	30.3	8.6	13.6	3.8	0.2	46.8	47.2	0	20.4	20.4	0	8.5	1.6
1203	4.3	14.5	1.9	3.6	0.7	0.1	33.7	40.8	0	13.7	16.3	0	5.4	1.5
1228	14.4	22.2	6.8	11.1	2.7	0.2	43.8	48.1	0	18.6	18.1	0	7.4	1.6
2087	3.7	14.1	1.5	2.7	0.4	0.2	33.1	40.7	0	13.3	16.3	0	5.1	1.6
2128	7.7	15.2	3.5	5.3	1.3	0.4	37.1	40.8	0	15.3	16.3	0	6.0	1.8
2174	10.1	18.2	5.0	7.8	2.3	0.1	39.5	40.8	0	16.8	16.3	0	7.0	1.5
2176	13.3	30.2	6.5	13.6	2.9	0.4	42.7	44.1	0	18.3	18.3	0	7.6	1.8
2189	8.9	13.6	4.4	7.1	2.0	0.1	38.3	40.8	0	16.2	16.3	0	6.7	1.5
2208	14.7	26.6	7.1	12.2	3.0	0.1	44.1	41.6	0	18.9	18.2	0	7.7	1.5
2209	22.2	35.8	10.3	17.3	4.0	0.3	51.6	49.0	0	22.1	22.1	0	8.7	1.7
2221	15.6	27.6	7.4	14.0	2.9	0.2	45.0	43.3	0	19.2	19.1	0	7.6	1.6
3098	0.5	3.7	0.2	0.6	0.0	0.0	29.9	40.7	0	12.0	16.3	0	4.7	1.4
3099	0.6	4.4	0.2	0.7	0.0	0.0	30.0	40.7	0	12.0	16.3	0	4.7	1.4
3100	0.6	4.6	0.2	0.8	0.0	0.0	30.0	40.7	0	12.0	16.3	0	4.7	1.4
3107	3.6	14.6	1.6	3.5	0.5	0.1	33.0	40.8	0	13.4	16.3	0	5.2	1.5
3113	4.8	28.1	2.1	5.9	0.8	0.1	34.2	45.3	0	13.9	16.3	0	5.5	1.5
3115	2.3	17.3	1.0	3.1	0.3	0.1	31.7	41.0	0	12.8	16.3	0	5.0	1.5
3117	2.0	15.9	0.8	2.9	0.2	0.1	31.4	40.9	0	12.6	16.3	0	4.9	1.5
3118	1.7	16.0	0.7	2.9	0.2	0.0	31.1	40.7	0	12.5	16.3	0	4.9	1.4

Table E6. Year 16 – Incremental and Cumulative Particulate Matter Concentration/Deposition Results for Project (CHC-owned receptors are marked by grey shaded cells)

Residence ID	Incremental Concentration/Deposition due to Project						Cumulative Concentration/Deposition due to Project + Background Air Quality							
	TSP Annual Average µg/m³	PM_{10} Maximum 24-hr µg/m³	PM_{10} Annual Average µg/m³	$PM_{2.5}$ Maximum 24-hr µg/m³	$PM_{2.5}$ Annual Average µg/m³	Deposition Annual Average g/m²/month	TSP Annual Average µg/m³	PM_{10} Maximum 24-hr µg/m³(b)	PM_{10} No. Of Days >50 µg/m³	PM_{10} Annual Average µg/m³	$PM_{2.5}$ Maximum 24-hr µg/m³(b)	$PM_{2.5}$ No. Of Days >25µg/m³	$PM_{2.5}$ Annual Average µg/m³	Deposition Annual Average g/m²/month
Criteria	**NA**	**NA**	**NA**	**NA**	**NA**	**2**	**90**	**50**	**NA**	**30**	**25[a]**	**NA**	**8[a]**	**4**
3126	31.1	49.9	15.2	26.7	6.4	0.8	60.5	61.5	7	27.0	29.7	1	11.1	2.2
3177	17.8	24.7	7.6	7.9	2.4	0.4	47.2	49.8	0	19.4	17.5	0	7.1	1.8
3218	24.4	34.1	11.1	15.8	4.0	0.6	53.8	52.1	1	22.9	20.6	0	8.7	2.0
3219	20.9	32.3	9.7	12.0	3.6	0.4	50.3	58.7	1	21.5	22.8	0	8.3	1.8
4081	0.8	2.9	0.4	0.6	0.1	0.0	30.2	40.7	0	12.2	16.3	0	4.8	1.4
4084	0.4	2.4	0.1	0.4	0.0	0.0	29.8	40.7	0	11.9	16.3	0	4.7	1.4
4085	1.7	7.3	0.6	1.1	0.1	0.1	31.1	40.7	0	12.4	16.3	0	4.8	1.5
4090	3.0	11.2	1.2	2.0	0.3	0.2	32.4	40.7	0	13.0	16.3	0	5.0	1.6
4101	0.7	5.9	0.3	1.0	0.1	0.0	30.1	40.7	0	12.1	16.3	0	4.8	1.4
4102	0.8	6.5	0.3	1.1	0.1	0.0	30.2	40.7	0	12.1	16.3	0	4.8	1.4
4103	0.8	7.4	0.3	1.4	0.1	0.0	30.2	40.7	0	12.1	16.3	0	4.8	1.4
4104	1.1	10.7	0.5	2.0	0.1	0.0	30.5	40.7	0	12.3	16.3	0	4.8	1.4
4105	1.4	12.8	0.6	2.4	0.1	0.0	30.8	40.7	0	12.4	16.3	0	4.8	1.4
4106	1.4	13.7	0.6	3.1	0.2	0.0	30.8	40.7	0	12.4	16.3	0	4.9	1.4
4109	11.3	31.2	5.0	7.7	1.7	0.2	40.7	44.3	0	16.8	16.3	0	6.4	1.6
4116	1.5	14.3	0.6	2.5	0.2	0.0	30.9	40.7	0	12.4	16.3	0	4.9	1.4
4123	32.7	68.2	14.3	20.3	4.8	1.7	62.1	79.6	18	26.1	25.4	1	9.5	3.1
4125	30.6	58.6	13.5	17.9	4.7	1.2	60.0	69.0	30	25.3	22.5	0	9.4	2.6
4150	338.9	413.4	149.0	117.7	35.8	11.8	368.3	426.5	336	160.8	123.0	261	40.5	13.2
4151	51.9	70.8	24.4	33.1	9.5	1.1	81.3	81.3	123	36.2	38.7	55	14.2	2.5
4161	21.0	27.4	8.7	7.8	2.6	0.5	50.4	45.8	0	20.5	16.6	0	7.3	1.9

Table E6. Year 16 – Incremental and Cumulative Particulate Matter Concentration/Deposition Results for Project (CHC-owned receptors are marked by grey shaded cells)

Residence ID	Incremental Concentration/Deposition due to Project						Cumulative Concentration/Deposition due to Project + Background Air Quality							
	TSP Annual Average µg/m³	PM_{10} Maximum 24-hr µg/m³	PM_{10} Annual Average µg/m³	$PM_{2.5}$ Maximum 24-hr µg/m³	$PM_{2.5}$ Annual Average µg/m³	Deposition Annual Average g/m²/month	TSP Annual Average µg/m³	PM_{10} Maximum 24-hr µg/m³(b)	PM_{10} No. Of Days >50 µg/m³	PM_{10} Annual Average µg/m³	$PM_{2.5}$ Maximum 24-hr µg/m³(b)	$PM_{2.5}$ No. Of Days >25µg/m³	$PM_{2.5}$ Annual Average µg/m³	Deposition Annual Average g/m²/month
Criteria	**NA**	**NA**	**NA**	**NA**	**NA**	**2**	**90**	**50**	**NA**	**30**	**25(a)**	**NA**	**8(a)**	**4**
4163	53.3	71.7	23.8	29.2	8.4	1.5	82.7	86.8	81	35.6	35.1	13	13.1	2.9
4182	20.9	48.3	10.0	14.1	4.2	0.4	50.3	61.9	7	21.8	21.3	0	8.9	1.8
4183	116.1	130.7	47.4	61.5	16.9	3.1	145.5	143.0	233	59.2	67.4	140	21.6	4.5
4190	39.6	44.9	18.6	22.9	7.8	0.6	69.0	59.4	19	30.4	28.7	11	12.5	2.0
4191	38.8	44.1	18.3	22.6	7.8	0.6	68.2	59.1	19	30.1	28.7	11	12.5	2.0
4193	37.9	53.9	18.0	23.0	7.4	0.5	67.3	70.4	11	29.8	27.5	6	12.1	1.9
4194	37.2	50.0	17.6	21.5	7.1	0.5	66.6	69.7	12	29.4	27.7	5	11.8	1.9
4196	38.0	74.2	16.8	21.5	6.1	1.0	67.4	86.1	20	28.6	27.8	2	10.8	2.4
4205	34.6	41.3	16.5	21.0	7.1	0.5	64.0	57.8	15	28.3	26.8	8	11.8	1.9
5002	39.2	79.5	17.2	22.2	6.2	1.1	68.6	92.0	20	29.0	28.3	2	10.9	2.5
5007	54.1	61.4	23.4	21.7	7.7	1.5	83.5	85.4	81	35.2	31.9	9	12.4	2.9
5008	45.3	48.0	20.8	24.3	8.2	1.0	74.7	70.8	41	32.6	32.2	21	12.9	2.4
5009	44.6	59.1	20.8	25.1	8.2	0.6	74.0	81.6	39	32.6	32.5	13	12.9	2.0
5010	4.3	13.6	1.9	3.1	0.6	0.3	33.7	40.7	0	13.7	16.3	0	5.3	1.7

Grey cell shading indicates CHC-owned properties

NA – Not applicable. Criteria are applicable to cumulative concentrations.

(a) The NEPM Advisory Reporting Standards for $PM_{2.5}$ are referenced for screening assessment purposes.

(b) The maximum cumulative value is not a sum of the maximum increment and the maximum baseline concentrations, since these maximums may occur on different days. Rather the maximum 24-hour cumulative concentrations reflect days on which background levels plus the concurrent Project-related increment were highest.

Table E7. Year 20 – Incremental and Cumulative Particulate Matter Concentration/Deposition Results for Project (CHC-owned receptors are marked by grey shaded cells)

Residence ID	Incremental Concentration/Deposition due to Project						Cumulative Concentration/Deposition due to Project + Background Air Quality							
	TSP Annual Average µg/m³	PM_{10} Maximum 24-hr µg/m³	PM_{10} Annual Average µg/m³	$PM_{2.5}$ Maximum 24-hr µg/m³	$PM_{2.5}$ Annual Average µg/m³	Deposition Annual Average g/m²/month	TSP Annual Average µg/m³	PM_{10} Maximum 24-hr µg/m³(b)	PM_{10} No. Of Days >50 µg/m³	PM_{10} Annual Average µg/m³	$PM_{2.5}$ Maximum 24-hr µg/m³(b)	$PM_{2.5}$ No. Of Days >25µg/m³	$PM_{2.5}$ Annual Average µg/m³	Deposition Annual Average g/m²/month
Criteria	**NA**	**NA**	**NA**	**NA**	**NA**	**2**	**90**	**50**	**NA**	**30**	**25[a]**	**NA**	**8[a]**	**4**
1088	5.2	9.1	2.6	4.4	1.3	0.1	34.6	40.7	0	14.4	16.3	0	6.0	1.5
1089	5.3	9.1	2.7	4.4	1.3	0.1	34.7	40.7	0	14.5	16.3	0	6.0	1.5
1094	0.4	3.2	0.2	0.7	0.0	0.0	29.8	40.7	0	12.0	16.3	0	4.7	1.4
1122	0.9	5.1	0.3	1.3	0.1	0.0	30.3	40.7	0	12.1	16.3	0	4.8	1.4
1133	5.7	10.8	3.0	5.7	1.6	0.2	35.1	40.7	0	14.8	16.3	0	6.3	1.6
1143	4.9	9.2	2.6	4.5	1.4	0.1	34.3	40.7	0	14.4	16.3	0	6.1	1.5
1144	4.9	9.3	2.6	4.5	1.4	0.1	34.3	40.7	0	14.4	16.3	0	6.1	1.5
1145	5.0	9.4	2.7	4.6	1.4	0.1	34.4	40.7	0	14.5	16.3	0	6.1	1.5
1147	5.2	9.1	2.7	4.9	1.4	0.1	34.6	40.7	0	14.5	16.3	0	6.1	1.5
1149	5.8	10.1	3.0	5.7	1.6	0.1	35.2	40.7	0	14.8	16.3	0	6.3	1.5
1158	1.3	4.8	0.6	1.9	0.2	0.0	30.7	40.7	0	12.4	16.3	0	4.9	1.4
1166	5.0	9.2	2.6	4.8	1.4	0.1	34.4	40.7	0	14.4	16.3	0	6.1	1.5
1170	6.1	10.2	3.2	5.5	1.7	0.0	35.5	40.7	0	15.0	16.3	0	6.4	1.4
1171	6.2	10.4	3.2	5.6	1.7	0.0	35.6	40.7	0	15.0	16.3	0	6.4	1.4
1172	7.7	12.6	4.0	7.4	2.2	0.1	37.1	40.8	0	15.8	16.3	0	6.9	1.5
1178	7.0	20.1	3.2	8.2	1.1	0.1	36.4	40.9	0	15.0	16.7	0	5.8	1.5
1179	1.8	8.1	0.9	2.3	0.3	0.0	31.2	40.7	0	12.7	16.3	0	5.0	1.4
1198	15.8	28.9	7.5	12.2	2.8	0.2	45.2	44.7	0	19.3	18.3	0	7.5	1.6
1199	15.3	29.8	7.2	12.7	2.8	0.2	44.7	43.5	0	19.0	18.1	0	7.5	1.6
1200	3.2	13.1	1.4	3.9	0.5	0.1	32.6	40.7	0	13.2	16.3	0	5.2	1.5
1201	0.9	6.5	0.4	1.5	0.1	0.0	30.3	40.7	0	12.2	16.3	0	4.8	1.4

Table E7. Year 20 – Incremental and Cumulative Particulate Matter Concentration/Deposition Results for Project (CHC-owned receptors are marked by grey shaded cells)

Residence ID	Incremental Concentration/Deposition due to Project						Cumulative Concentration/Deposition due to Project + Background Air Quality							
	TSP Annual Average µg/m³	PM_{10} Maximum 24-hr µg/m³	PM_{10} Annual Average µg/m³	$PM_{2.5}$ Maximum 24-hr µg/m³	$PM_{2.5}$ Annual Average µg/m³	Deposition Annual Average g/m²/month	TSP Annual Average µg/m³	PM_{10} Maximum 24-hr µg/m³(b)	PM_{10} No. Of Days >50 µg/m³	PM_{10} Annual Average µg/m³	$PM_{2.5}$ Maximum 24-hr µg/m³(b)	$PM_{2.5}$ No. Of Days >25µg/m³	$PM_{2.5}$ Annual Average µg/m³	Deposition Annual Average g/m²/month
Criteria	**NA**	**NA**	**NA**	**NA**	**NA**	**2**	**90**	**50**	**NA**	**30**	**25[a]**	**NA**	**8[a]**	**4**
1213	12.0	18.5	5.6	8.3	2.0	0.2	41.4	42.6	0	17.4	17.4	0	6.7	1.6
1215	5.7	13.8	2.5	4.7	0.8	0.2	35.1	43.5	0	14.3	16.6	0	5.5	1.6
1222	17.7	28.0	8.5	14.2	3.6	0.3	47.1	58.7	1	20.3	25.4	1	8.3	1.7
1223	17.7	27.9	8.5	14.7	3.6	0.3	47.1	59.1	1	20.3	26.2	1	8.3	1.7
1225	9.2	19.0	4.1	6.0	1.3	0.2	38.6	43.1	0	15.9	16.5	0	6.0	1.6
1230	15.3	26.5	7.4	13.3	3.2	0.2	44.7	53.1	1	19.2	23.0	0	7.9	1.6
1232	14.5	25.9	7.0	12.1	3.0	0.3	43.9	56.9	1	18.8	25.0	0	7.7	1.7
1233	10.6	21.4	5.2	10.3	2.3	0.1	40.0	44.0	0	17.0	17.9	0	7.0	1.5
1234	10.0	20.7	4.9	9.9	2.2	0.1	39.4	43.8	0	16.7	17.7	0	6.9	1.5
1240	6.0	13.0	3.0	6.0	1.5	0.2	35.4	40.7	0	14.8	16.3	0	6.2	1.6
1243	7.0	17.6	3.5	9.4	1.7	0.2	36.4	40.7	0	15.3	16.9	0	6.4	1.6
1252	8.6	27.1	4.0	8.7	1.7	0.2	38.0	41.6	0	15.8	16.4	0	6.4	1.6
1253	8.1	21.3	3.9	8.2	1.7	0.2	37.5	40.7	0	15.7	16.4	0	6.4	1.6
3086	1.4	6.1	0.5	1.5	0.1	0.1	30.8	40.7	0	12.3	16.3	0	4.8	1.5
3108	5.3	21.2	2.4	4.7	0.9	0.1	34.7	41.6	0	14.2	16.3	0	5.6	1.5
3224	19.8	31.4	9.5	16.2	4.1	0.3	49.2	62.2	1	21.3	28.4	1	8.8	1.7
5001	2.7	16.3	1.3	3.7	0.5	0.1	32.1	40.7	0	13.1	16.3	0	5.2	1.5
5003	0.4	2.7	0.2	0.4	0.0	0.0	29.8	40.7	0	12.0	16.3	0	4.7	1.4
5006	6.4	11.5	3.3	6.2	1.7	0.2	35.8	40.7	0	15.1	16.3	0	6.4	1.6
5024	11.9	16.6	5.7	9.0	2.4	0.2	41.3	47.9	0	17.5	21.1	0	7.1	1.6
5025	14.1	26.1	6.7	12.0	2.8	0.2	43.5	53.5	1	18.5	24.0	0	7.5	1.6

Table E7. Year 20 – Incremental and Cumulative Particulate Matter Concentration/Deposition Results for Project (CHC-owned receptors are marked by grey shaded cells)

Residence ID	Incremental Concentration/Deposition due to Project						Cumulative Concentration/Deposition due to Project + Background Air Quality							
	TSP Annual Average µg/m³	PM_{10} Maximum 24-hr µg/m³	PM_{10} Annual Average µg/m³	$PM_{2.5}$ Maximum 24-hr µg/m³	$PM_{2.5}$ Annual Average µg/m³	Deposition Annual Average g/m²/month	TSP Annual Average µg/m³	PM_{10} Maximum 24-hr µg/m³(b)	PM_{10} No. Of Days >50 µg/m³	PM_{10} Annual Average µg/m³	$PM_{2.5}$ Maximum 24-hr µg/m³(b)	$PM_{2.5}$ No. Of Days >25µg/m³	$PM_{2.5}$ Annual Average µg/m³	Deposition Annual Average g/m²/month
Criteria	**NA**	**NA**	**NA**	**NA**	**NA**	**2**	**90**	**50**	**NA**	**30**	**25[a]**	**NA**	**8[a]**	**4**
1083	0.4	2.3	0.1	0.4	0.0	0.0	29.8	40.7	0	11.9	16.3	0	4.7	1.4
1093	0.5	5.0	0.2	1.2	0.0	0.0	29.9	40.7	0	12.0	16.3	0	4.7	1.4
1180	20.7	35.2	9.7	12.8	3.6	0.3	50.1	56.6	3	21.5	21.9	0	8.3	1.7
1203	3.9	14.8	1.8	4.2	0.6	0.1	33.3	40.8	0	13.6	16.3	0	5.3	1.5
1228	18.1	36.0	8.7	16.6	3.8	0.2	47.5	55.6	3	20.5	22.8	0	8.5	1.6
2087	5.0	25.6	2.4	6.8	1.1	0.2	34.4	42.2	0	14.2	16.5	0	5.8	1.6
2128	9.1	17.2	4.3	8.3	1.9	0.3	38.5	40.8	0	16.1	16.3	0	6.6	1.7
2174	9.6	15.4	4.9	9.6	2.6	0.2	39.0	40.8	0	16.7	16.9	0	7.3	1.6
2176	14.4	21.5	6.9	10.6	3.2	0.5	43.8	41.2	0	18.7	16.6	0	7.9	1.9
2189	12.1	20.8	6.2	11.3	3.1	0.1	41.5	40.8	0	18.0	16.7	0	7.8	1.5
2208	22.5	49.9	11.1	24.2	5.1	0.2	51.9	62.2	4	22.9	29.2	3	9.8	1.6
2209	41.1	85.8	19.3	34.9	7.9	0.5	70.5	97.6	40	31.1	39.4	15	12.6	1.9
2221	22.5	45.0	10.8	20.8	4.7	0.2	51.9	58.2	8	22.6	25.9	1	9.4	1.6
3098	0.6	5.1	0.2	1.1	0.0	0.0	30.0	40.7	0	12.0	16.3	0	4.7	1.4
3099	0.6	5.6	0.2	1.3	0.1	0.0	30.0	40.7	0	12.0	16.3	0	4.8	1.4
3100	0.7	6.0	0.3	1.3	0.1	0.0	30.1	40.7	0	12.1	16.3	0	4.8	1.4
3107	3.8	18.0	1.8	4.2	0.7	0.1	33.2	40.8	0	13.6	16.3	0	5.4	1.5
3113	4.3	26.6	1.9	5.6	0.8	0.1	33.7	44.0	0	13.7	16.3	0	5.5	1.5
3115	2.4	16.6	1.1	2.7	0.4	0.1	31.8	41.0	0	12.9	16.3	0	5.1	1.5
3117	2.2	15.7	1.0	2.6	0.3	0.1	31.6	40.9	0	12.8	16.3	0	5.0	1.5
3118	1.9	15.7	0.9	2.8	0.4	0.0	31.3	40.7	0	12.7	16.3	0	5.1	1.4

Table E7. Year 20 – Incremental and Cumulative Particulate Matter Concentration/Deposition Results for Project (CHC-owned receptors are marked by grey shaded cells)

Residence ID	Incremental Concentration/Deposition due to Project						Cumulative Concentration/Deposition due to Project + Background Air Quality							
	TSP Annual Average µg/m³	PM_{10} Maximum 24-hr µg/m³	PM_{10} Annual Average µg/m³	$PM_{2.5}$ Maximum 24-hr µg/m³	$PM_{2.5}$ Annual Average µg/m³	Deposition Annual Average g/m²/month	TSP Annual Average µg/m³	PM_{10} Maximum 24-hr µg/m³(b)	PM_{10} No. Of Days >50 µg/m³	PM_{10} Annual Average µg/m³	$PM_{2.5}$ Maximum 24-hr µg/m³(b)	$PM_{2.5}$ No. Of Days >25µg/m³	$PM_{2.5}$ Annual Average µg/m³	Deposition Annual Average g/m²/month
Criteria	**NA**	**NA**	**NA**	**NA**	**NA**	**2**	**90**	**50**	**NA**	**30**	**25(a)**	**NA**	**8(a)**	**4**
3126	35.3	51.8	16.8	24.1	6.4	0.8	64.7	66.6	1	28.6	27.6	1	11.1	2.2
3177	15.9	33.5	6.8	8.0	1.9	0.4	45.3	58.3	1	18.6	18.3	0	6.6	1.8
3218	19.8	36.8	9.7	20.8	3.9	0.3	49.2	51.6	1	21.5	26.8	1	8.6	1.7
3219	22.9	36.8	11.0	17.9	4.5	0.4	52.3	62.4	1	22.8	26.4	1	9.2	1.8
4081	0.9	3.8	0.4	0.9	0.1	0.0	30.3	40.8	0	12.2	16.3	0	4.8	1.4
4084	0.4	1.7	0.1	0.3	0.0	0.0	29.8	40.7	0	11.9	16.3	0	4.7	1.4
4085	1.7	6.8	0.7	2.0	0.2	0.1	31.1	40.7	0	12.5	16.3	0	4.9	1.5
4090	3.8	10.9	1.9	4.5	0.9	0.2	33.2	40.7	0	13.7	16.3	0	5.6	1.6
4101	0.8	7.2	0.3	1.8	0.1	0.0	30.2	40.7	0	12.1	16.3	0	4.8	1.4
4102	0.8	7.5	0.3	1.8	0.1	0.0	30.2	40.7	0	12.1	16.3	0	4.8	1.4
4103	0.9	7.8	0.3	1.8	0.1	0.0	30.3	40.7	0	12.1	16.3	0	4.8	1.4
4104	1.3	10.9	0.6	2.7	0.2	0.0	30.7	40.7	0	12.4	16.3	0	4.9	1.4
4105	1.6	12.5	0.8	2.9	0.3	0.0	31.0	40.7	0	12.6	16.3	0	5.0	1.4
4106	1.7	14.5	0.8	3.2	0.4	0.0	31.1	40.7	0	12.6	16.3	0	5.1	1.4
4109	11.9	32.6	5.2	7.8	1.8	0.3	41.3	46.7	0	17.0	16.3	0	6.5	1.7
4116	1.7	15.8	0.7	2.4	0.3	0.1	31.1	40.7	0	12.5	16.3	0	5.0	1.5
4123	51.4	101.2	21.1	22.6	6.2	3.3	80.8	108.4	47	32.9	28.0	1	10.9	4.7
4125	38.8	70.2	17.3	17.1	5.0	1.4	68.2	84.3	81	29.1	22.7	0	9.7	2.8
4150	370.2	437.1	163.7	133.5	43.0	11.8	399.6	450.9	337	175.5	138.7	269	47.7	13.2
4151	56.0	90.9	26.3	35.0	10.1	1.0	85.4	102.8	138	38.1	41.1	68	14.8	2.4
4161	27.9	62.4	11.1	11.7	2.9	0.9	57.3	74.2	8	22.9	19.3	0	7.6	2.3

Table E7. Year 20 – Incremental and Cumulative Particulate Matter Concentration/Deposition Results for Project (CHC-owned receptors are marked by grey shaded cells)

Residence ID	Incremental Concentration/Deposition due to Project						Cumulative Concentration/Deposition due to Project + Background Air Quality							
	TSP Annual Average µg/m³	PM_{10} Maximum 24-hr µg/m³	PM_{10} Annual Average µg/m³	$PM_{2.5}$ Maximum 24-hr µg/m³	$PM_{2.5}$ Annual Average µg/m³	Deposition Annual Average g/m²/month	TSP Annual Average µg/m³	PM_{10} Maximum 24-hr µg/m³(b)	PM_{10} No. Of Days >50 µg/m³	PM_{10} Annual Average µg/m³	$PM_{2.5}$ Maximum 24-hr µg/m³(b)	$PM_{2.5}$ No. Of Days >25µg/m³	$PM_{2.5}$ Annual Average µg/m³	Deposition Annual Average g/m²/month
Criteria	**NA**	**NA**	**NA**	**NA**	**NA**	**2**	**90**	**50**	**NA**	**30**	**25(a)**	**NA**	**8(a)**	**4**
4163	47.3	81.4	21.7	32.0	7.7	1.1	76.7	93.2	76	33.5	36.8	14	12.4	2.5
4182	21.5	31.7	10.0	15.8	3.8	0.3	50.9	51.5	2	21.8	22.7	0	8.5	1.7
4183	63.6	62.2	21.0	33.3	9.3	1.4	93.0	75.1	92	32.8	38.7	60	14.0	2.8
4190	40.6	61.9	19.6	32.8	8.7	0.5	70.0	77.1	43	31.4	37.9	25	13.4	1.9
4191	40.5	60.5	19.6	32.6	8.7	0.5	69.9	75.9	43	31.4	37.9	25	13.4	1.9
4193	44.6	64.1	21.5	32.8	9.7	0.6	74.0	91.4	41	33.3	41.2	26	14.4	2.0
4194	42.8	58.9	20.7	33.3	9.2	0.6	72.2	77.6	43	32.5	36.5	30	13.9	2.0
4196	27.4	32.4	12.8	16.4	4.8	0.5	56.8	50.7	3	24.6	23.6	0	9.5	1.9
4205	37.6	55.1	18.2	30.6	8.2	0.5	67.0	73.0	28	30.0	36.8	16	12.9	1.9
5002	26.8	31.8	12.6	16.3	4.7	0.5	56.2	50.2	3	24.4	23.6	0	9.4	1.9
5007	62.7	87.1	28.9	47.5	12.5	1.1	92.1	100.4	109	40.7	53.2	74	17.2	2.5
5008	39.1	53.9	19.1	32.5	8.4	0.6	68.5	68.2	27	30.9	38.4	22	13.1	2.0
5009	49.3	69.7	23.7	38.9	10.3	0.7	78.7	84.3	76	35.5	43.6	50	15.0	2.1
5010	6.3	24.6	2.9	7.3	1.2	0.3	35.7	41.0	0	14.7	16.3	0	5.9	1.7

Grey cell shading indicates CHC-owned properties

NA – Not applicable. Criteria are applicable to cumulative concentrations.

(a) The NEPM Advisory Reporting Standards for $PM_{2.5}$ are referenced for screening assessment purposes.

(b) The maximum cumulative value is not a sum of the maximum increment and the maximum baseline concentrations, since these maximums may occur on different days. Rather the maximum 24-hour cumulative concentrations reflect days on which background levels plus the concurrent Project-related increment were highest.

Table E8. Maximum Incremental Gaseous Pollutant Concentration Results for Project – Across All Mine Years (CHC-owned receptors are marked by grey shaded cells)

Residence ID	Incremental Concentration due to Project									
	Nitrogen Dioxide		Sulphur Dioxide			Carbon Monoxide		Benzene	Toluene	Xylenes
	Highest Hourly Average (µg/m³)	Annual Average (µg/m³)	Highest Hourly Average (µg/m³)	Highest 24-hour Average (µg/m³)	Annual Average (µg/m³)	Highest Hourly Average (µg/m³)	Highest 8-hour Rolling Average (µg/m³)	99.9th Percentile Hourly Average (µg/m³)	99.9th Percentile Hourly Average (µg/m³)	99.9th Percentile Hourly Average (µg/m³)
Criteria (a)	**246**	**62**	**570**	**228**	**60**	**30,000**	**10,000**	**29**	**360**	**190**
1088	48.8	2.9	12.7	0.5	0.2	432.4	54.8	0.2	0.2	<0.1
1089	49.3	3.0	14.1	0.6	0.2	480.2	60.8	0.2	0.2	<0.1
1094	48.3	0.2	16.5	0.6	<0.1	563.9	70.6	<0.1	<0.1	<0.1
1122	45.4	0.4	12.8	0.5	<0.1	436.3	54.6	<0.1	<0.1	<0.1
1133	44.4	3.7	11.4	0.5	0.1	389.9	49.4	0.2	0.1	<0.1
1143	48.0	3.3	16.7	0.7	0.1	568.6	71.6	0.1	0.1	<0.1
1144	47.5	3.3	15.8	0.7	0.1	536.2	67.7	0.1	0.1	<0.1
1145	46.5	3.4	12.7	0.5	0.1	430.6	54.7	0.1	0.1	<0.1
1147	44.8	3.5	7.8	0.3	0.1	264.5	33.4	0.2	0.1	<0.1
1149	48.3	3.8	16.9	0.7	0.1	574.5	71.9	0.2	0.1	<0.1
1158	45.5	1.0	12.0	0.5	<0.1	407.7	51.3	0.1	<0.1	<0.1
1166	44.2	3.4	5.3	0.2	0.1	181.5	23.8	0.1	0.1	<0.1
1170	47.2	4.0	7.0	0.3	0.1	238.0	30.0	0.2	0.1	<0.1
1171	48.1	4.0	5.5	0.2	0.1	186.5	23.3	0.2	0.1	<0.1
1172	49.6	4.9	9.0	0.4	0.2	305.4	38.6	0.2	0.2	<0.1
1178	55.5	5.4	23.9	1.0	0.3	816.0	103.3	0.3	0.3	0.1
1179	46.1	1.6	13.5	0.5	<0.1	460.8	58.3	0.2	<0.1	<0.1
1198	61.3	7.6	28.6	1.2	0.5	973.6	122.2	0.5	0.5	0.2
1199	60.7	7.4	27.5	1.1	0.4	936.4	117.5	0.5	0.4	0.1
1200	49.6	3.0	17.8	0.7	0.1	609.8	77.1	0.2	0.1	<0.1

Table E8. Maximum Incremental Gaseous Pollutant Concentration Results for Project – Across All Mine Years (CHC-owned receptors are marked by grey shaded cells)

Residence ID	Incremental Concentration due to Project									
	Nitrogen Dioxide		Sulphur Dioxide			Carbon Monoxide		Benzene	Toluene	Xylenes
	Highest Hourly Average (µg/m³)	Annual Average (µg/m³)	Highest Hourly Average (µg/m³)	Highest 24-hour Average (µg/m³)	Annual Average (µg/m³)	Highest Hourly Average (µg/m³)	Highest 8-hour Rolling Average (µg/m³)	99.9th Percentile Hourly Average (µg/m³)	99.9th Percentile Hourly Average (µg/m³)	99.9th Percentile Hourly Average (µg/m³)
Criteria (a)	**246**	**62**	**570**	**228**	**60**	**30,000**	**10,000**	**29**	**360**	**190**
1201	49.8	0.6	18.1	0.8	<0.1	619.6	78.4	<0.1	<0.1	<0.1
1213	59.6	7.9	29.0	1.2	0.3	988.5	124.3	0.4	0.3	0.1
1215	48.1	4.3	16.6	0.7	0.1	564.8	71.0	0.2	0.1	<0.1
1222	68.8	14.3	20.2	0.8	0.9	686.2	86.0	0.9	0.9	0.3
1223	71.9	14.9	30.1	1.3	0.8	1,024.7	128.5	0.8	0.8	0.2
1225	59.6	5.8	30.8	1.3	0.2	1,048.6	131.9	0.3	0.2	<0.1
1230	59.1	7.9	29.6	1.2	0.4	1,007.4	126.0	0.5	0.4	0.1
1232	68.3	7.7	41.5	1.7	0.6	1,411.4	177.0	0.6	0.6	0.2
1233	59.1	5.7	28.6	1.2	0.4	973.7	122.0	0.4	0.4	0.1
1234	61.9	5.4	33.9	1.4	0.3	1,152.4	144.5	0.4	0.3	0.1
1240	60.3	3.4	31.9	1.3	0.3	1,086.0	136.1	0.3	0.3	<0.1
1243	64.6	3.7	36.8	1.5	0.4	1,254.0	156.9	0.4	0.4	0.1
1252	64.6	4.6	37.0	1.5	0.4	1,259.7	161.0	0.4	0.4	0.1
1253	59.3	4.0	30.3	1.2	0.3	1,033.5	129.3	0.4	0.3	0.1
3086	54.3	0.5	24.2	0.9	<0.1	824.1	103.6	<0.1	<0.1	<0.1
3108	54.6	6.4	18.3	0.8	0.2	622.8	79.1	0.3	0.2	<0.1
3224	73.6	17.9	47.9	2.0	0.8	1,631.5	205.0	0.8	0.8	0.3
5001	50.2	3.6	17.3	0.7	<0.1	589.2	74.8	0.2	0.1	<0.1
5003	55.3	0.2	24.5	0.5	<0.1	836.0	104.6	<0.1	<0.1	<0.1
5006	50.9	3.9	13.7	0.6	0.2	465.7	59.2	0.2	0.2	<0.1

Table E8. Maximum Incremental Gaseous Pollutant Concentration Results for Project – Across All Mine Years (CHC-owned receptors are marked by grey shaded cells)

Residence ID	Incremental Concentration due to Project									
	Nitrogen Dioxide		Sulphur Dioxide			Carbon Monoxide		Benzene	Toluene	Xylenes
	Highest Hourly Average (µg/m³)	Annual Average (µg/m³)	Highest Hourly Average (µg/m³)	Highest 24-hour Average (µg/m³)	Annual Average (µg/m³)	Highest Hourly Average (µg/m³)	Highest 8-hour Rolling Average (µg/m³)	99.9th Percentile Hourly Average (µg/m³)	99.9th Percentile Hourly Average (µg/m³)	99.9th Percentile Hourly Average (µg/m³)
Criteria (a)	**246**	**62**	**570**	**228**	**60**	**30,000**	**10,000**	**29**	**360**	**190**
5024	77.1	8.4	51.7	2.2	0.5	1,758.8	220.7	0.5	0.5	0.2
5025	60.7	11.1	25.3	1.1	0.7	862.0	108.4	0.7	0.7	0.2
1083	54.0	0.2	23.3	0.6	<0.1	794.5	99.4	<0.1	<0.1	<0.1
1093	49.6	0.2	17.7	0.7	<0.1	606.2	75.9	<0.1	<0.1	<0.1
1180	71.5	12.5	32.3	1.3	0.6	1,101.0	138.3	0.9	0.6	0.3
1203	49.3	3.6	17.6	0.7	0.2	600.2	75.9	0.2	0.2	<0.1
1228	67.2	9.2	38.3	1.6	0.6	1,303.6	163.0	0.6	0.6	0.2
2087	54.3	3.1	20.4	0.8	0.1	696.4	87.7	0.3	0.1	<0.1
2128	54.9	5.4	24.2	1.0	0.3	822.8	103.2	0.3	0.3	<0.1
2174	55.5	6.1	19.3	0.8	0.2	655.4	82.2	0.3	0.2	<0.1
2176	72.7	7.9	31.1	1.3	0.5	1,057.2	134.4	0.5	0.5	0.1
2189	58.6	7.3	13.7	0.6	0.2	467.6	58.5	0.3	0.2	0.1
2208	69.1	11.7	11.4	0.5	0.3	389.8	63.8	0.7	0.4	0.2
2209	73.4	18.4	26.1	1.1	0.3	889.9	112.1	0.9	0.5	0.3
2221	74.3	11.3	17.4	0.7	0.6	594.2	75.3	0.7	0.6	0.2
3098	54.7	0.2	23.6	0.8	<0.1	806.9	100.9	<0.1	<0.1	<0.1
3099	51.0	0.3	18.9	0.7	<0.1	648.9	81.2	<0.1	<0.1	<0.1
3100	53.0	0.3	21.5	0.8	<0.1	736.7	92.2	<0.1	<0.1	<0.1
3107	58.4	5.9	17.7	0.7	0.1	602.8	76.6	0.3	0.2	<0.1
3113	62.4	5.7	33.2	0.9	0.2	1,133.6	141.9	0.5	0.2	0.1

Table E8. Maximum Incremental Gaseous Pollutant Concentration Results for Project – Across All Mine Years (CHC-owned receptors are marked by grey shaded cells)

Residence ID	Incremental Concentration due to Project									
	Nitrogen Dioxide		Sulphur Dioxide			Carbon Monoxide		Benzene	Toluene	Xylenes
	Highest Hourly Average (µg/m³)	Annual Average (µg/m³)	Highest Hourly Average (µg/m³)	Highest 24-hour Average (µg/m³)	Annual Average (µg/m³)	Highest Hourly Average (µg/m³)	Highest 8-hour Rolling Average (µg/m³)	99.9th Percentile Hourly Average (µg/m³)	99.9th Percentile Hourly Average (µg/m³)	99.9th Percentile Hourly Average (µg/m³)
Criteria (a)	**246**	**62**	**570**	**228**	**60**	**30,000**	**10,000**	**29**	**360**	**190**
3115	61.1	2.4	30.9	1.0	<0.1	1,057.1	132.3	0.2	0.1	<0.1
3117	61.8	2.0	32.0	1.0	<0.1	1,092.4	136.7	0.1	<0.1	<0.1
3118	55.5	2.0	24.9	0.8	<0.1	851.4	106.6	0.2	<0.1	<0.1
3126	128.3	31.2	59.4	2.5	1.6	2,020.5	255.6	1.7	1.6	0.5
3177	57.4	11.2	24.3	1.0	0.2	830.3	105.3	0.5	0.2	0.1
3218	75.8	13.4	50.3	2.1	0.6	1,713.2	215.8	0.6	0.6	0.2
3219	75.4	17.6	37.0	1.3	1.0	1,260.7	158.4	1.0	1.0	0.3
4081	43.2	2.2	8.4	0.3	<0.1	289.8	36.4	<0.1	<0.1	<0.1
4084	50.2	0.2	18.2	0.5	<0.1	622.9	77.9	<0.1	<0.1	<0.1
4085	51.0	0.7	20.1	0.8	<0.1	683.5	86.5	<0.1	<0.1	<0.1
4090	61.6	3.4	33.1	1.4	0.1	1,128.2	142.9	0.2	0.1	<0.1
4101	52.2	0.5	21.2	0.7	<0.1	724.8	90.8	<0.1	<0.1	<0.1
4102	52.2	0.6	20.9	0.7	<0.1	713.4	89.3	<0.1	<0.1	<0.1
4103	59.3	0.8	29.6	0.6	<0.1	1,009.6	126.3	<0.1	<0.1	<0.1
4104	57.0	1.4	27.1	0.7	<0.1	923.2	115.6	0.1	<0.1	<0.1
4105	55.1	1.7	24.7	0.7	<0.1	842.6	105.5	0.1	<0.1	<0.1
4106	59.1	1.9	29.3	0.5	<0.1	1,002.1	125.4	0.2	<0.1	<0.1
4109	69.5	10.5	36.6	1.5	0.4	1,245.6	158.9	0.5	0.4	0.2
4116	59.9	1.8	29.8	1.0	<0.1	1,020.6	127.7	0.1	<0.1	<0.1
4123	86.8	18.8	49.8	2.1	0.9	1,693.2	216.9	1.1	0.9	0.3

Table E8. Maximum Incremental Gaseous Pollutant Concentration Results for Project – Across All Mine Years (CHC-owned receptors are marked by grey shaded cells)

Residence ID	Incremental Concentration due to Project									
	Nitrogen Dioxide		Sulphur Dioxide			Carbon Monoxide		Benzene	Toluene	Xylenes
	Highest Hourly Average (µg/m³)	Annual Average (µg/m³)	Highest Hourly Average (µg/m³)	Highest 24-hour Average (µg/m³)	Annual Average (µg/m³)	Highest Hourly Average (µg/m³)	Highest 8-hour Rolling Average (µg/m³)	99.9th Percentile Hourly Average (µg/m³)	99.9th Percentile Hourly Average (µg/m³)	99.9th Percentile Hourly Average (µg/m³)
Criteria (a)	**246**	**62**	**570**	**228**	**60**	**30,000**	**10,000**	**29**	**360**	**190**
4125	94.5	18.9	21.7	0.8	1.0	739.7	97.2	1.0	1.0	0.3
4150	107.0	38.9	67.6	2.8	1.8	2,300.9	289.0	1.8	1.8	0.5
4151	155.8	36.5	83.4	1.8	2.5	2,835.5	355.8	2.5	2.5	0.7
4161	59.7	14.1	23.5	1.0	0.3	801.5	100.7	0.4	0.3	0.1
4163	142.3	26.5	74.1	2.5	2.4	2,523.4	323.1	2.4	2.4	0.7
4182	78.5	19.7	33.6	1.1	0.8	1,146.5	144.3	1.0	0.8	0.3
4183	93.1	34.7	65.0	2.7	0.7	2,209.5	278.6	0.8	0.7	0.3
4190	184.0	36.6	174.4	7.3	1.7	5,929.5	743.7	1.5	1.5	0.4
4191	112.6	36.2	77.6	3.3	1.5	2,638.9	330.7	1.5	1.5	0.4
4193	105.6	39.0	69.0	2.9	1.4	2,346.9	294.4	1.4	1.4	0.4
4194	85.1	38.3	34.5	1.4	1.3	1,175.3	148.3	1.3	1.3	0.4
4196	88.8	23.6	62.2	1.6	0.9	2,116.8	265.4	0.9	0.9	0.3
4205	92.6	32.3	60.3	2.5	1.4	2,051.5	257.4	1.4	1.4	0.4
5002	96.9	23.3	72.6	1.3	0.8	2,468.4	309.2	0.9	0.8	0.3
5007	116.1	28.9	96.9	4.0	0.9	3,294.6	412.5	1.0	0.9	0.3
5008	100.9	22.6	57.5	2.4	1.1	1,954.4	246.4	1.1	1.1	0.3
5009	93.3	39.3	68.8	2.9	1.3	2,341.2	293.8	1.3	1.3	0.4
5010	69.0	3.6	42.5	1.8	0.1	1,448.2	183.9	0.3	0.2	<0.1

Grey cell shading indicates CHC-owned properties

(a) Criteria for SO2, NO2 and CO are applicable to cumulative concentrations. Due to lack of localised sources and absence of ambient monitoring data, background concentrations are assumed to be negligible.

Appendix F
Incremental Air Pollutant Isopleths

Scenarios	Pollutant	Averaging Period	Figure No.
Year 1	PM_{10}	Highest 24-hour	F1
	PM_{10}	Annual average	F2
	$PM_{2.5}$	Highest 24-hour	F3
	$PM_{2.5}$	Annual average	F4
	TSP	Annual average	F5
	Dust Deposition	Annual average	F6
Year 2	PM_{10}	Highest 24-hour	F7
	PM_{10}	Annual average	F8
	$PM_{2.5}$	Highest 24-hour	F9
	$PM_{2.5}$	Annual average	F10
	TSP	Annual average	F11
	Dust Deposition	Annual average	F12
Year 4	PM_{10}	Highest 24-hour	F13
	PM_{10}	Annual average	F14
	$PM_{2.5}$	Highest 24-hour	F15
	$PM_{2.5}$	Annual average	F16
	TSP	Annual average	F17
	Dust Deposition	Annual average	F18
Year 8	PM_{10}	Highest 24-hour	F19
	PM_{10}	Annual average	F20
	$PM_{2.5}$	Highest 24-hour	F21
	$PM_{2.5}$	Annual average	F22
	TSP	Annual average	F23
	Dust Deposition	Annual average	F24

Scenarios	Pollutant	Averaging Period	Figure No.
Year 12	PM_{10}	Highest 24-hour	F25
	PM_{10}	Annual average	F26
	$PM_{2.5}$	Highest 24-hour	F27
	$PM_{2.5}$	Annual average	F28
	TSP	Annual average	F29
	Dust Deposition	Annual average	F30
Year 16	PM_{10}	Highest 24-hour	F31
	PM_{10}	Annual average	F32
	$PM_{2.5}$	Highest 24-hour	F33
	$PM_{2.5}$	Annual average	F34
	TSP	Annual average	F35
	Dust Deposition	Annual average	F36
Year 20	PM_{10}	Highest 24-hour	F37
	PM_{10}	Annual average	F38
	$PM_{2.5}$	Highest 24-hour	F39
	$PM_{2.5}$	Annual average	F40
	TSP	Annual average	F41
	Dust Deposition	Annual average	F42

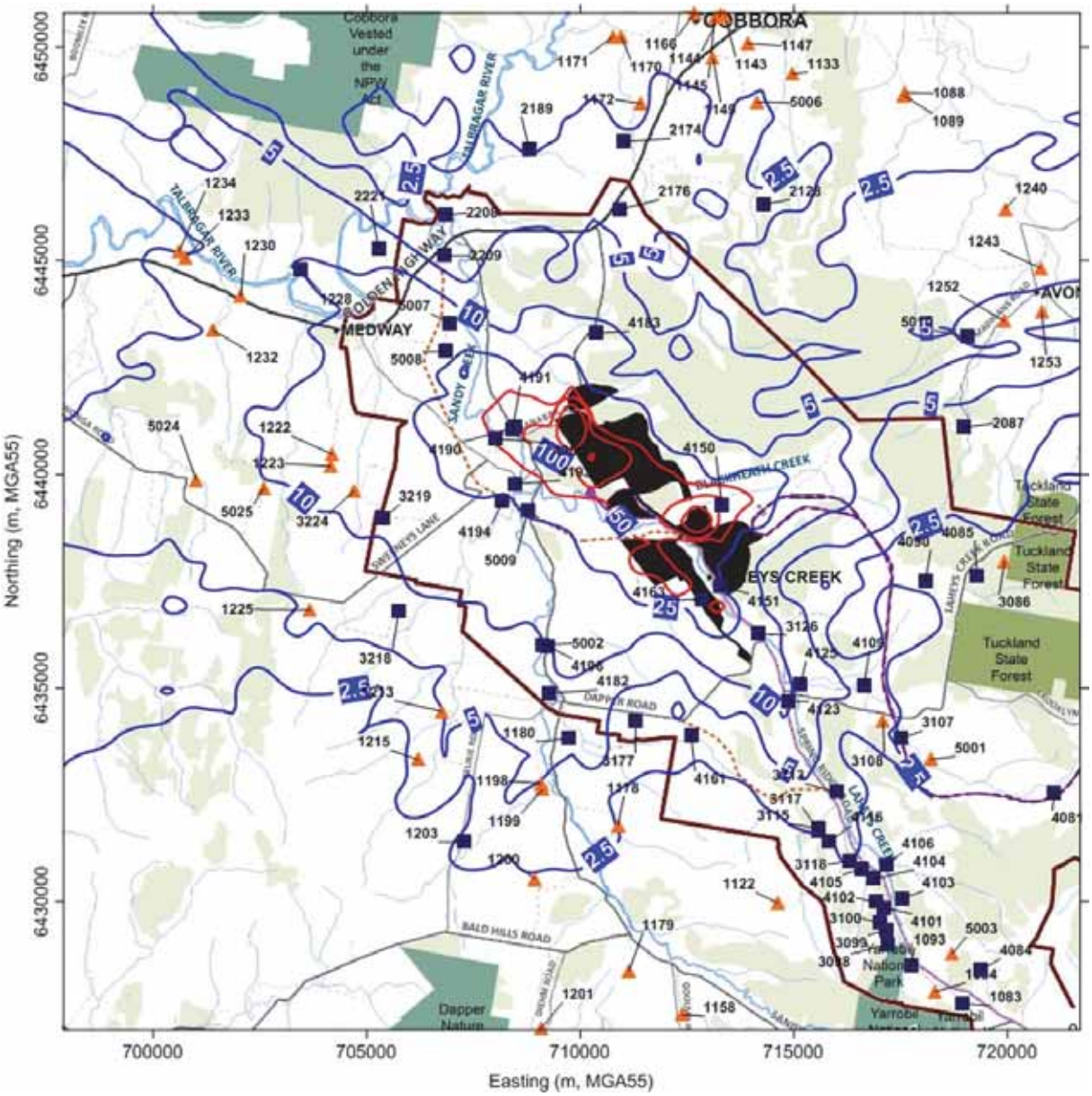

Figure F1 - Year 1 Operations – Highest 24-hour average PM_{10} Concentrations (µg/m³) - Project Only Increment

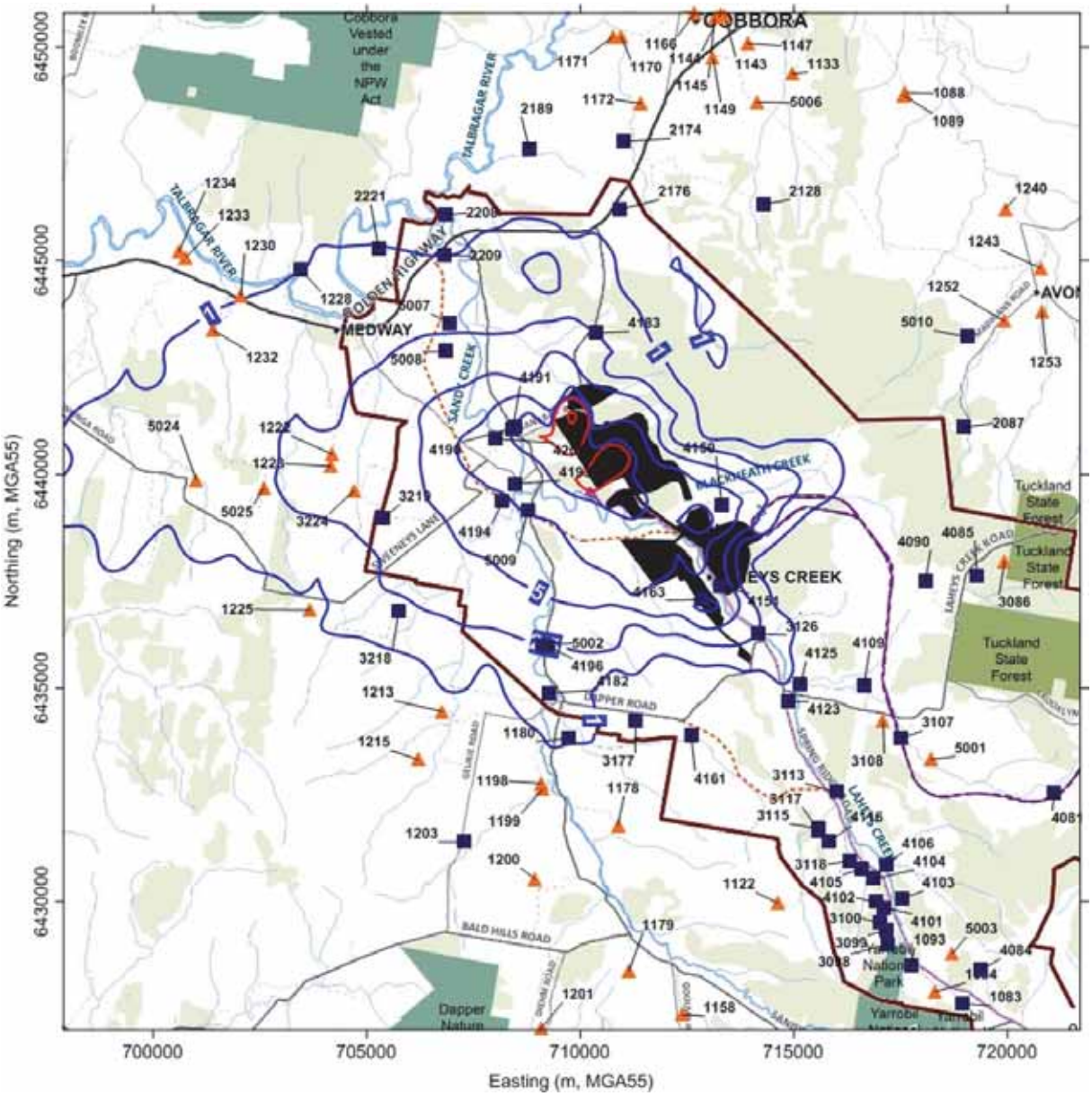

Figure F2 - Year 1 Operations – Annual average PM_{10} Concentrations (µg/m³) - Project Only Increment

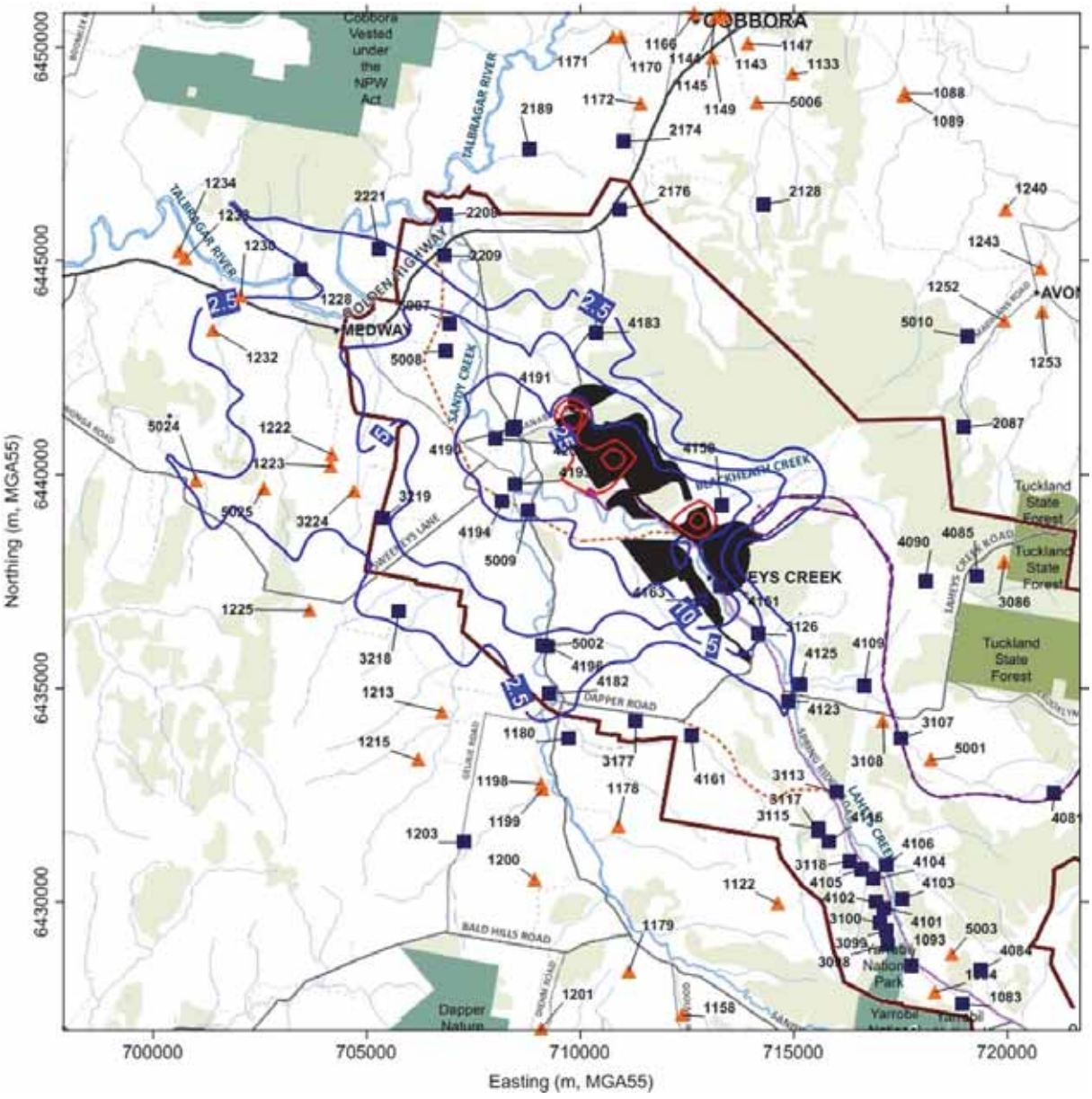

Figure F3 - Year 1 Operations – Highest 24-hour average $PM_{2.5}$ Concentrations (µg/m³) - Project Only Increment

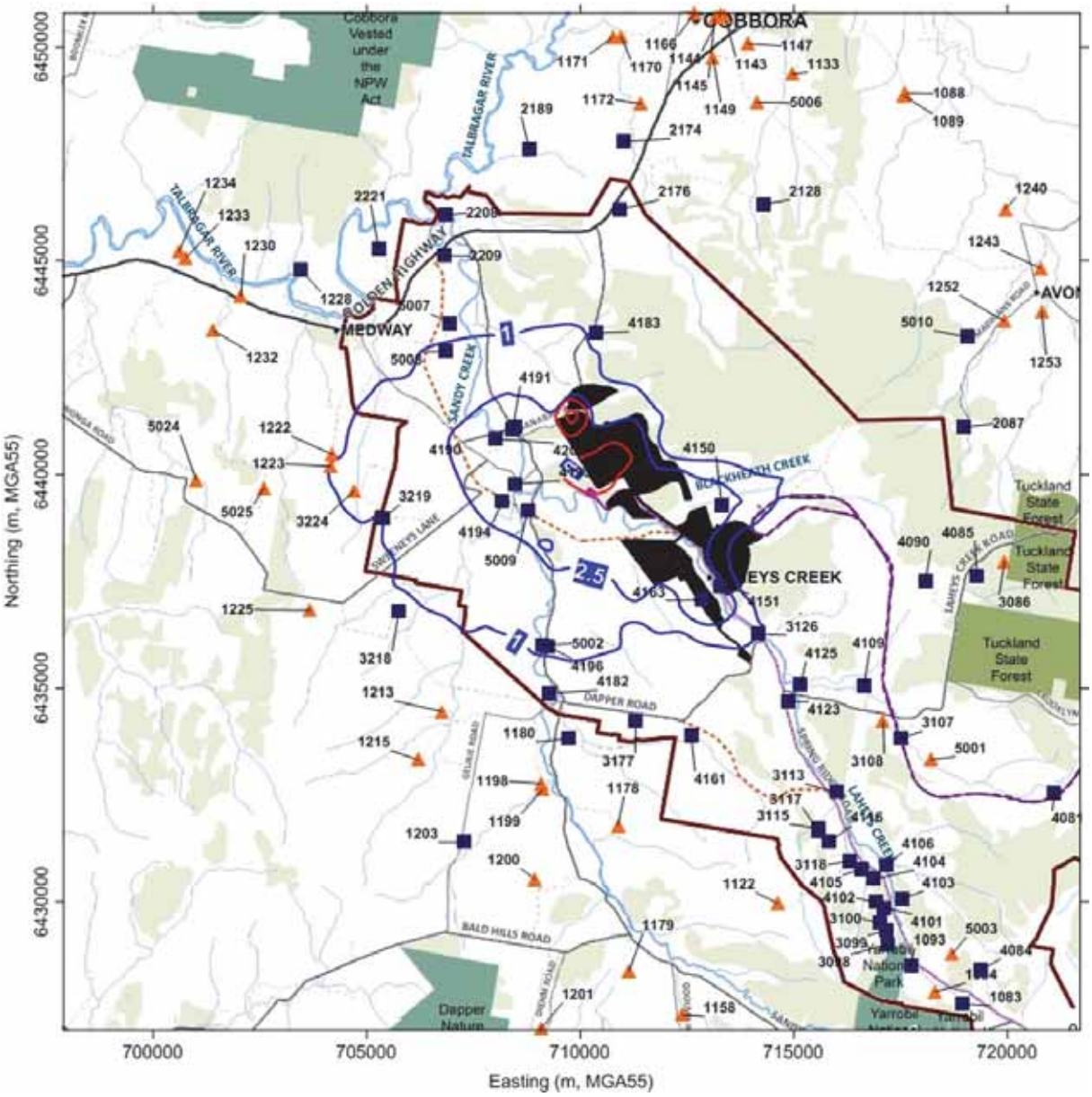

Figure F4 - Year 1 Operations – Annual average $PM_{2.5}$ Concentrations (µg/m³) - Project Only Increment

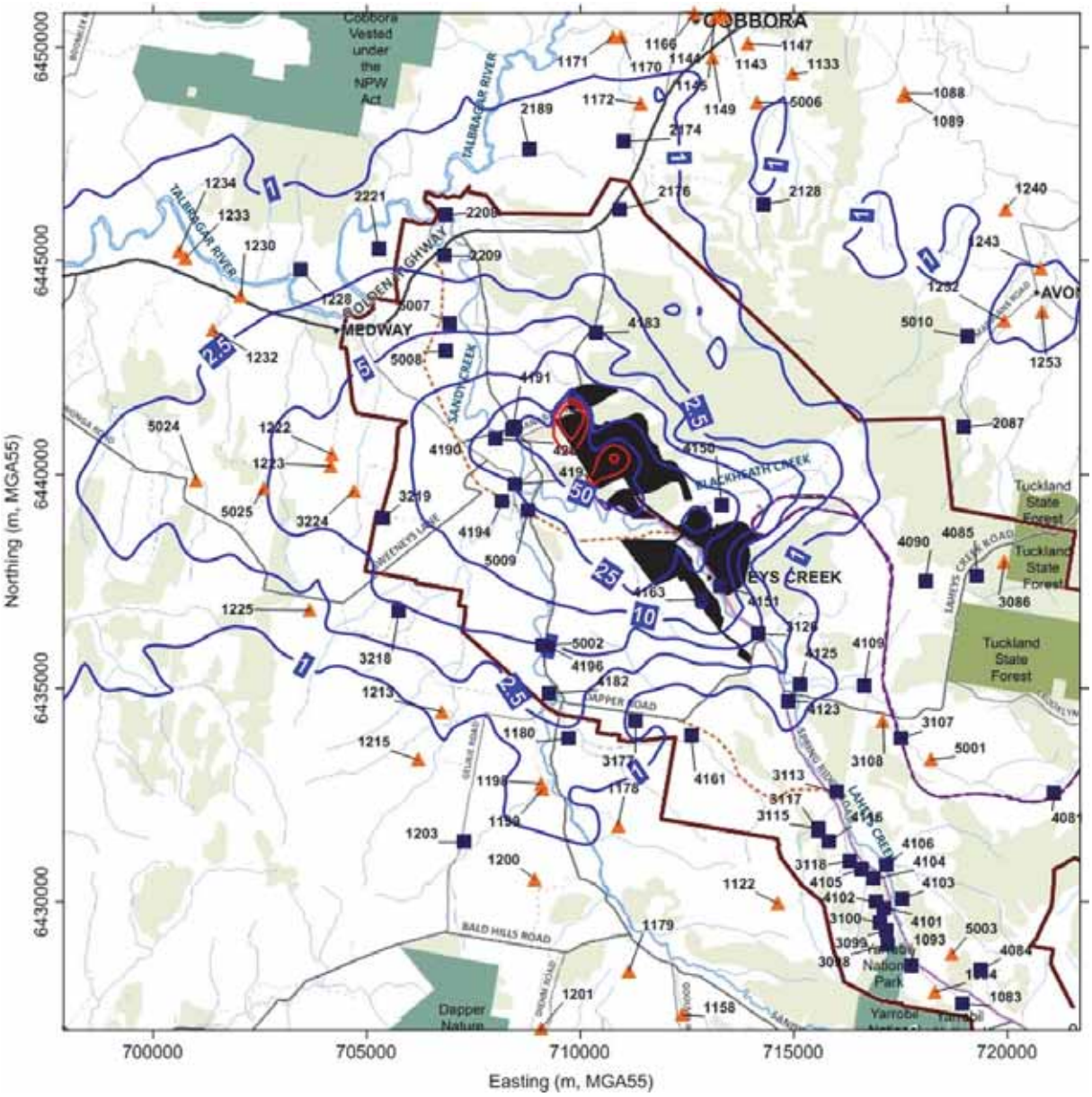

Figure F5 - Year 1 Operations – Annual average TSP Concentrations (µg/m³) - Project Only Increment

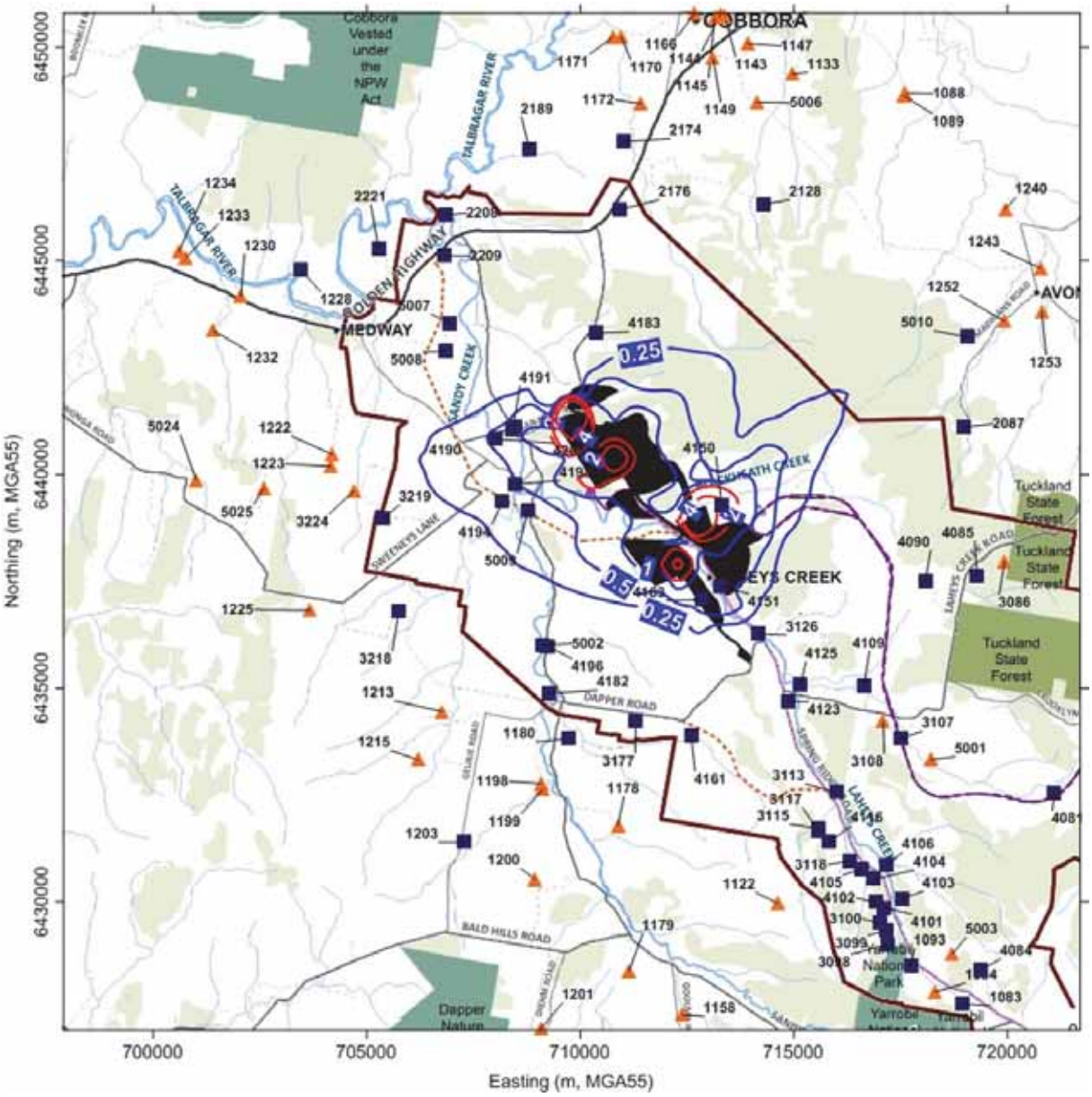

Figure F6 - Year 1 Operations – Annual average Dust Deposition (g/m^2/month) - Project Only Increment

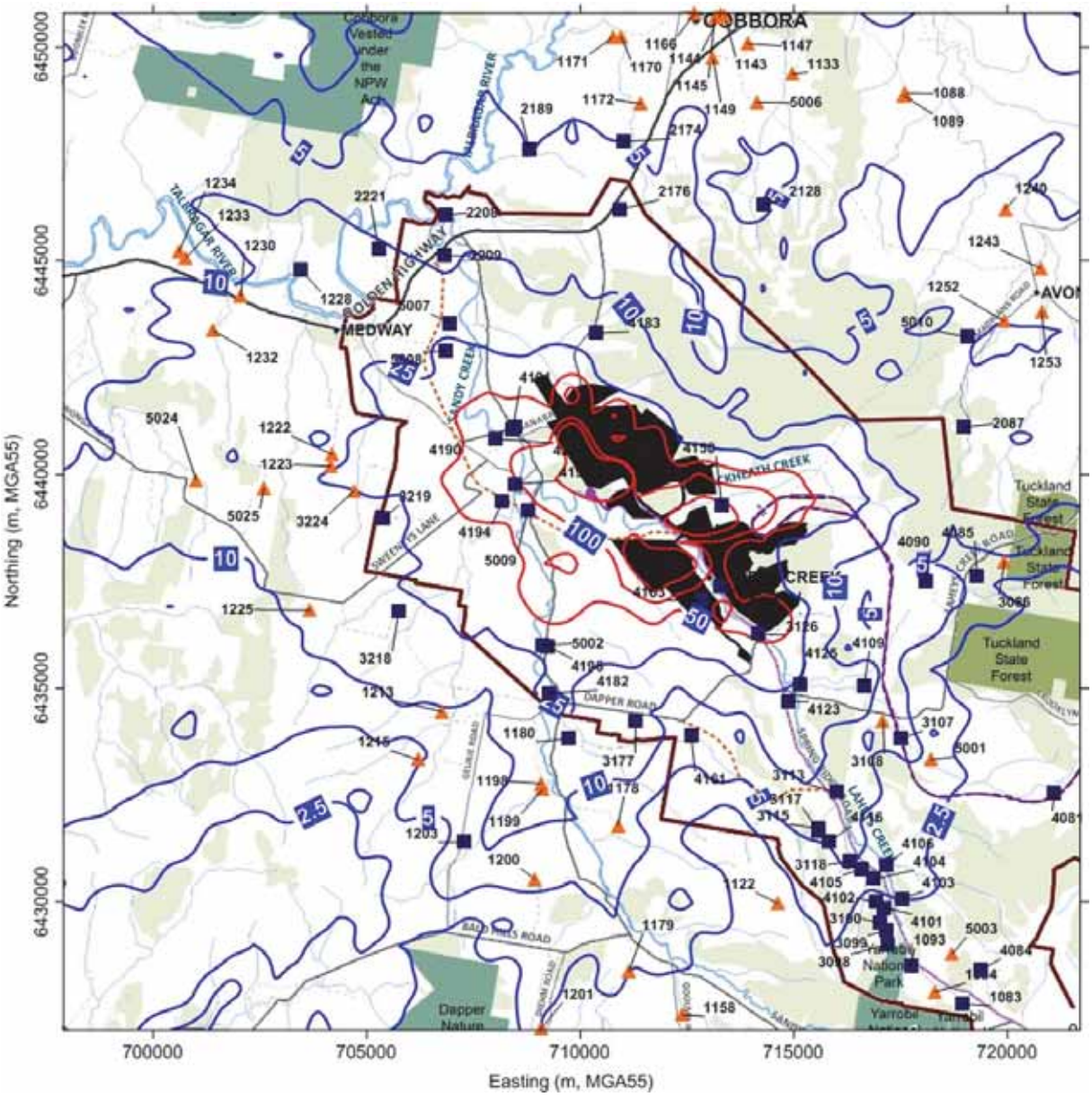

Figure F7 - Year 2 Operations – Highest 24-hour average PM_{10} Concentrations (µg/m³) - Project Only Increment

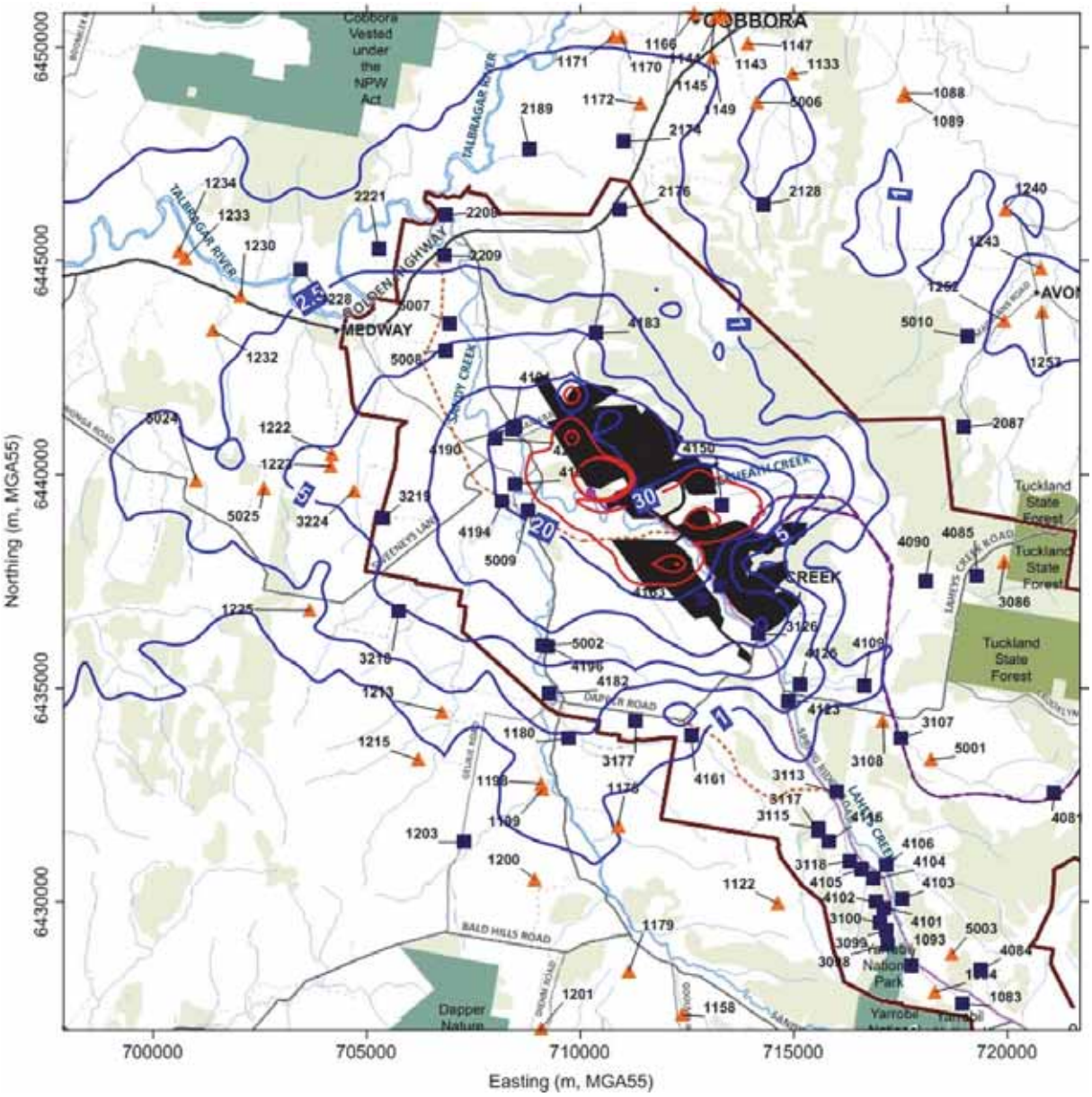

Figure F8 - Year 2 Operations – Annual average PM_{10} Concentrations (µg/m³) - Project Only Increment

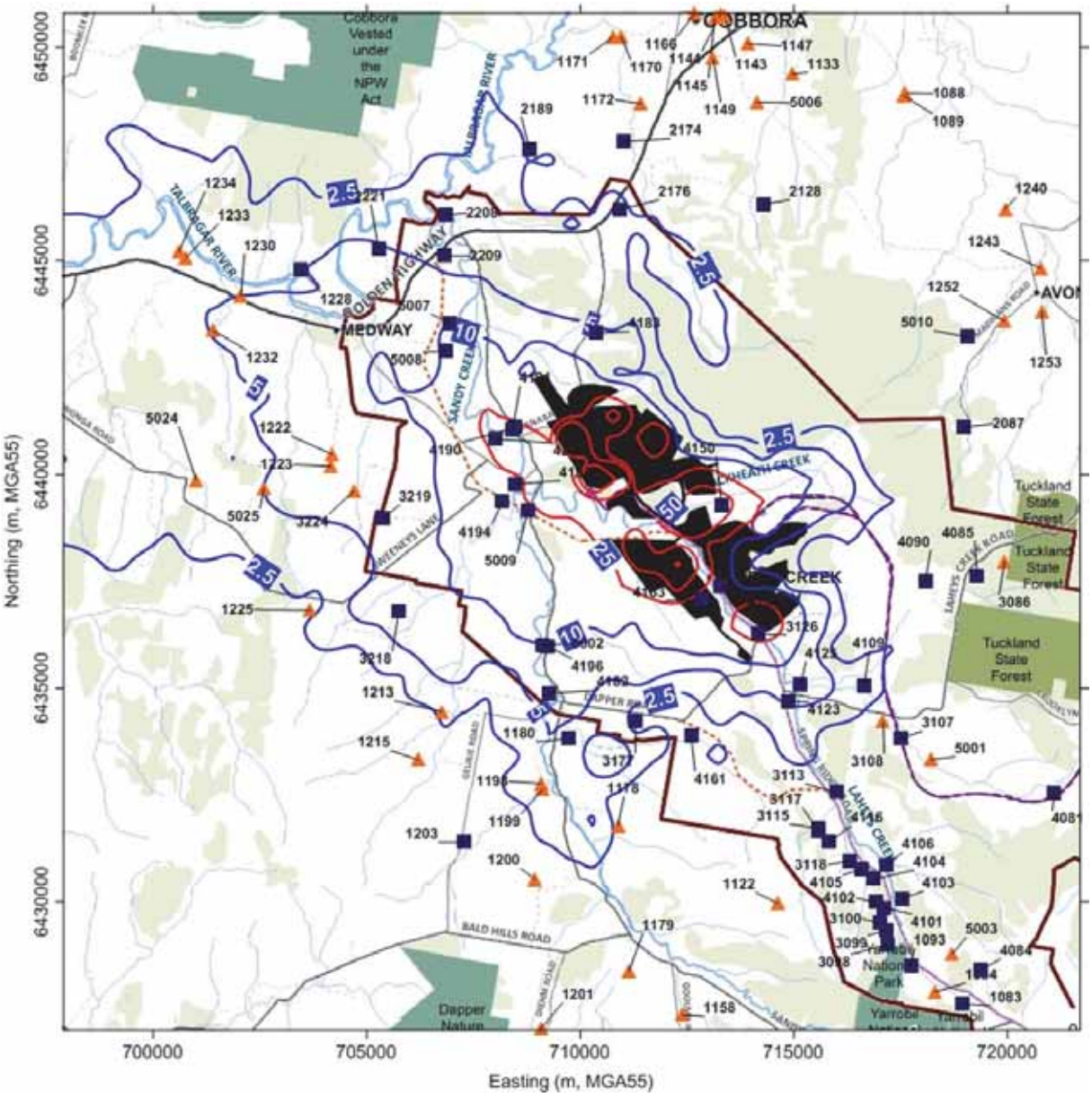

Figure F9 - Year 2 Operations – Highest 24-hour average $PM_{2.5}$ Concentrations (µg/m³) - Project Only Increment

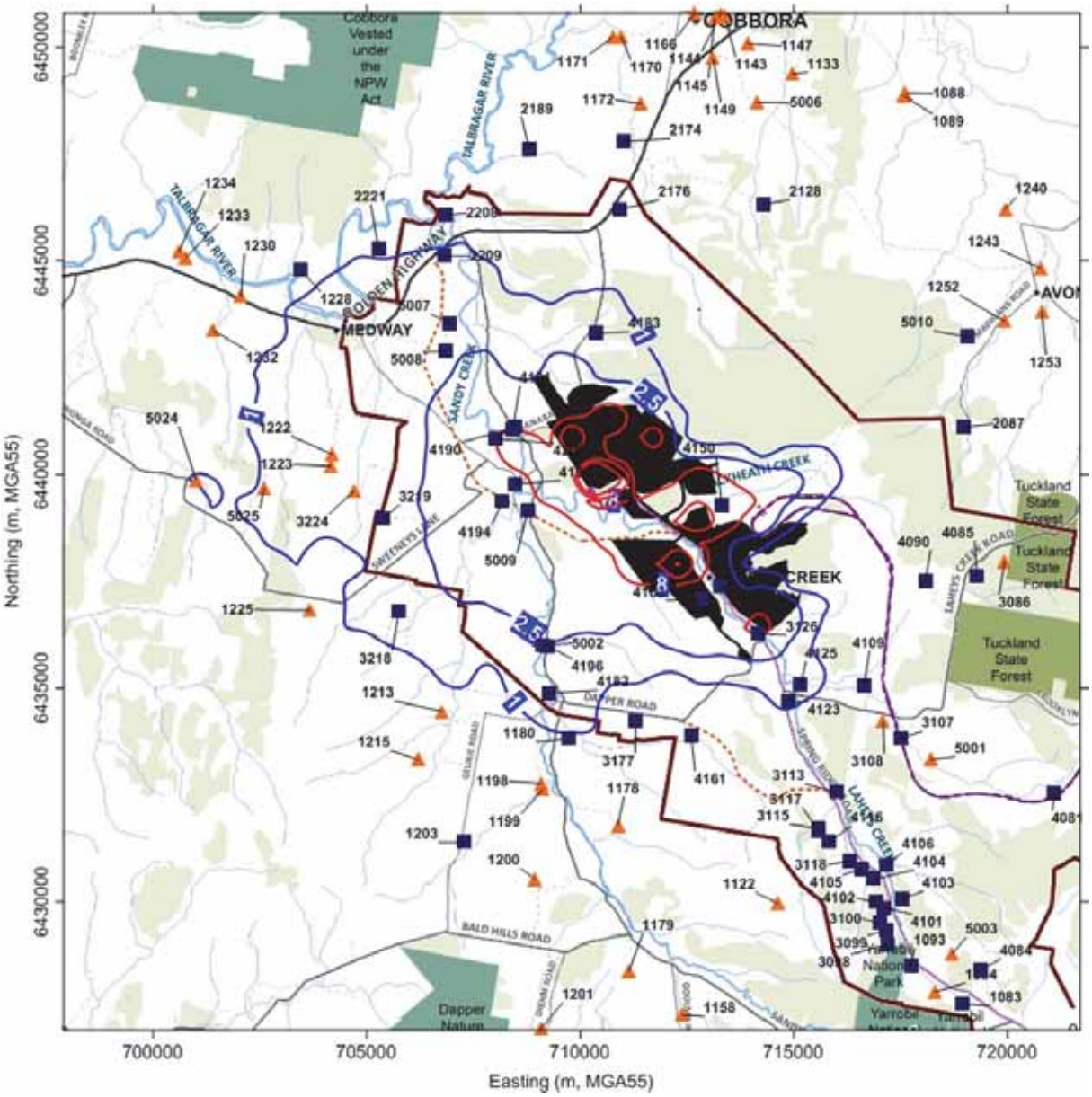

Figure F10 - Year 2 Operations – Annual average $PM_{2.5}$ Concentrations (µg/m³) - Project Only Increment

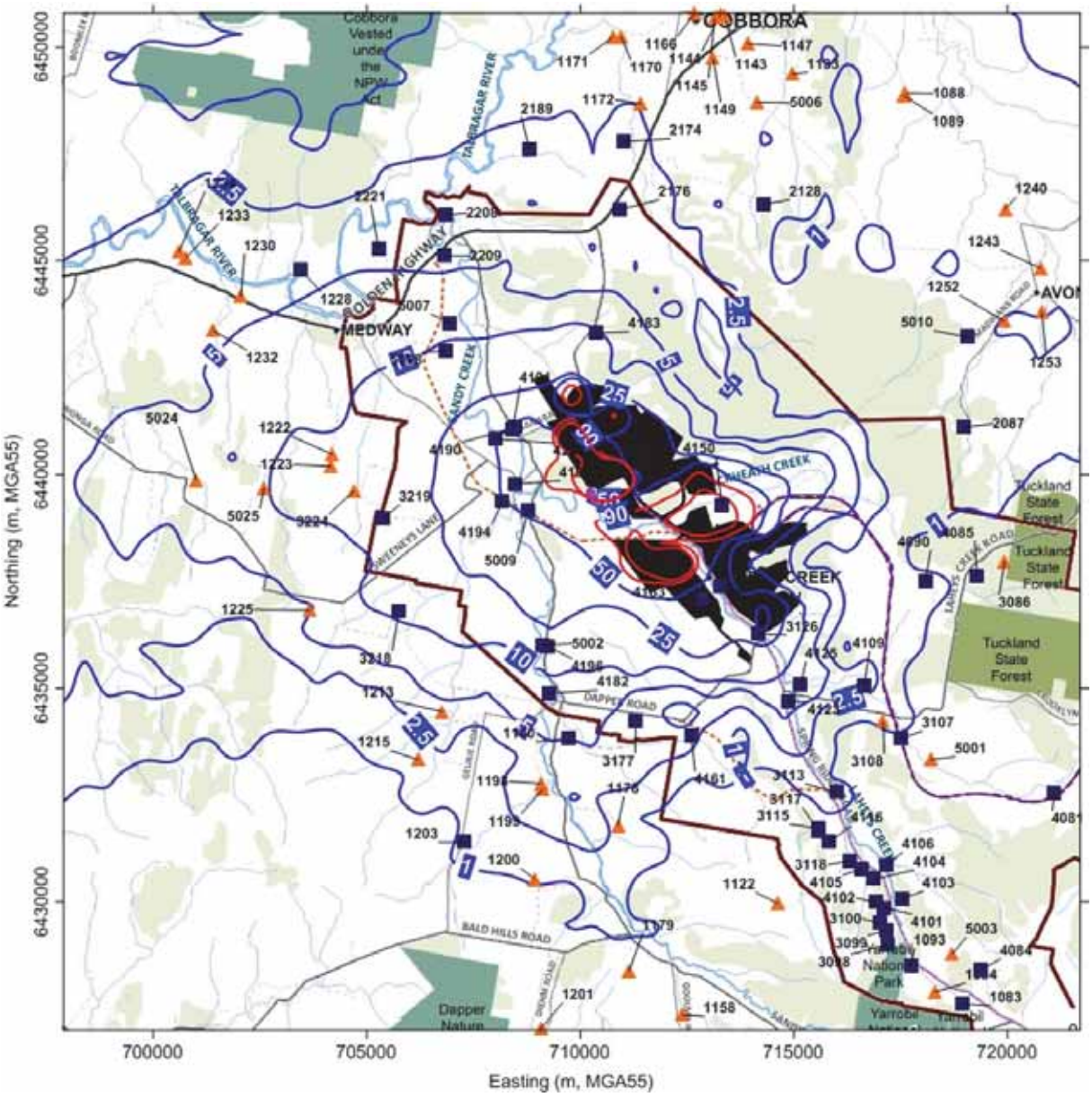

Figure F11 - Year 2 Operations – Annual average TSP Concentrations (µg/m³) - Project Only Increment

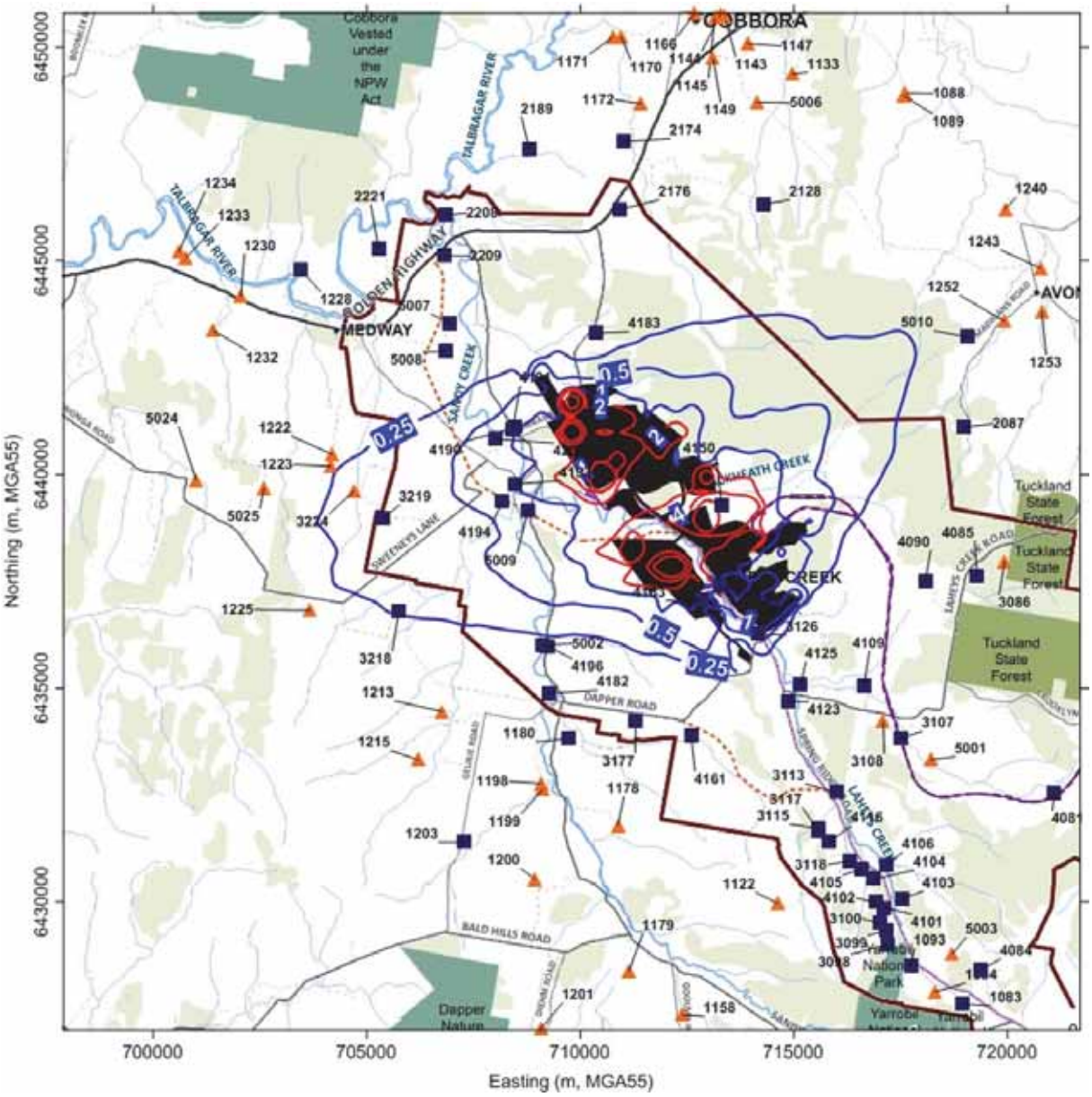

Figure F12 - Year 2 Operations – Annual average Dust Deposition (g/m^2/month) - Project Only Increment

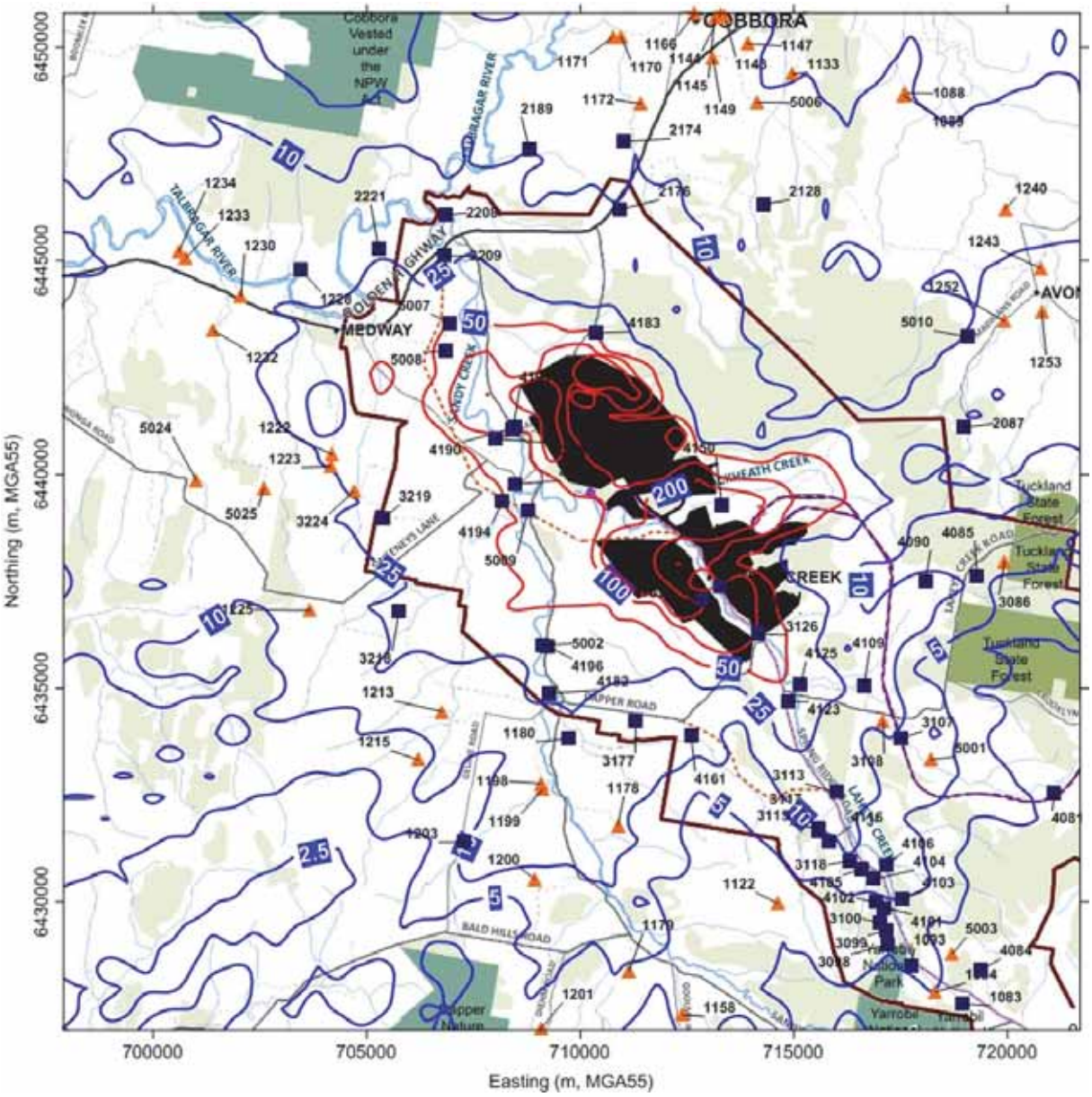

Figure F13 - Year 4 Operations – Highest 24-hour average PM_{10} Concentrations (µg/m³) - Project Only Increment

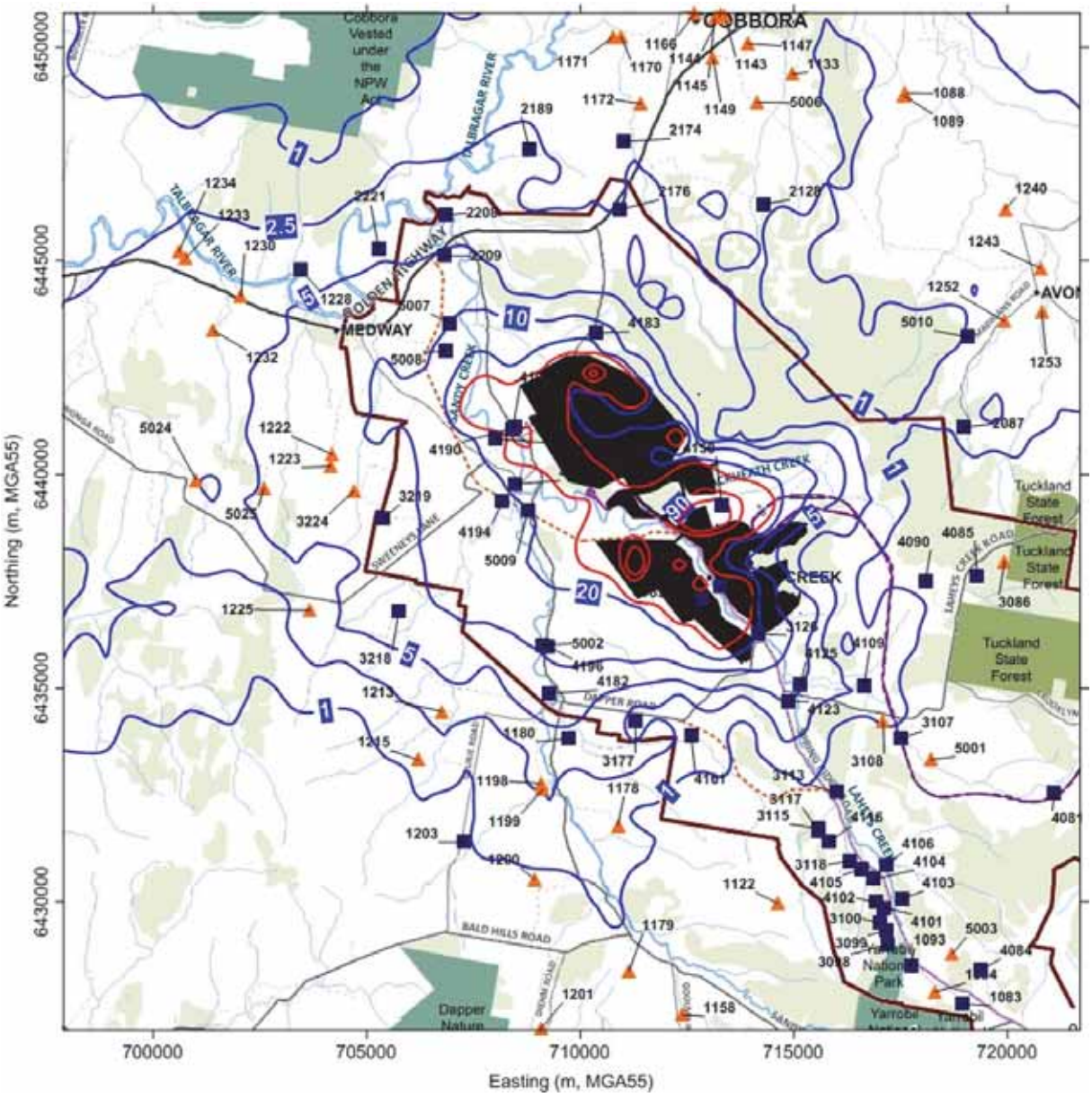

Figure F14 - Year 4 Operations – Annual average PM_{10} Concentrations (µg/m³) - Project Only Increment

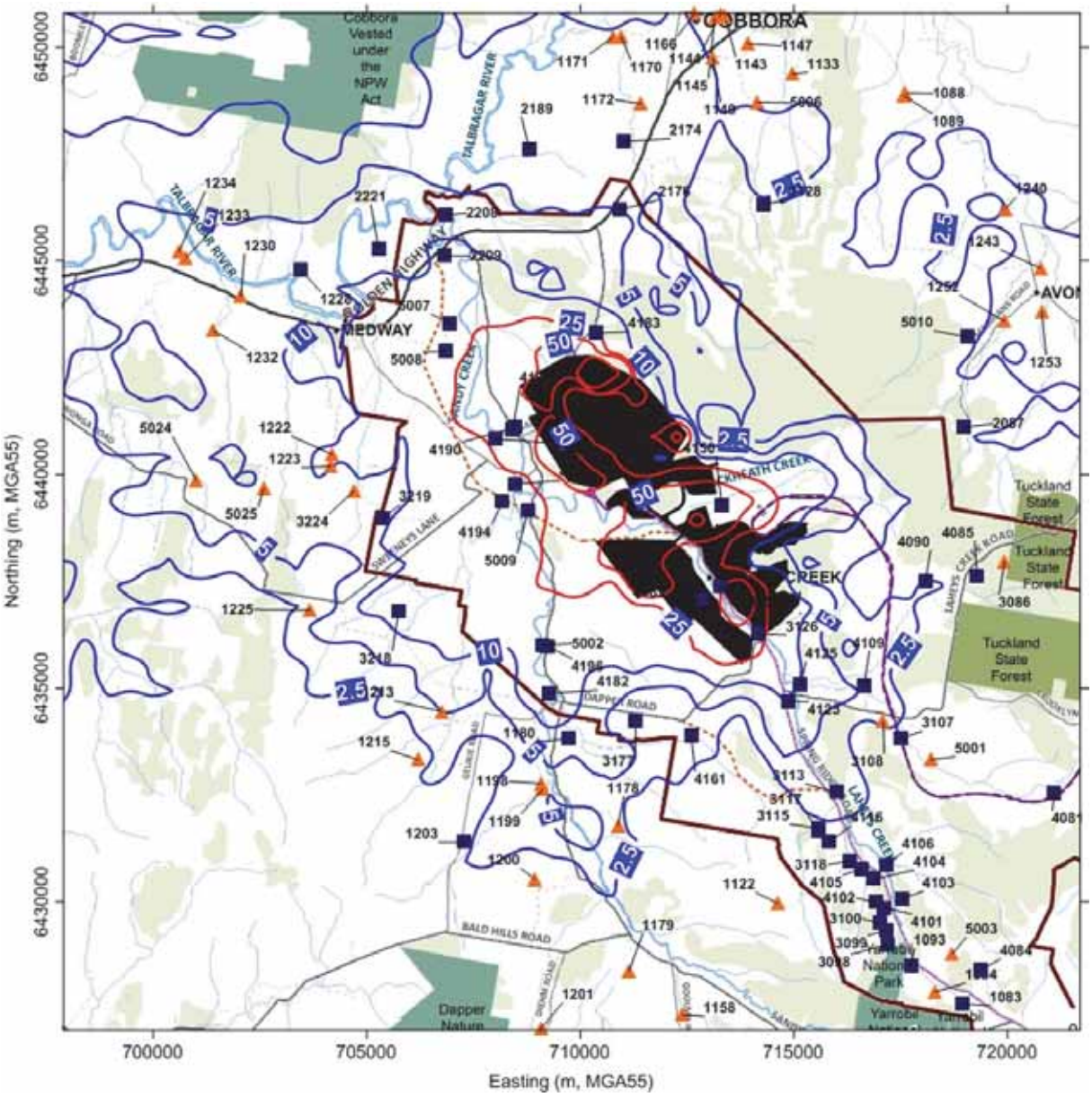

Figure F15 - Year 4 Operations – Highest 24-hour average $PM_{2.5}$ Concentrations (µg/m³) - Project Only Increment

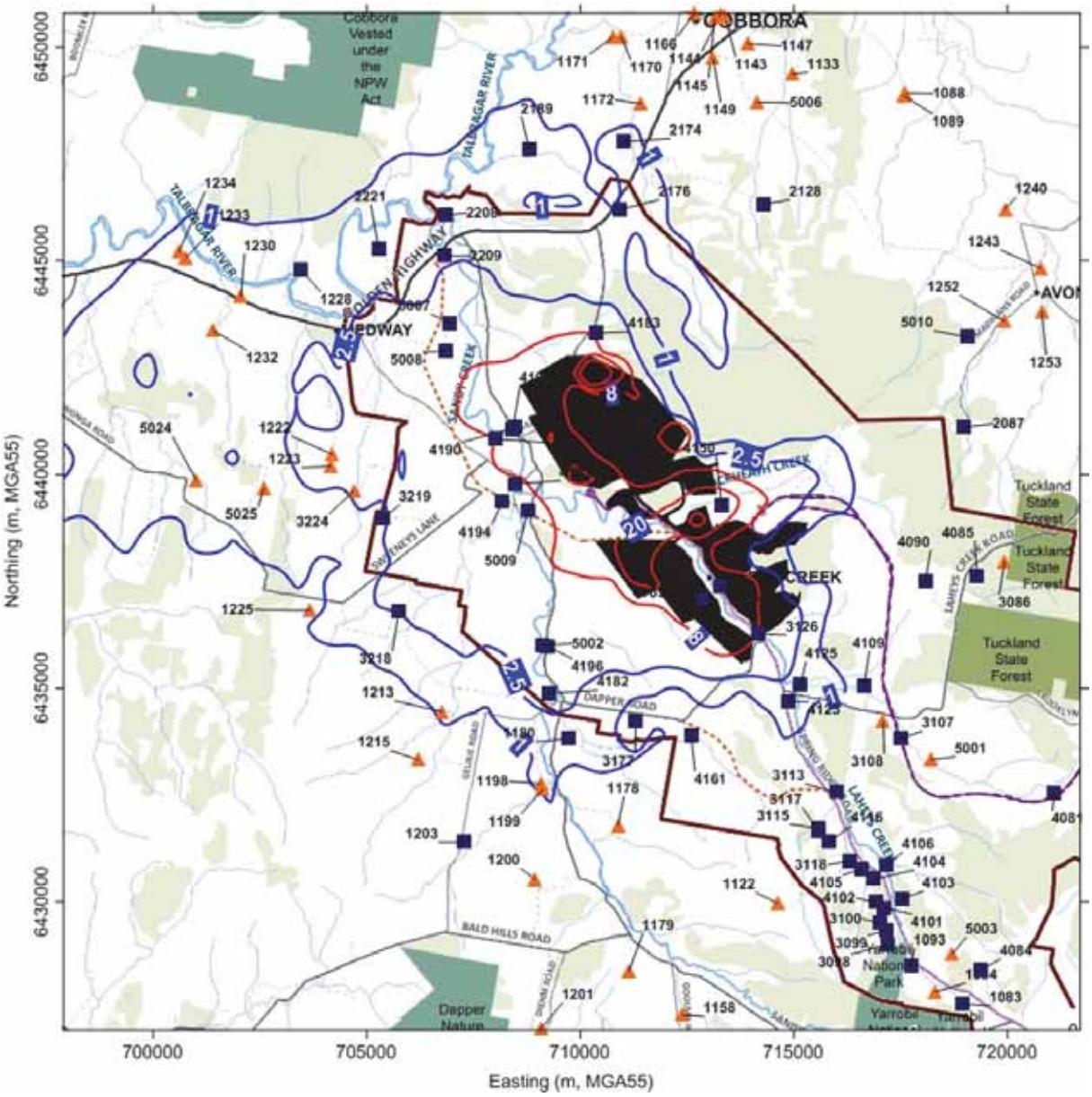

Figure F16 - Year 4 Operations – Annual average $PM_{2.5}$ Concentrations (µg/m³) - Project Only Increment

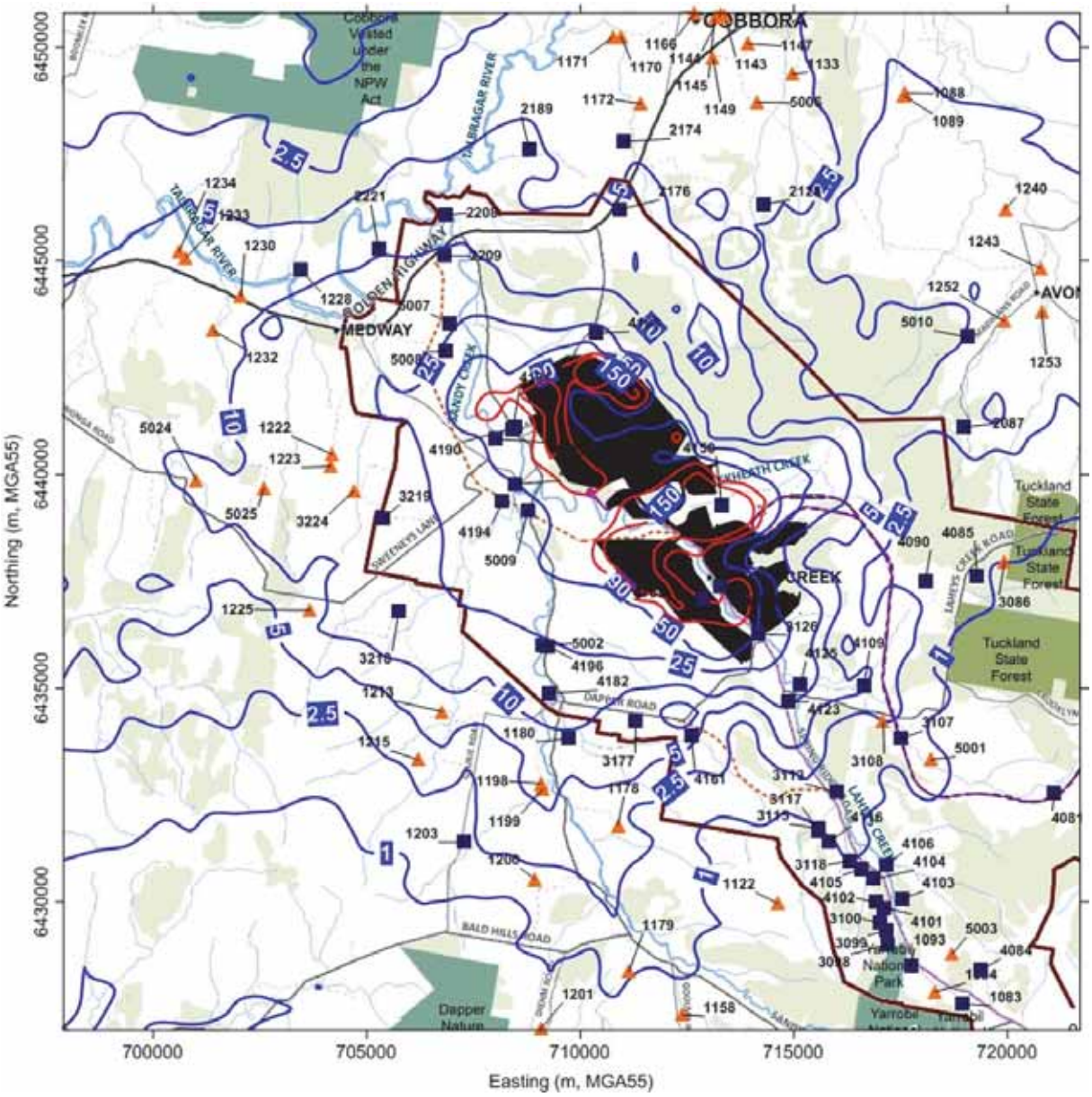

Figure F17 - Year 4 Operations – Annual average TSP Concentrations (µg/m³) - Project Only Increment

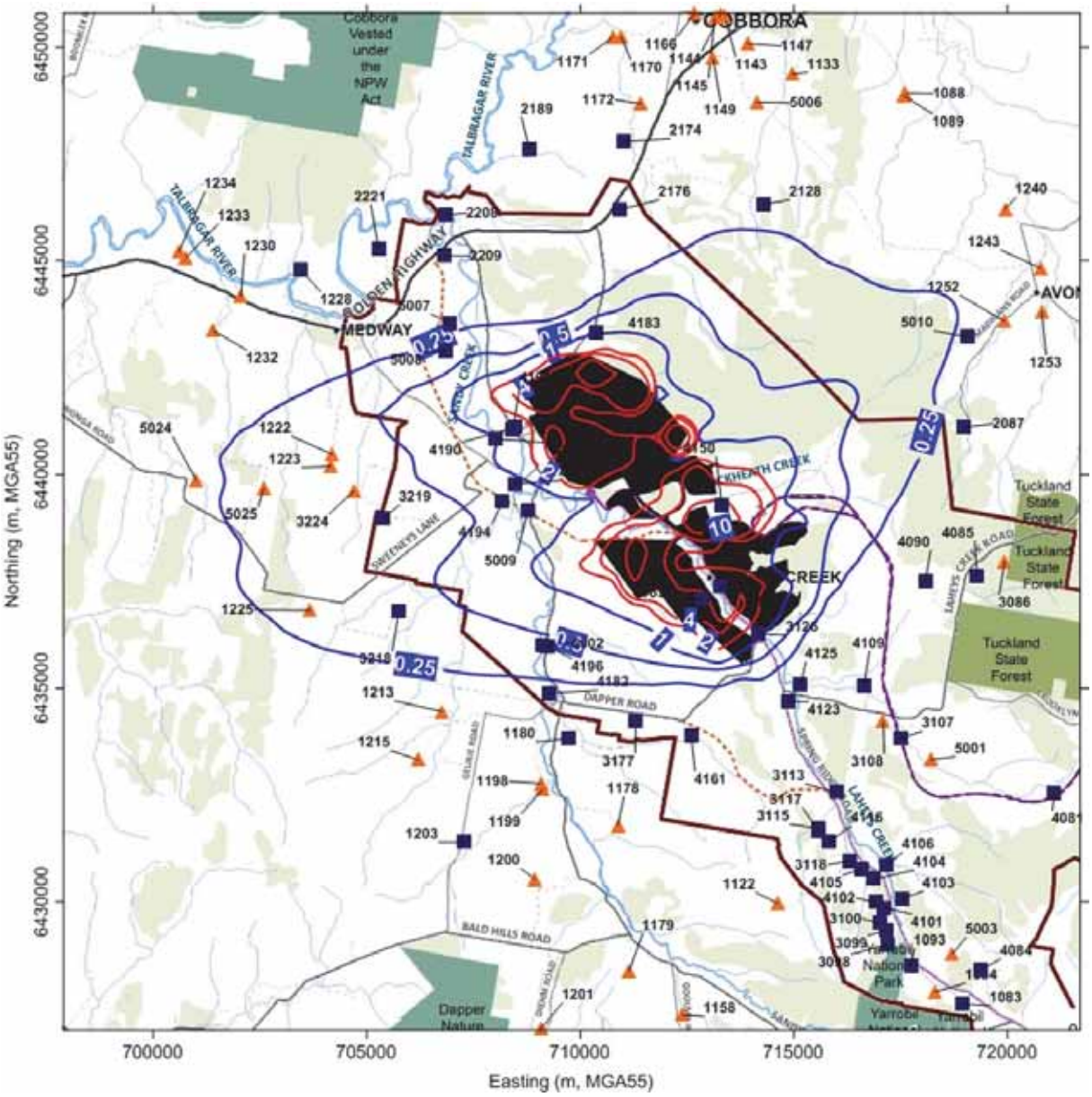

Figure F18 - Year 4 Operations – Annual average Dust Deposition (g/m^2/month) - Project Only Increment

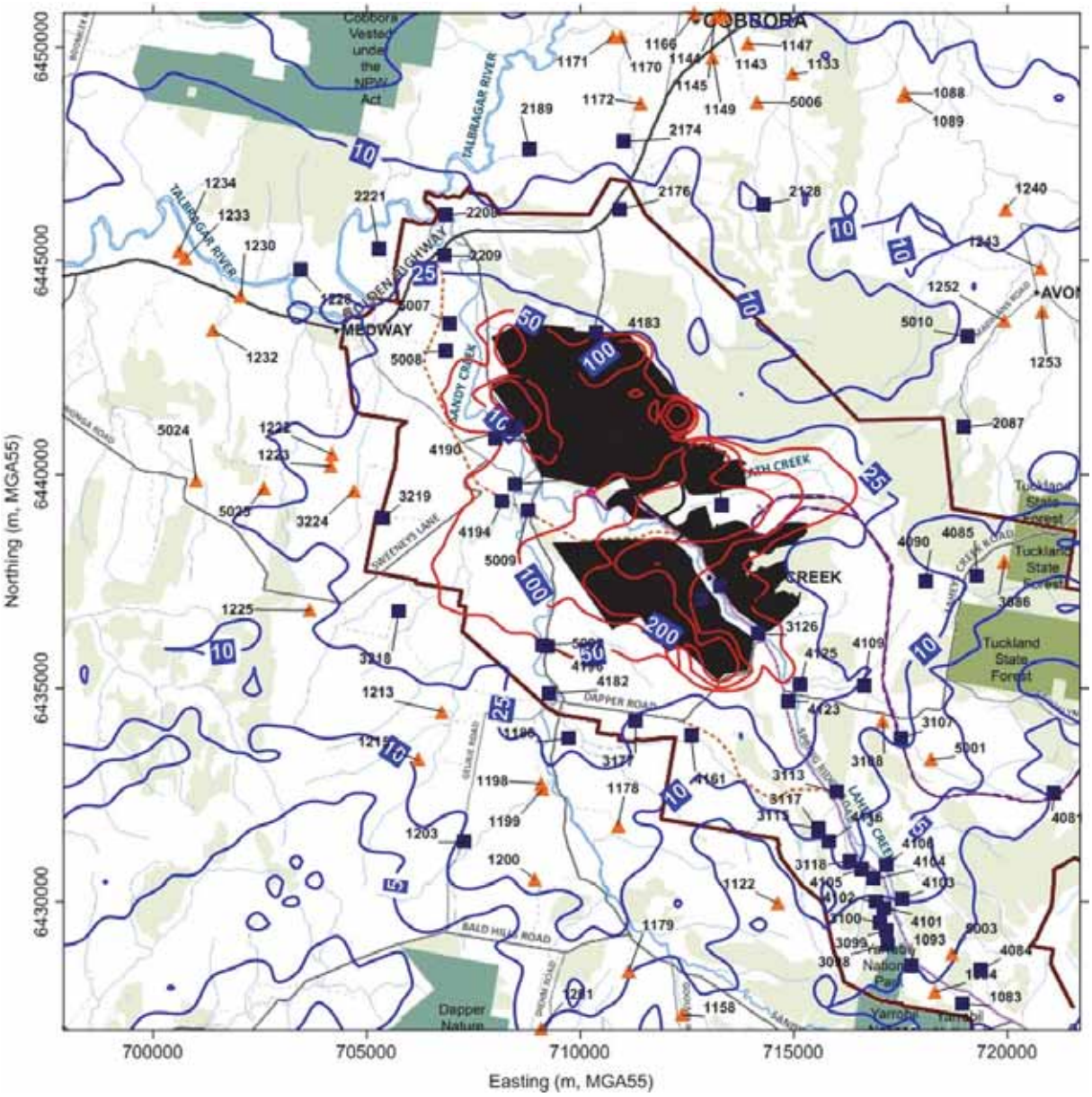

Figure F19 - Year 8 Operations – Highest 24-hour average PM_{10} Concentrations (µg/m³) - Project Only Increment

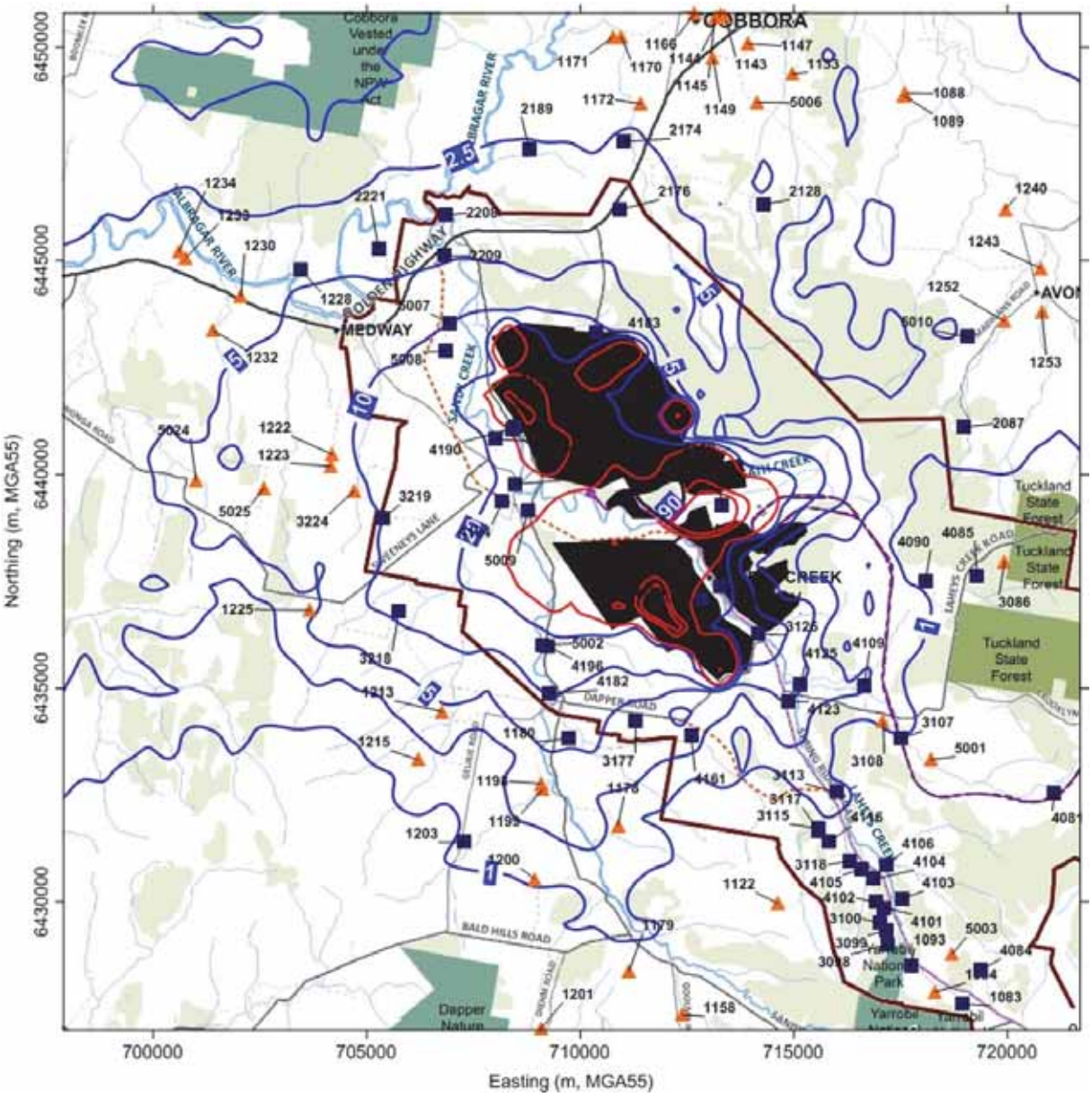

Figure F20 - Year 8 Operations – Annual average PM_{10} Concentrations (µg/m³) - Project Only Increment

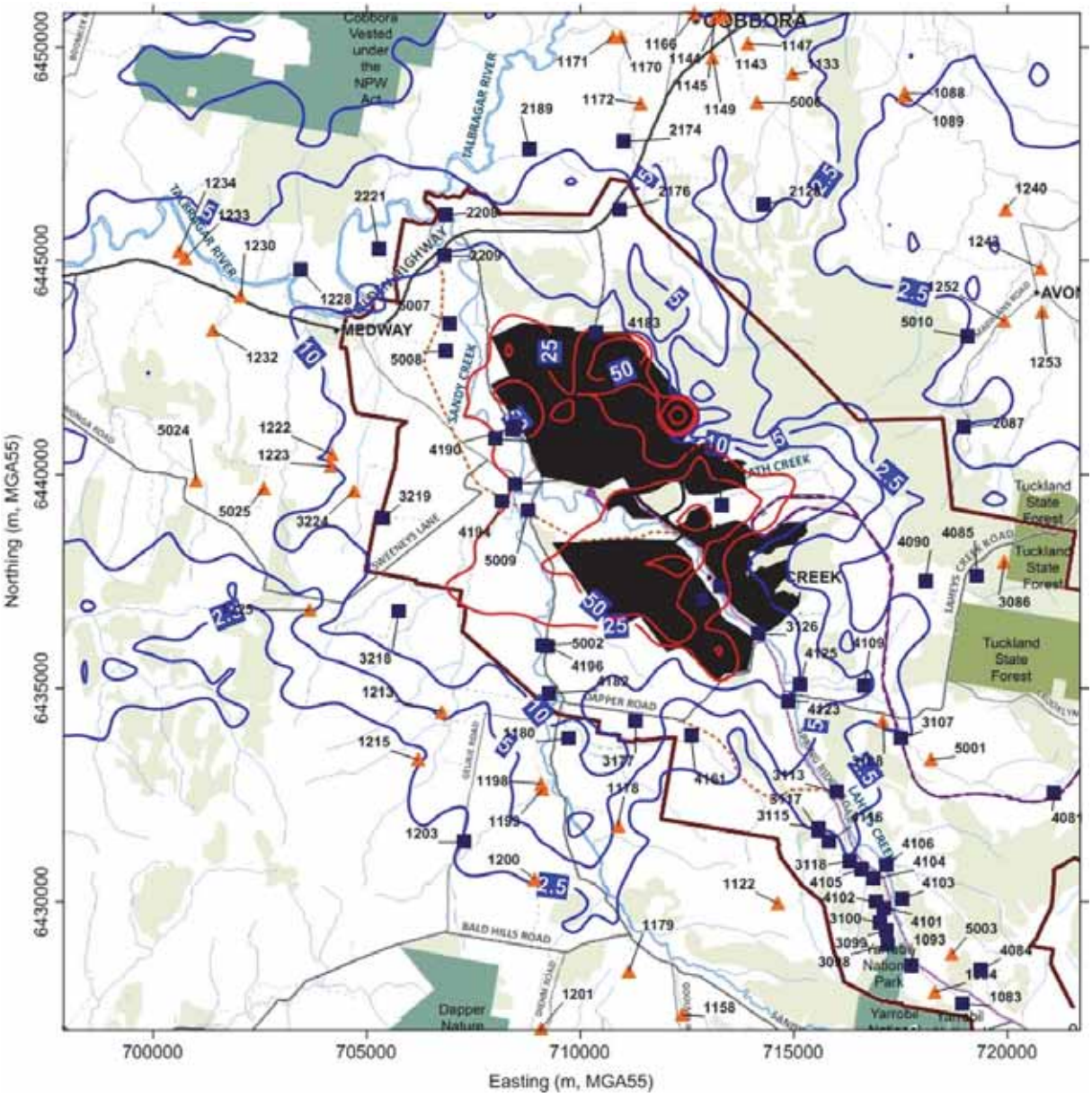

Figure F21 - Year 8 Operations – Highest 24-hour average $PM_{2.5}$ Concentrations (µg/m³) - Project Only Increment

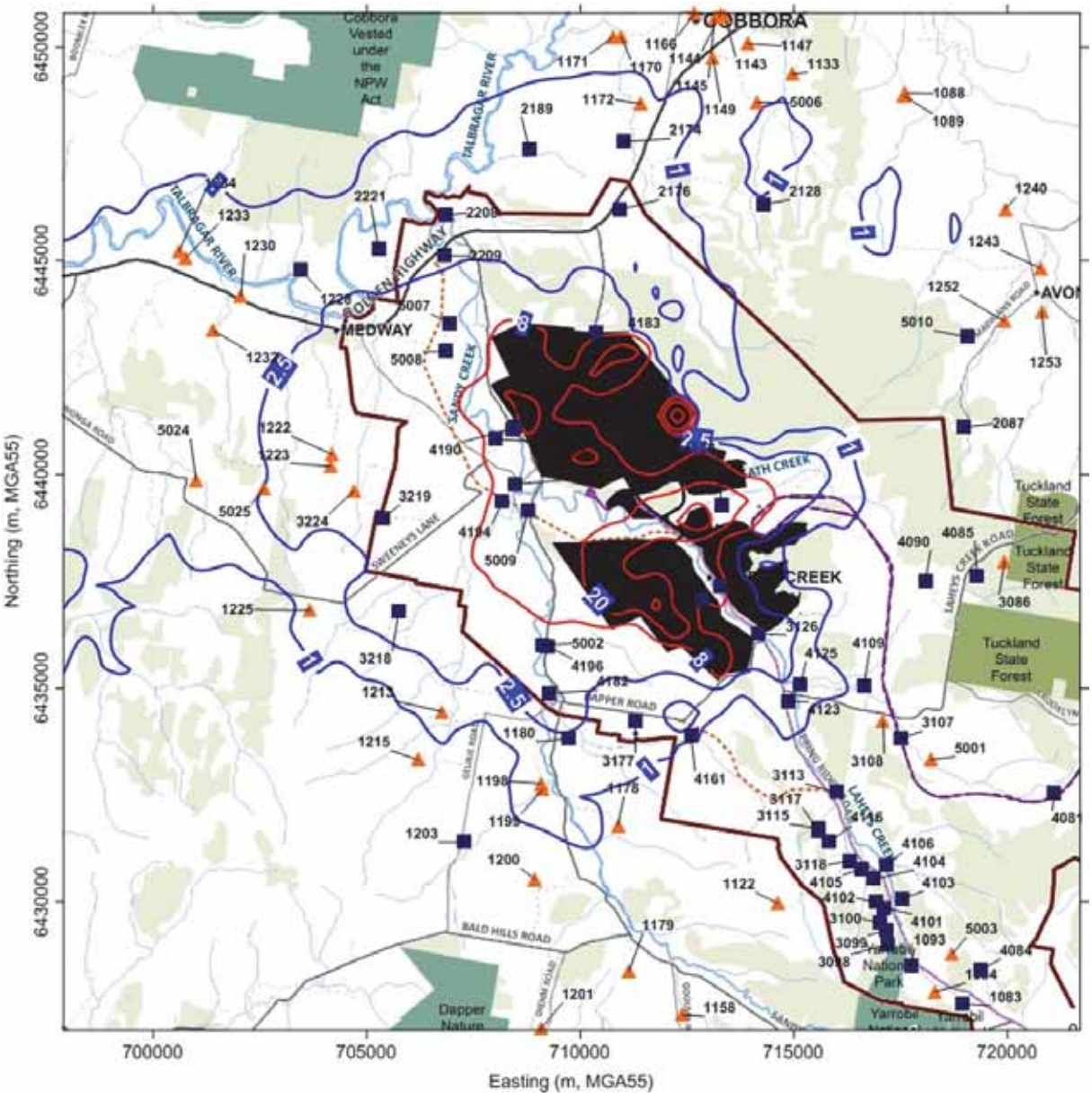

Figure F22 - Year 8 Operations – Annual average $PM_{2.5}$ Concentrations (µg/m³) - Project Only Increment

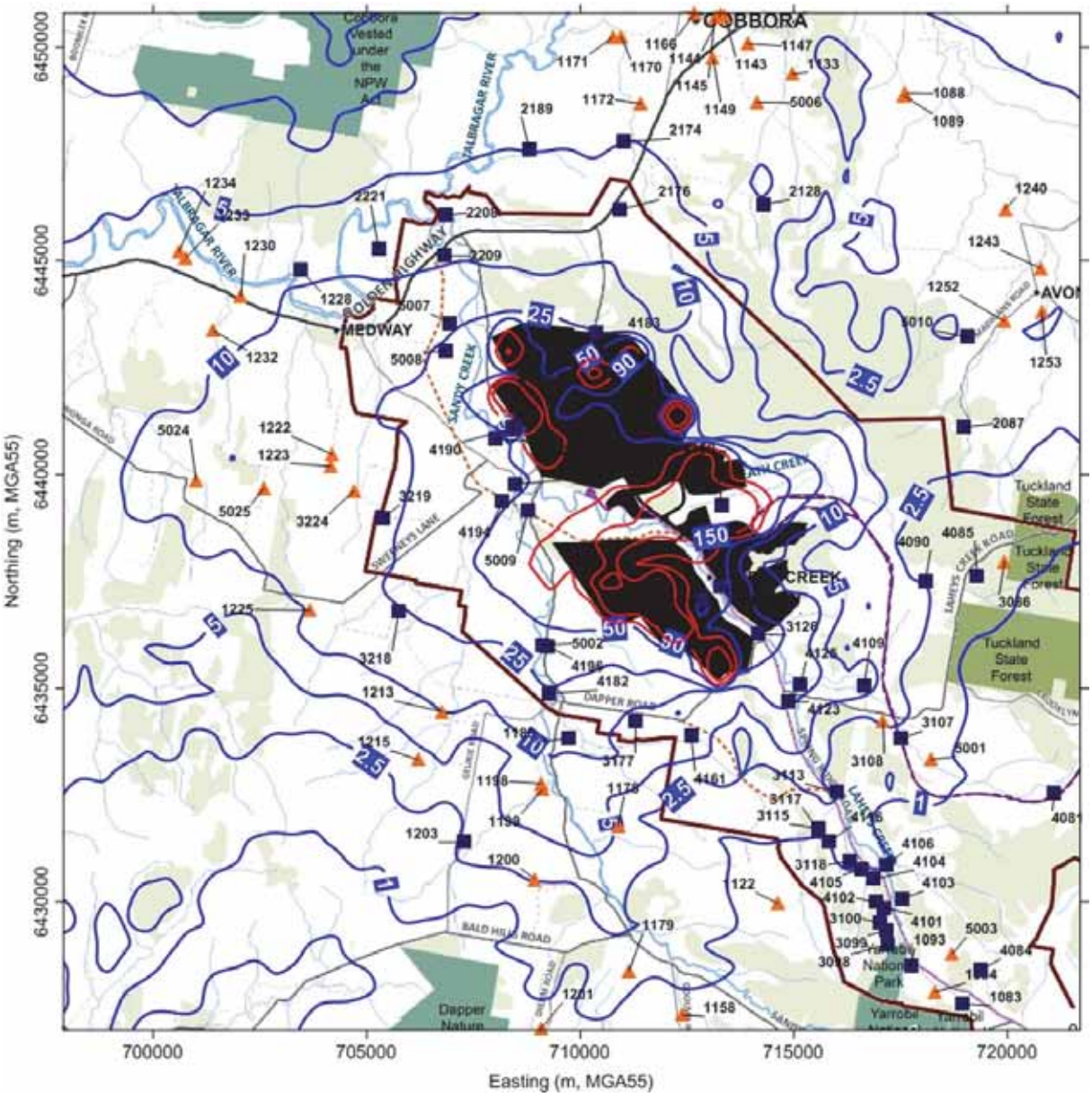

Figure F23 - Year 8 Operations – Annual average TSP Concentrations (µg/m³) - Project Only Increment

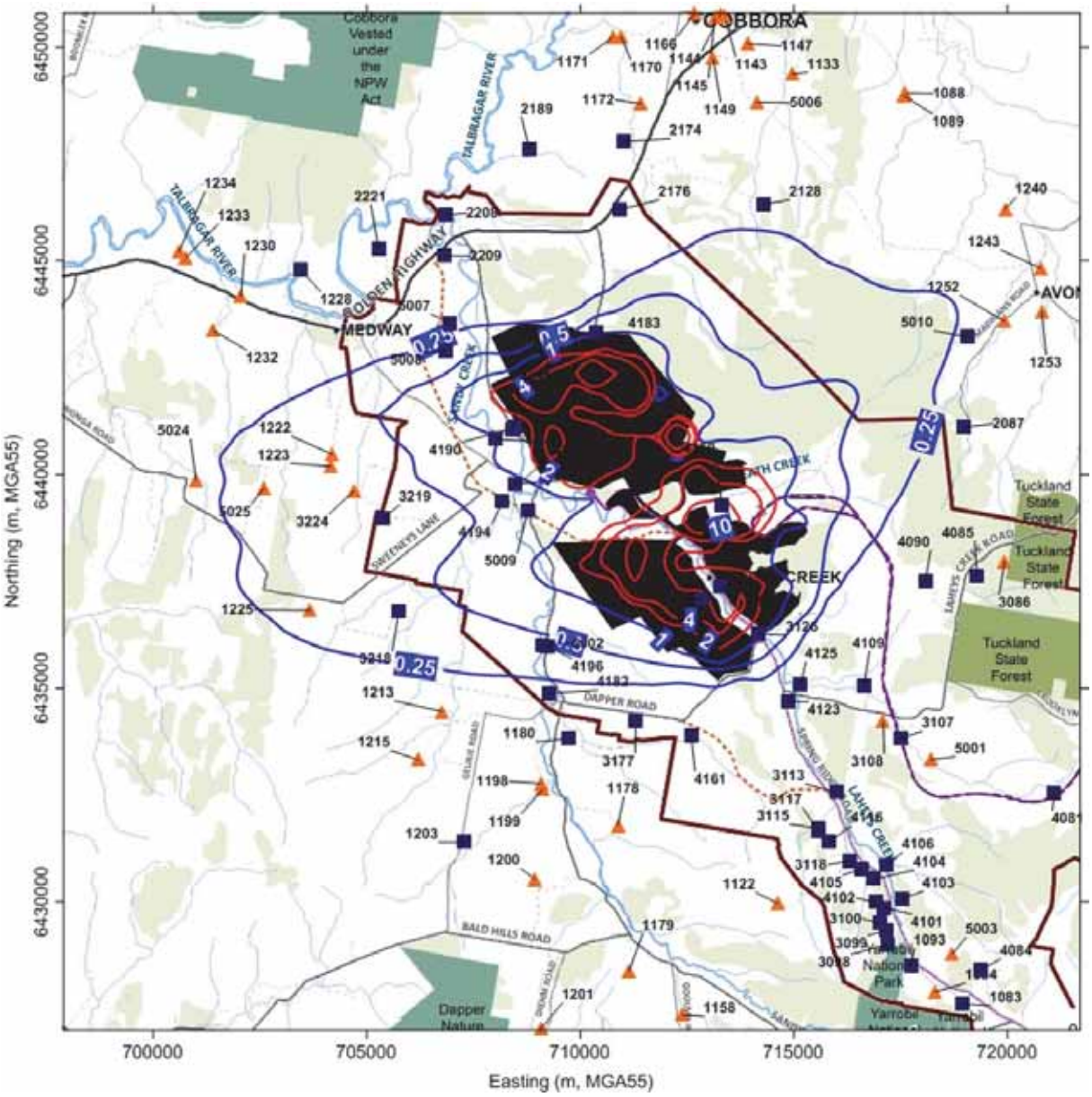

Figure F24 - Year 8 Operations – Annual average Dust Deposition (g/m^2/month) - Project Only Increment

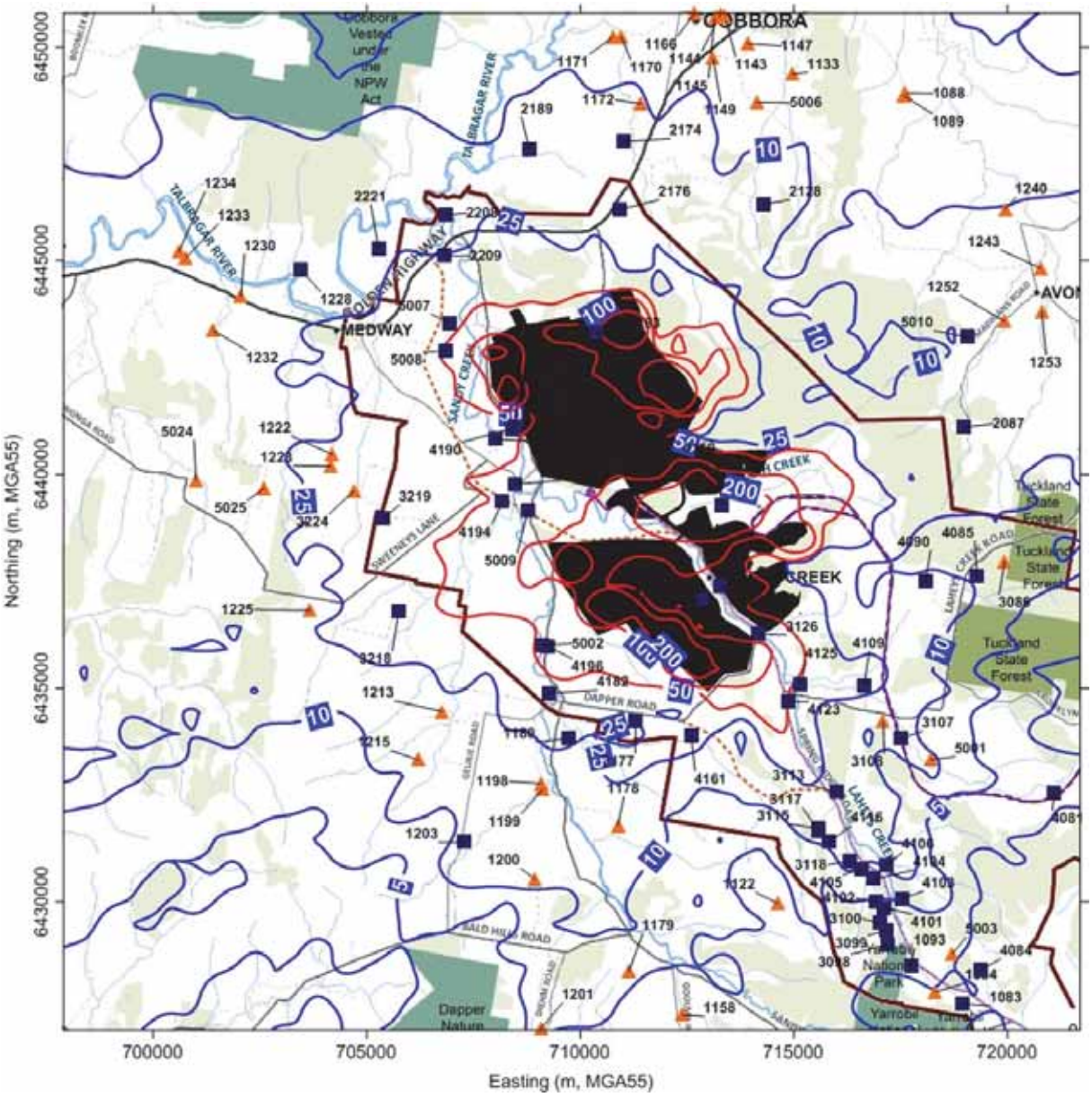

Figure F25 - Year 12 Operations – Highest 24-hour average PM_{10} Concentrations (µg/m³) - Project Only Increment

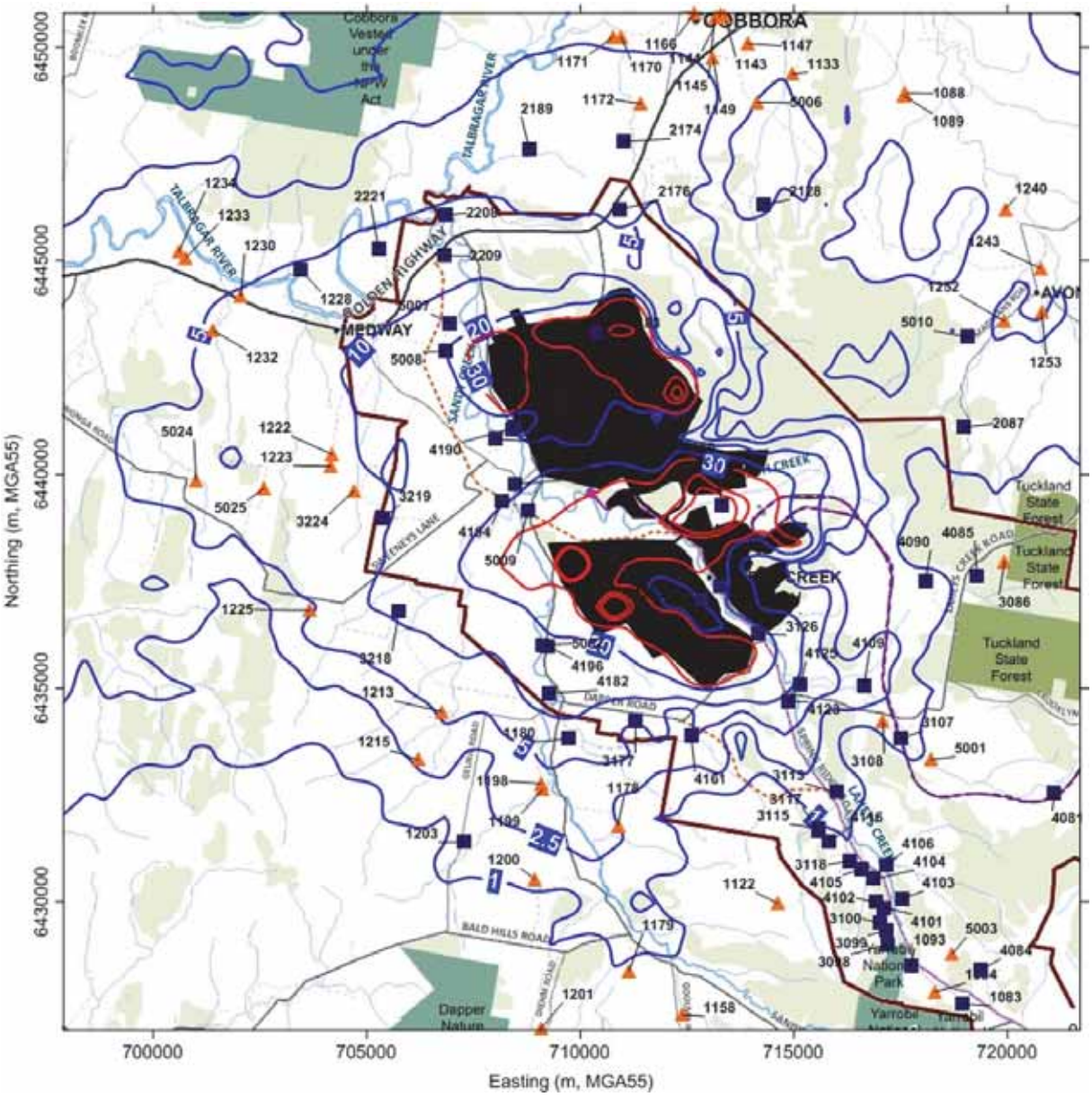

Figure F26 - Year 12 Operations – Annual average PM_{10} Concentrations (µg/m³) - Project Only Increment

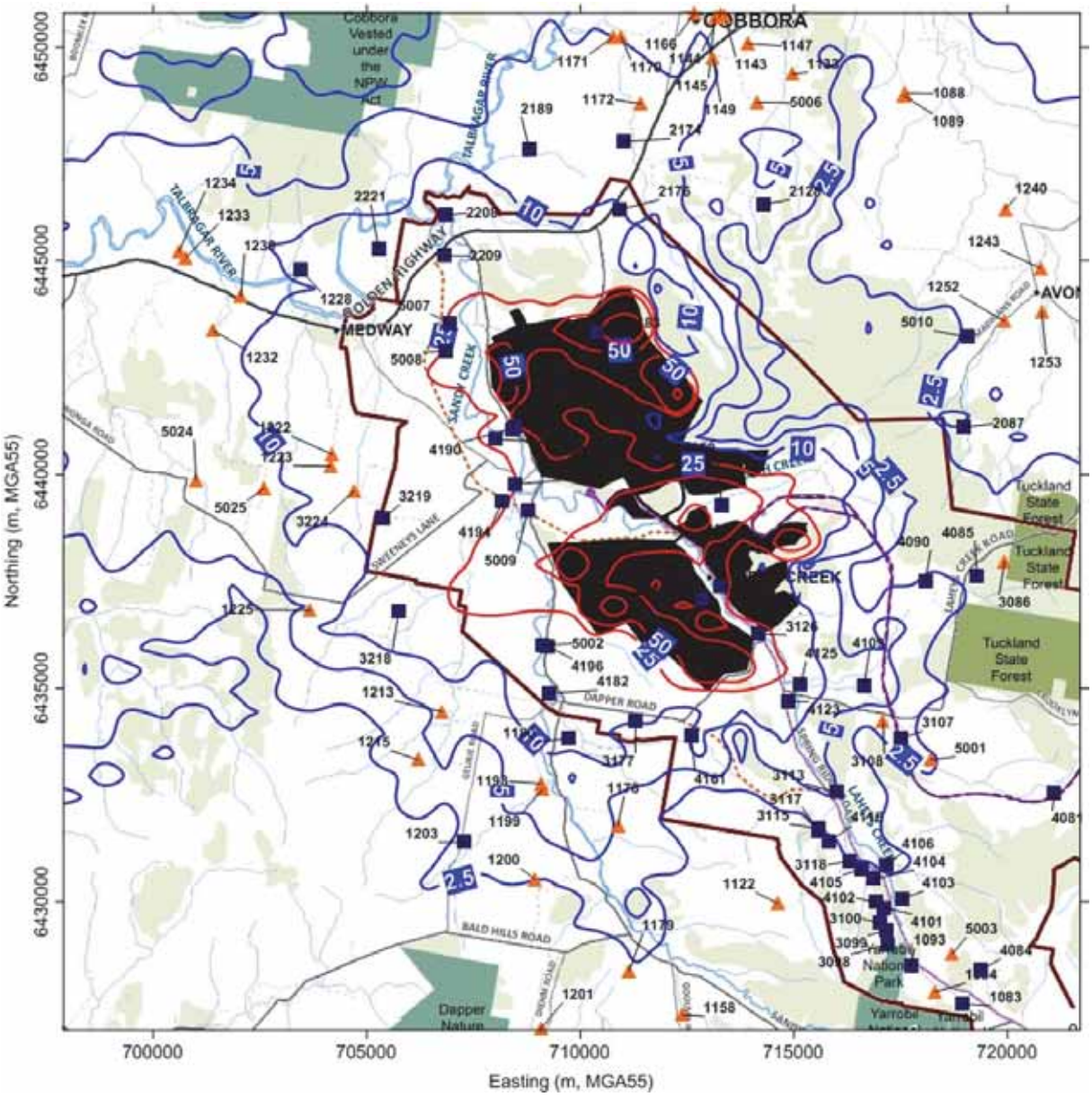

Figure F27 - Year 12 Operations – Highest 24-hour average $PM_{2.5}$ Concentrations (µg/m³) - Project Only Increment

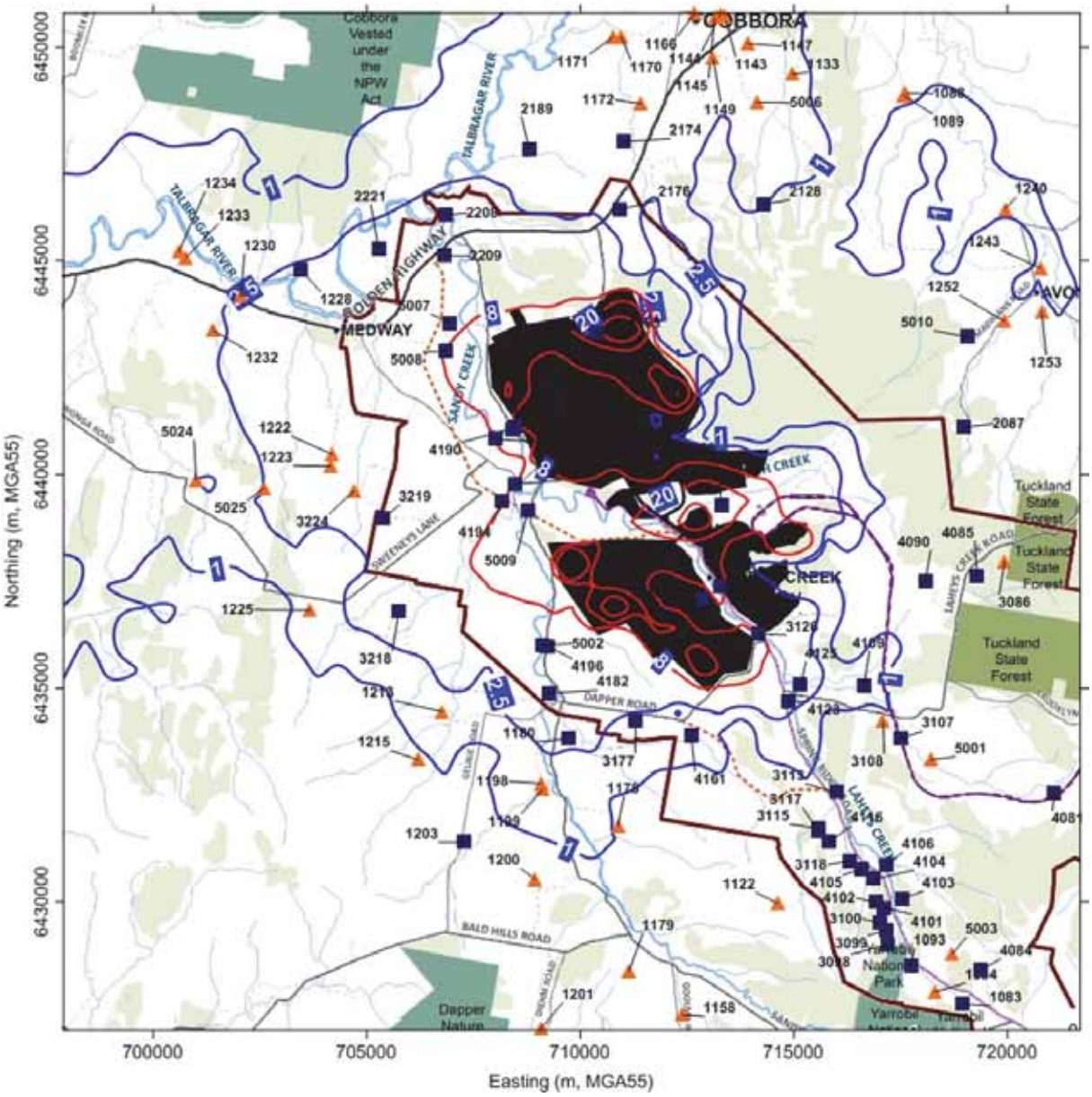

Figure F28 - Year 12 Operations – Annual average $PM_{2.5}$ Concentrations (µg/m³) - Project Only Increment

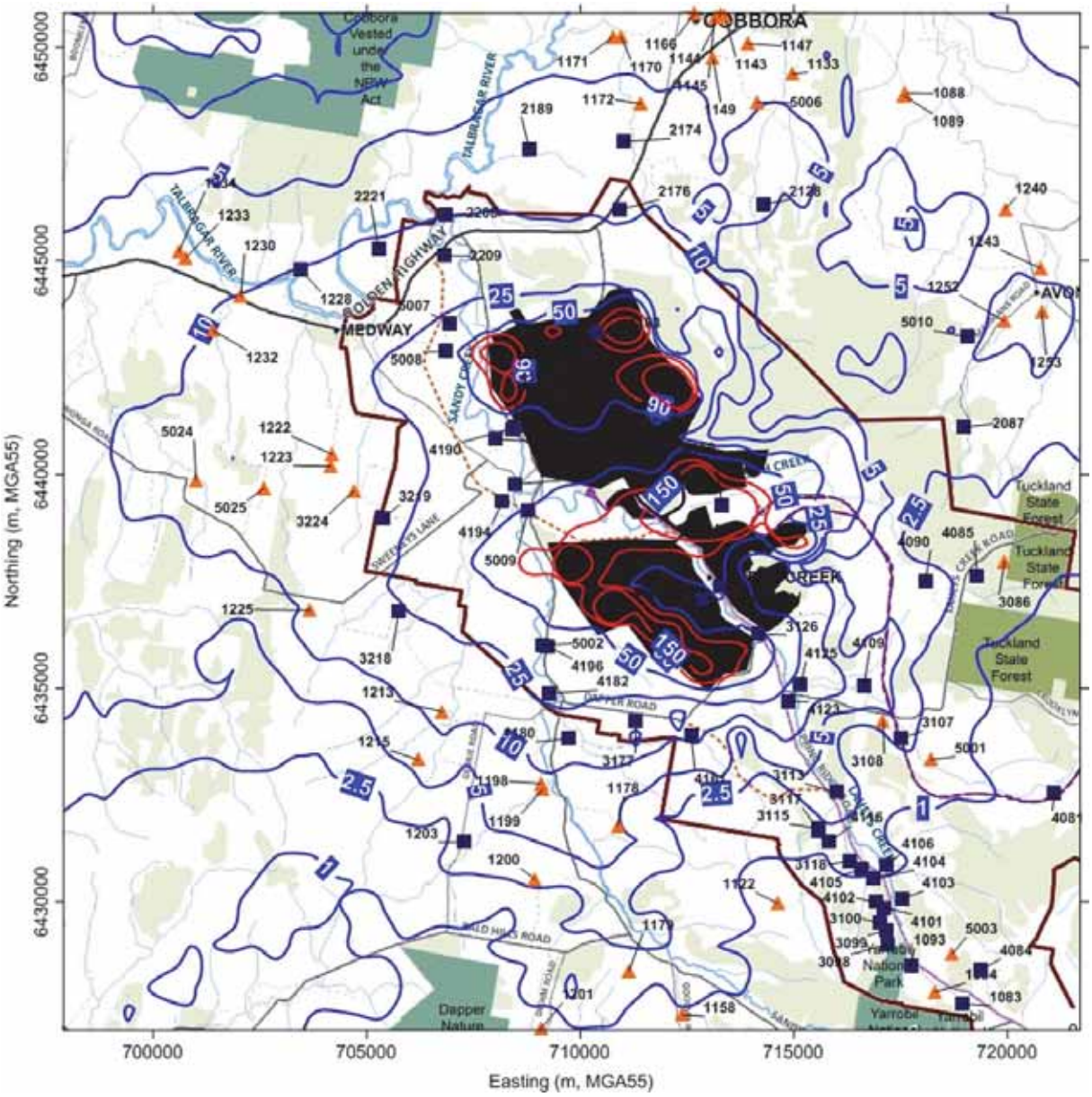

Figure F29 - Year 12 Operations – Annual average TSP Concentrations (µg/m³) - Project Only Increment

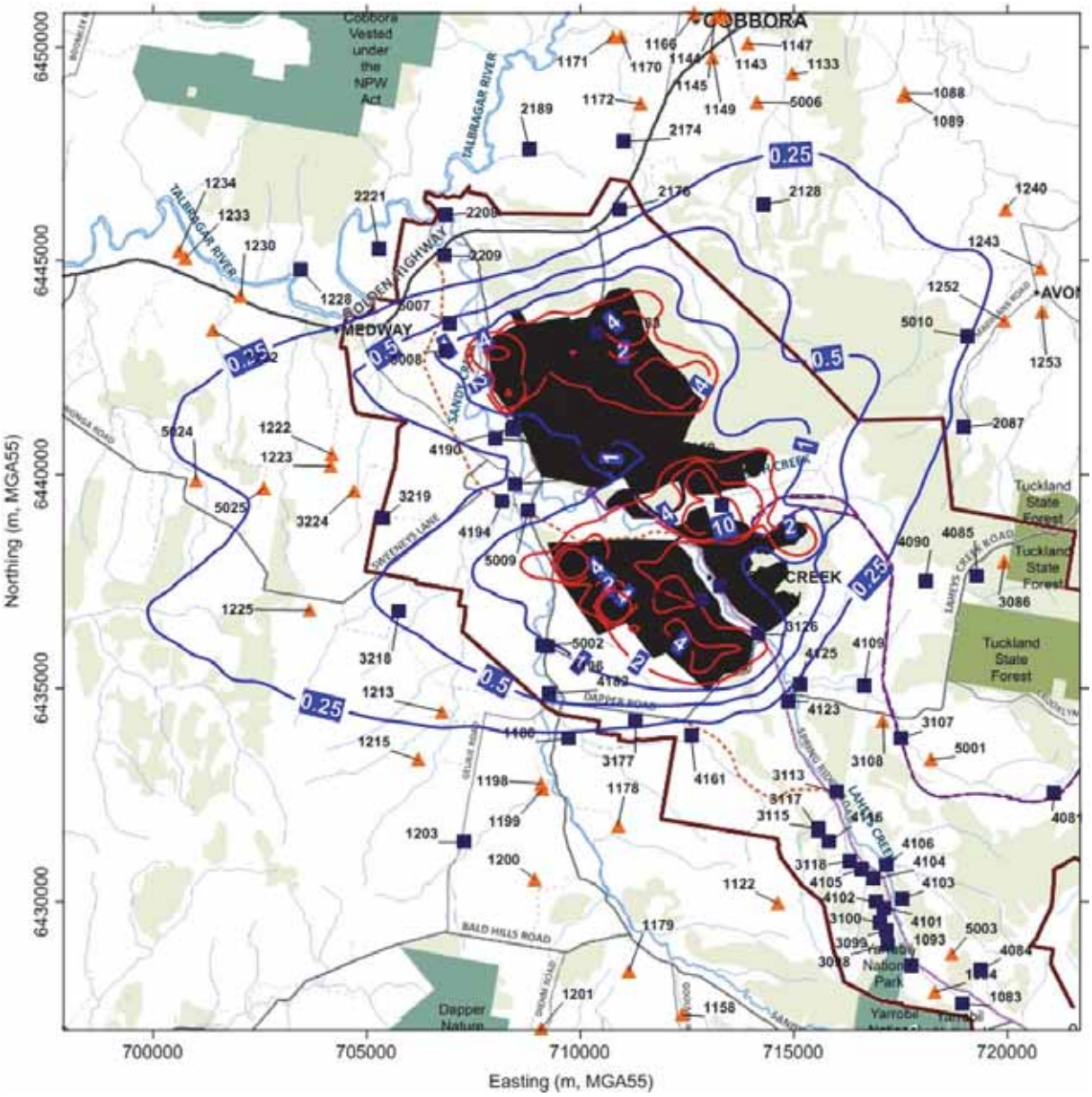

Figure F30 - Year 12 Operations – Annual average Dust Deposition (g/m^2/month) - Project Only Increment

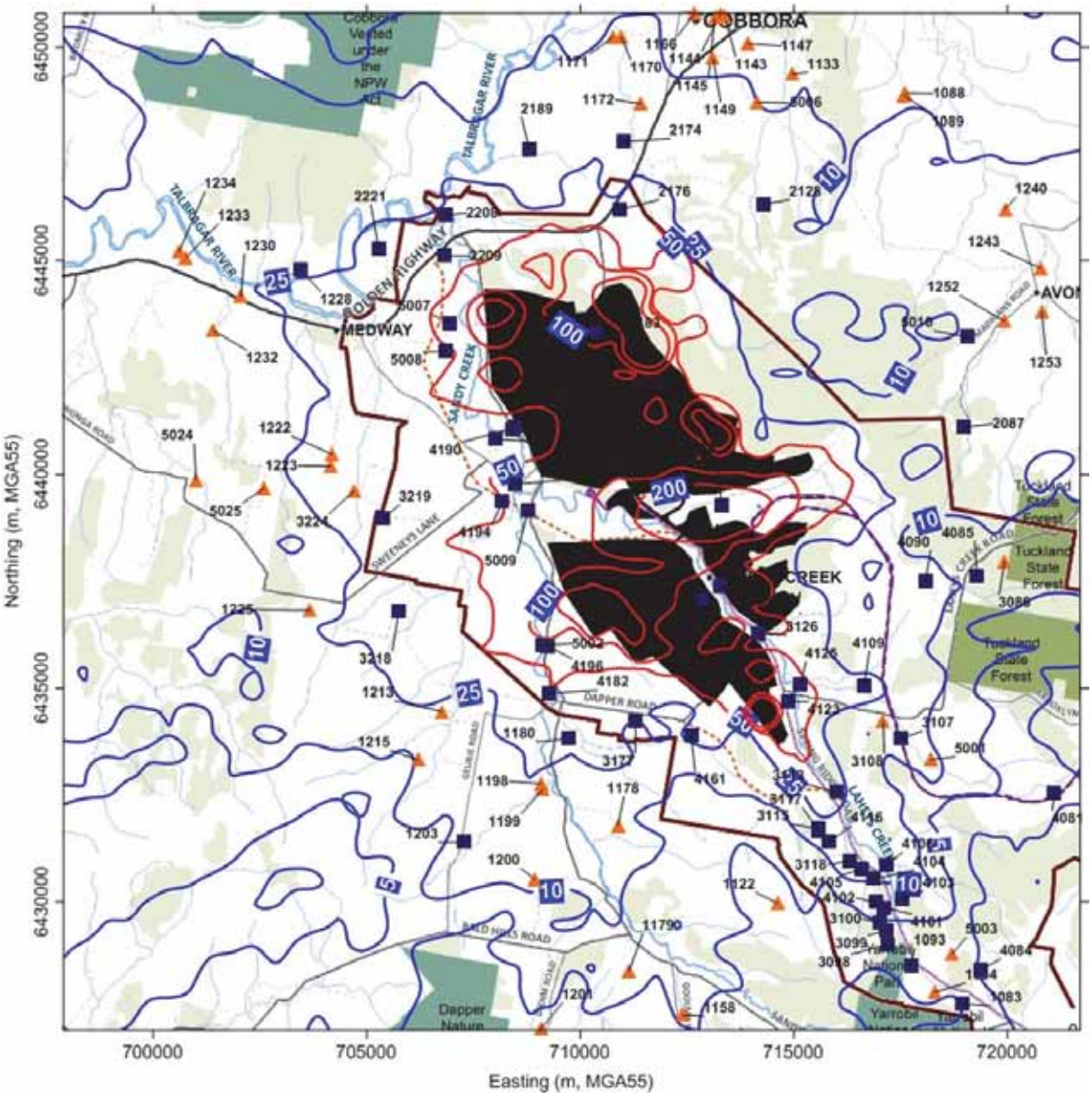

Figure F31 - Year 16 Operations – Highest 24-hour average PM_{10} Concentrations (µg/m³) - Project Only Increment

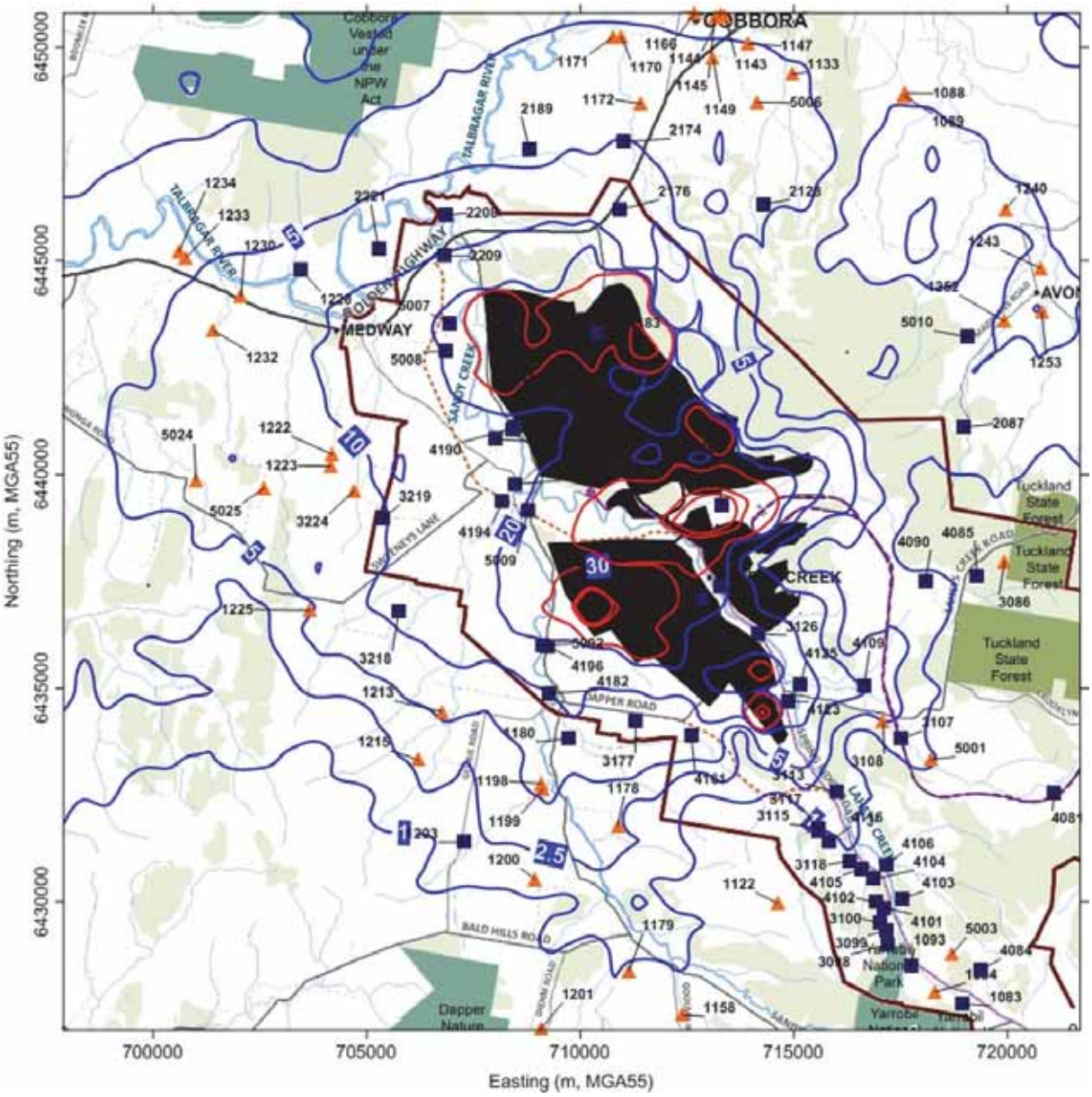

Figure F 32 - Year 16 Operations – Annual average PM_{10} Concentrations (µg/m³) - Project Only Increment

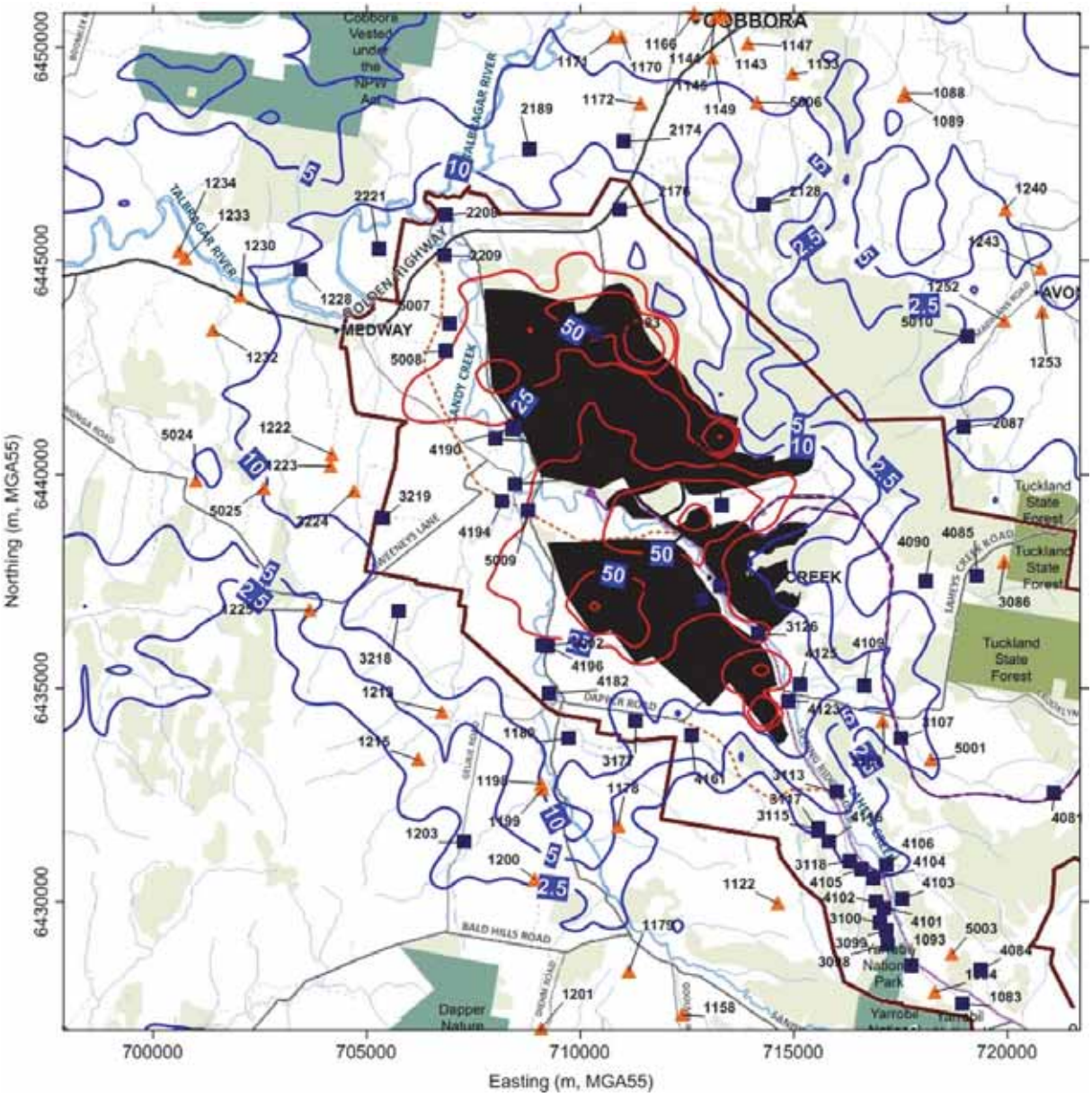

Figure F33 - Year 16 Operations – Highest 24-hour average $PM_{2.5}$ Concentrations (µg/m³) - Project Only Increment

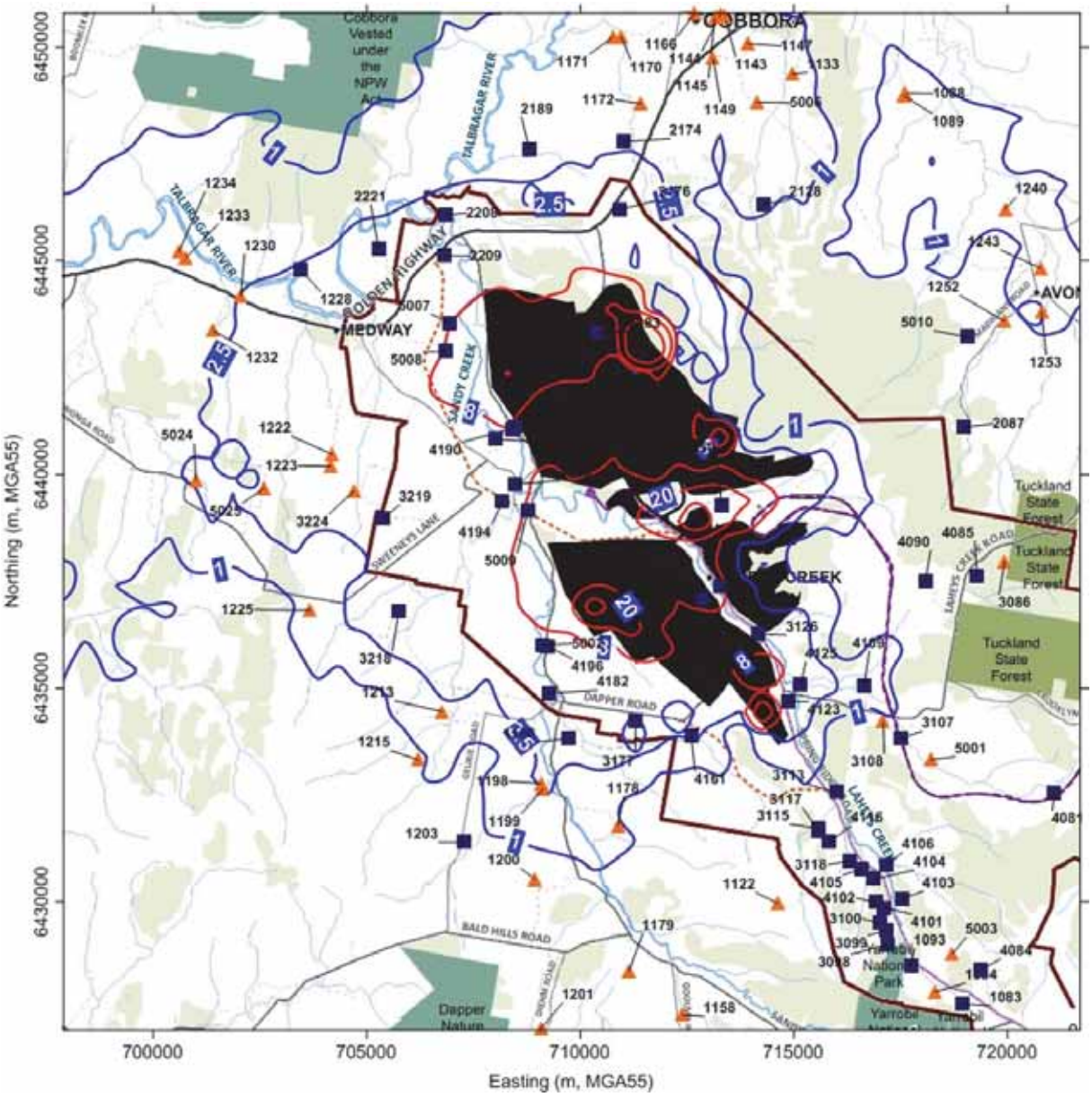

Figure F34 - Year 16 Operations – Annual average $PM_{2.5}$ Concentrations (µg/m³) - Project Only Increment

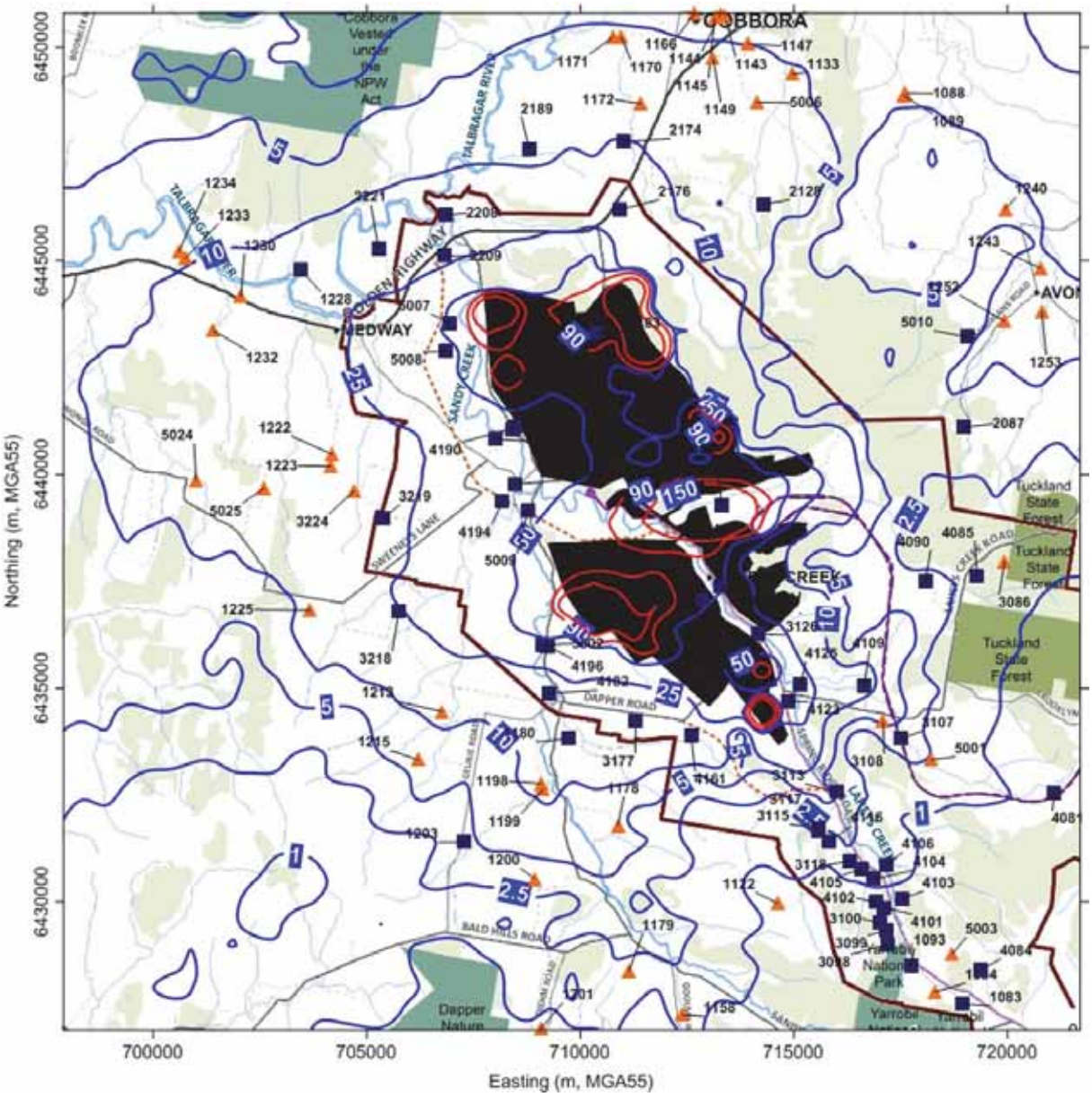

Figure F35 - Year 16 Operations – Annual average TSP Concentrations (µg/m³) - Project Only Increment

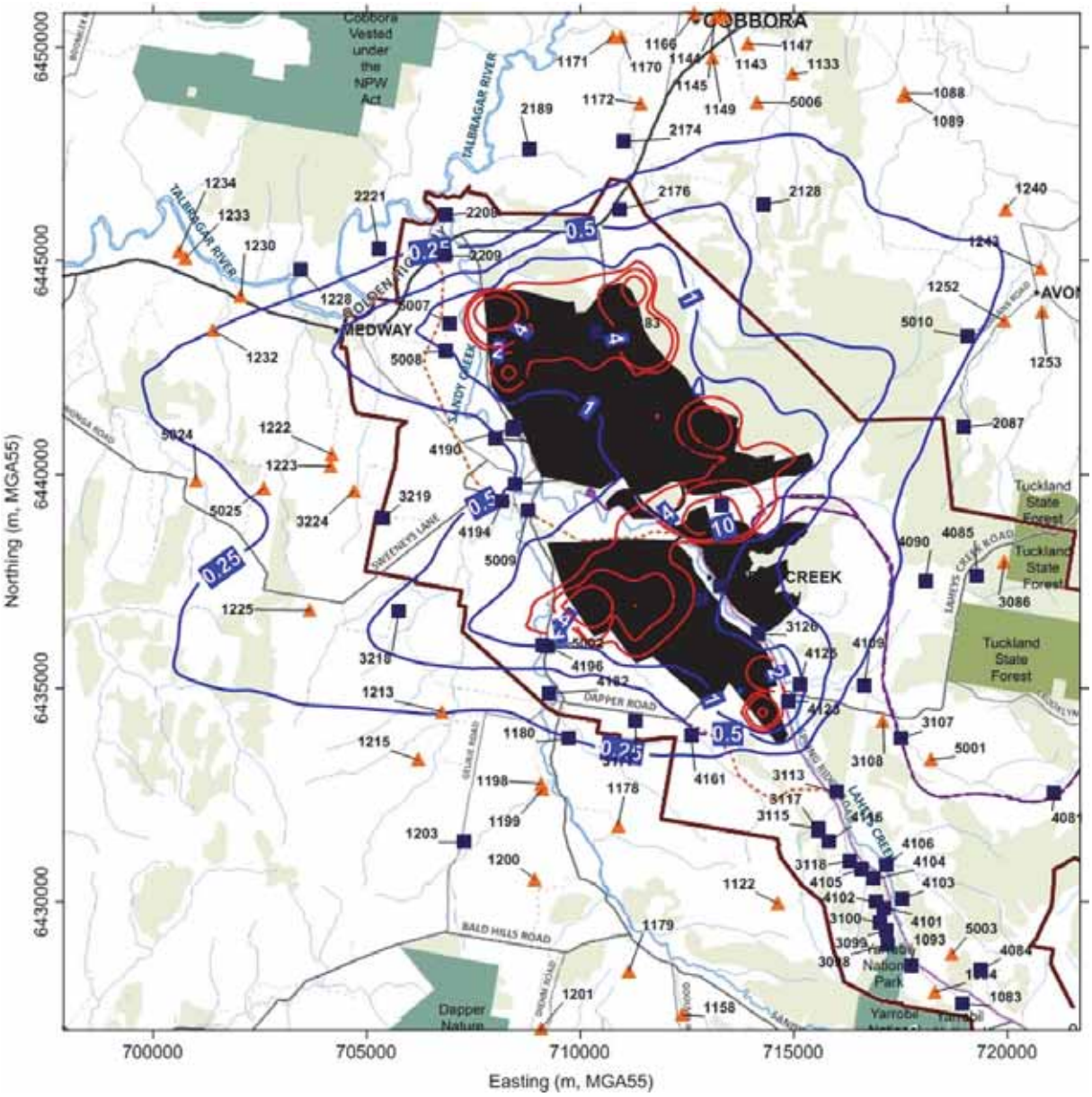

Figure F36 - Year 16 Operations – Annual average Dust Deposition (g/m^2/month) - Project Only Increment

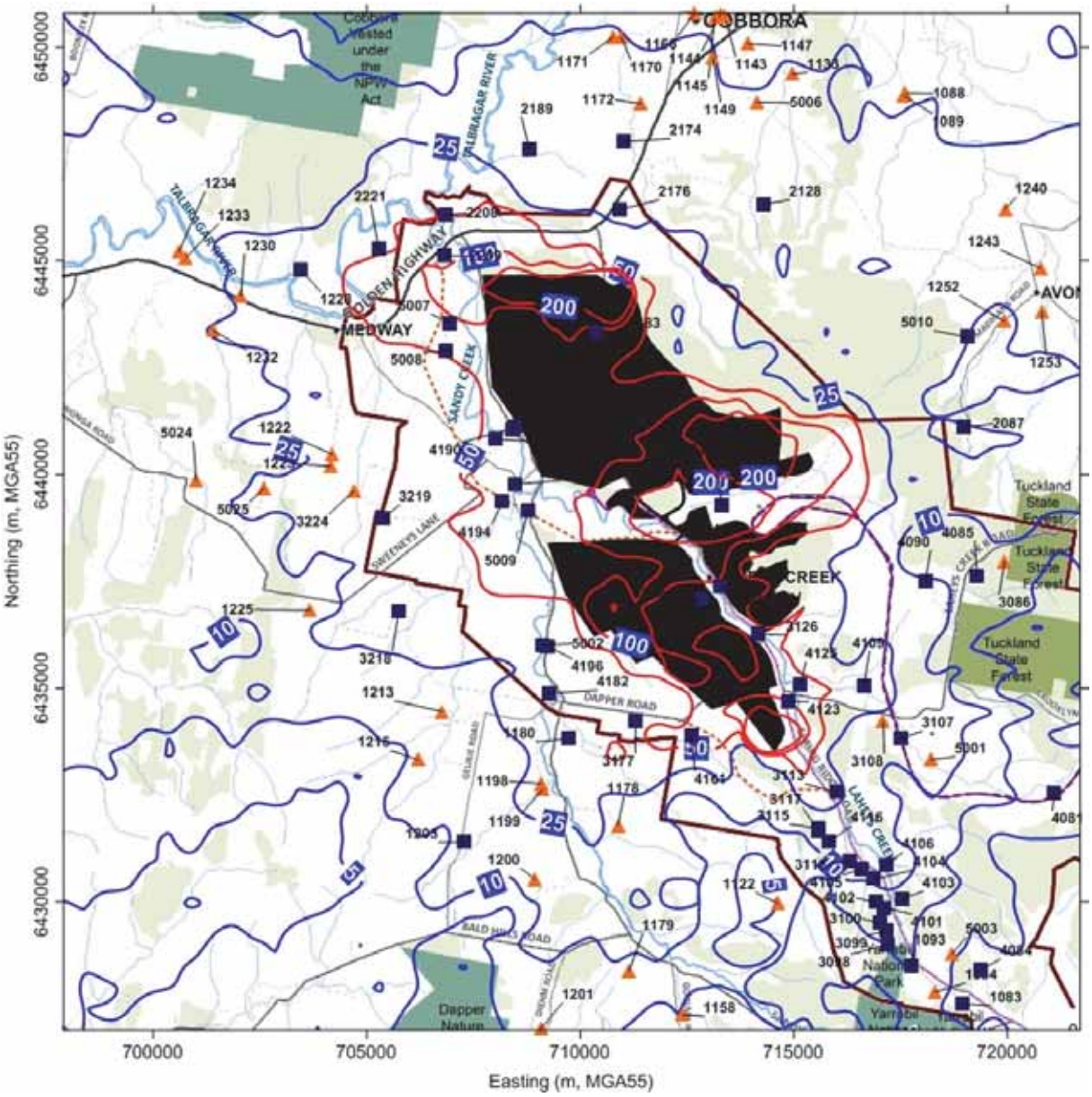

Figure F37 - Year 20 Operations – Highest 24-hour average PM_{10} Concentrations (µg/m³) - Project Only Increment

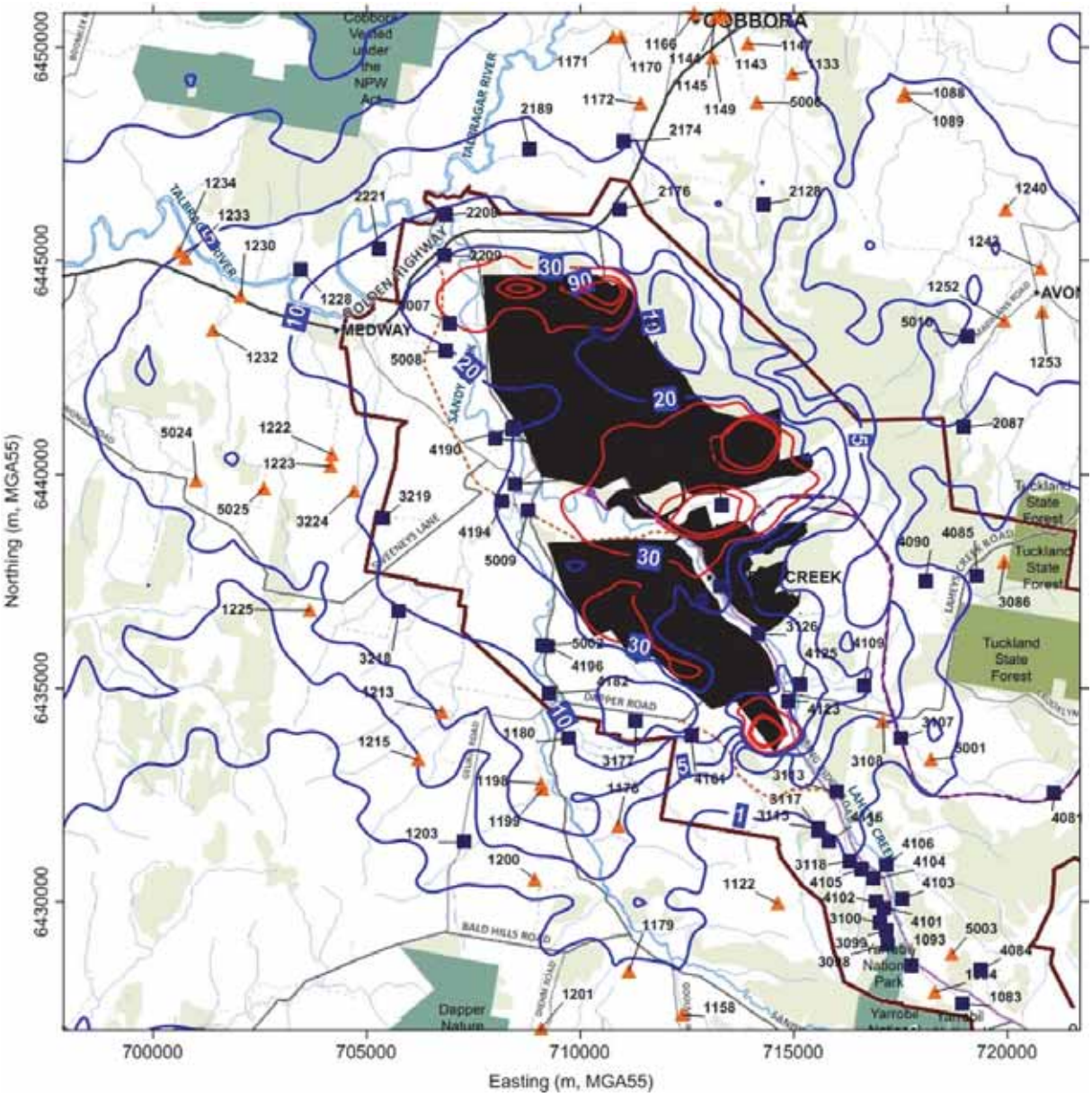

Figure F38 - Year 20 Operations – Annual average PM_{10} Concentrations (µg/m³) - Project Only Increment

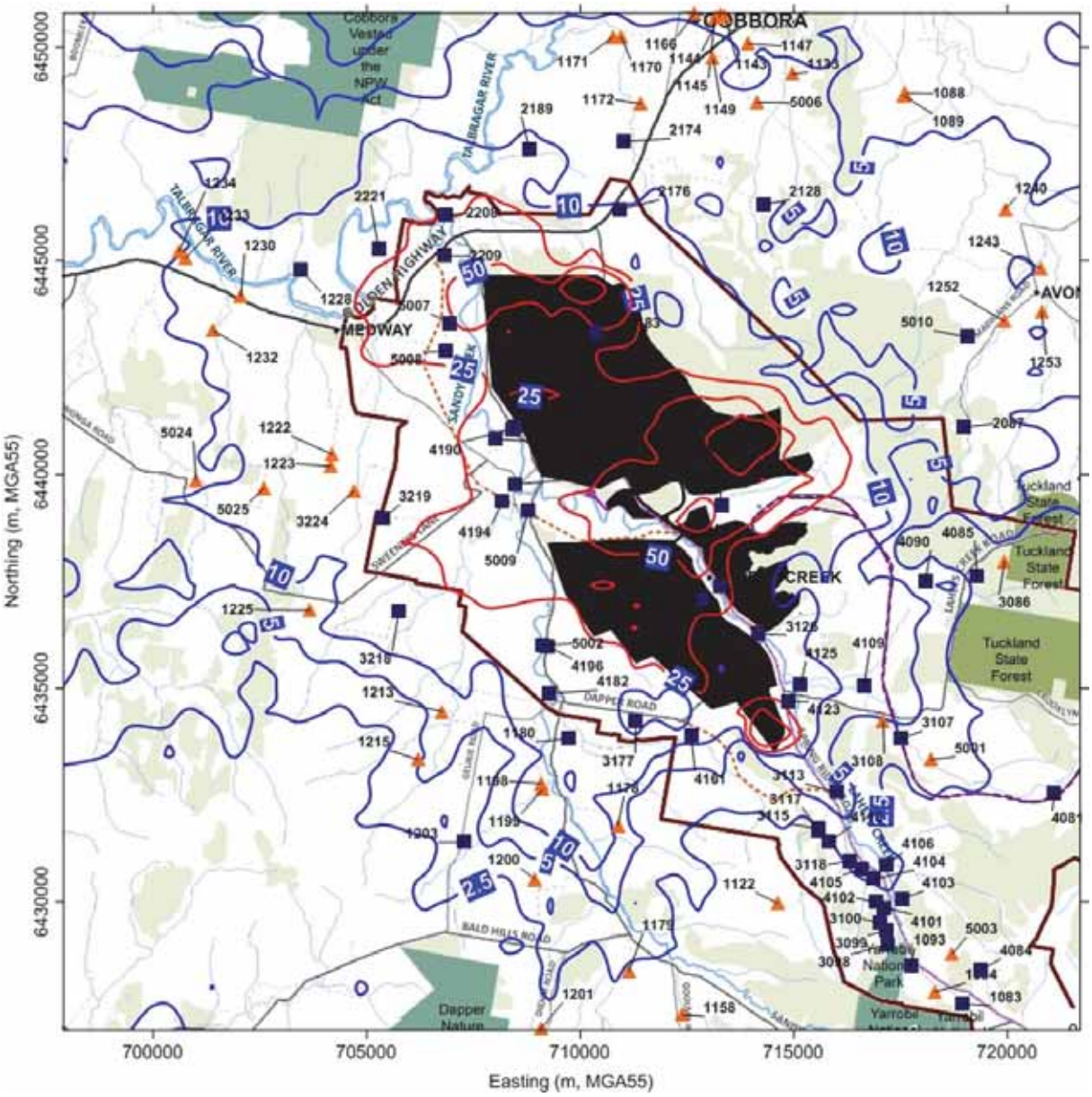

Figure F39 - Year 20 Operations – Highest 24-hour average $PM_{2.5}$ Concentrations (µg/m³) - Project Only Increment

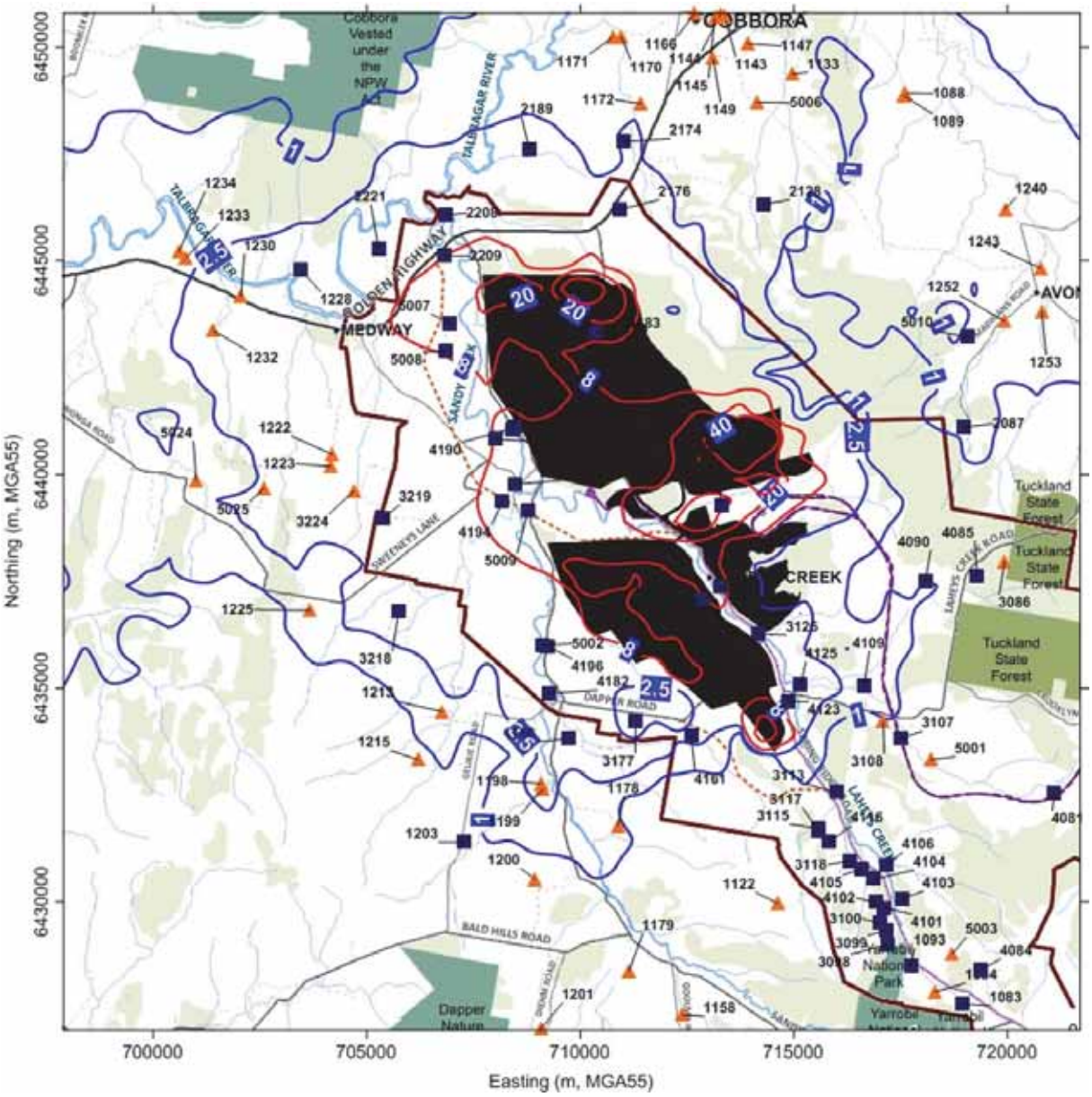

Figure F40 - Year 20 Operations – Annual average $PM_{2.5}$ Concentrations (µg/m³) - Project Only Increment

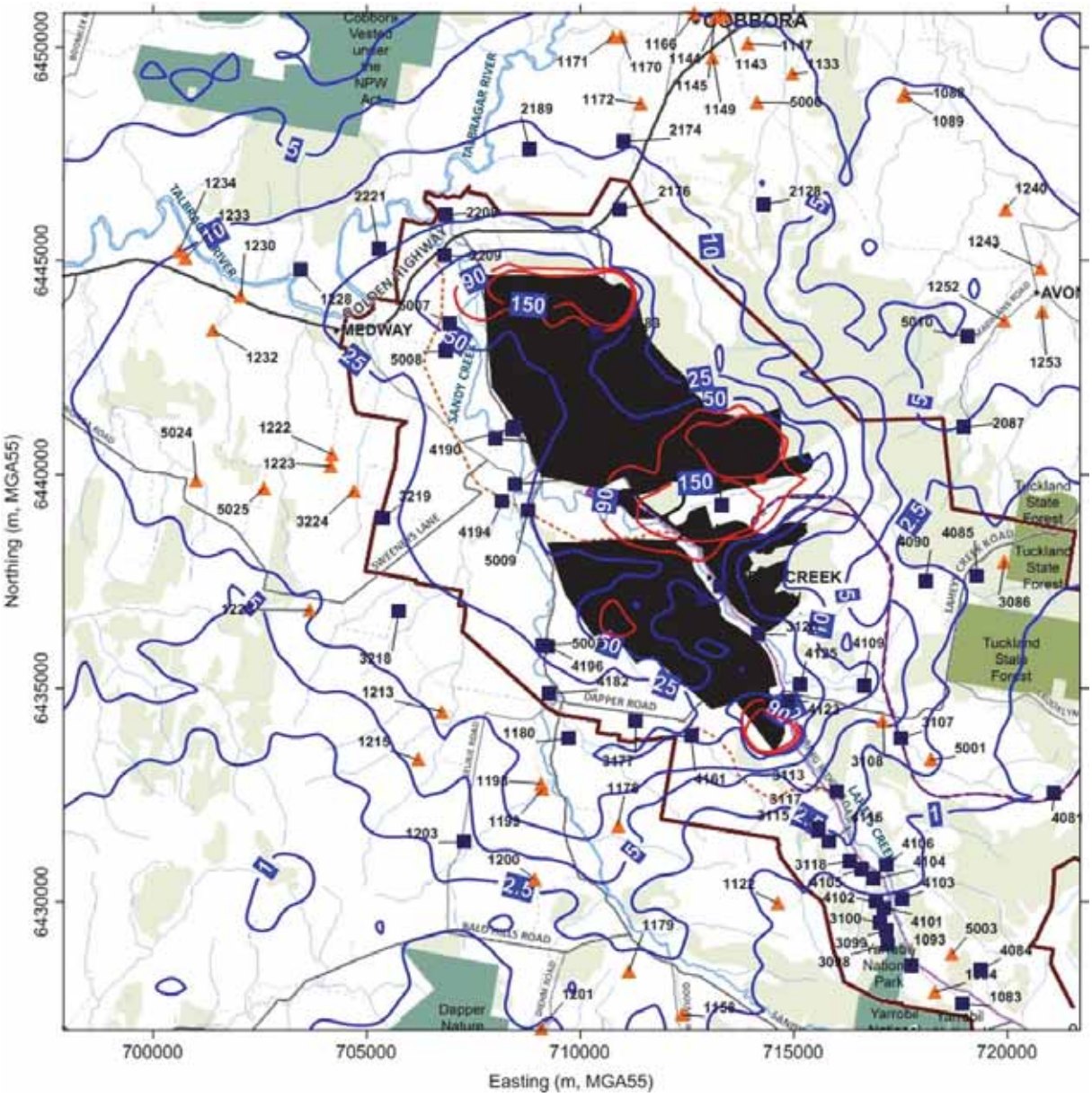

Figure F41 - Year 20 Operations – Annual average TSP Concentrations (µg/m³) - Project Only Increment

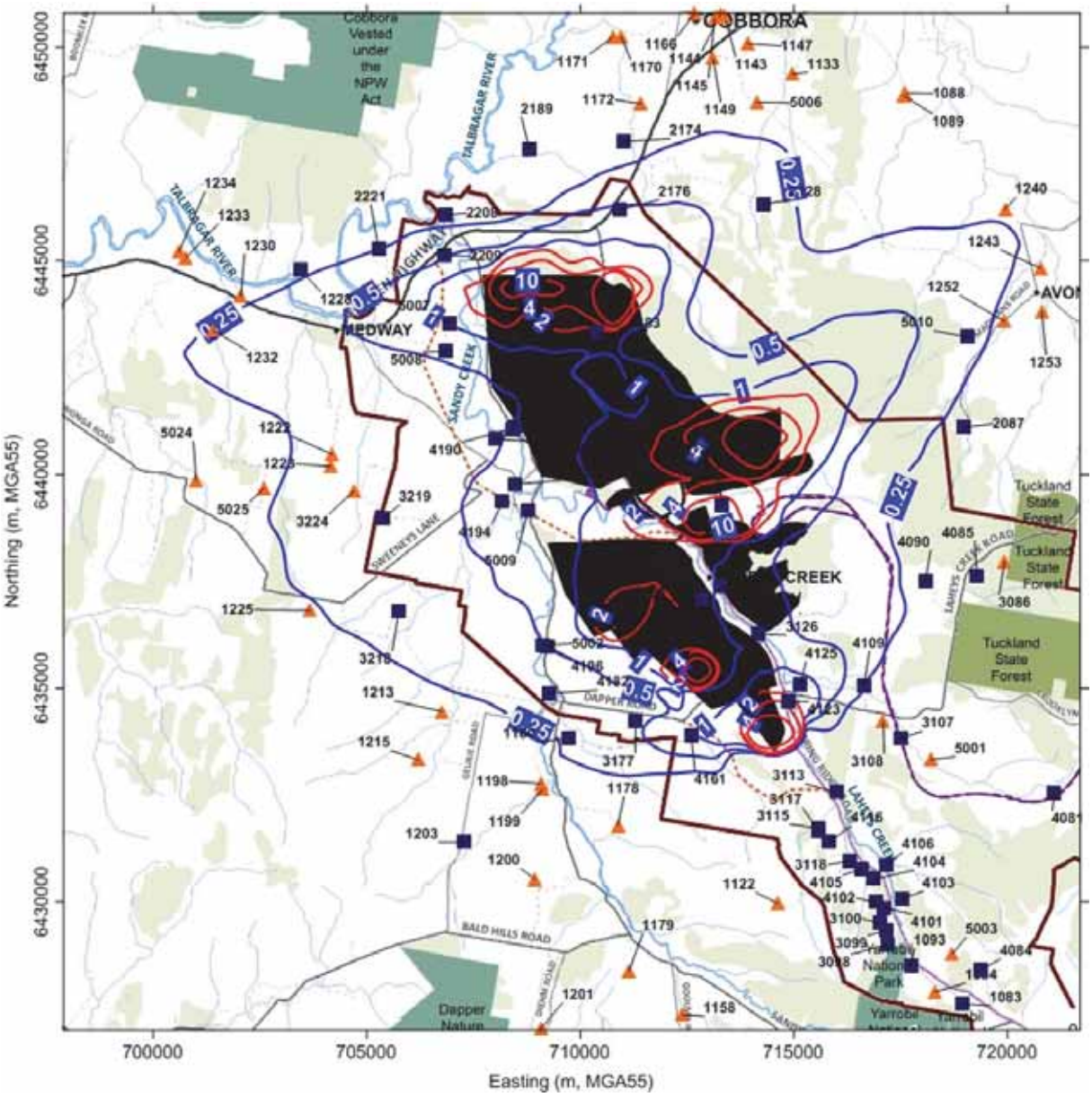

Figure F42 - Year 20 Operations – Annual average Dust Deposition (g/m^2/month) - Project Only Increment

Appendix G
Cumulative Air Pollutant Isopleths

Scenarios	Pollutant	Averaging Period	Figure No.
Year 1	PM_{10}	Highest 24-hour	G1
	PM_{10}	Annual average	G2
	$PM_{2.5}$	Highest 24-hour	G3
	$PM_{2.5}$	Annual average	G4
	TSP	Annual average	G5
	Dust Deposition	Annual average	G6
Year 2	PM_{10}	Highest 24-hour	G7
	PM_{10}	Annual average	G8
	$PM_{2.5}$	Highest 24-hour	G9
	$PM_{2.5}$	Annual average	G10
	TSP	Annual average	G11
	Dust Deposition	Annual average	G12
Year 4	PM_{10}	Highest 24-hour	G13
	PM_{10}	Annual average	G14
	$PM_{2.5}$	Highest 24-hour	G15
	$PM_{2.5}$	Annual average	G16
	TSP	Annual average	G17
	Dust Deposition	Annual average	G18
Year 8	PM_{10}	Highest 24-hour	G19
	PM_{10}	Annual average	G20
	$PM_{2.5}$	Highest 24-hour	G21
	$PM_{2.5}$	Annual average	G22
	TSP	Annual average	G23
	Dust Deposition	Annual average	G24

Scenarios	Pollutant	Averaging Period	Figure No.
Year 12	PM_{10}	Highest 24-hour	G25
	PM_{10}	Annual average	G26
	$PM_{2.5}$	Highest 24-hour	G27
	$PM_{2.5}$	Annual average	G28
	TSP	Annual average	G29
	Dust Deposition	Annual average	G30
Year 16	PM_{10}	Highest 24-hour	G31
	PM_{10}	Annual average	G32
	$PM_{2.5}$	Highest 24-hour	G33
	$PM_{2.5}$	Annual average	G34
	TSP	Annual average	G35
	Dust Deposition	Annual average	G36
Year 20	PM_{10}	Highest 24-hour	G37
	PM_{10}	Annual average	G38
	$PM_{2.5}$	Highest 24-hour	G39
	$PM_{2.5}$	Annual average	G40
	TSP	Annual average	G41
	Dust Deposition	Annual average	G42

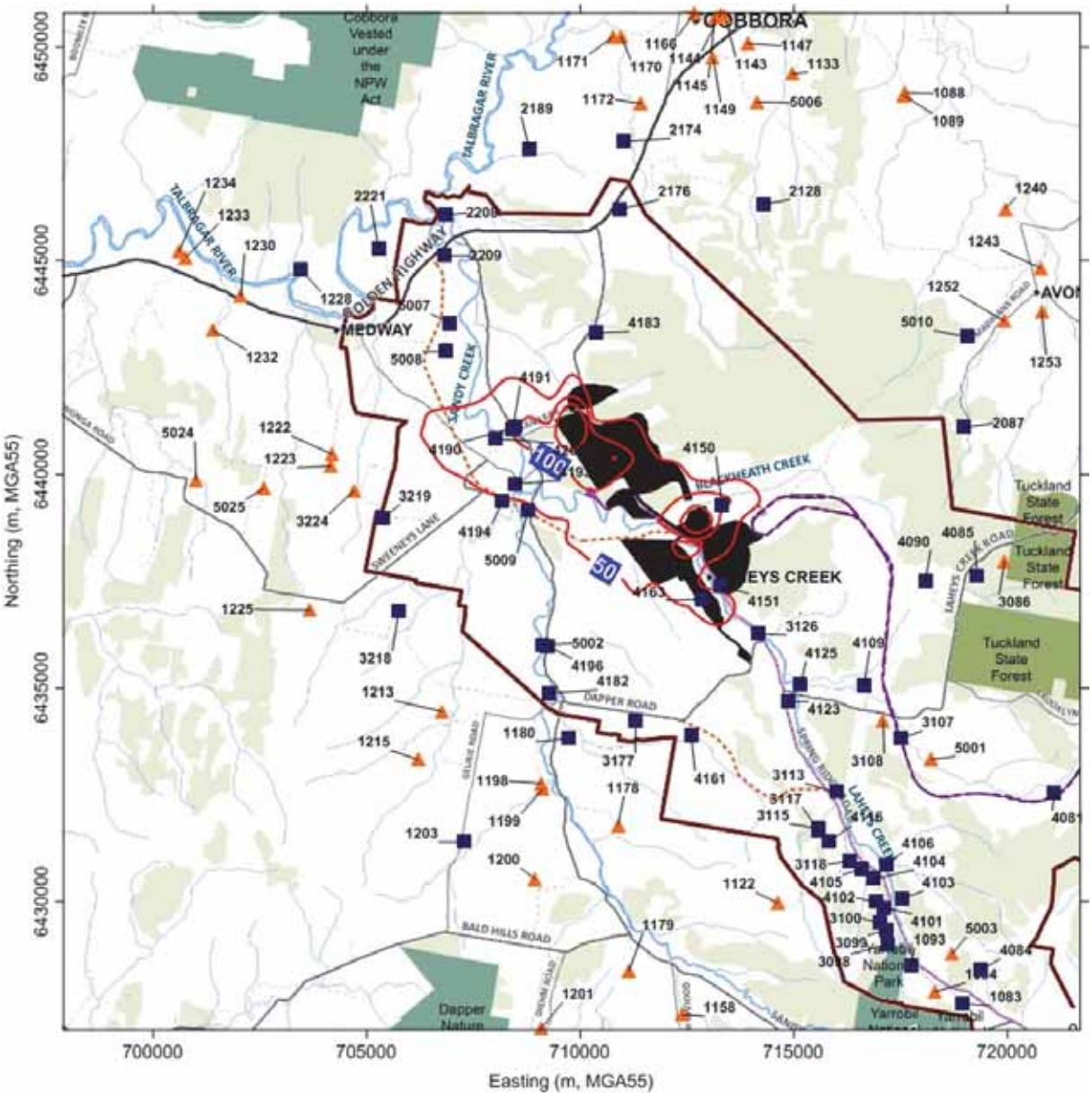

Figure G1 - Year 1 Operations – Highest 24-hour average PM_{10} Concentrations (µg/m³) - Cumulative (Project + Background)

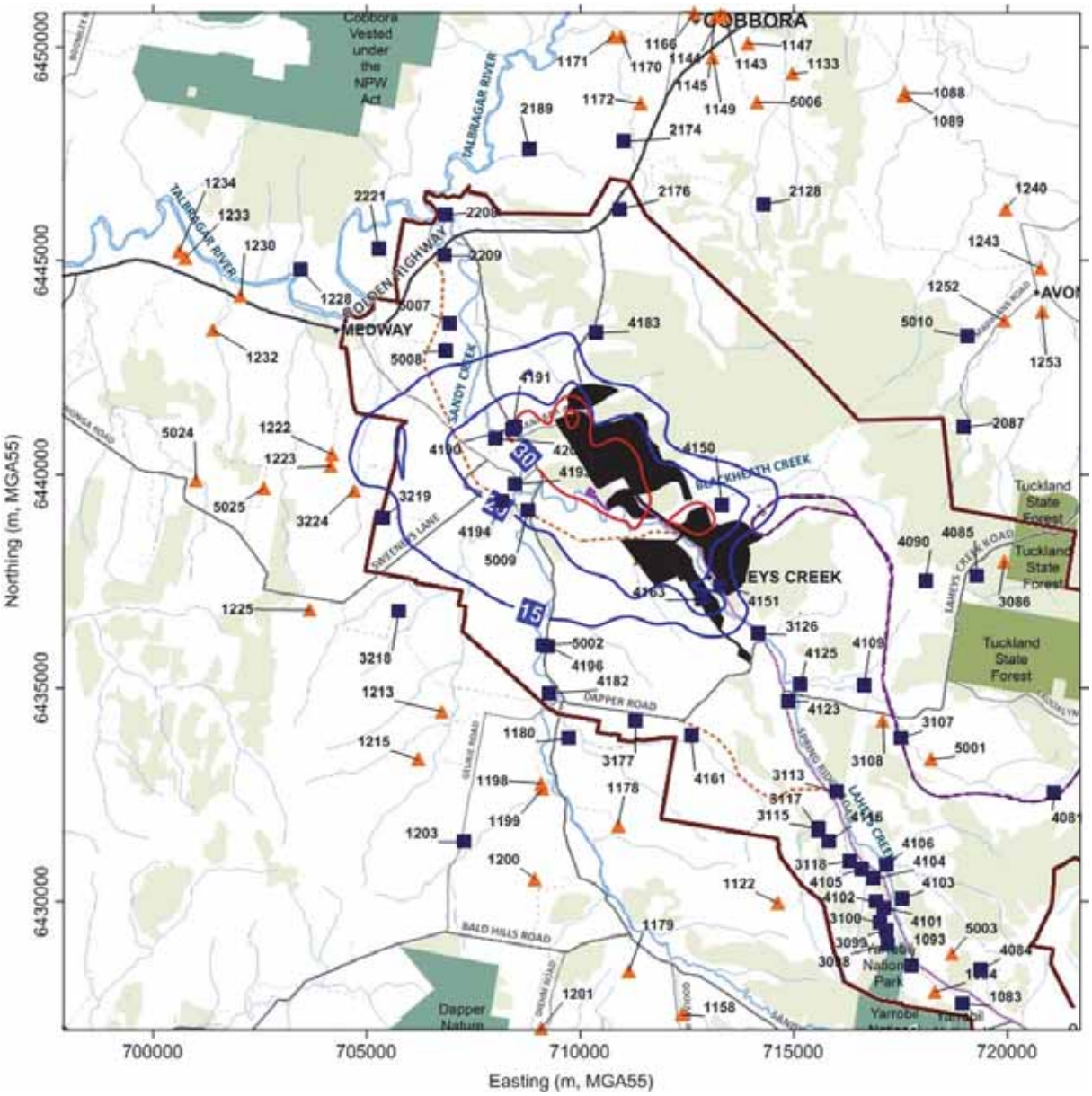

Figure G2 - Year 1 Operations – Annual average PM_{10} Concentrations (µg/m³) - Cumulative (Project + Background)

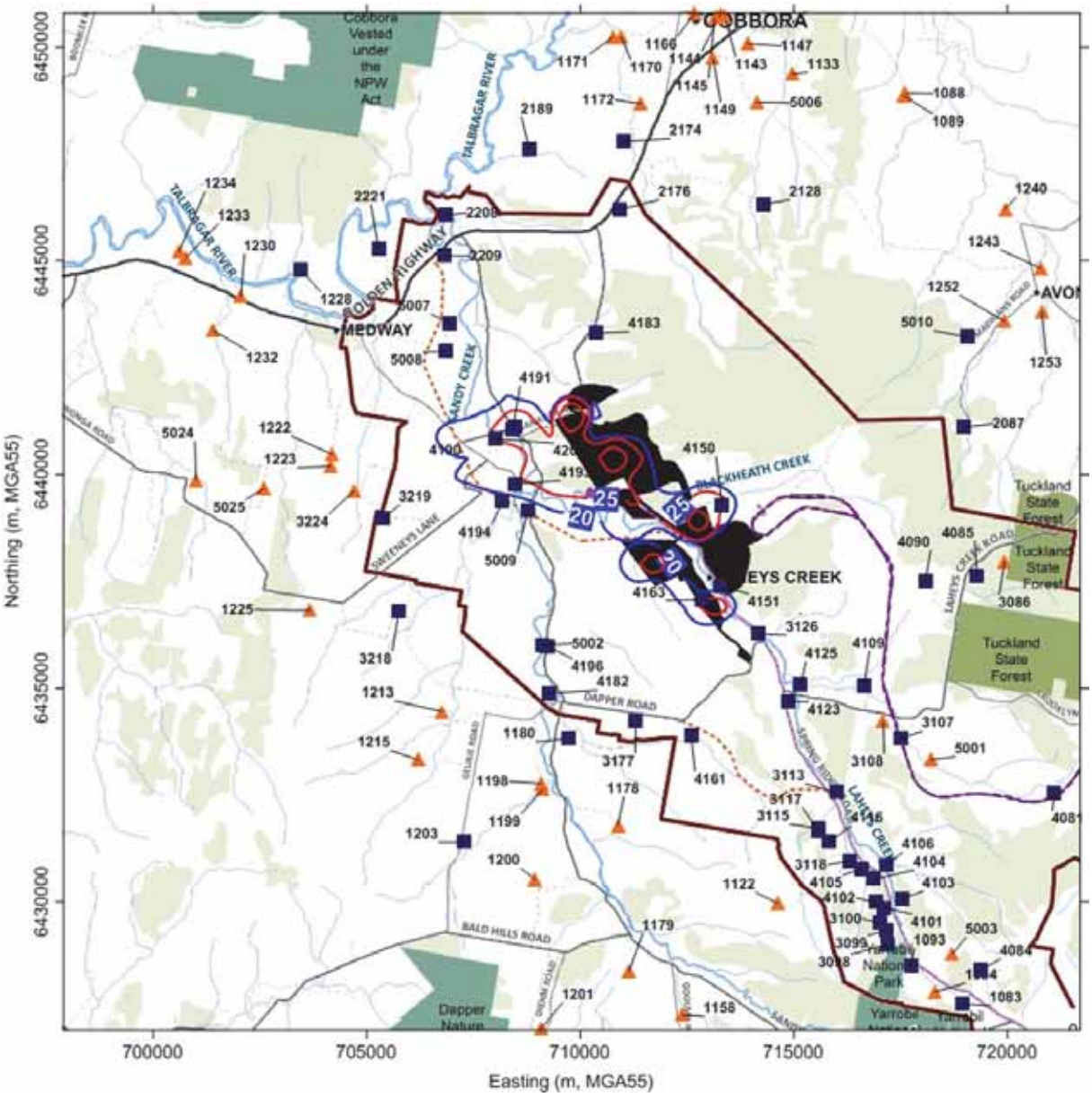

Figure G3 - Year 1 Operations – Highest 24-hour average $PM_{2.5}$ Concentrations (µg/m³) - Cumulative (Project + Background)

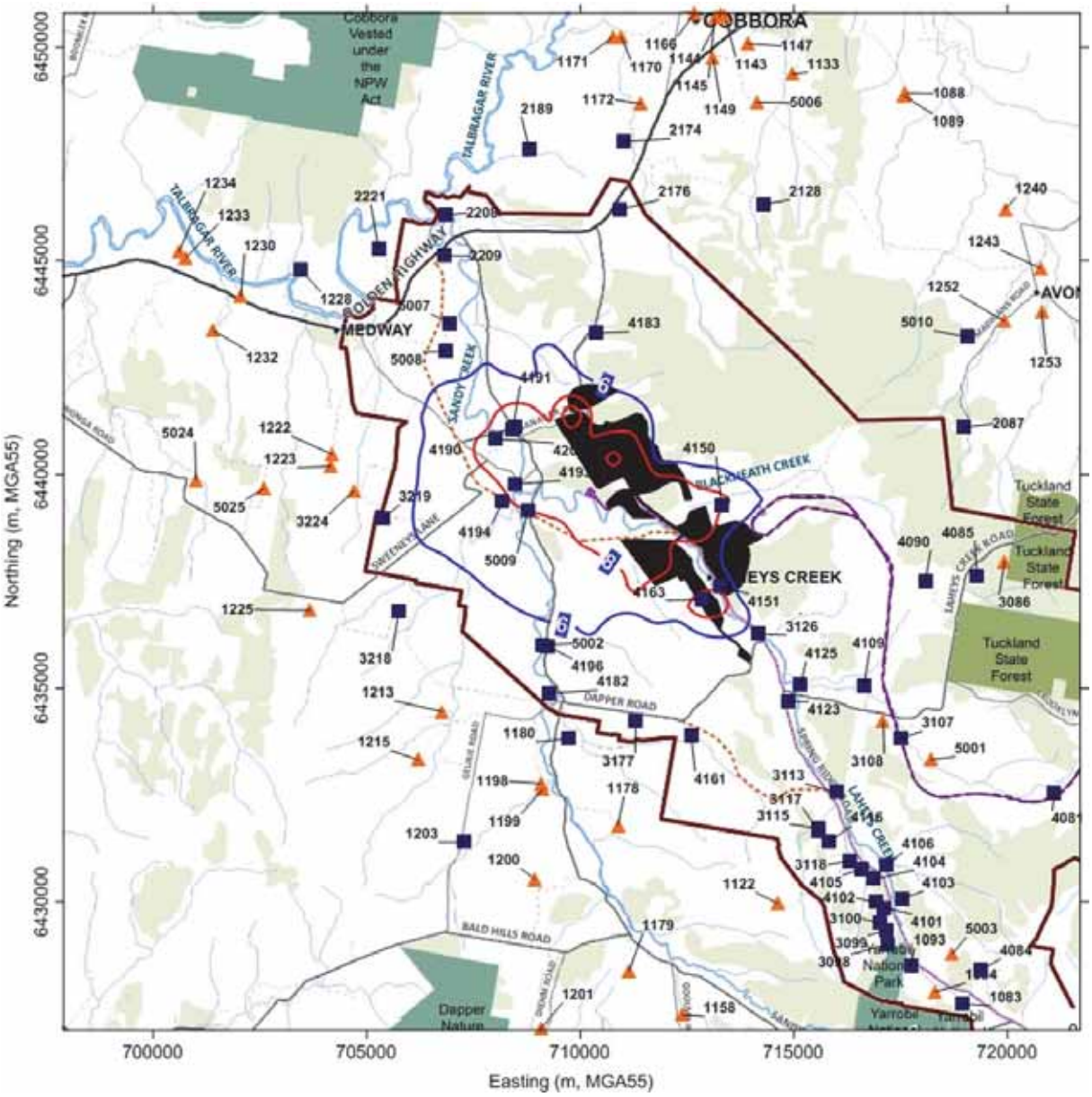

Figure G4 - Year 1 Operations – Annual average $PM_{2.5}$ Concentrations (µg/m³) - Cumulative (Project + Background)

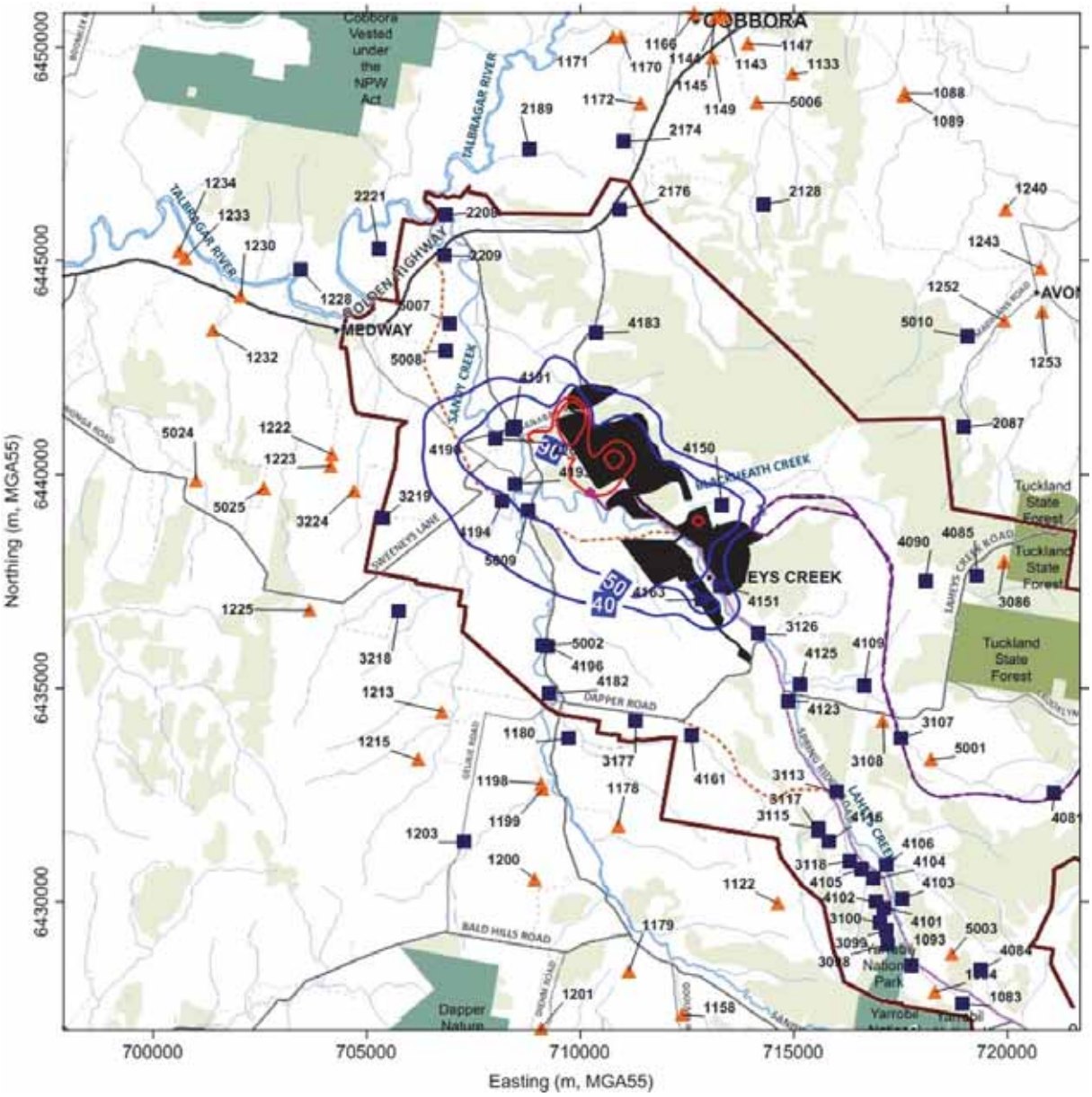

Figure G5 - Year 1 Operations – Annual average TSP Concentrations (µg/m³) - Cumulative (Project + Background)

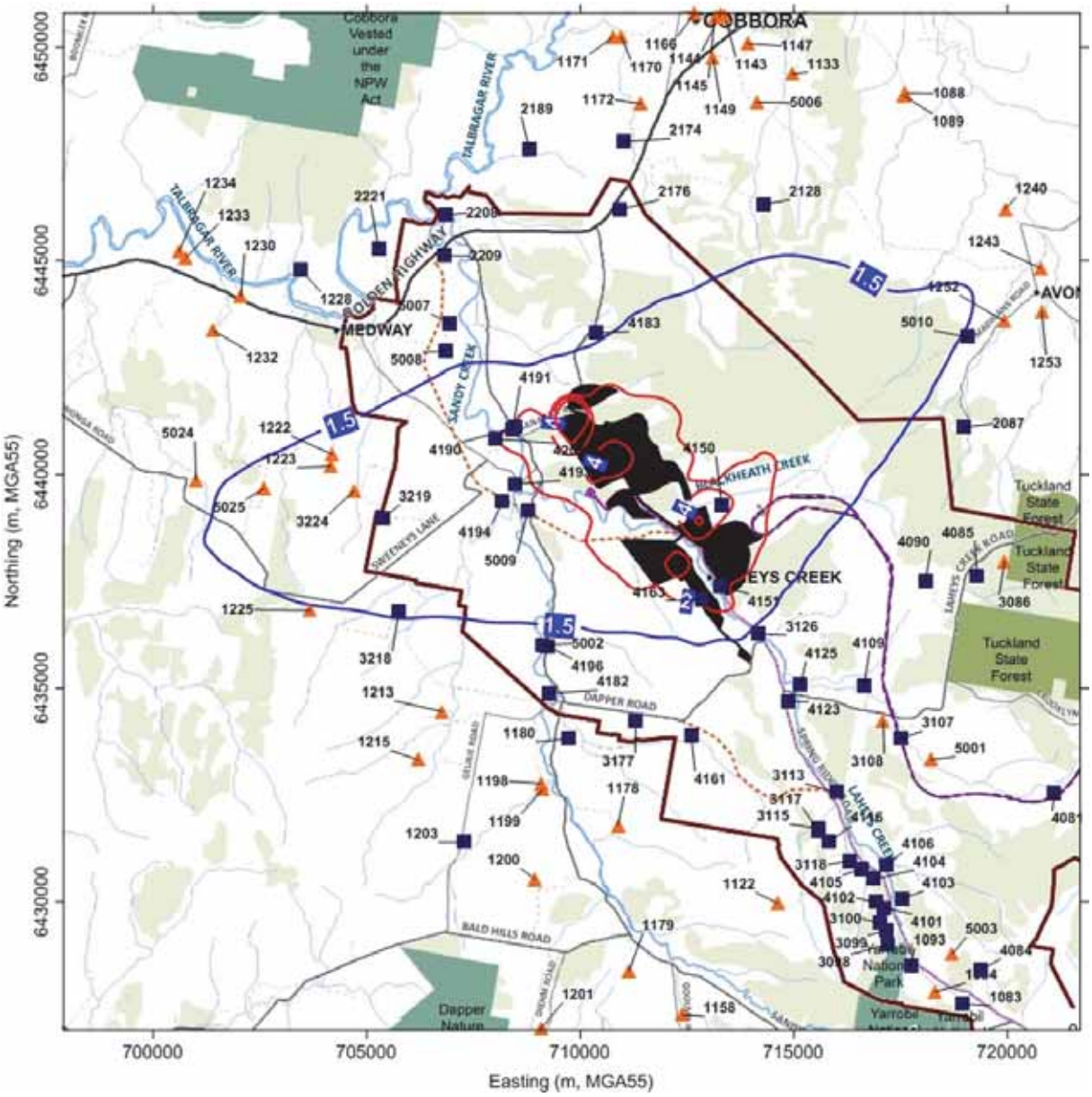

Figure G6 - Year 1 Operations – Annual average Dust Deposition (g/m^2/month) - Cumulative (Project + Background)

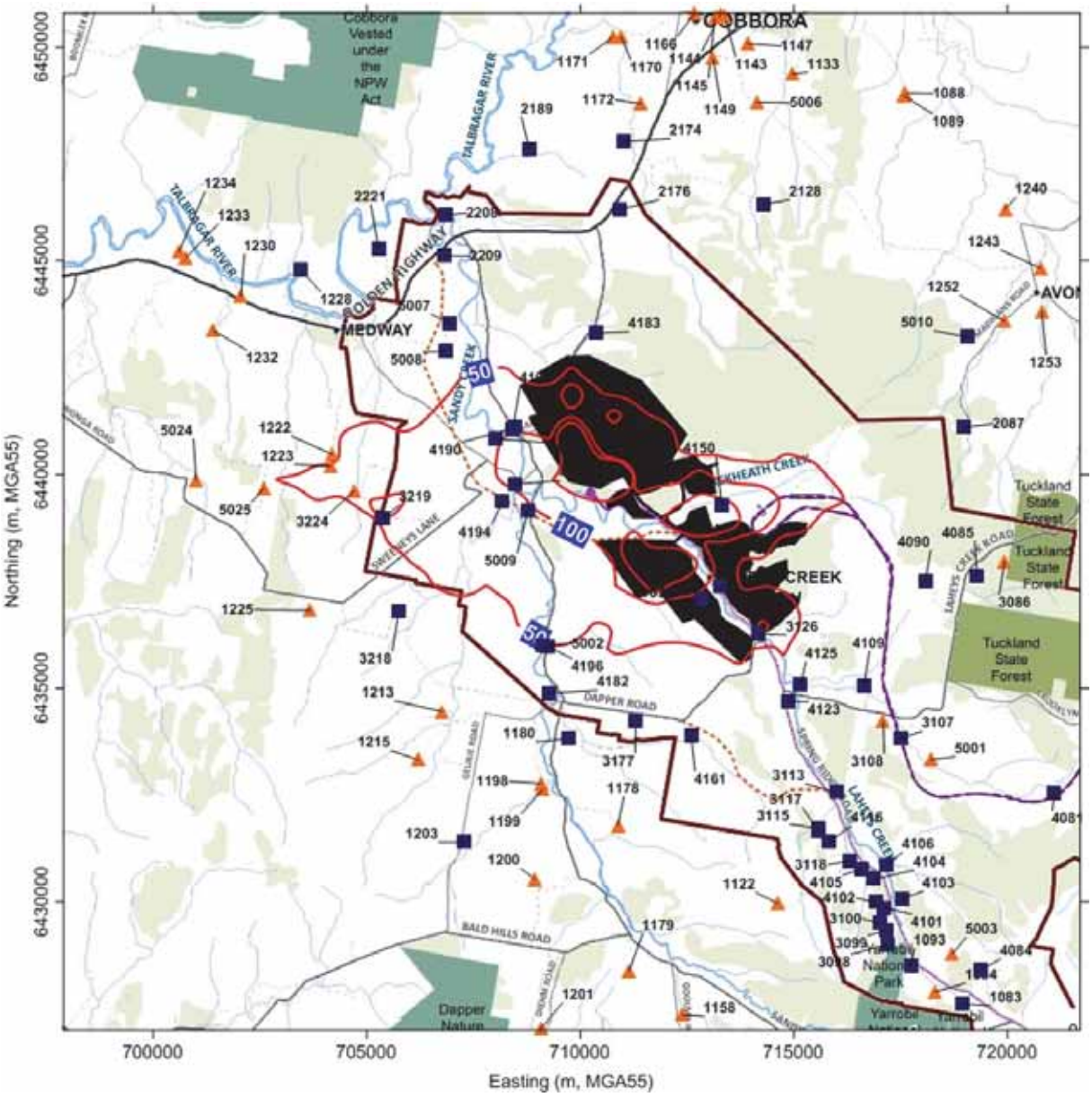

Figure G7 - Year 2 Operations – Highest 24-hour average PM_{10} Concentrations (µg/m³) - Cumulative (Project + Background)

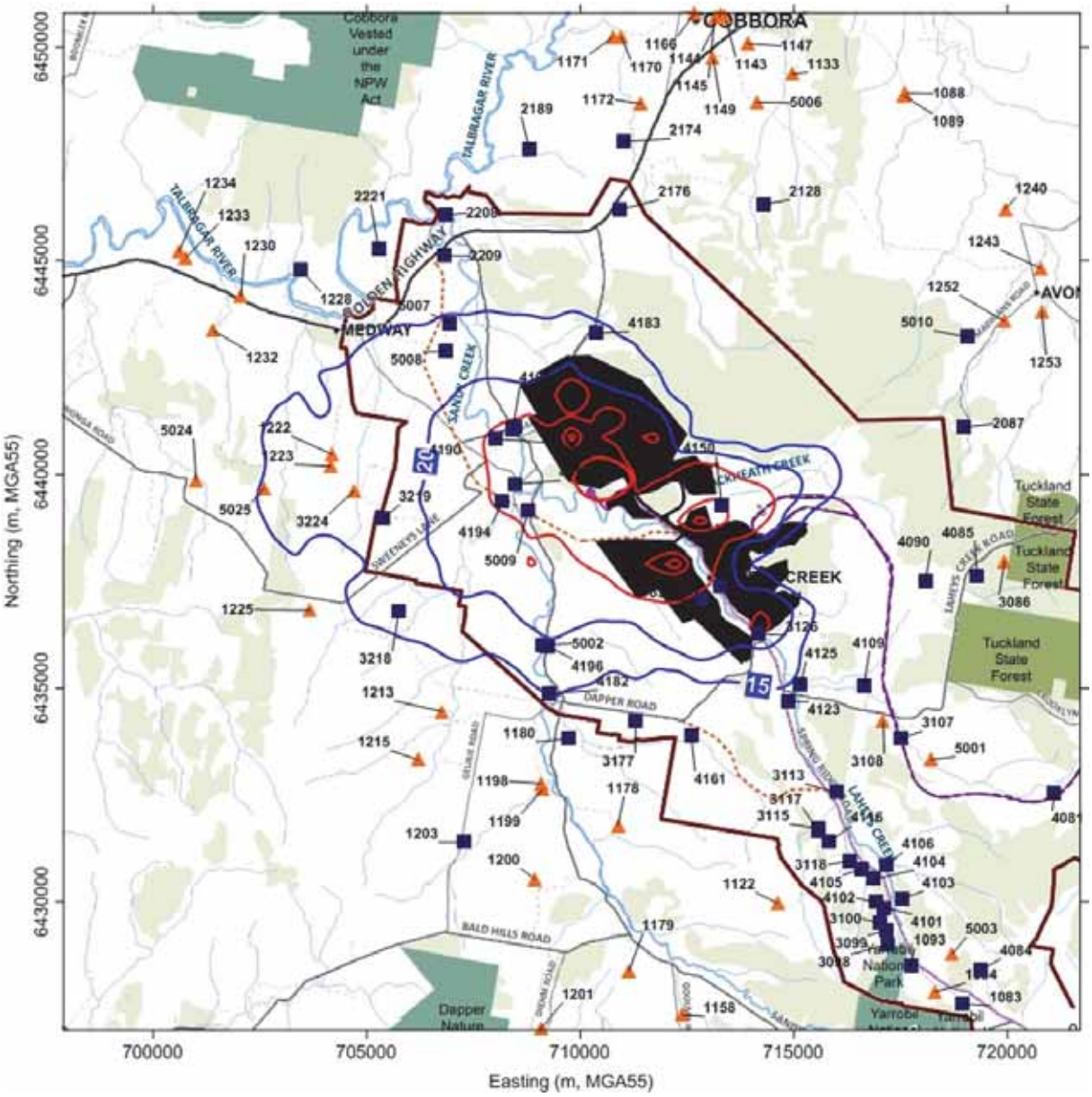

Figure G8 - Year 2 Operations – Annual average PM_{10} Concentrations (µg/m³) - Cumulative (Project + Background)

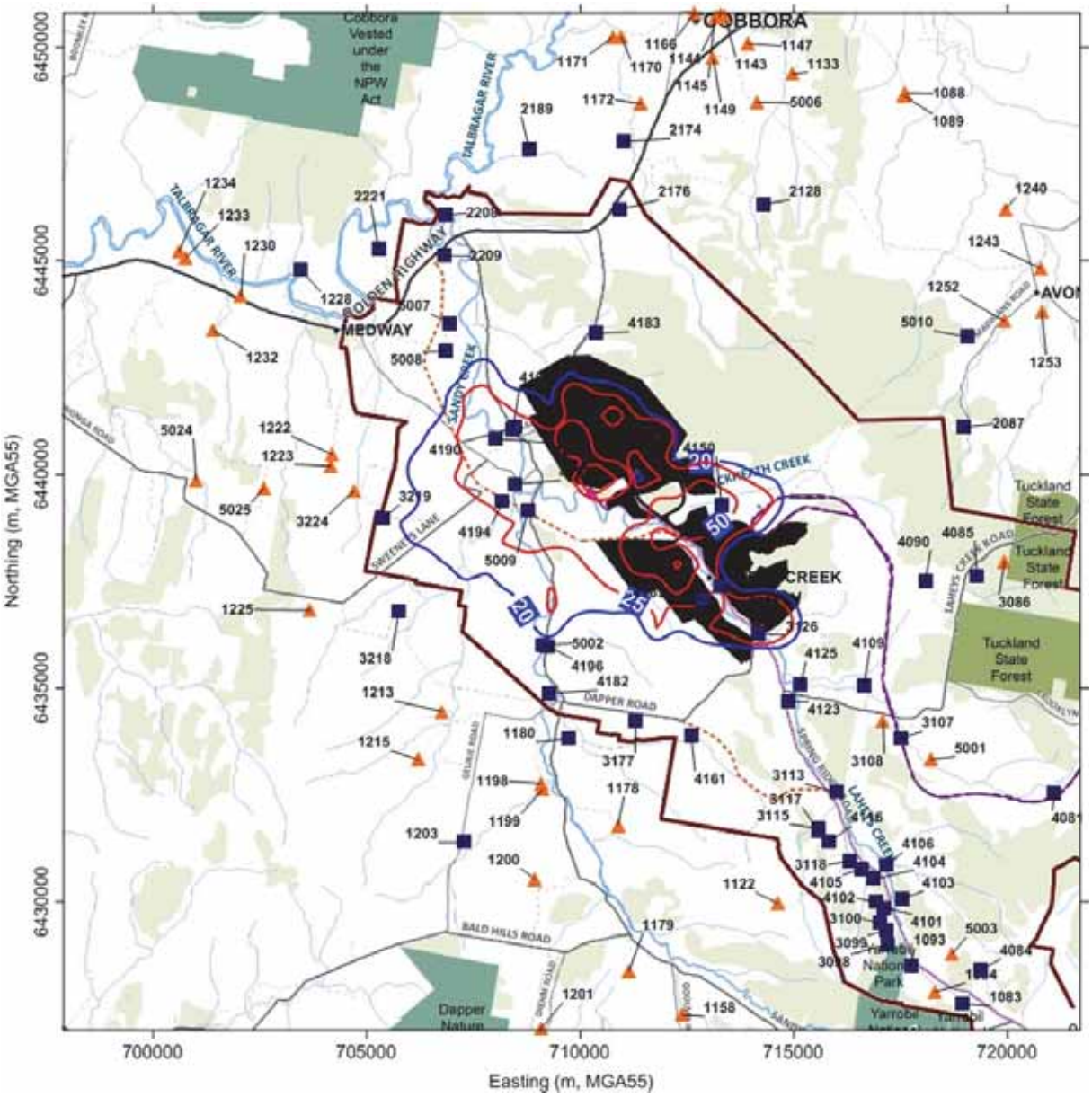

Figure G9 - Year 2 Operations – Highest 24-hour average $PM_{2.5}$ Concentrations (µg/m³) - Cumulative (Project + Background)

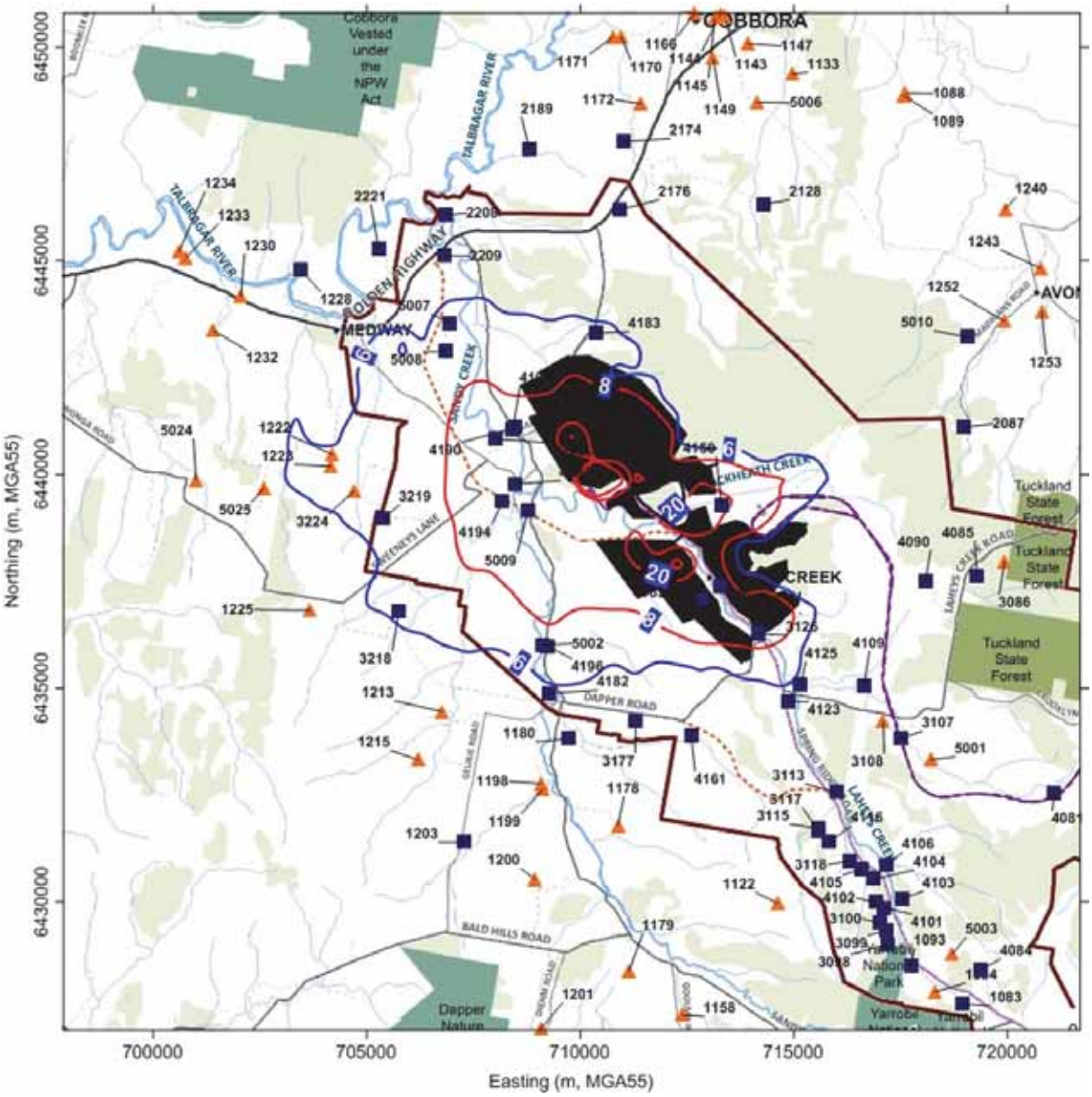

Figure G10 - Year 2 Operations – Annual average $PM_{2.5}$ Concentrations (µg/m³) - Cumulative (Project + Background)

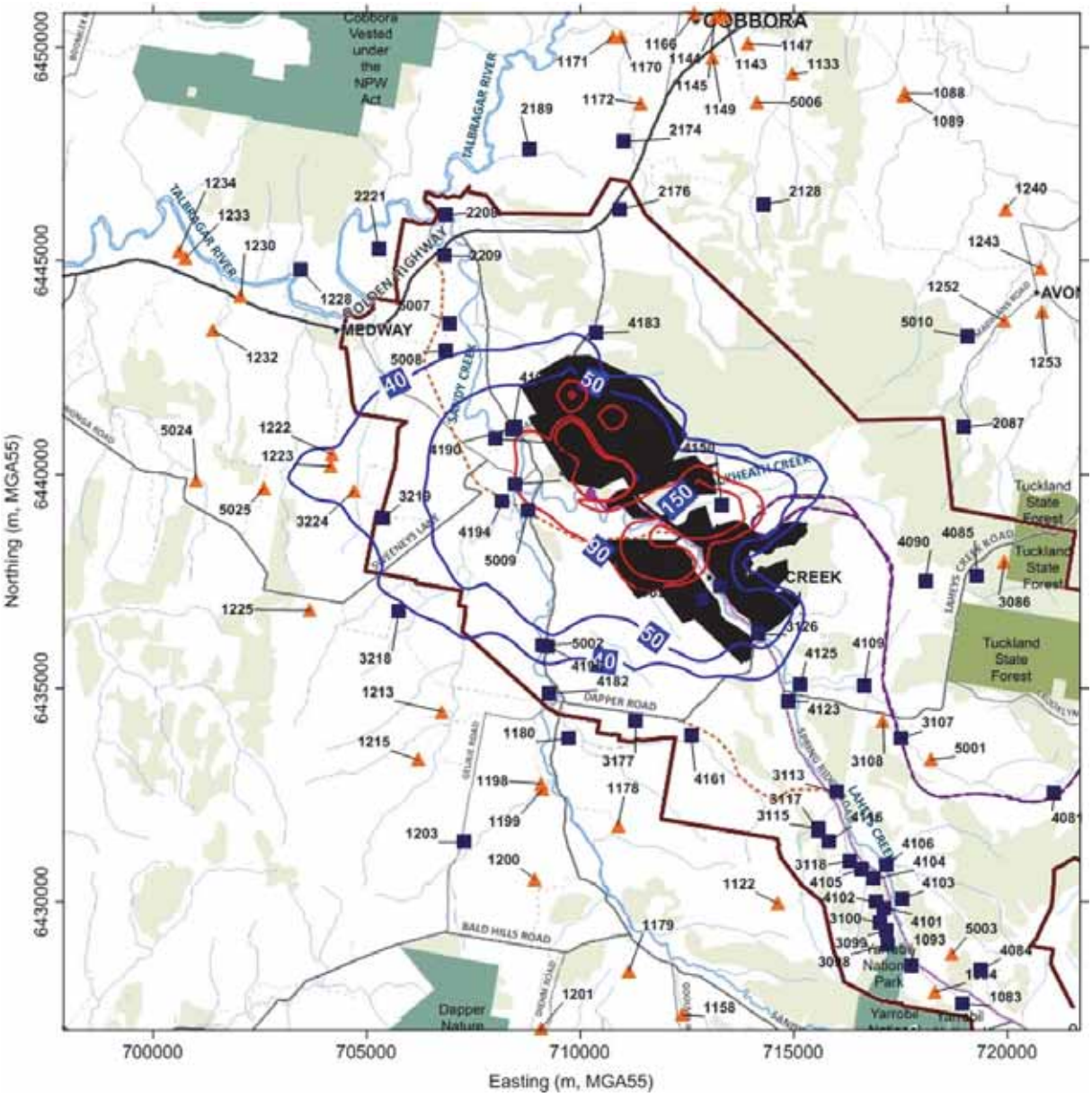

Figure G11 - Year 2 Operations – Annual average TSP Concentrations (µg/m³) - Cumulative (Project + Background)

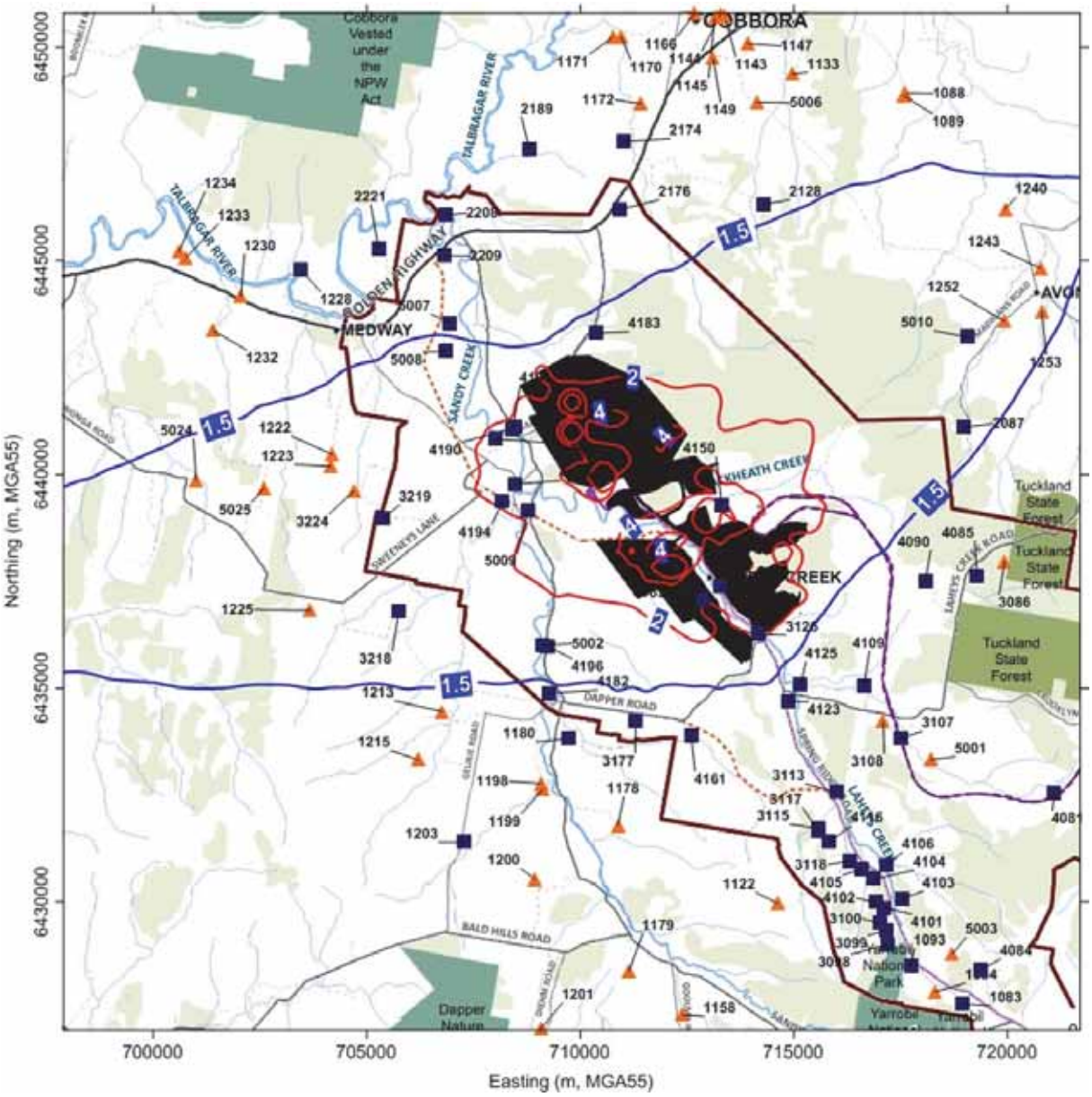

Figure G12 - Year 2 Operations – Annual average Dust Deposition (g/m^2/month) - Cumulative (Project + Background)

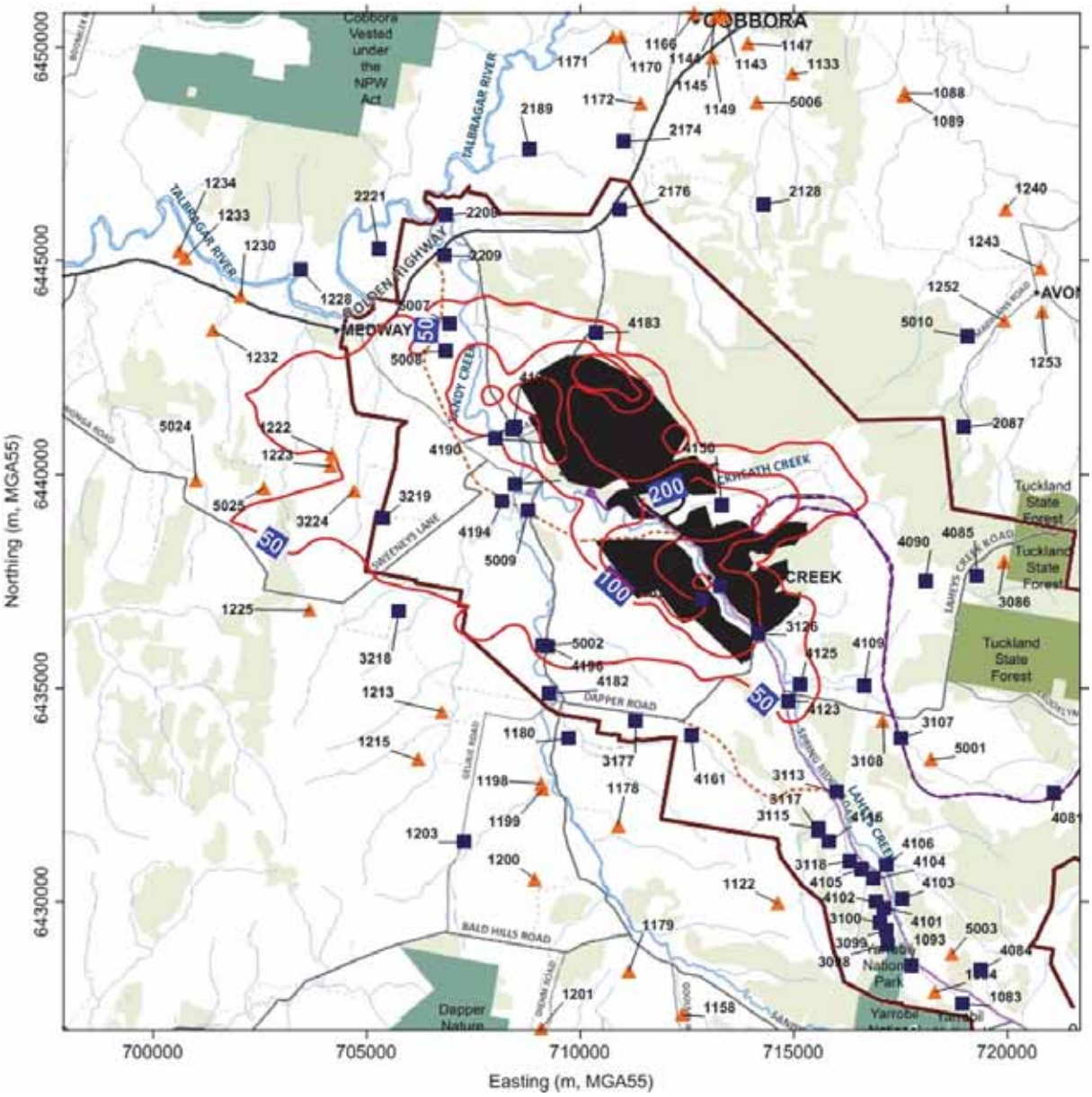

Figure G13 - Year 4 Operations – Highest 24-hour average PM_{10} Concentrations (µg/m³) - Cumulative (Project + Background)

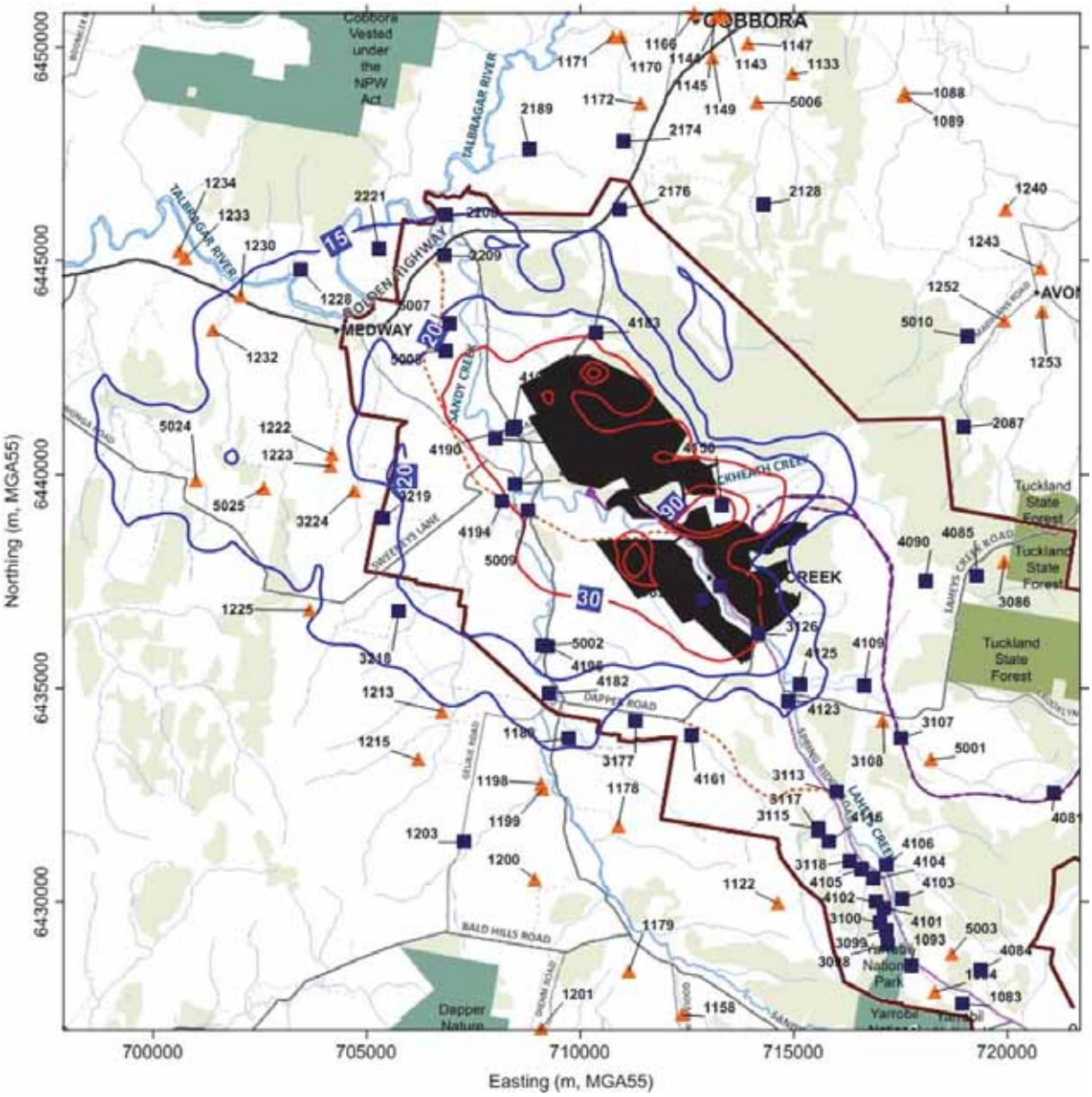

Figure G14 - Year 4 Operations – Annual average PM_{10} Concentrations (µg/m³) - Cumulative (Project + Background)

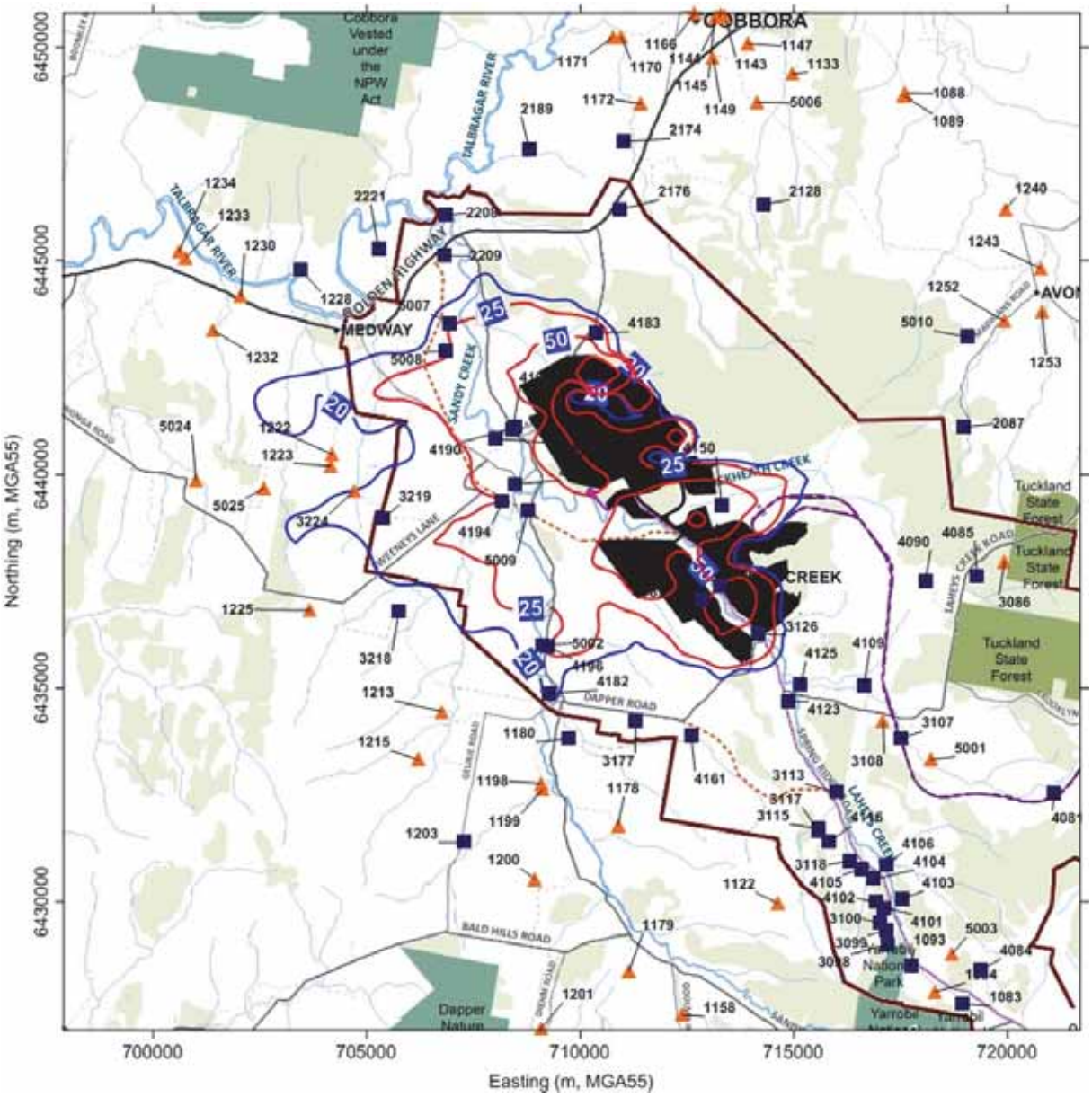

Figure G15 - Year 4 Operations – Highest 24-hour average $PM_{2.5}$ Concentrations (µg/m³) - Cumulative (Project + Background)

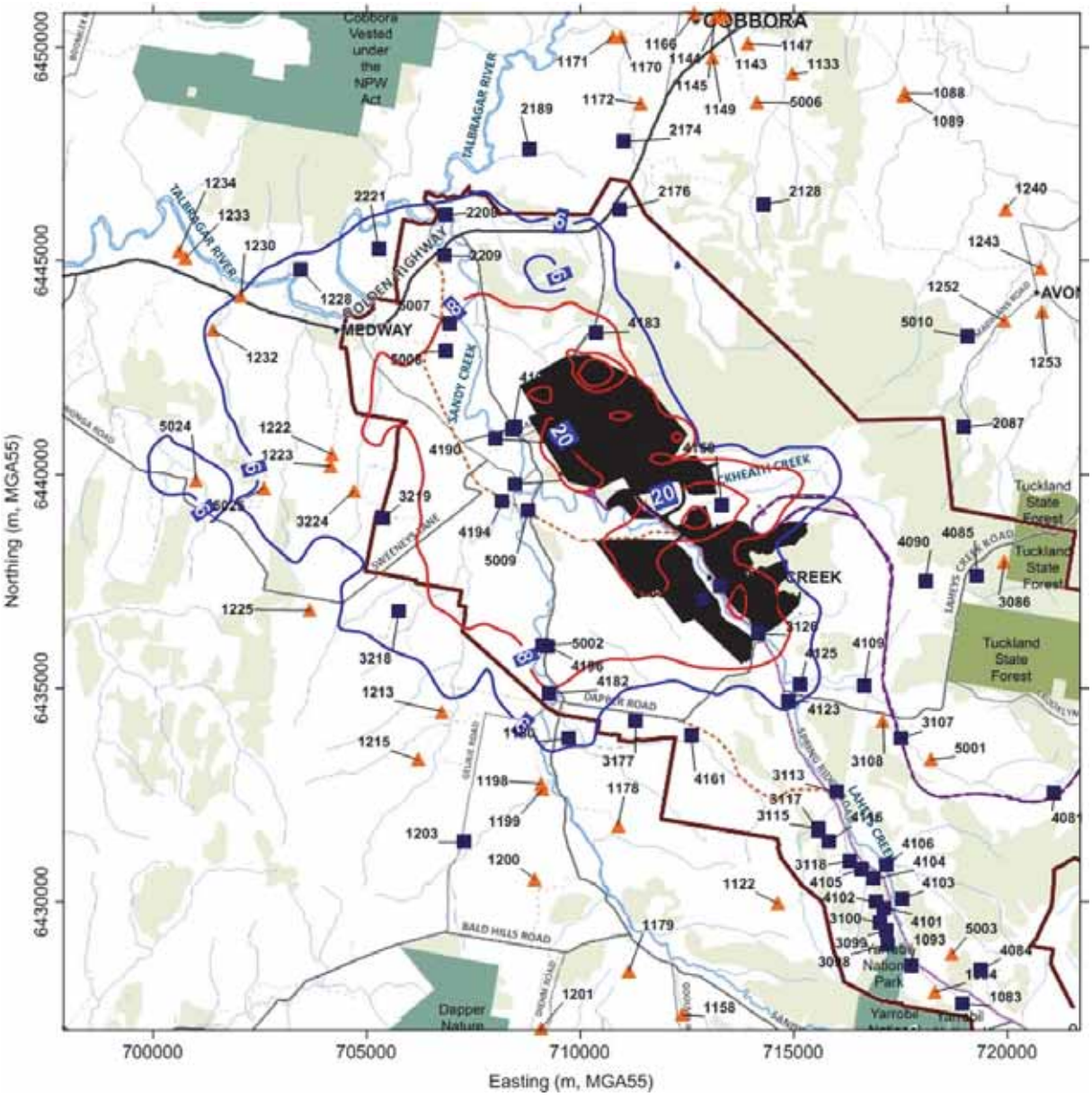

Figure G16 - Year 4 Operations – Annual average $PM_{2.5}$ Concentrations (µg/m³) - Cumulative (Project + Background)

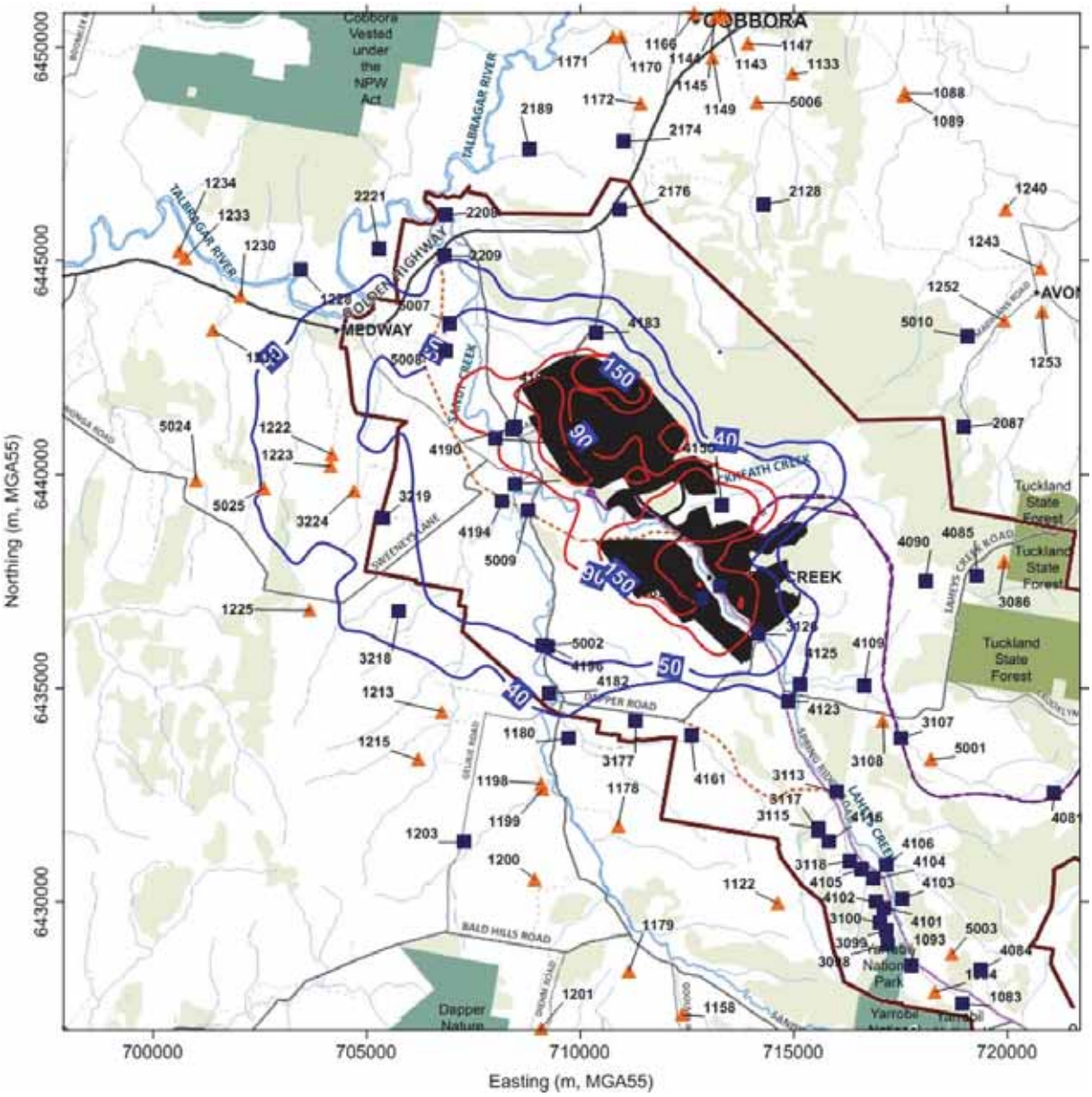

Figure G17 - Year 4 Operations – Annual average TSP Concentrations (µg/m³) - Cumulative (Project + Background)

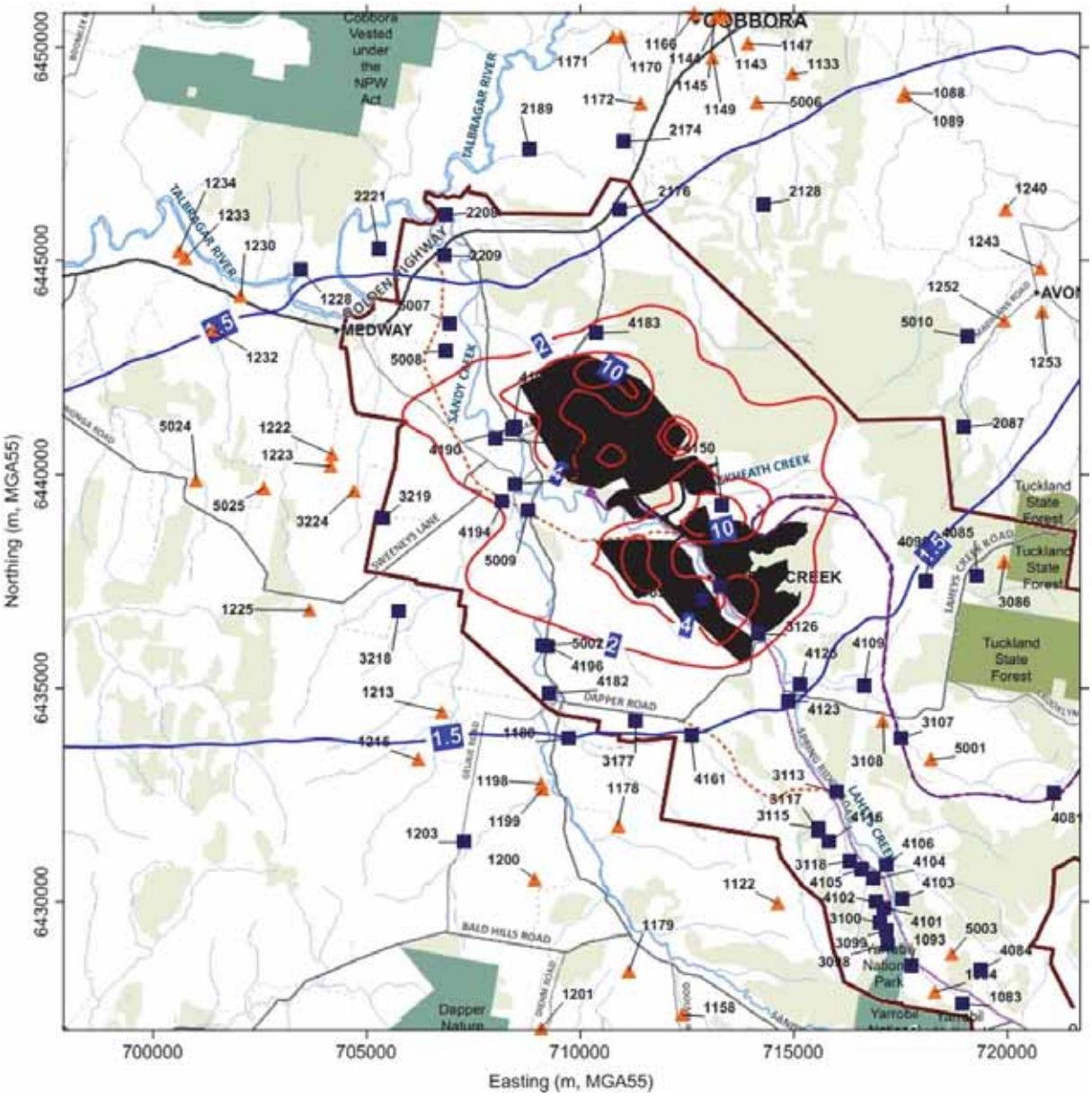

Figure G18 - Year 4 Operations – Annual average Dust Deposition (g/m^2/month) - Cumulative (Project + Background)

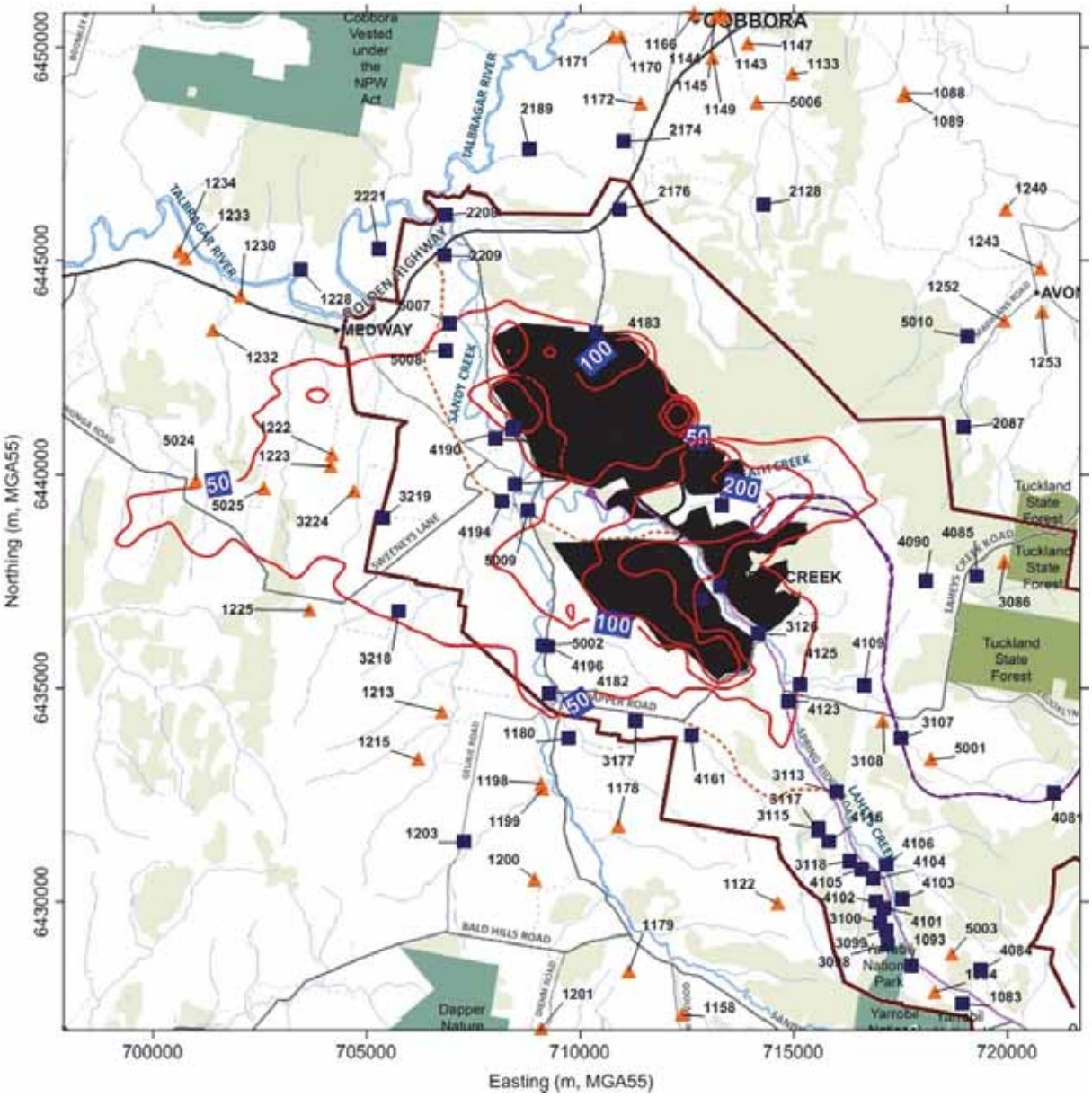

Figure G19 - Year 8 Operations – Highest 24-hour average PM_{10} Concentrations (µg/m³) - Cumulative (Project + Background)

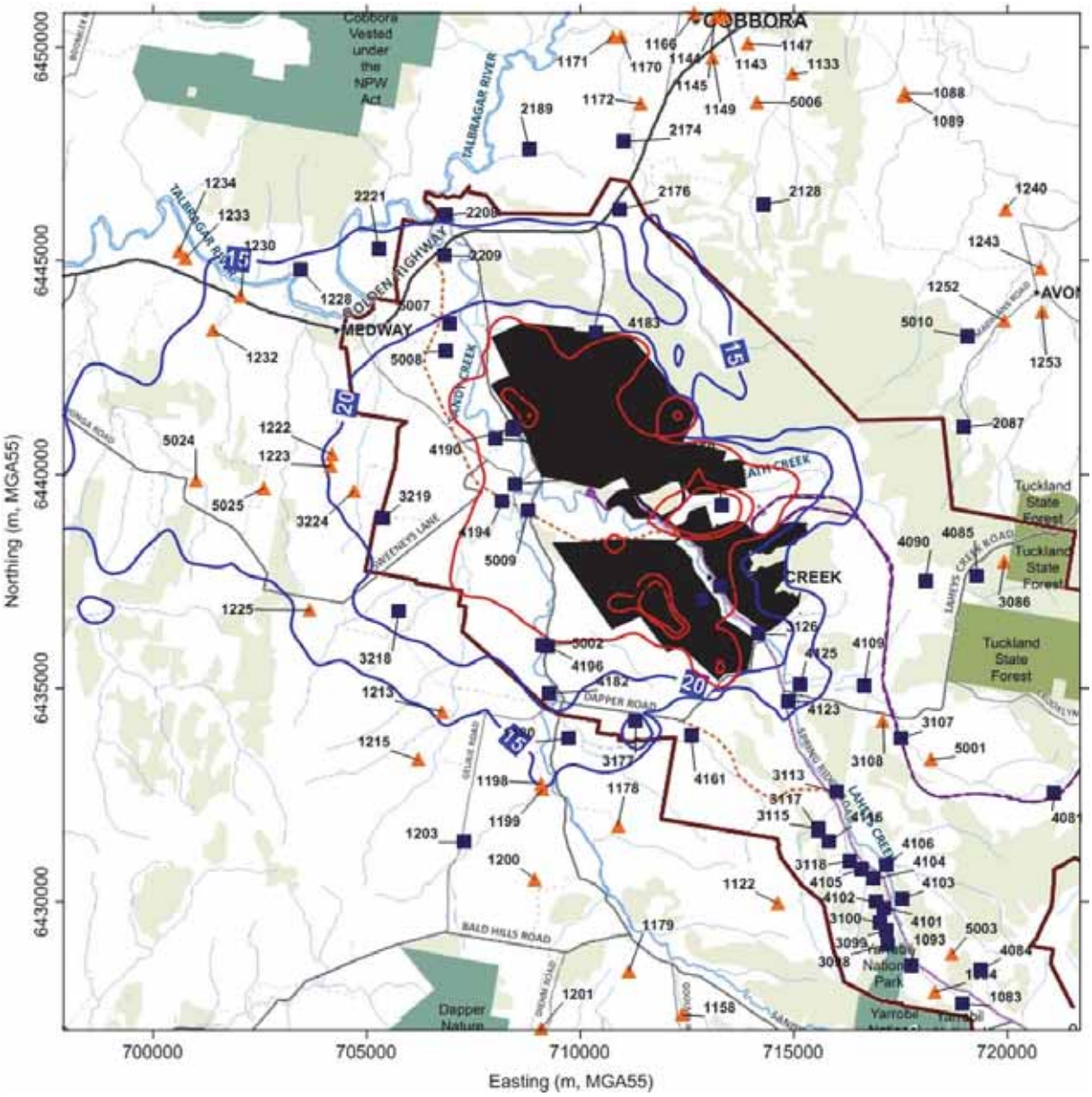

Figure G20 - Year 8 Operations – Annual average PM_{10} Concentrations (µg/m³) - Cumulative (Project + Background)

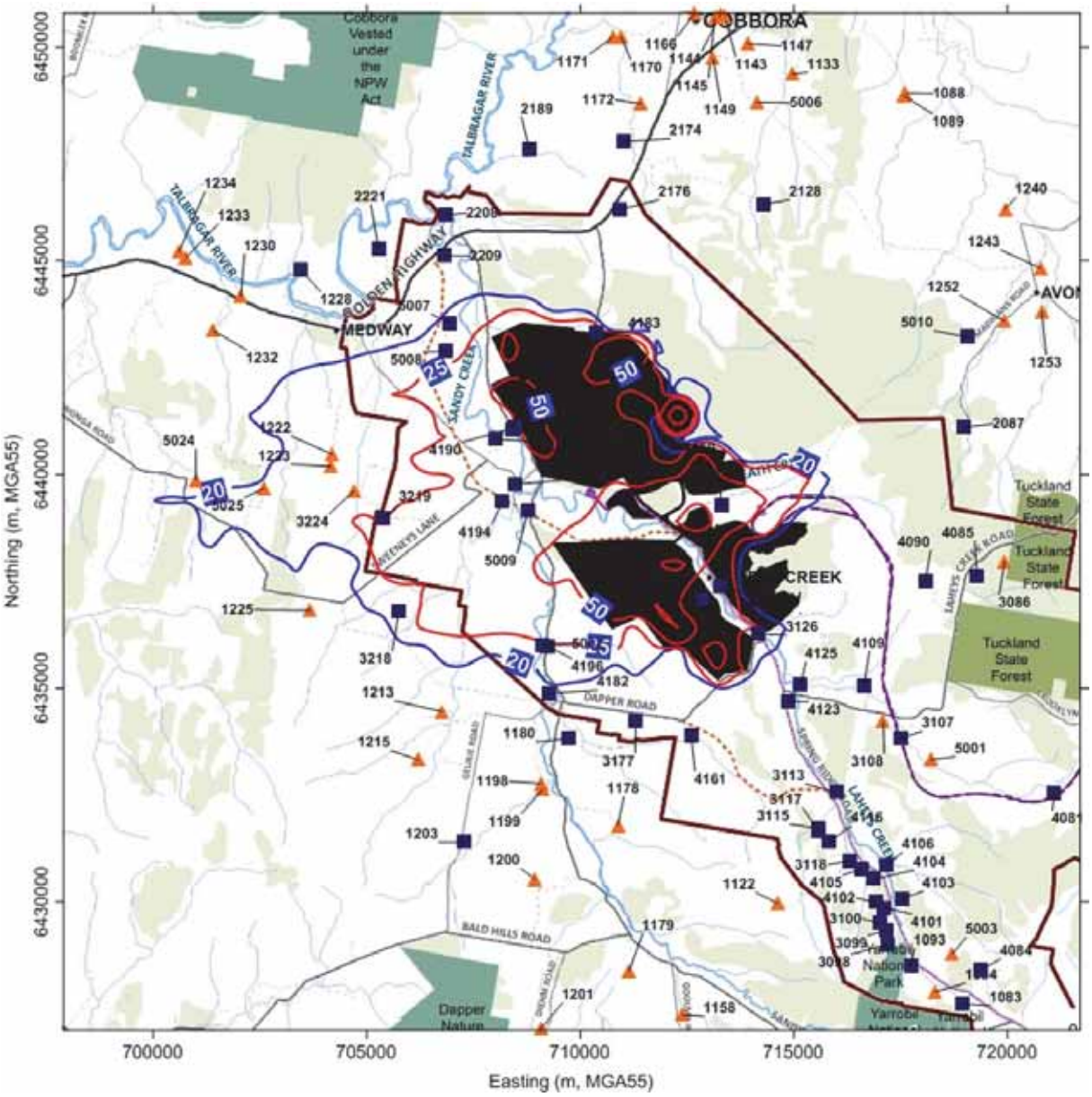

Figure G21 - Year 8 Operations – Highest 24-hour average $PM_{2.5}$ Concentrations (µg/m³) - Cumulative (Project + Background)

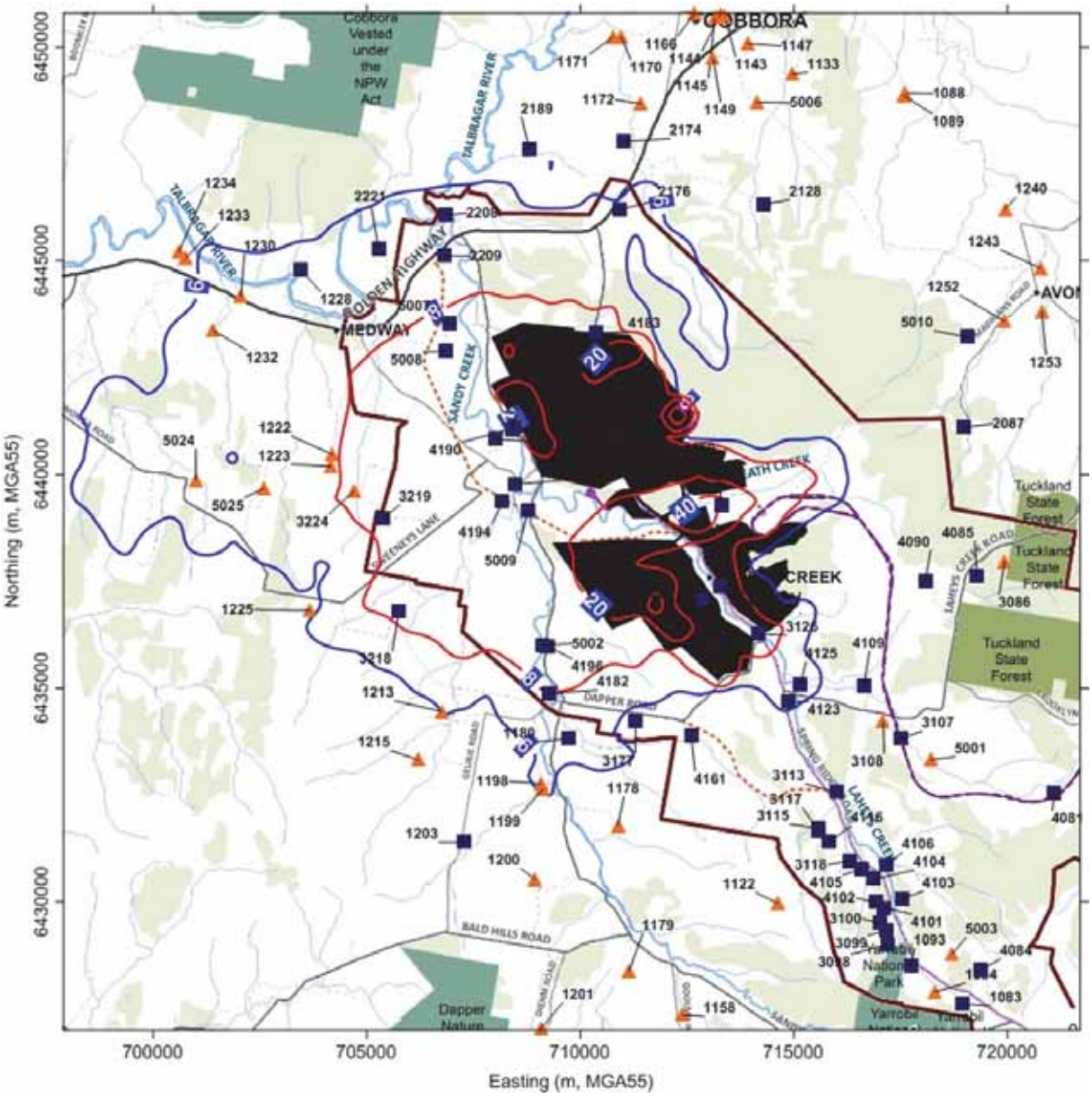

Figure G22 - Year 8 Operations – Annual average $PM_{2.5}$ Concentrations (µg/m³) - Cumulative (Project + Background)

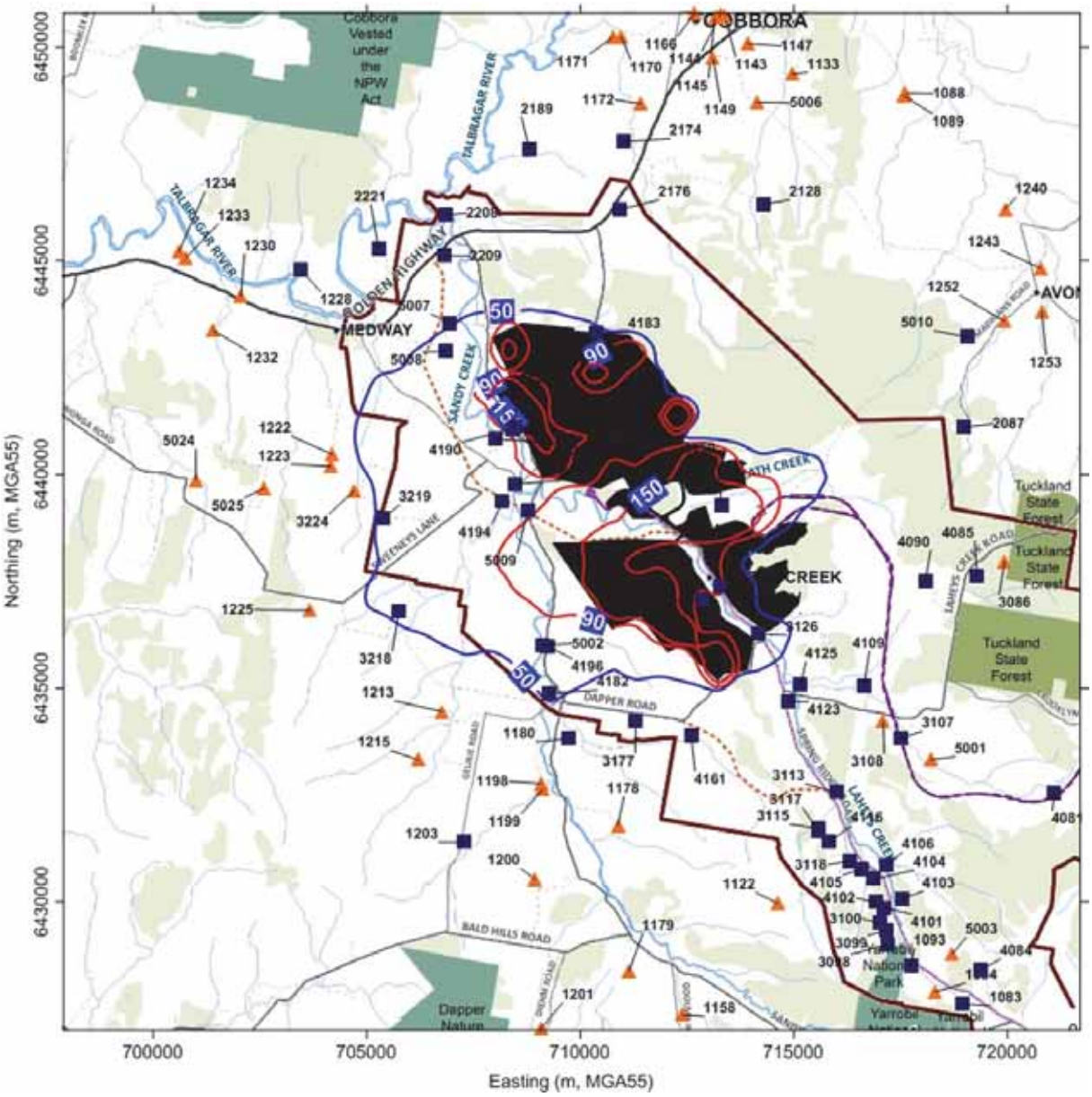

Figure G23 - Year 8 Operations – Annual average TSP Concentrations (µg/m³) - Cumulative (Project + Background)

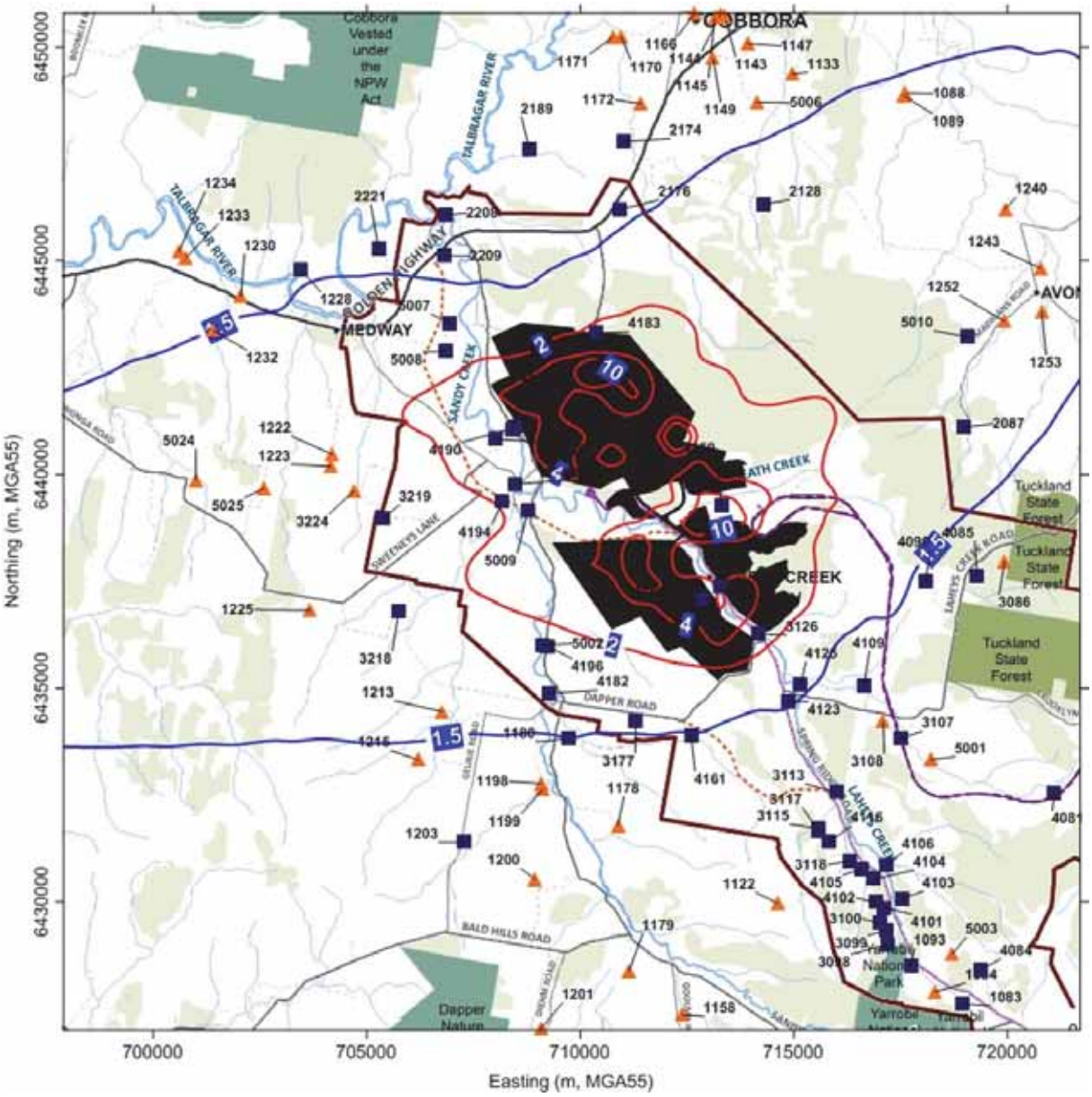

Figure G24 - Year 8 Operations – Annual average Dust Deposition (g/m^2/month) - Cumulative (Project + Background)

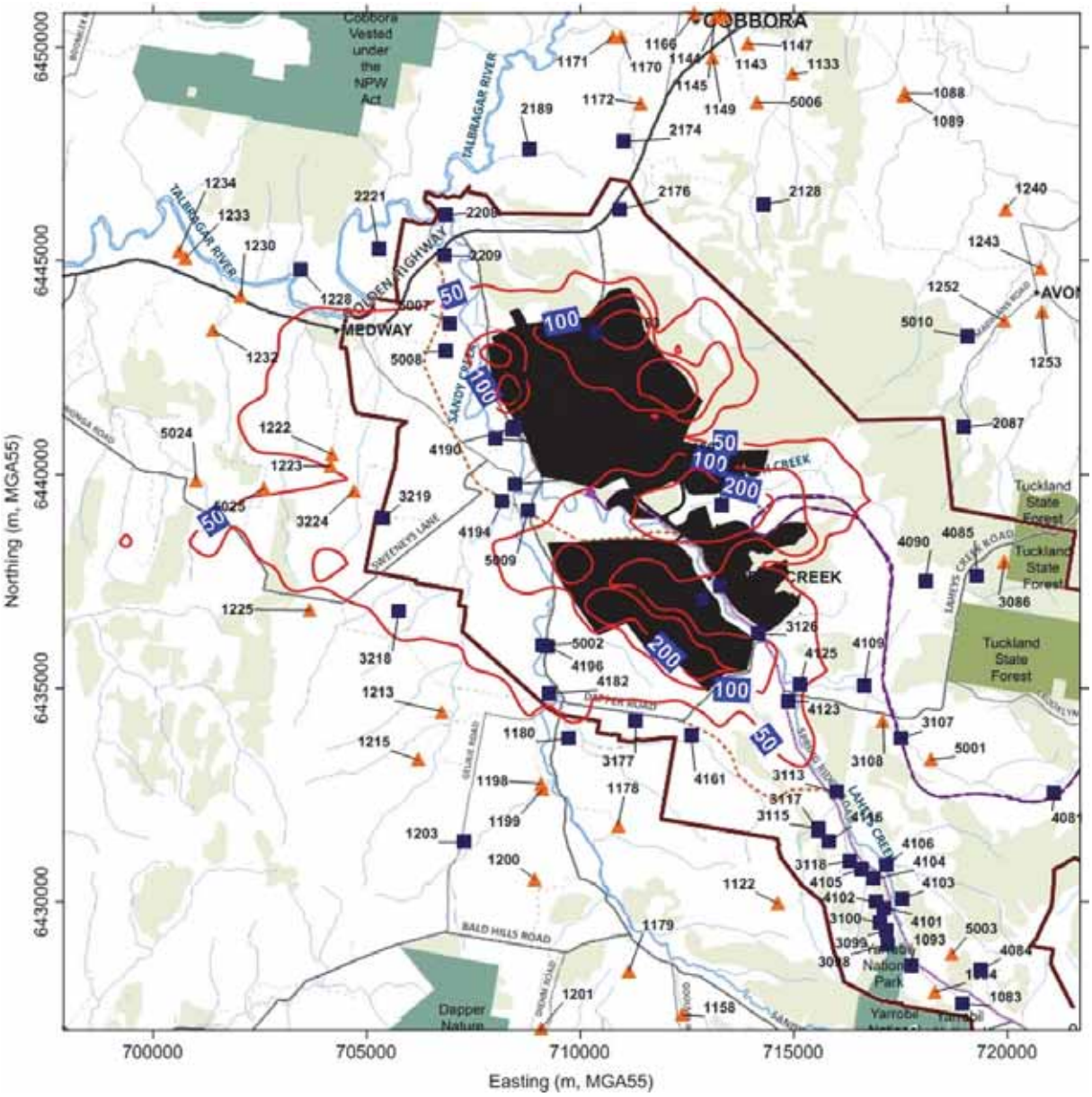

Figure G25 - Year 12 Operations – Highest 24-hour average PM_{10} Concentrations (µg/m³) - Cumulative (Project + Background)

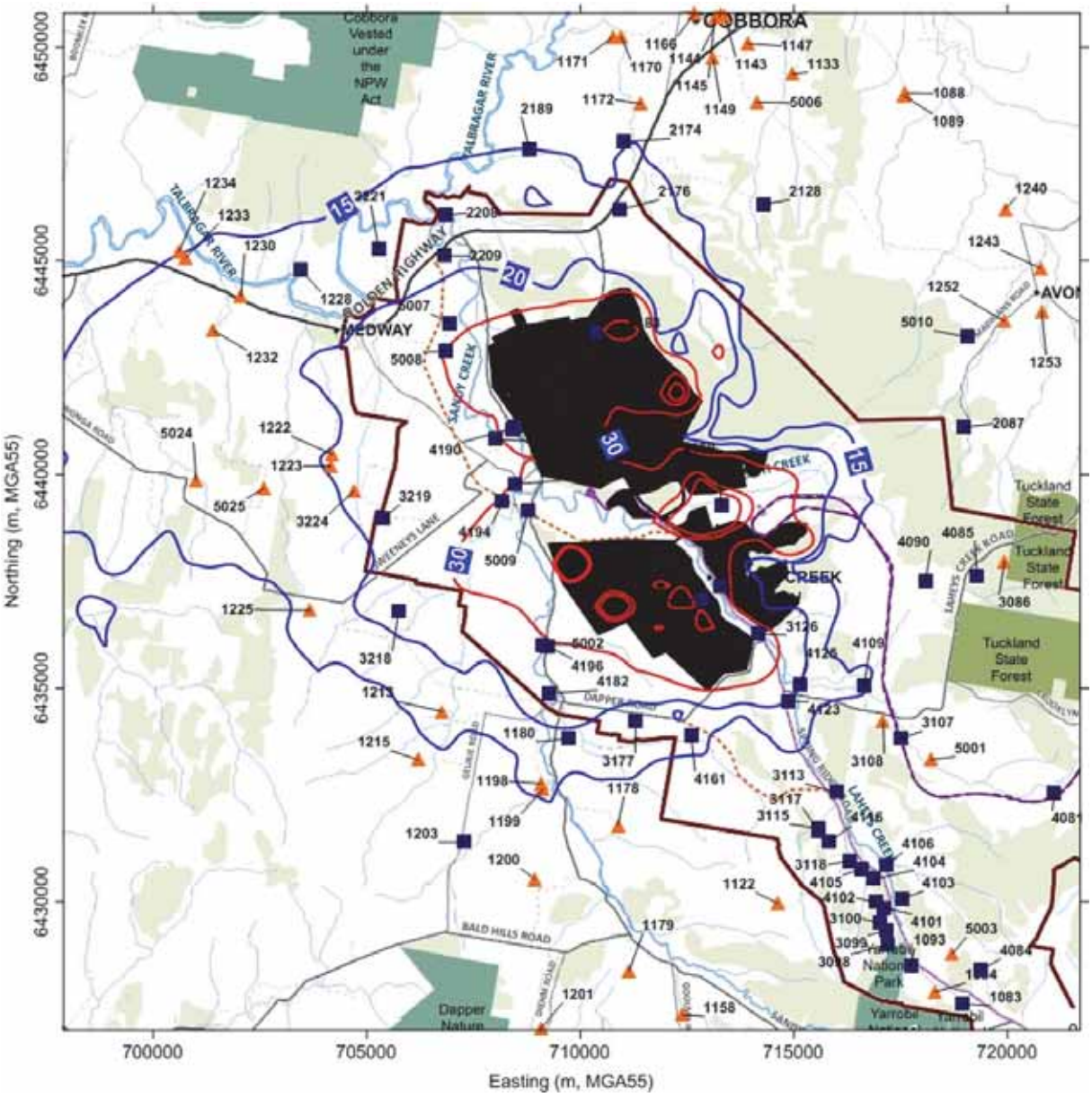

Figure G26 - Year 12 Operations – Annual average PM_{10} Concentrations (µg/m³) - Cumulative (Project + Background)

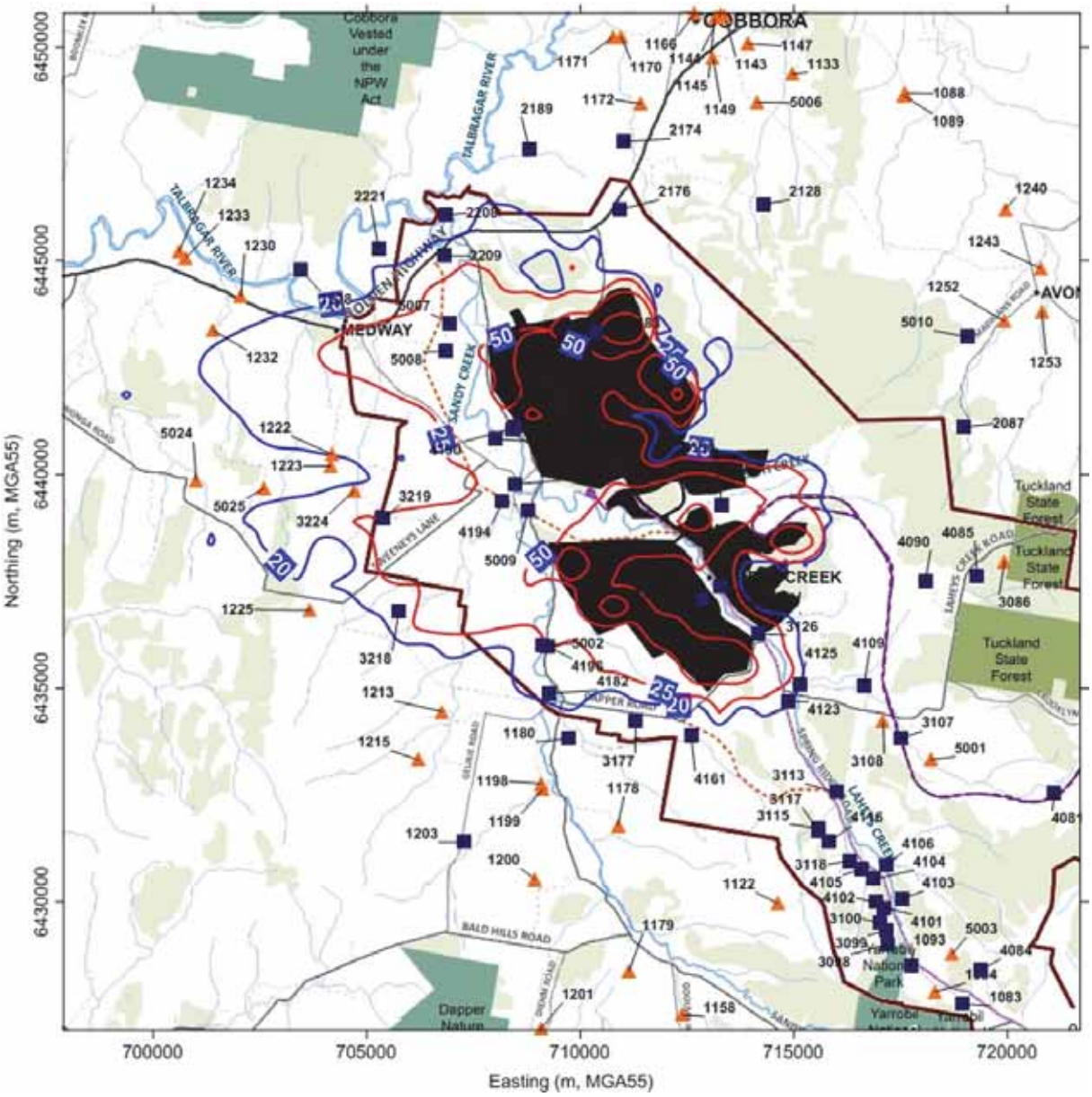

Figure G27 - Year 12 Operations – Highest 24-hour average $PM_{2.5}$ Concentrations (µg/m³) - Cumulative (Project + Background)

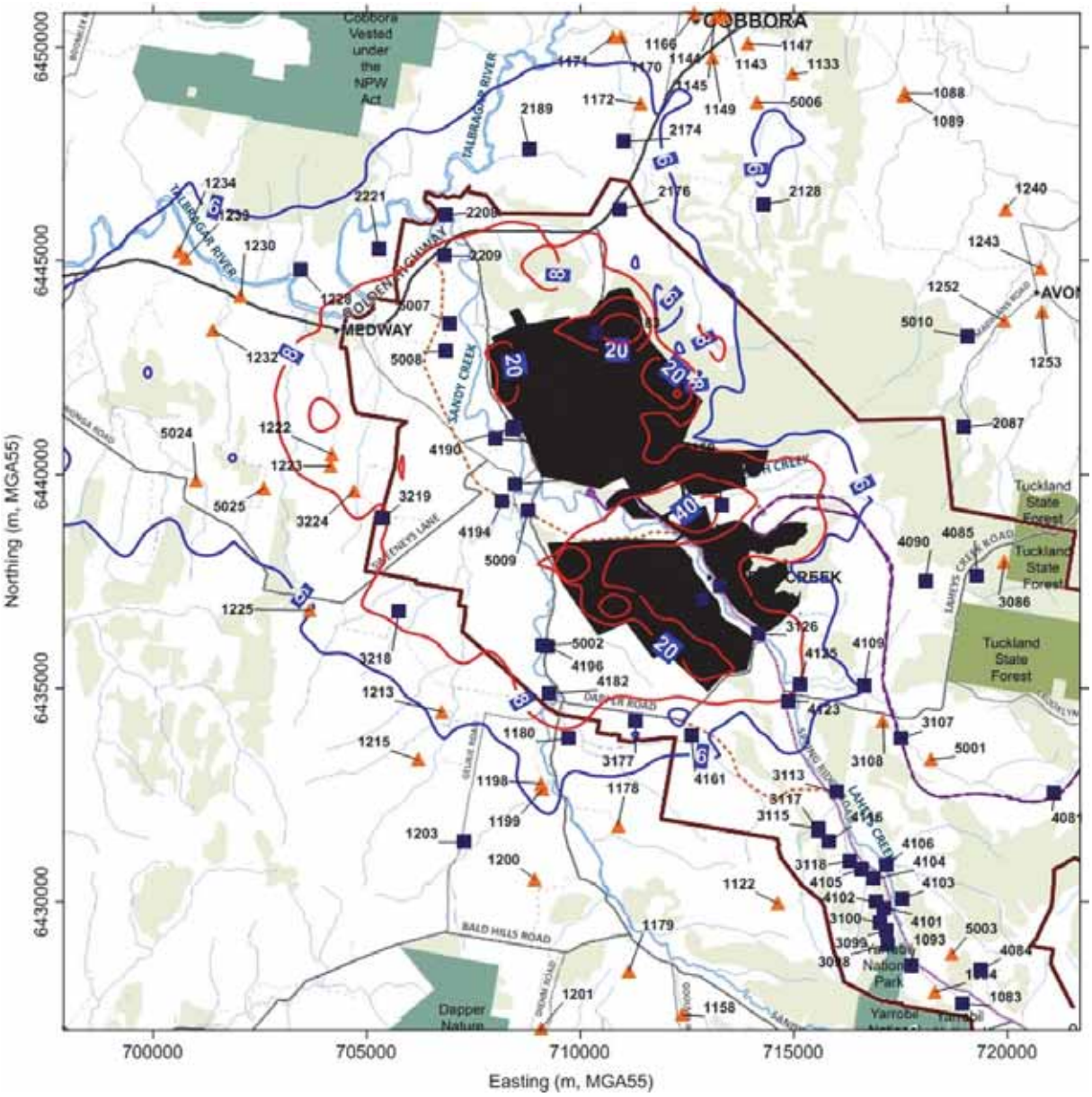

Figure G28 - Year 12 Operations – Annual average $PM_{2.5}$ Concentrations (µg/m³) - Cumulative (Project + Background)

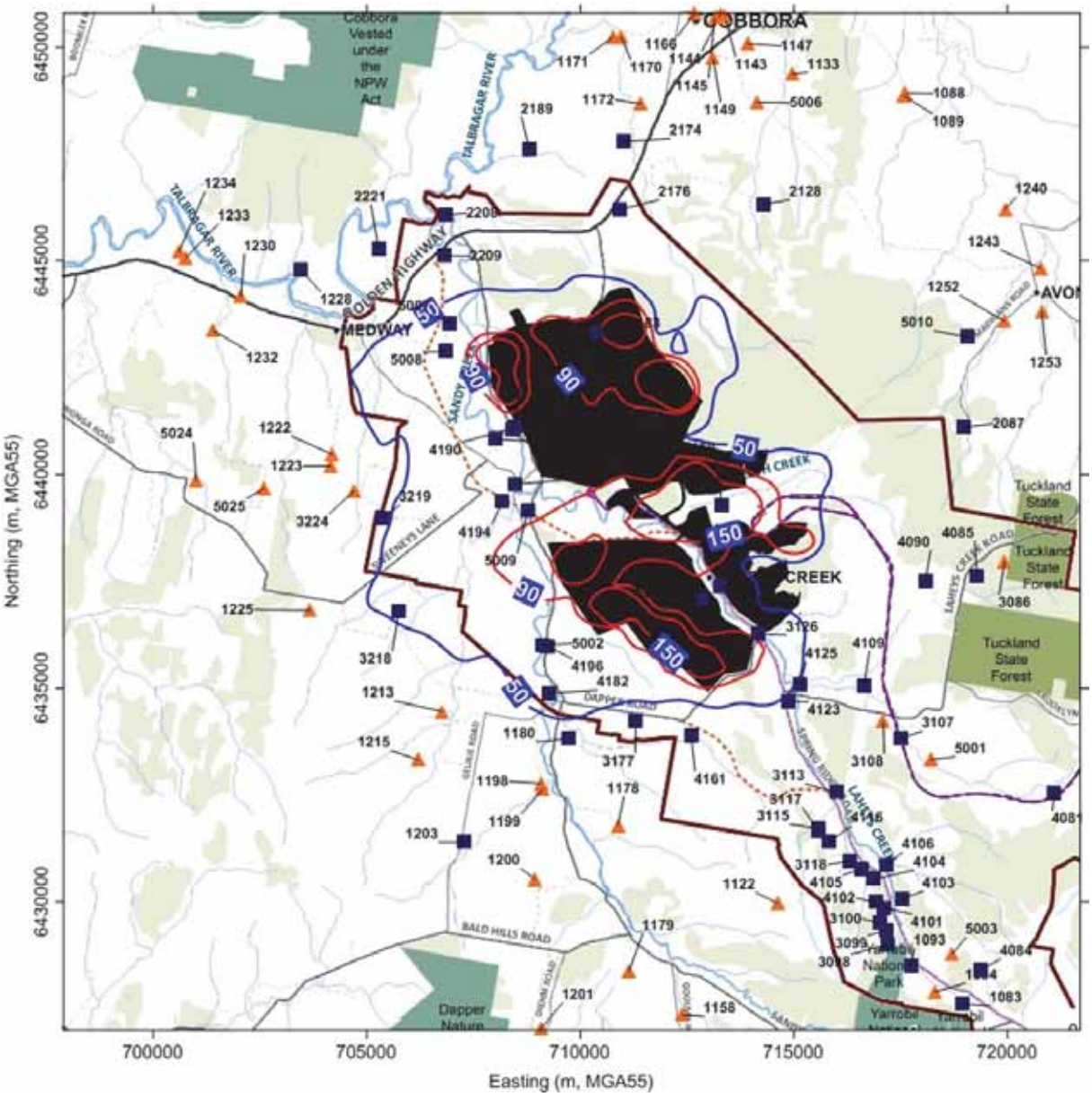

Figure G29 - Year 12 Operations – Annual average TSP Concentrations (µg/m³) - Cumulative (Project + Background)

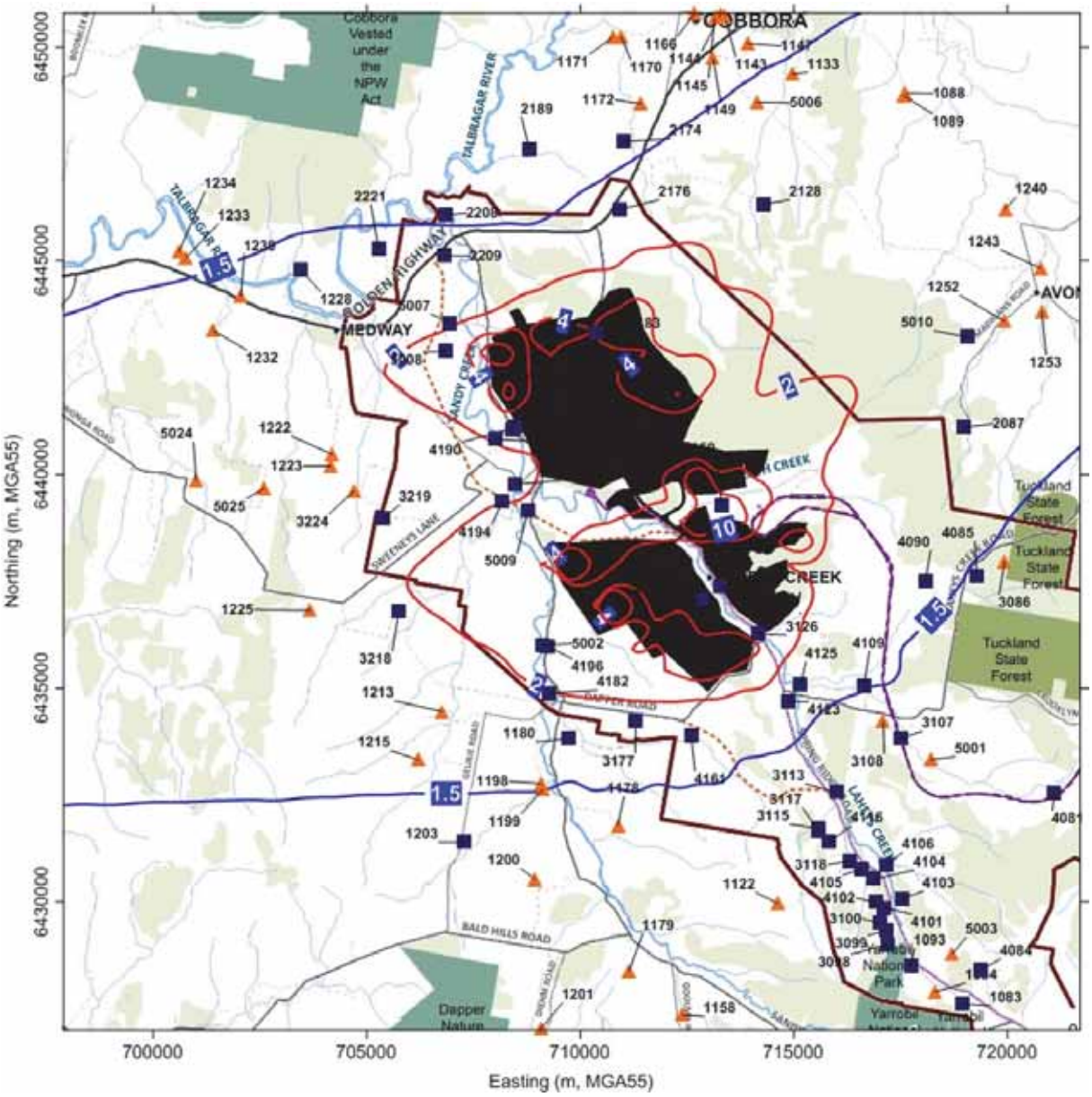

Figure G30 - Year 12 Operations – Annual average Dust Deposition (g/m^2/month) - Cumulative (Project + Background)

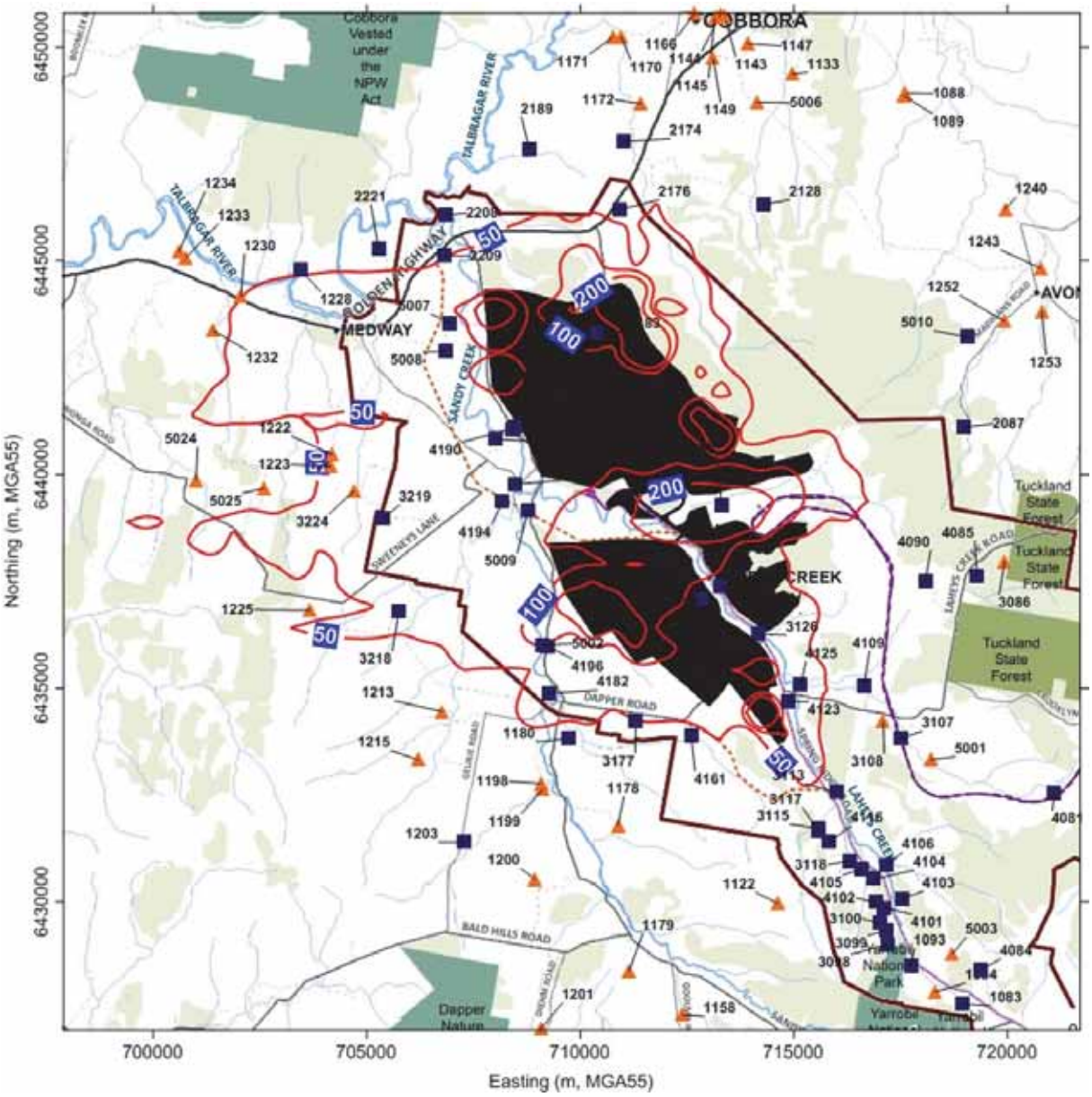

Figure G31 - Year 16 Operations – Highest 24-hour average PM_{10} Concentrations (µg/m³) - Cumulative (Project + Background)

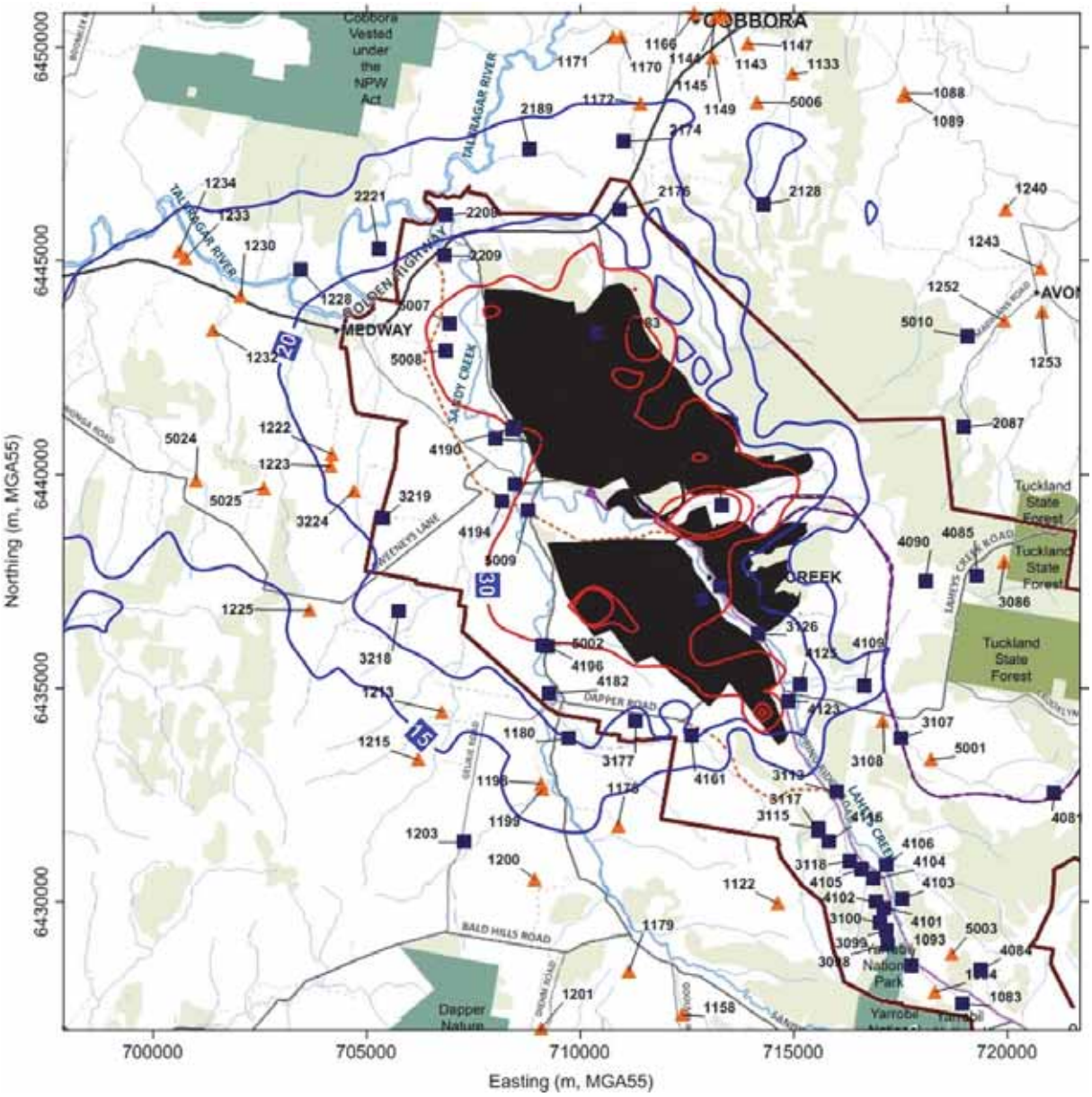

Figure G 32 - Year 16 Operations – Annual average PM_{10} Concentrations (µg/m³) - Cumulative (Project + Background)

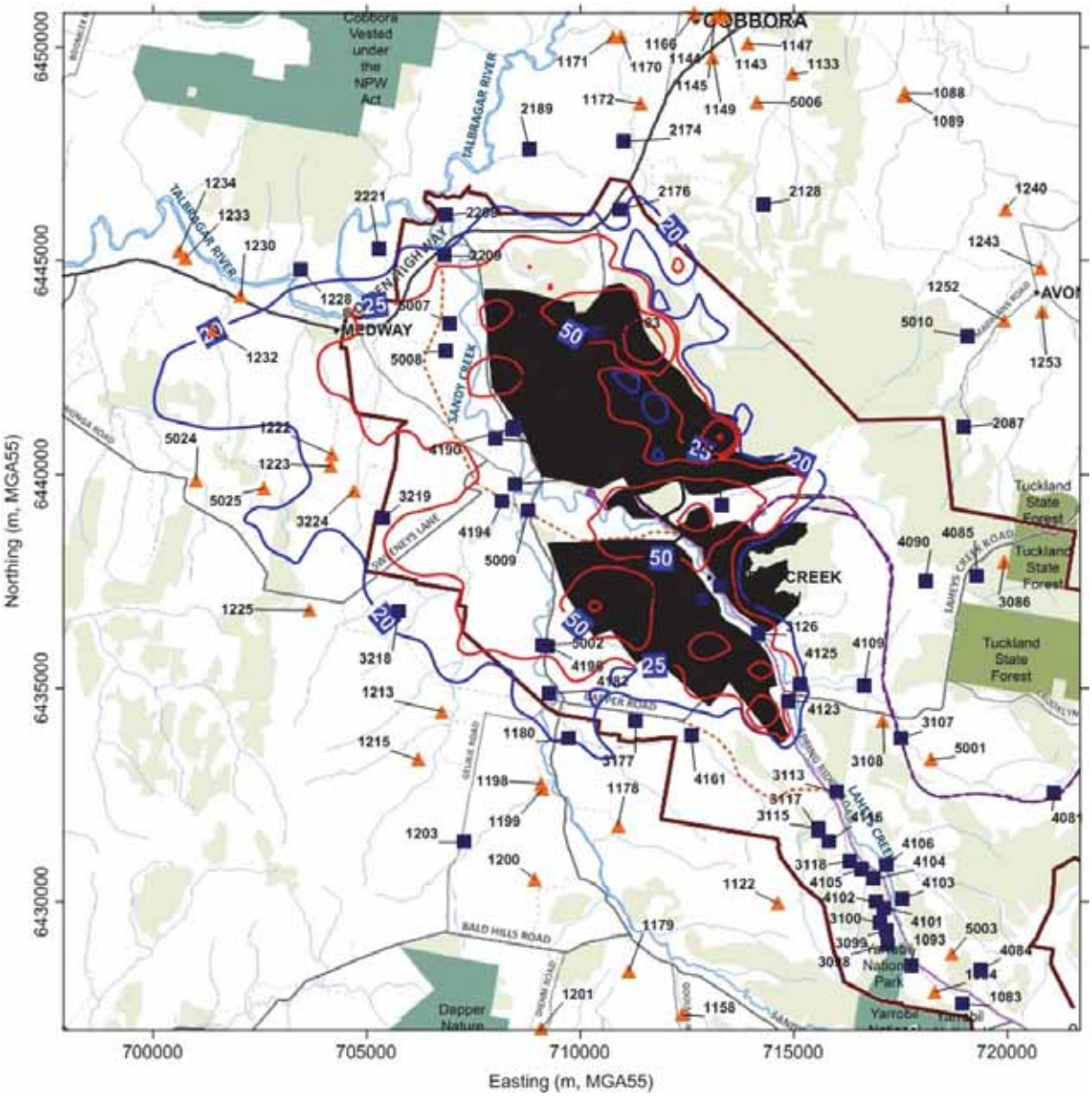

Figure G33 - Year 16 Operations – Highest 24-hour average $PM_{2.5}$ Concentrations (µg/m³) - Cumulative (Project + Background)

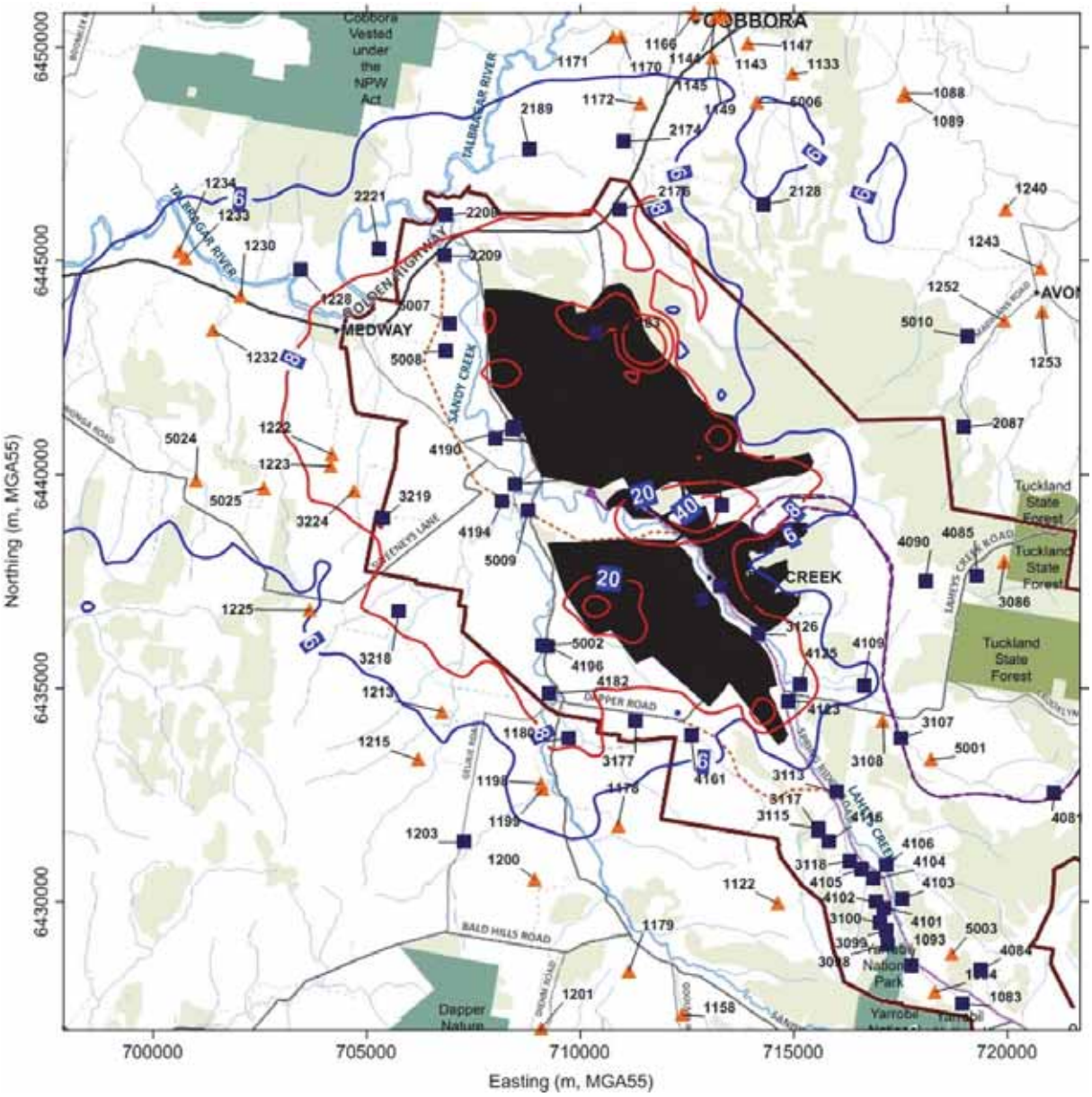

Figure G34 - Year 16 Operations – Annual average $PM_{2.5}$ Concentrations (µg/m³) - Cumulative (Project + Background)

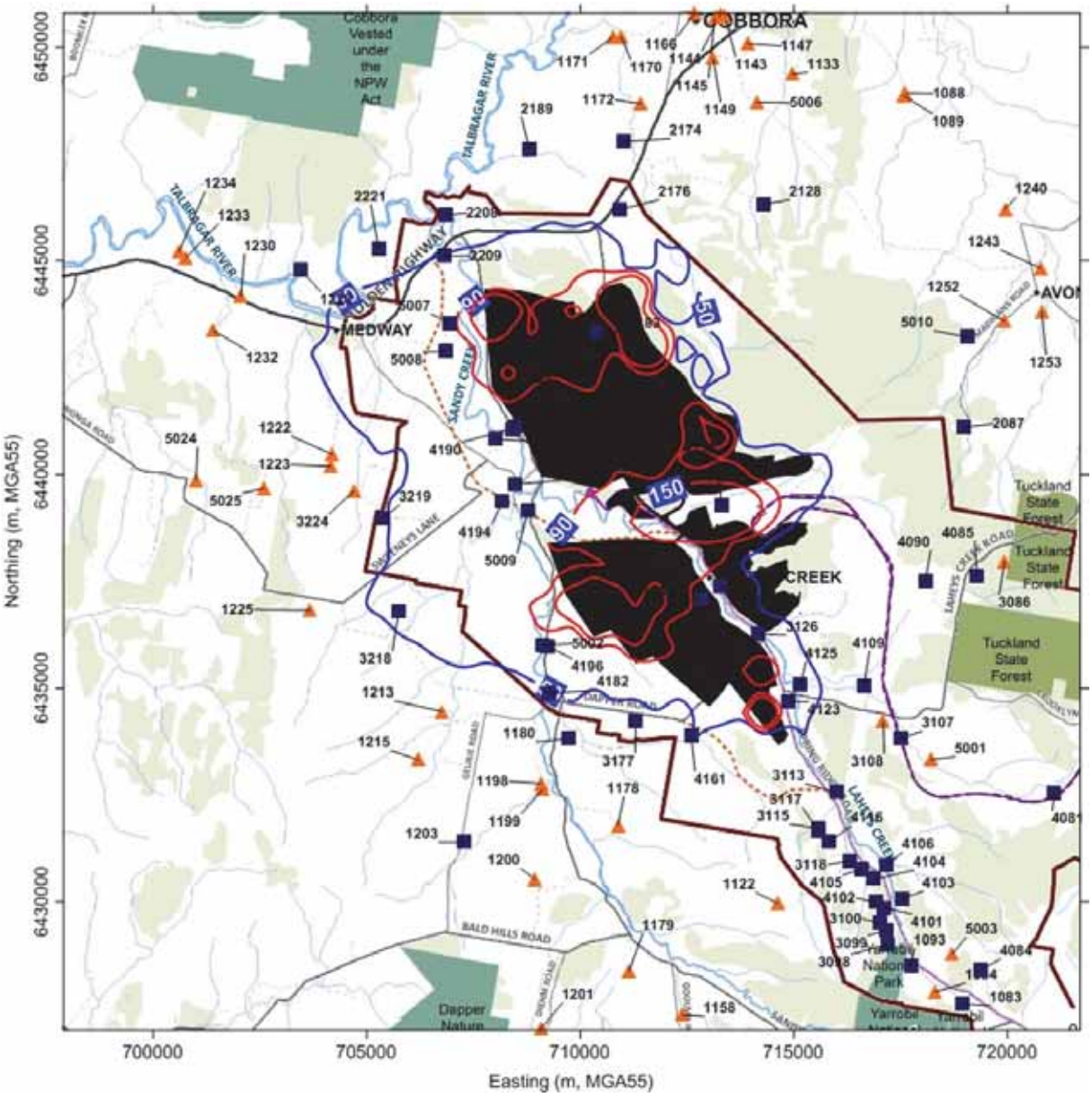

Figure G35 - Year 16 Operations – Annual average TSP Concentrations (µg/m³) - Cumulative (Project + Background)

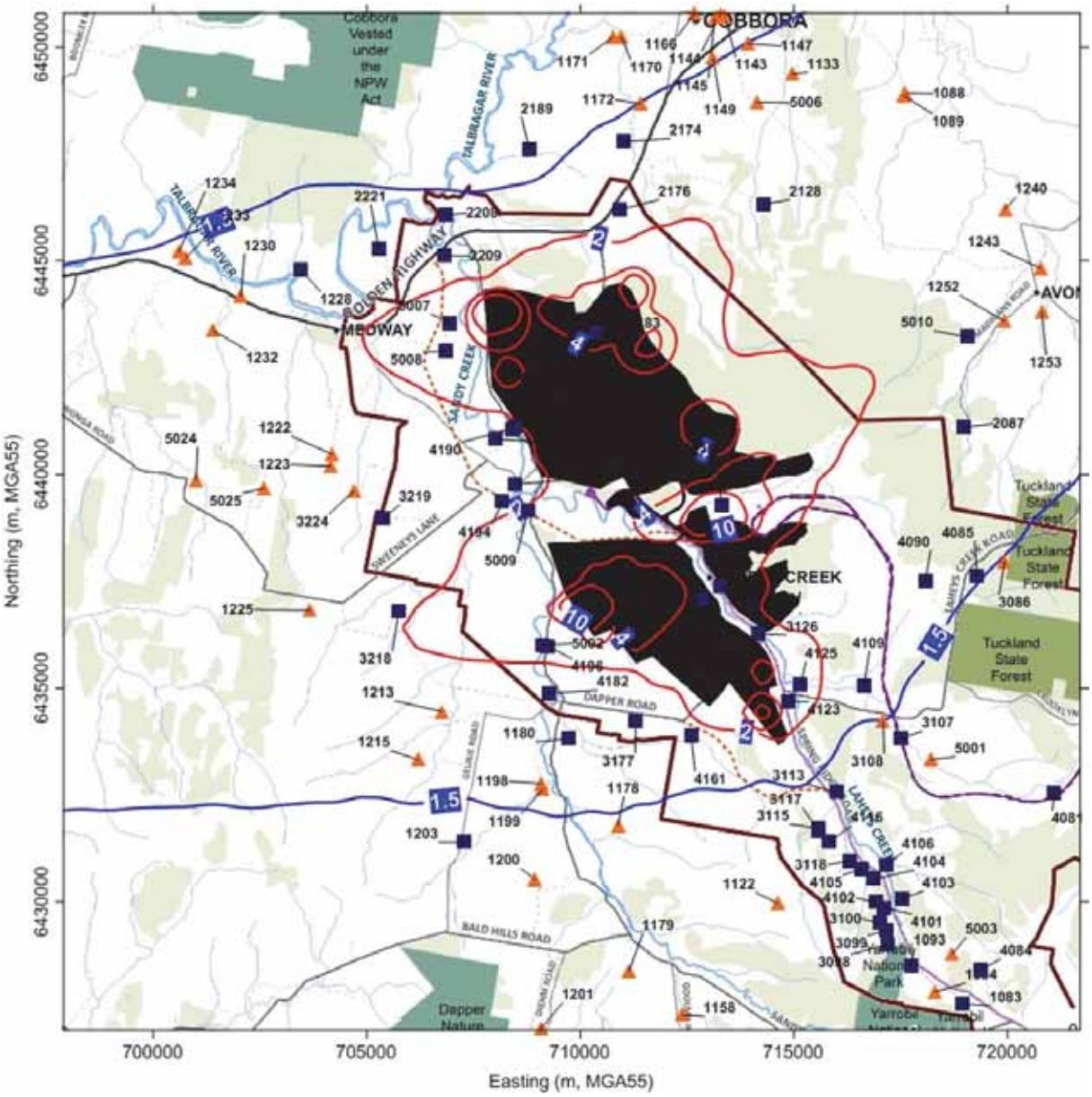

Figure G36 - Year 16 Operations – Annual average Dust Deposition (g/m^2/month) - Cumulative (Project + Background)

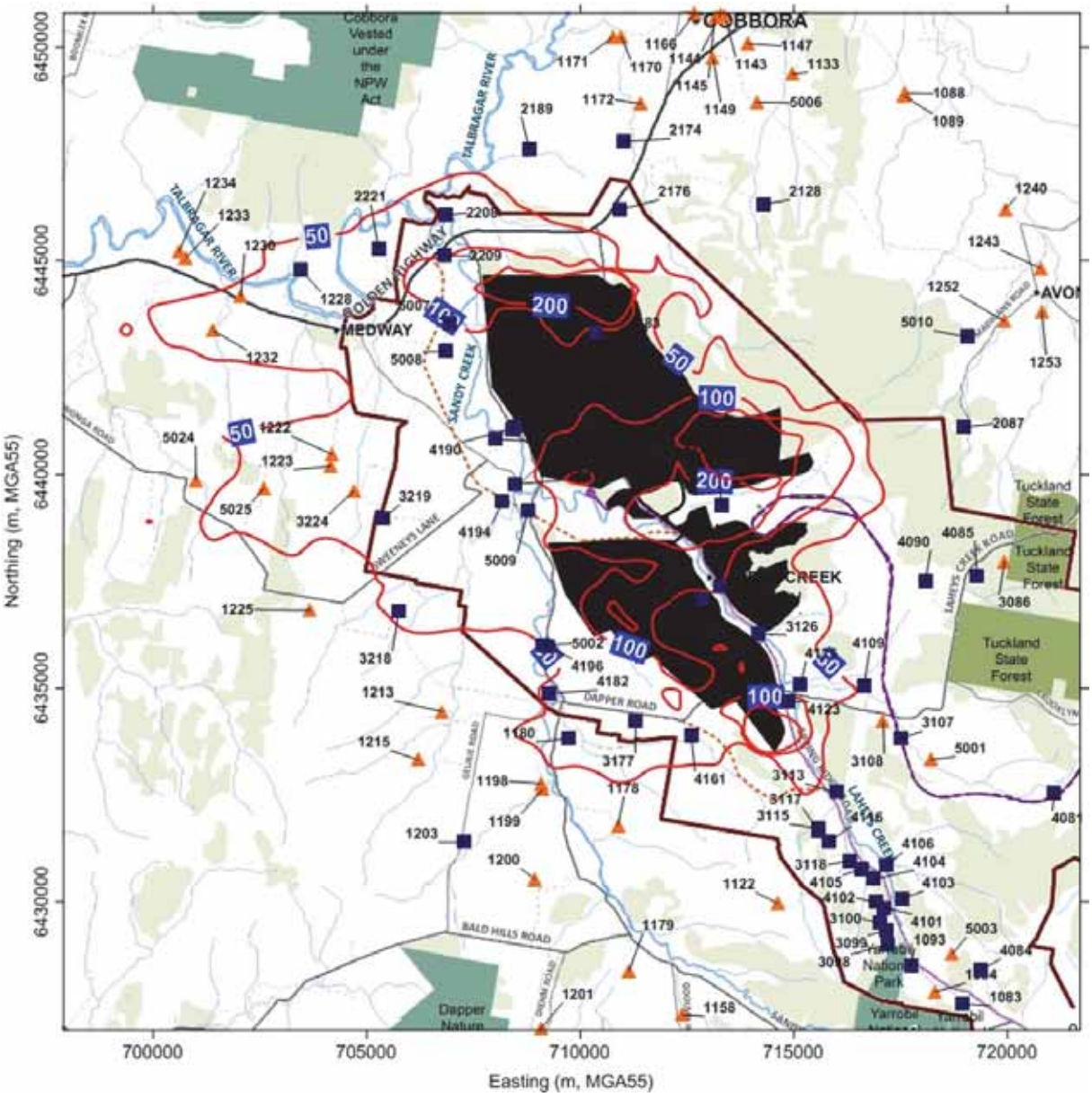

Figure G37 - Year 20 Operations – Highest 24-hour average PM_{10} Concentrations (µg/m³) - Cumulative (Project + Background)

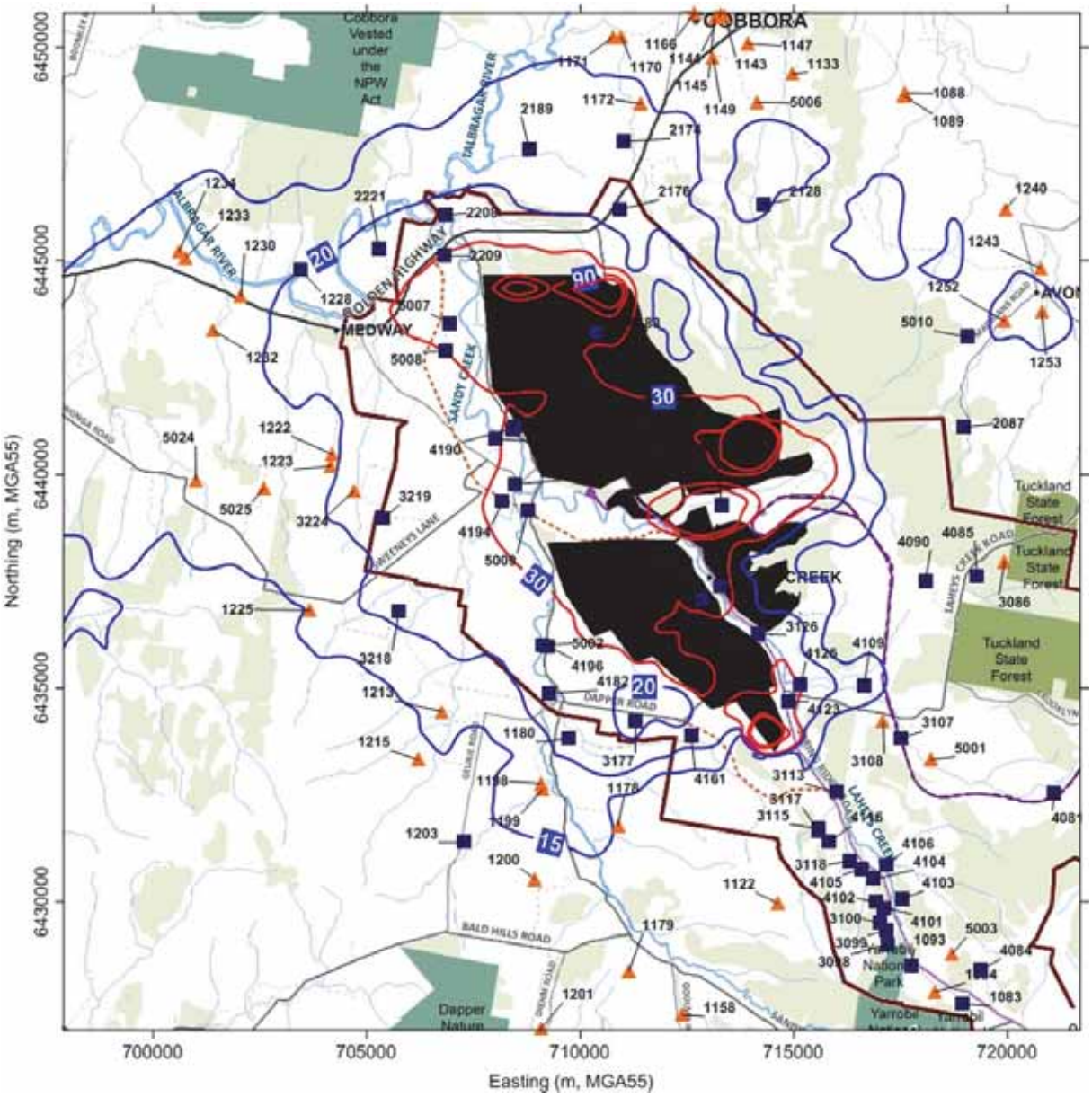

Figure G38 - Year 20 Operations – Annual average PM_{10} Concentrations (µg/m³) - Cumulative (Project + Background)

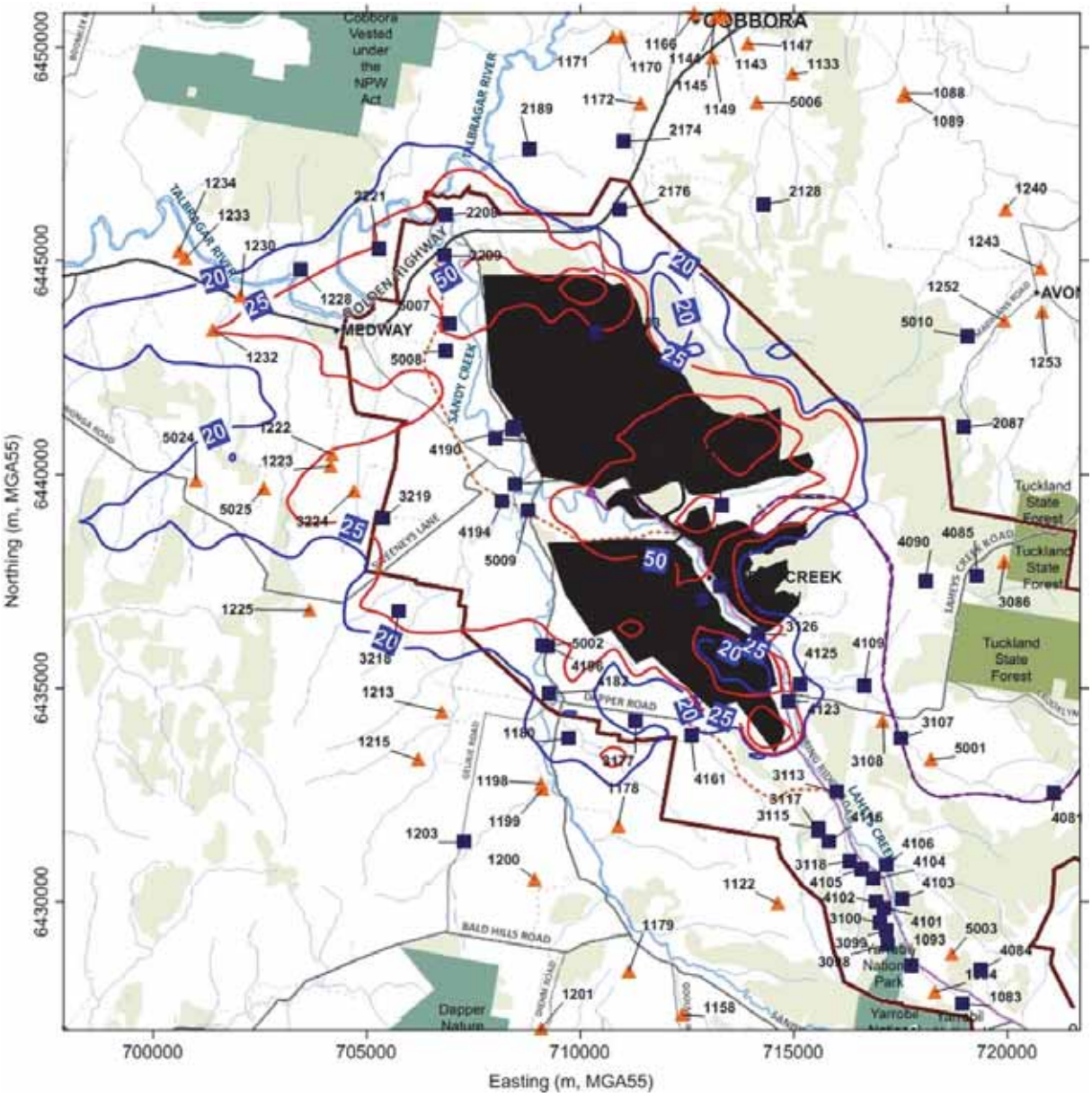

Figure G39 - Year 20 Operations – Highest 24-hour average $PM_{2.5}$ Concentrations (µg/m³) - Cumulative (Project + Background)

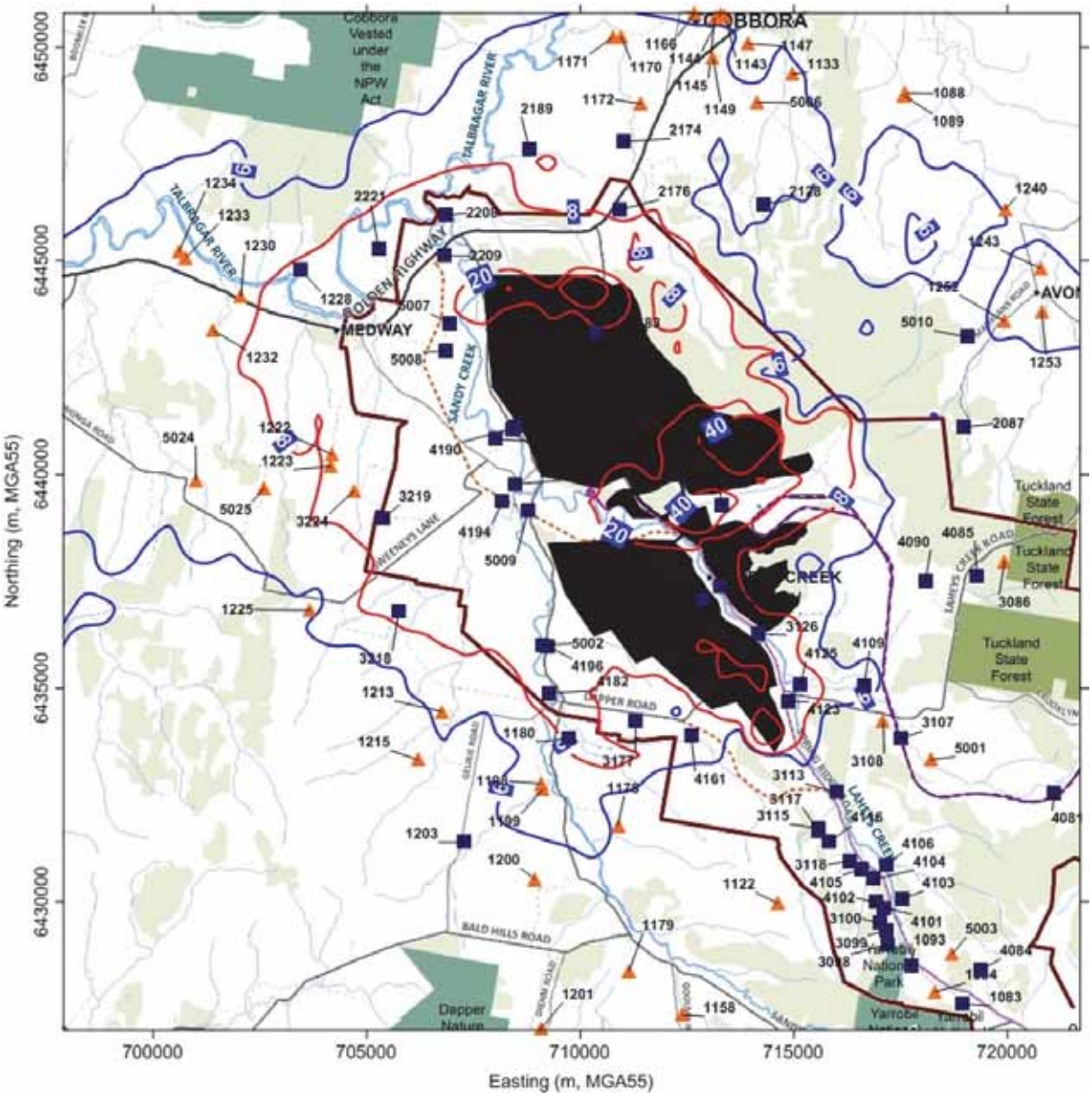

Figure G40 - Year 20 Operations – Annual average $PM_{2.5}$ Concentrations (µg/m³) - Cumulative (Project + Background)

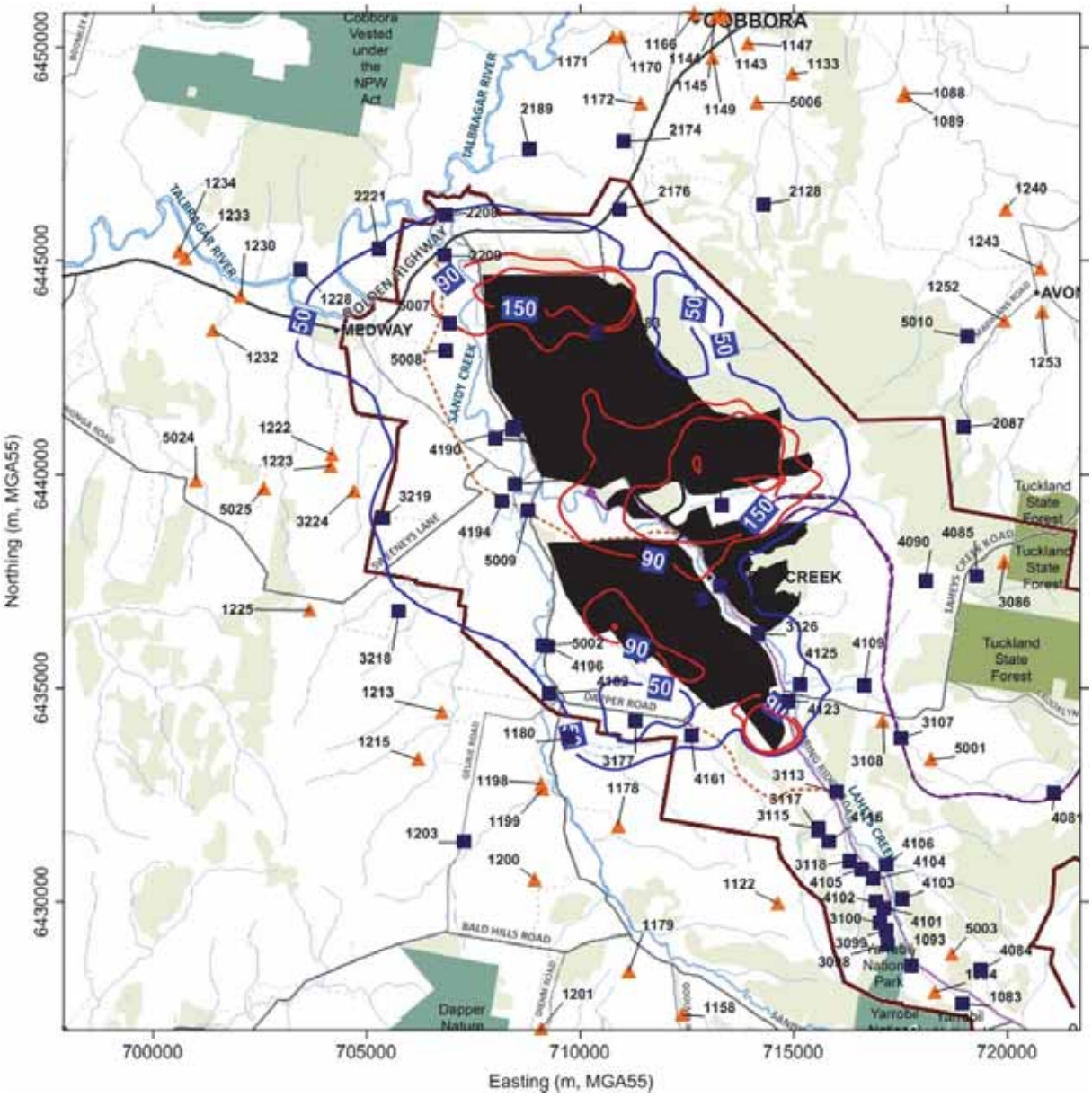

Figure G41 - Year 20 Operations – Annual average TSP Concentrations (µg/m³) - Cumulative (Project + Background)

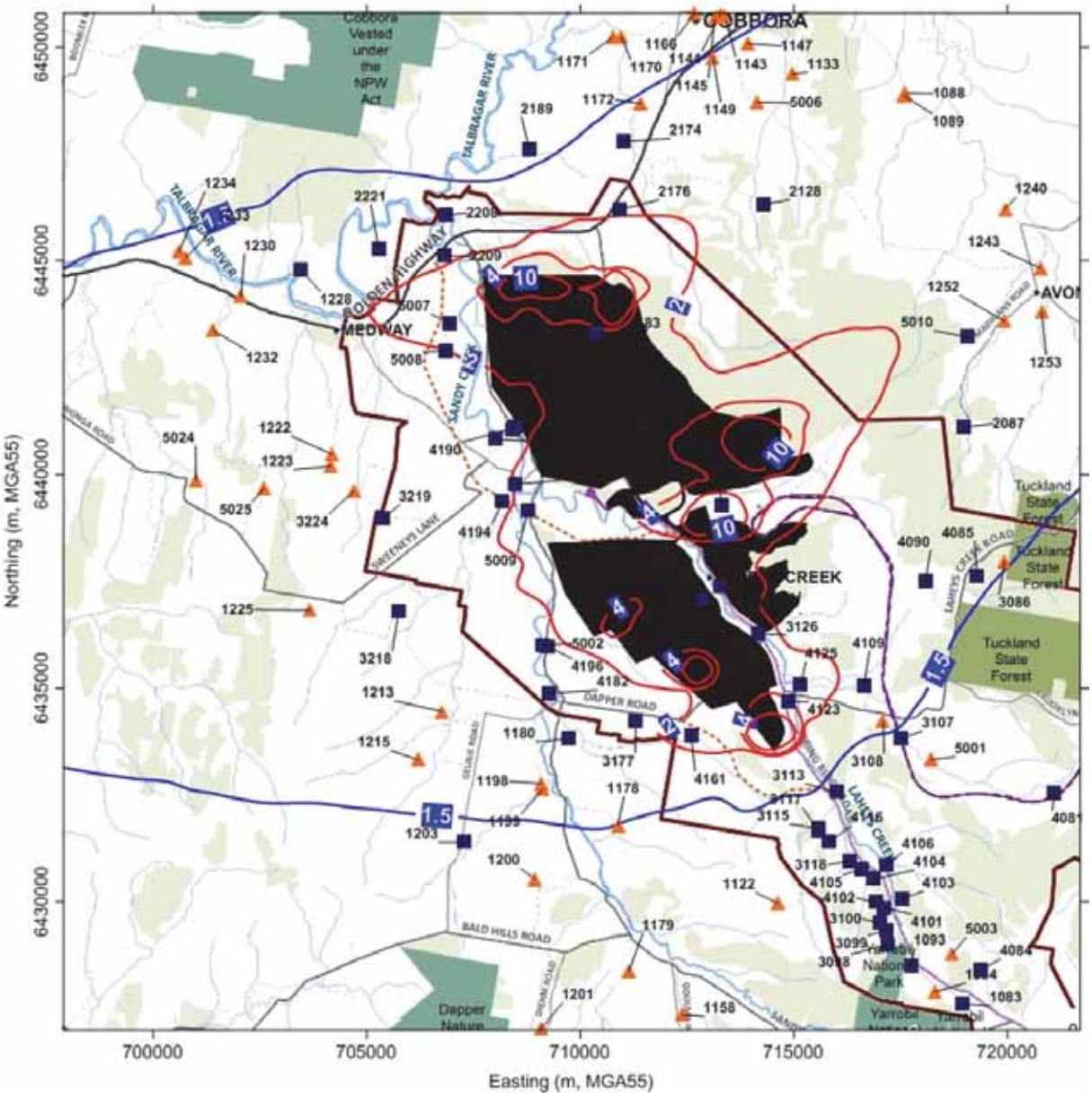

Figure G42 - Year 20 Operations – Annual average Dust Deposition (g/m^2/month) - Cumulative (Project + Background)

Appendix H
Vacant Land Assessment

As discussed in **Section 8.1.10**, 33 privately-owned properties (owned by eight different land owners) were predicted to experience a maximum 24-hour average PM_{10} concentration greater than the 50µg/m^3 across more than 25% of the lot area at some time during the life of the Project.

A list of these properties is presented in **Table H1**, while the spatial extent of the maximum 24-hour average PM_{10} concentration footprint and the location of the affected properties is illustrated in **Figure H1**.

Table H1: Lot/DP Numbers for Privately-Owned Vacant Land with Greater than 25% of Land Area Impacted by Project – All Mine Years

Land Owner	Lot/DP Numbers
Land Owner 1	39//754317, 46//754317, 47//754317
Land Owner 2	2//180421, 1//726827, 2//726827
Land Owner 3	1//586695, 1//795846, 2//795846, 3//795846, 10//754312, 27//754312, 32//754312, 33//754312, 39//754312, 67//754317, 71//754317
Land Owner 4	34//754317, 35//754317, 54//754317, 61//754317
Land Owner 5	5//754302, 3//754317
Land Owner 6	6//754305, 14//754305, 20//754305, 41//754305, 50//754305
Land Owner 7	116//754305
Land Owner 8	41//754317, 42//754317, 43//754317, 62//754317

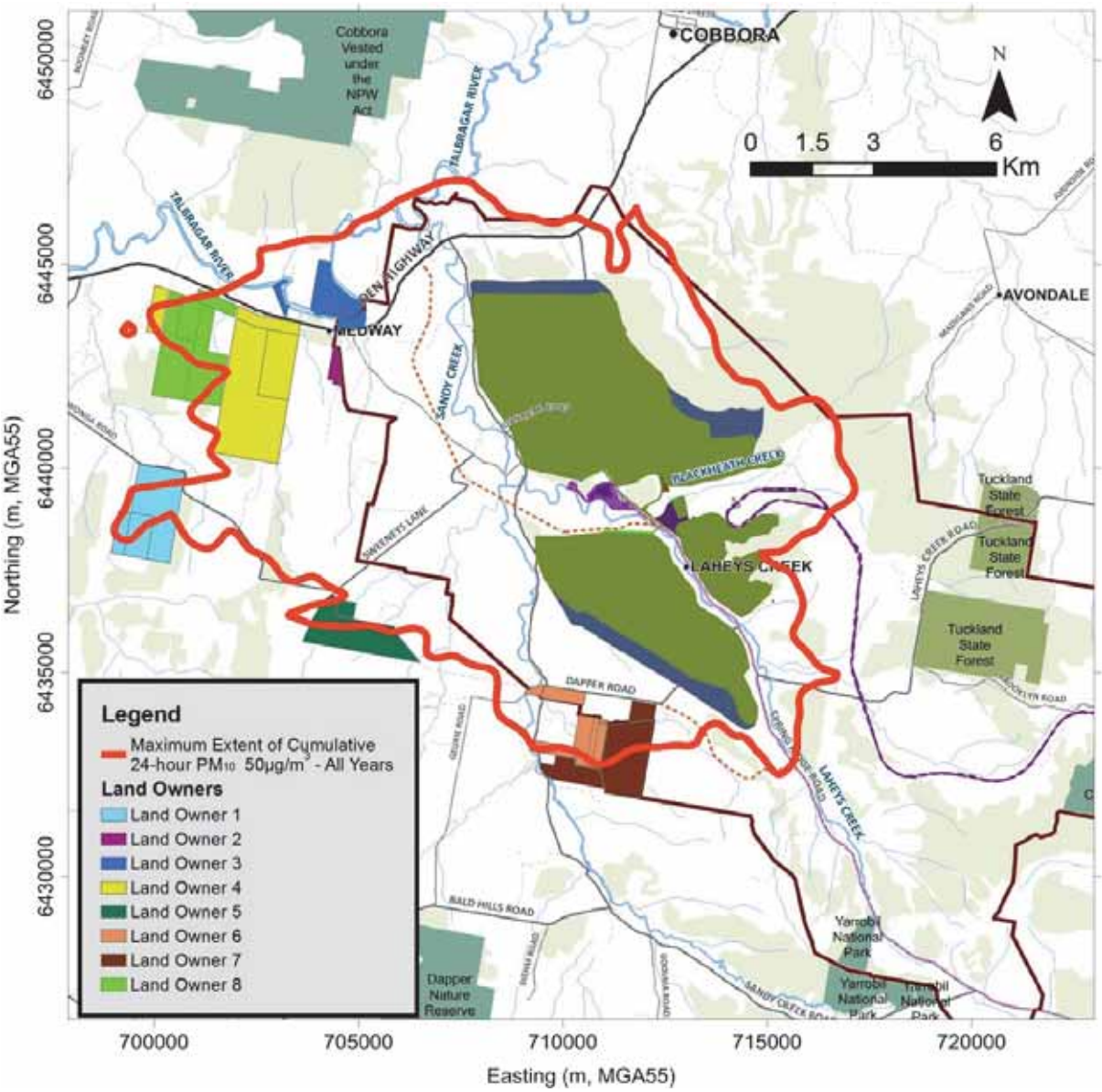

Figure H1 - Private Land with more than 25% of Area Impacted by Cumulative 24-hour Average PM_{10} 50µg/m^3 Contour – All Modelled Years Combined

Appendix I
Assessment of Rail Wagon Emissions

As discussed in earlier sections of this report, the Project would supply 9.5 Mtpa of coal to five NSW power stations, along with up to 2.5 Mtpa of coal to the Port of Newcastle for international export.

Connell Hatch (2008) estimated that almost 90% of coal dust emissions from rail wagons was emitted from the wagon surface with parasitic loads on sills and bodies, door leakage and residual coal in unloaded wagons representing more minor sources. It is therefore pertinent to focus on dust emissions from rail wagon surfaces in this assessment.

At peak production, it is expected that a coal delivery rate of 12 Mtpa would be achieved. Based on information provided to ENVIRON, maximum train coal capacity would be of the order of 9,000 t. The capacity of a single coal wagon is assumed to be 100 t.

Transport of coal from the Project train loading facility to the customers and the port may be divided into four sections (**Table I1**).

Table I1 Coal Transport Sections

Section name	Track owner	Length	Description
Train loading facility to the Dunedoo-Gulgong Rail line near Tallawang	CHC	Approximately 28 km including the balloon loop	Cobbora Coal Project rail spur line Primarily to be used by CHC Will include an ARTC train provisioning facility
Tallawang to Ulan Balloon Loop Junction	ARTC	Approximately 45 km	Currently used to transport magnetite from the Tallawang mine to coal mines in NSW in four train (650 m long) movements per week Occasionally used for grain transport
Ulan Balloon Loop Junction to Islington Junction and to the port	ARTC	Approximately 275 km to Islington Junction and a further 4 km to the port Coal unloaders at Kooragang and Port Waratah.	Currently used extensively for the transport of coal from mines in the Hunter Valley to the port and other coal users Passenger services are on a separate line between Maitland and the port Bayswater and Liddell power stations are on this section
Islington Junction to Vales Point Rail Loop Junction	RailCorp	Approximately 45 km	Currently used for passenger services with some freight movements Eraring, Vales Point and Munmorah power stations are on this section

Of the above sections of coal transport, the CHC-owned rail spur and Tallawang-Ulan Balloon Loop are not currently used for coal transportation. Consequently, the potential for impacts of dust emissions from coal wagons along these sections will be addressed within this appendix.

Queensland Rail Limited (QR) recently commissioned a comprehensive study into fugitive dust emissions from a number of their coal rail transportation systems in the Queensland coal fields. This study comprised a literature review, a network of air quality monitoring equipment and atmospheric dispersion and numerical modelling.

During this assessment, conducted by Connell Hatch (2008), reference was made to a paper by Ferreira *et al.* (2003) which focused on the release of coal dust from train wagons. The study by Ferreira *et al.* (2003) conducted measurement of TSP emissions from coal wagons over a 350km journey and found that for such a distance, a 60t semi-covered wagon would lose approximately 0.001% of its load. (Semi-covered wagons were defined as wagons having 0.5m wide automatic doors running the length of the wagon. When in the closed position, there is a gap of about 1 m wide between the two doors.) Further testing by Ferreira *et al.* (2003) showed that if the wagon was uncovered, emissions could be increased by up to five times that of a semi-covered wagon. Based on the specifics of the study conducted by Ferreira *et al.*, emission factors of 1.71g/km/wagon and 8.57g/km/wagon were derived for semi-covered and uncovered wagons respectively.

The findings of Ferreira *et al.* (2003) were used to derive emission factors for the dispersion modelling assessment conducted for the QR study. The resulting predicted concentrations paired well with the track-side air quality monitoring conducted during the QR study, suggesting that the conclusions of the Ferreira *et al.* (2003) study were acceptable for estimating the fugitive coal dust emissions from rail wagons. Consequently, in the absence of site specific emissions estimation methods, the findings of Ferreira *et al.* (2003) have been adopted to estimate coal dust emissions from trains transporting coal from the Project.

Rail wagons used for coal transportation in NSW are generally uncovered but have curved side walls resulting in their having a reduced exposed area compared to uncovered wagons used elsewhere (e.g. exposed area of approximately 25m² is typical compared to an exposed area of approximately 30m² for rail wagons used in Queensland). It is therefore appropriate to consider the aforementioned range in emission factors given for semi-covered and uncovered wagons.

To determine the potential impact along the identified rail sections, the transportation dispersion model CAL3QHCR, developed by the United States Environmental Protection Agency (USEPA), was used. CAL3QHCR is based on the dispersion algorithms contained within CALINE-3. While this model is designed to represent road emissions, with in-built algorithms to account for thermal turbulence, it is appropriate for the purpose of this assessment.

Review of the proposed transportation route between the Project Site and Ulan indicates that coal wagons will pass receptors situated approximately 50m from the rail corridor, primarily as the path moves through the town of Gulgong.

The alignment of the railway line through Gulgong turns in several directions and is consequently considered suitable for assessing the potential impacts that could be

experienced at receptors in close proximity to the rail corridor. The 5km track alignment through Gulgong was digitised and inserted into the CAL3QHCR model. Calculation points were positioned at distances away from the railway corridor (at 10m, 20m, 50m and 100m from the centre of the railway path) and spaced at 100m intervals along the railway.

A cross section of predicted maximum 24-hour average TSP concentrations of coal dust from uncovered rail wagons transporting coal from the Project, as predicted by CAL3QHCR, is presented in **Figure I1**. TSP concentrations are predicted to decrease with distance from the railway corridor, as is to be expected.

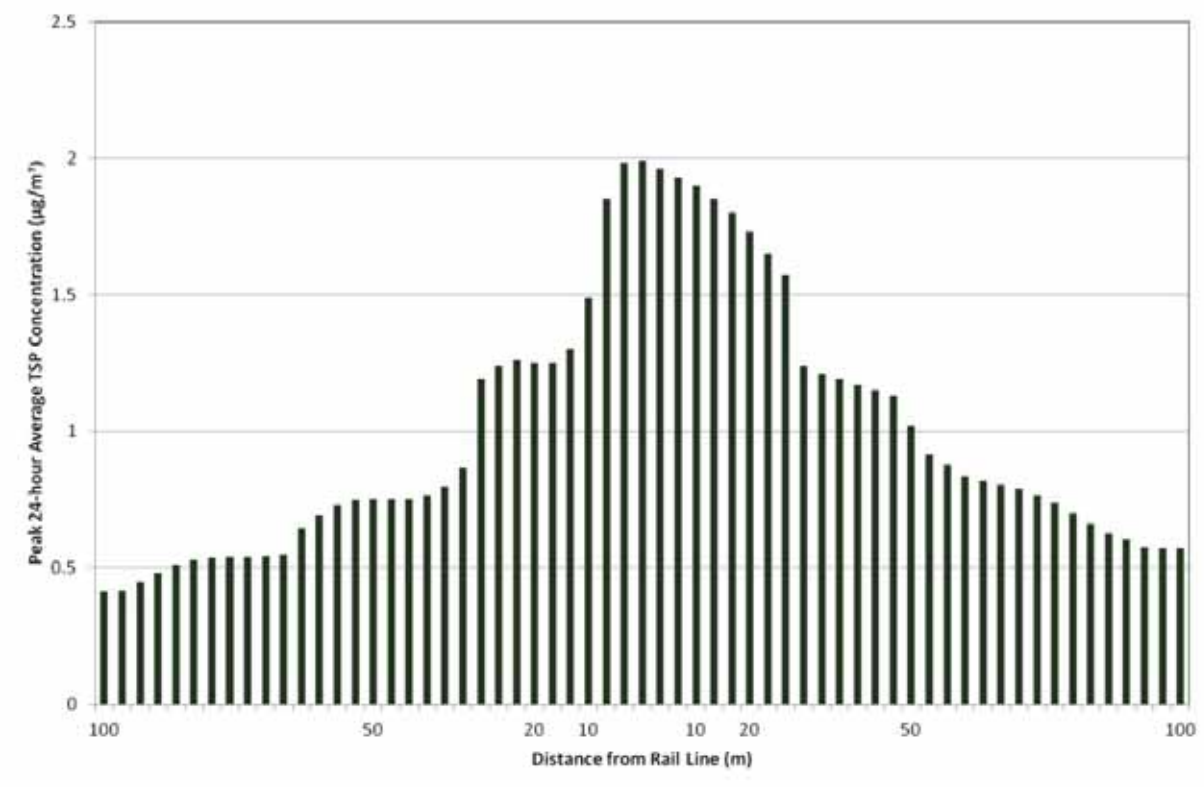

Figure I1 - Cross-section of Predicted Maximum 24-hour Average TSP Concentrations due to Coal Dust Emissions from Rail Wagons – Project Site to Ulan

Peak 24-hour average TSP concentrations due to fugitive emissions from rail wagons between the Project Site and Ulan, on the basis of the model configured for Gulgong, were predicted to be in the range of 2µg/m³ in close proximity (within 10m) of the railway corridor. Further afield, at 50m from the rail corridor which reflects the distance of the closest receptors, concentrations were predicted to be less than 1µg/m³.

The PM_{10} concentrations could be assumed to be 50% based on the ratio of PM_{10} to TSP emissions within the USEPA predictive emission factor for wind entrained dust from stockpiles.

On the basis of the modelling conducted, it is considered unlikely that adverse impacts from coal dust emissions from rail wagons travelling from the Project Site to Ulan would be experienced.