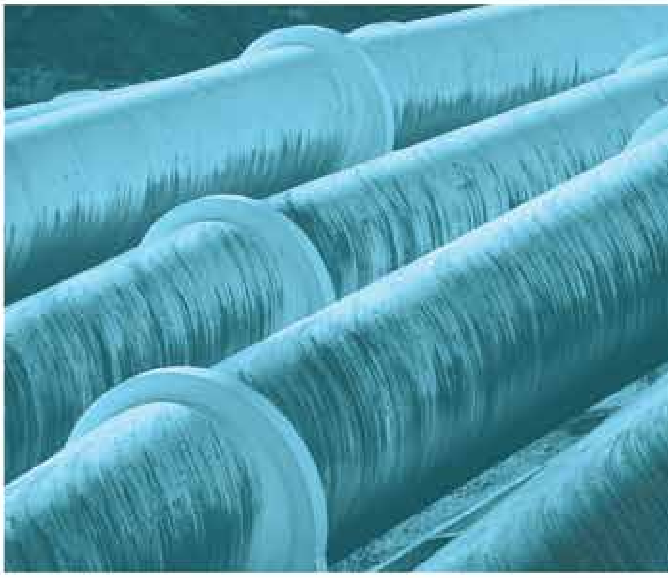
Appendix F

Charbon Colliery - Air quality impact assessment


Charbon Colliery - Modification 2

Air quality impact assessment

Prepared for Charbon Coal Pty Limited
August 2020

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Charbon Colliery - Modification 2

Air quality impact assessment

Report Number

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Client

Charbon Coal Pty Limited

Date

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Version

Final

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Associate - Air Quality	Associate - National Practice Leader, Air Quality
26 August 2020	26 August 2020

This report has been prepared in accordance with the brief provided by the client and has relied upon the information collected at the time and under the conditions specified in the report. All findings, conclusions or recommendations contained in the report are based on the aforementioned circumstances. The report is for the use of the client and no responsibility will be taken for its use by other parties. The client may, at its discretion, use the report to inform regulators and the public.

Executive Summary

This air quality impact assessment (AQIA) supports an application for a modification to operations at the Charbon Colliery (Charbon). Charbon is an underground and open cut coal mine approximately 87 kilometres (km) north-west of Lithgow and 3 km south of Kandos in the Western Coalfields of New South Wales (NSW). Charbon Coal is seeking to modify SSD 08_0211, pursuant to Section 4.55(2) of the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act), to allow for the transfer of coarse coal reject (CCR) from Clarence to Charbon and the use of this material on-site during rehabilitation activities.

The AQIA documents the existing air quality and meteorological environment, applicable impact assessment criteria, air pollutant emission calculations, dispersion modelling of calculated emissions and provides an assessment of predicted impacts relative to criteria.

The AQIA has been prepared in general accordance with the guidelines specified by the NSW Environment Protection Authority (EPA) in the *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (EPA 2016).

Local meteorological conditions were quantified primarily using data from the Charbon automatic weather station (AWS). Data from the Charbon AWS has been supplemented with data from the Bureau of Meteorology (BoM) monitoring station at Mudgee Airport in order to obtain parameters not measured by the local monitoring site but required for modelling (ie cloud and atmospheric pressure).

Background air quality was characterised using data from the Charbon monitoring network as well as monitoring data from the NSW Department of Planning, Industry and Environment's (DPIE) Bathurst station.

Emissions estimation and dispersion modelling was completed for a worst-case operational scenario at Charbon. This scenario corresponds to the estimated maximum amount of overburden and CCR moved around the site as well as the extent of areas exposed to wind erosion.

Emissions of total suspended particulates (TSP), particulate matter less than 10 micrometres (µm) in aerodynamic diameter (PM_{10}) and particulate matter less than 2.5 µm in aerodynamic diameter ($PM_{2.5}$) were estimated and modelled.

The atmospheric dispersion of air pollutant emissions was simulated using the CALPUFF model.

The results of the modelling show that the predicted concentrations and deposition rates for incremental particulate matter (TSP, PM_{10}, $PM_{2.5}$ and dust deposition) were below the applicable impact assessment criteria at all assessment locations.

Cumulative impacts were assessed by combining modelled Charbon impacts with recorded ambient background levels. The cumulative results showed that compliance with applicable NSW EPA impact assessment criteria is predicted at all assessment locations for all pollutants and averaging periods.

A range of best practice dust mitigation measures will be employed at Charbon. These include the use of water carts on unpaved roads, grading routes and exposed areas. These measures have been taken into account in the emissions estimation and modelling.

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1 Introduction

1.1 Overview

Charbon Colliery (Charbon) is an underground and open cut coal mine owned and operated by Charbon Coal Pty Limited (Charbon Coal), a joint venture between Centennial Coal Company Limited (Centennial) and SK Networks Resources Australia Pty Ltd. Charbon is approximately 87 kilometres (km) north-west of Lithgow and 3 km south of Kandos in the Western Coalfields of New South Wales (NSW) within the Mid-Western Regional local government area (LGA). Figure 1.1 shows Charbon in a regional context and Figure 1.2 shows it in a local context.

Charbon was approved as a Major Project under the now repealed Section 75J Part 3A of the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act) on 7 September 2010 (PA 08_0211). PA 08_0211 has since been declared a State significant development (SSD) under Clause 6 of Schedule 2 of NSW Environmental Planning and Assessment (Savings, Transitional and Other Provisions) Regulation 2017 (SSD 08_0211).

Charbon has been in operation since the 1920s and has been owned and operated by Charbon Coal since 1994. In 2015, mining operations ceased following the depletion of Charbon's approved coal reserves. Since the cessation of mining, Charbon Coal has been progressively rehabilitating the site.

Charbon Coal undertakes rehabilitation and mine closure activities at the site pursuant to SSD 08_0211. While mining is permitted to continue until 31 August 2025, only rehabilitation and mine closure activities are currently being undertaken and these activities are approved to continue beyond 31 August 2025. In addition to rehabilitation activities, water is currently transferred from Charbon's existing surface water dams via rail to Centennial Airly Pty Limited's (Centennial Airly's) Airly Mine (Figure 1.1) in accordance with the relevant conditions of SSD 08_0211 and Airly's development consent (SSD-5581). Under SSD-5581, this activity is approved until 31 January 2037.

It is proposed to use coarse coal reject (CCR) material from Centennial's Clarence Colliery (Clarence) to enhance rehabilitation at Charbon. Clarence is an underground coal mining operation utilising bord and pillar mining and partial extraction techniques. It is in the Western Coalfields of NSW, approximately 10 km east of Lithgow in the Lithgow LGA (Figure 1.1). Clarence operates under DA 504-00 which was granted in 2005 by the NSW Department of Infrastructure, Planning and Natural Resources (now NSW Department of Planning, Industry and Environment (DPIE)). Clarence is managed by Centennial.

As nominated in Charbon's *Mining Operations Plan* (MOP), Charbon Coal proposes to import CCR from Clarence by train to backfill historical mining areas requiring rehabilitation. The transfer of CCR from Clarence to Charbon will assist Charbon Coal to better develop a final landform that is representative of existing landforms within and adjacent to the site.

Charbon Coal is seeking to modify SSD 08_0211, pursuant to Section 4.55(2) of the EP&A Act, to allow for the transfer of CCR from Clarence to Charbon and the use of this material on-site during rehabilitation activities. If approved, the proposed modification will authorise:

- the importation of CCR from Clarence to Charbon by rail;
- use of CCR for ongoing rehabilitation at Charbon; and
- an extension of the time permitted to undertake water transfers between Charbon and Airly Mine.

At the same time Charbon Coal is seeking to modify SSD 08_0211, Centennial will submit a modification application for DA 504-00 to allow for the exportation of CCR from Clarence to Charbon by rail.

This air quality impact assessment (AQIA) has been prepared by EMM Consulting Pty Limited (EMM) on behalf of Centennial, to assess potential air quality impacts associated with the proposed modification on the surrounding environment. The AQIA has been prepared in general accordance with the guidelines specified by the NSW Environment Protection Authority (EPA) in the *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (EPA 2016), referred to herein as 'the Approved Methods for Modelling'.

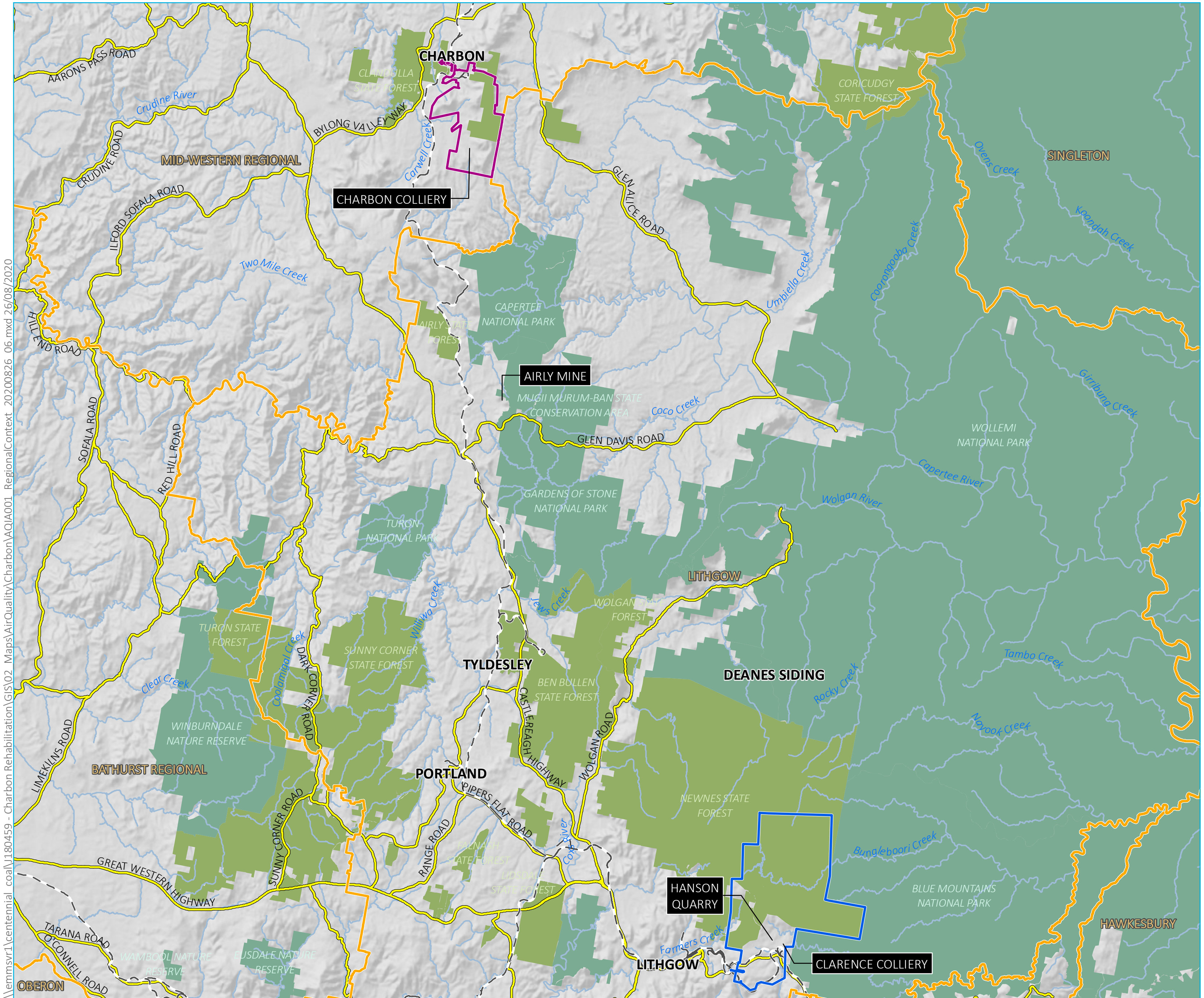
Heggies Pty Ltd (Heggies) (2009) prepared an AQIA for Charbon, which sought approval for the continued operation of mining activities. Information for this assessment has been sourced from Heggies (2009) where appropriate.

1.2 Purpose of this report

This AQIA documents the existing air quality and meteorological environment, applicable impact assessment criteria, air pollutant emission calculations, dispersion modelling of calculated emissions and assessment of predicted impacts relative to criteria.

This AQIA consists of the following sections:

- a description of the local setting and surrounds of Charbon;
- the pollutants which are relevant to the assessment, and the applicable impact assessment criteria;
- a description of the existing environment, specifically:
  - the meteorology and climate; and
  - the existing air quality environment;
- a detailed air pollutant emissions inventory for Charbon;
- atmospheric dispersion modelling for the quantified emissions, including an analysis of mine-only and cumulative impacts accounting for baseline air quality; and
- an overview of mitigation measures and air quality monitoring requirements.



Source: EMM (2020); Centennial (2019); DFSI (2017); GA (2011)

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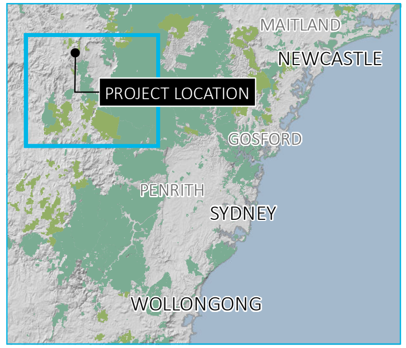

KEY

- Charbon Colliery project site boundary
- Clarence Colliery holding boundary
- Rail line
- Main road
- Watercourse
- NPWS reserve
- State forest
- LGA boundary

Regional context

Charbon Colliery Modification 2
Air quality impact assessment
Figure 1.1

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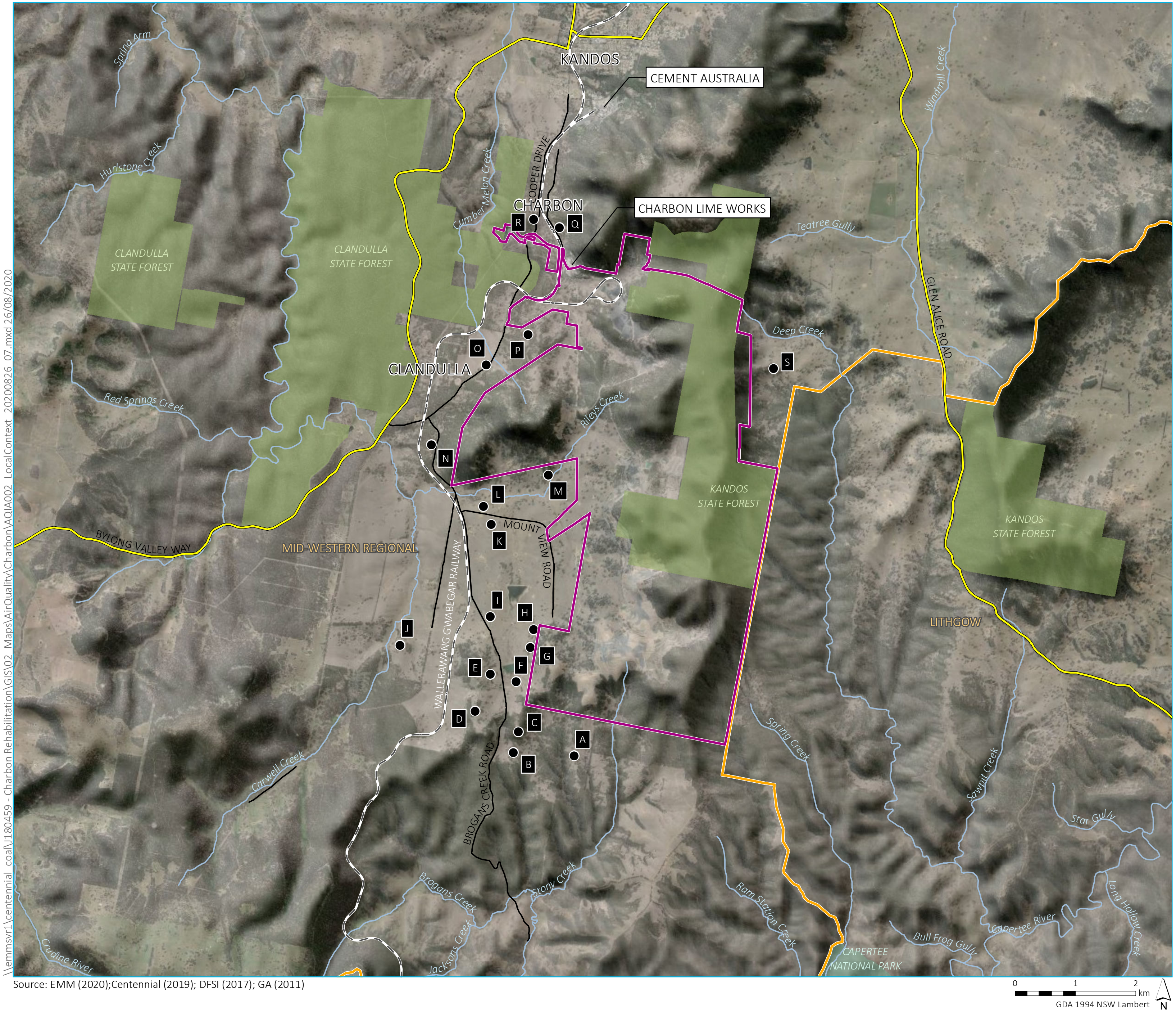

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Source: EMM (2020);Centennial (2019); DFSI (2017); GA (2011)

Local context

Charbon Colliery Modification 2
Air quality impact assessment
Figure 1.2

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1.3 Proposed modification

Charbon Coal is seeking to modify SSD 08_0211, pursuant to Section 4.55(2) of the EP&A Act, to allow for the transfer of CCR from Clarence to Charbon and the use of this material on-site during rehabilitation activities. The transfer of CCR from Clarence to Charbon will assist Charbon Coal to better develop a final landform that is representative of existing landforms within and adjacent to the site. The proposed modification includes:

- Construction of a 3,000 square metre (m^2) hardstand pad adjacent to Charbon's existing rail loop. During unloading activities, a forklift and other machinery will be operated on this hardstand. Containers used to transport CCR to Charbon may also be stored on this hardstand. Some minor vegetation clearance is required to construct the proposed hardstand.

- Construction of a link road to facilitate vehicle movements between the proposed hardstand and Charbon's existing haul roads (Figure 2.1). The link road will be constructed within the existing disturbance footprint for Charbon's reject emplacement area (REA) complex.

- Widening of Charbon's existing haul roads in some areas to ensure a minimum width of 8.8 m is maintained. Widening activities will remain within Charbon's existing approved disturbance footprint.

- Importation of CCR from Clarence to Charbon by rail (one loaded train per day).

- Unloading of CCR containers at Charbon's existing rail loop using a forklift truck. Containers will either be moved directly onto waiting trucks for transfer to the active rehabilitation areas or placed on the proposed hardstand for temporary storage. A fleet of three or four trucks will be used to transport the containers from the proposed hardstand to the active rehabilitation areas.

- Use of CCR for ongoing rehabilitation at Charbon (including establishment of management measures to mitigate the risk of acid metalliferous drainage (AMD) and potential impacts on the surrounding environment).

- Construction of powerline poles and an additional 11 kV transmission line to Charbon's existing pump shed.

- An extension to the approved water transfer activities from Charbon to Airly Mine from 31 August 2025 to 31 January 2037 to align with Airly Mine's Development Consent (SSD-5581).

The mine layout is shown on Figure 1.3.

1.3.1 Construction activities

As described above, as part of the proposed modification, the following construction activities will be undertaken:

- construction of a 3,000 m^2 hardstand pad adjacent to Charbon's existing rail loop;

- construction of a link road to facilitate vehicle movements between the proposed hardstand and Charbon's existing haul roads;

- widening of Charbon's existing haul roads in some areas to ensure a minimum width of 8.8 m is maintained; and

- construction of powerline poles and an additional 11 kV transmission line from close to Charbon's access road to the existing pump shed.

The majority of plant, materials and equipment required to complete these activities is available on-site. Additional materials may be delivered to site via the local road network.

The proposed areas for the additional construction activities have been extensively disturbed as part of previous mining activities on-site (including construction of surface water dams, water loading infrastructure and Charbon's rail loader).

The 11 kV transmission line will replace an existing powerline that provides electricity to the pump station and will be rerouted away from the proposed hardstand pad.

All construction activities will be undertaken during standard daytime construction hours in accordance with the *Interim Construction Noise Guideline* (ICNG) (DECC 2009). Construction works will be restricted to:

- Monday to Friday: 7 am–6 pm;
- Saturday: 8 am–1 pm; and
- no work on Sundays and public holidays.

No additional employees will be required during construction.

1.3.2 Proposed rail movements

Charbon's existing rail loop is connected to the Wallerawang-Gwabegar Rail Line, which is not operated to a fixed timetable. During mining, an average of eight coal trains (ie sixteen train movements) per week were dispatched from Charbon on the Wallerawang-Gwabegar Rail Line. Charbon is currently approved to operate eight train movements in the day period (7 am–10 pm) and two train movements in the night period (10 pm–7 am).

Since the completion of mining, rail transport has been used infrequently for importation of materials to Charbon's pit top for rehabilitation activities. In addition, one water-laden train per day (ie two rail movements) is permitted to travel from Charbon to Airly Mine.

As part of the proposed modification, one CCR-laden train will be used per day (ie two rail movements) to transport CCR from Clarence to Charbon. It is anticipated that trains will consist of 2 locomotives and approximately 30 wagons. Each train will carry 2 containers per wagon, providing a total of 60 containers per train. Containers are able to hold 25 tonnes (t) of CCR. Therefore, each train will have the ability to transport up to approximately 1,500 t of CCR.

Over a period of five years, it is anticipated that up to 1.5 million tonnes (Mt) of CCR will be transported from Clarence to Charbon with an average annual transfer of between 300,000 t and 350,000 t.

1.3.3 Material handling

On arrival at Charbon, containers with CCR will be transferred from the train to trucks and transported to the areas being rehabilitated for use during the construction of the final landform.

To transfer the containers from the train to trucks, a forklift and other machinery will be operated on the hardstand pad. Containers used to transport CCR to Charbon may also be stored on this hardstand.

A grader and water truck will be used to maintain the haul roads used to transport CCR from the proposed hardstand to the rehabilitation areas.

1.3.4 Water transfers to Airly Mine

It is proposed to continue to operate pumping infrastructure to load trains with water at Charbon. Charbon Coal will continue to transport up to 170 megalitres per year (ML/year) to Airly Mine by rail, in accordance with SSD 08_0211 MOD 1.

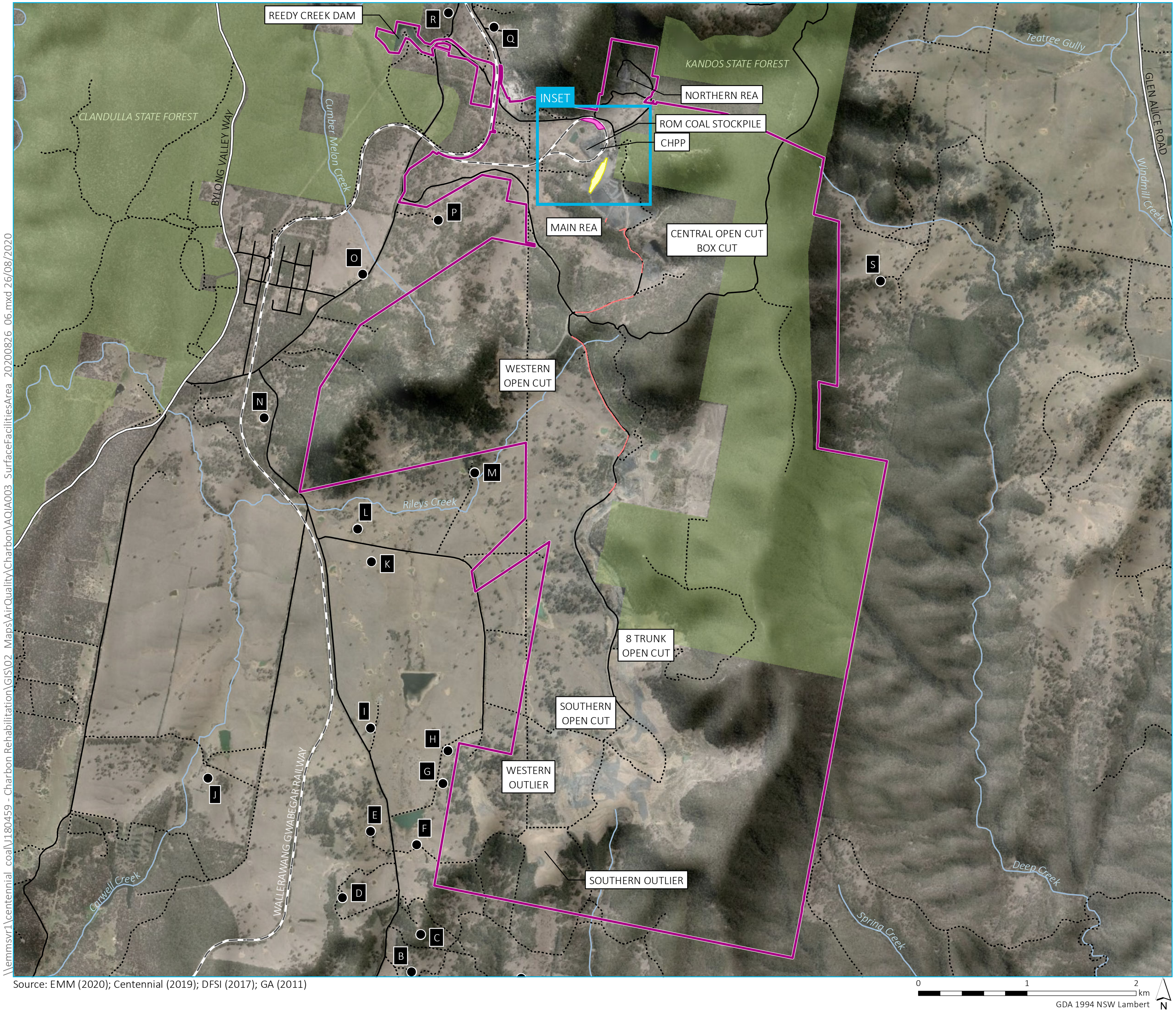
1.4 Site and surrounding area

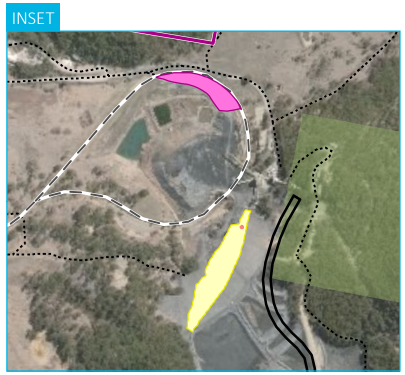
The project site boundary is the existing development consent boundary applicable to SSD 08_0211 and includes all areas of disturbance requiring rehabilitation. The majority of the site is owned by Centennial. Forestry Corporation of NSW owns Kandos State Forest and Clandulla State Forest, both of which intersect with the project site boundary. Various small private landholdings occur in the southern and western portions of the site and several small areas of Crown land (mostly Crown road reserves) also occur.

Land uses surrounding Charbon include rural residences, agriculture, transport infrastructure and commercial forestry. There is bushland, Charbon Lime Works and the village of Charbon to the north, bushland (Kandos State Forest) and escarpment (Great Dividing Range) to the east and bushland and agricultural land to the south and west (Figure 1.2).

There are a number of non-mine owned residences in the area surrounding the project site boundary (Figure 1.2). The closest non-mine owned residence is Residence H, approximately 80 m from the project site boundary. The closest non-mine owned residence to the rail loop and proposed rail unloading activities is Residence P, approximately 1,500 m south-west of the rail loop.

The topography surrounding Charbon is characterised by a notable north-south aligned ridgeline to the east of the historic open cut mining areas. Another prominent elevated terrain feature exists at the centre of the site, with the remainder of the site dominated by rolling terrain. Elevation ranges from approximately 630 mAHD to 940 mAHD within approximately 5 km of Charbon. A three-dimensional representation of the local topography is shown in Figure 1.4.





Source: EMM (2020); Centennial (2019); DFSI (2017); GA (2011)

KEY

- Charbon Colliery project site boundary
- Assessment location
- Rail line
- Main road
- Local road
- Vehicular track
- Watercourse
- State forest

Proposed modification elements

- Hardstand
- Link road
- Haul road widening

Mine layout

Charbon Colliery Modification 2
Air quality impact assessment
Figure 1.3

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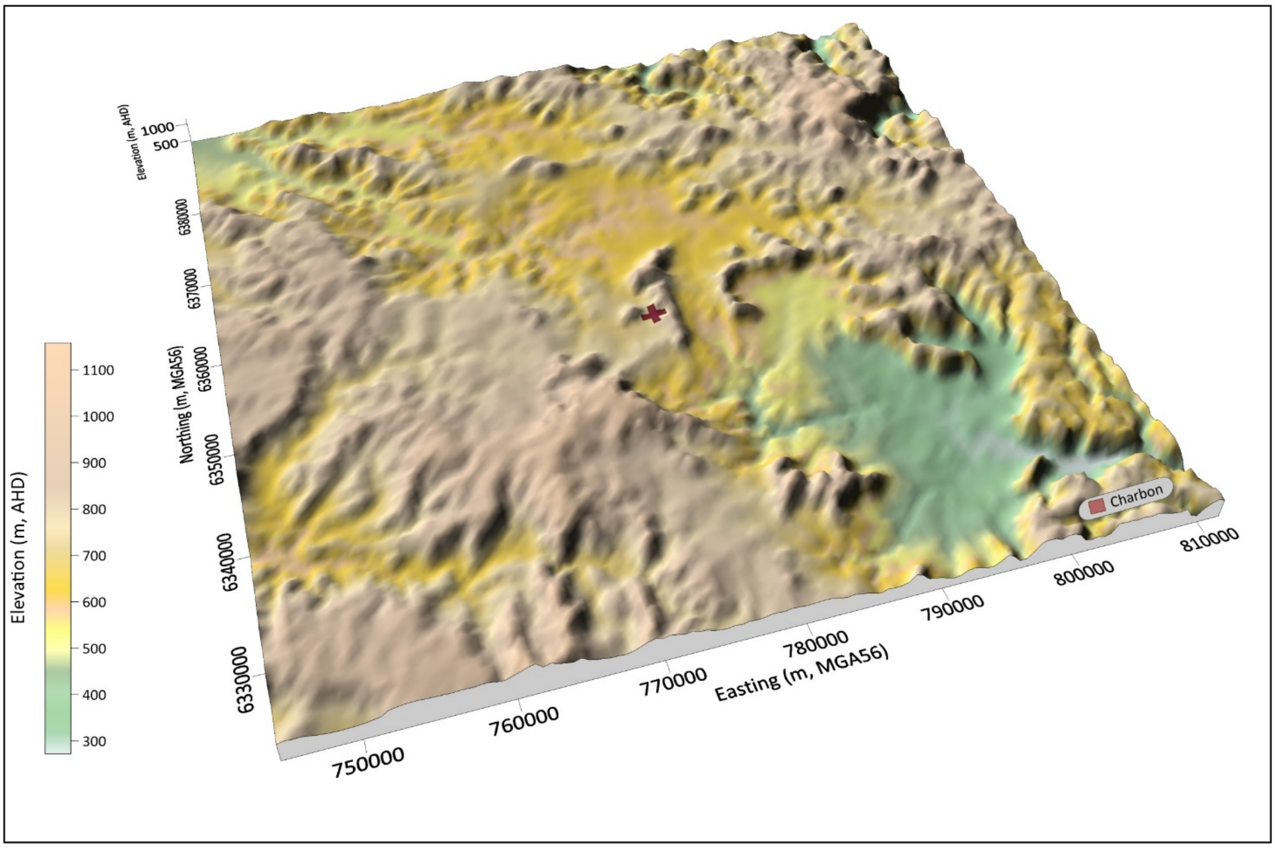


Figure 1.4 Three-dimensional topography surrounding Charbon

1.5 Assessment locations

The nearest representative air quality sensitive locations to Charbon have been identified for the purpose of assessing potential air quality impacts. Details are provided in Table 1.1 and their locations are shown in Figure 1.2. They are referred to in this report as assessment locations.

Table 1.1 Air quality assessment locations

Location ID	Assessment location type	Easting	Northing
A	Residential	778004	6348902
B	Residential	776997	6348960
C	Centennial-owned	777081	6349303
D	Residential	776360	6349643
E	Residential	776617	6350251
F	Residential	777043	6350130
G	Centennial-owned	777282	6350695
H	Residential	777330	6350995
I	Residential	776618	6351205
J	Residential	775121	6350738
K	Residential	776628	6352732
L	Residential	776500	6353035
M	Centennial-owned	777574	6353551
N	Residential	775636	6354055
O	Residential	776547	6355379
P	Residential	777240	6355876
Q	Residential	777754	6357652
R	Residential	777332	6357784
S	Residential	781297	6355305

2 Pollutants and assessment criteria

2.1 Potential air pollutants

This assessment includes consideration of potential impacts from activities at Charbon (Chapter 5). An 'existing' scenario has not been assessed given the small scale of changes proposed under the modification (Section 1.3). Mining operations at Charbon have ceased and Charbon Coal will continue to progressively rehabilitate the site.

Emissions will principally consist of particulate matter emissions from loading and unloading overburden and CCR from Clarence, transport of overburden and CCR, dozers working on spoil and wind erosion of exposed areas.

The proposed modification will include some minor construction activities which have the potential to generate dust emissions. Emissions during construction will principally consist of particulate matter emissions from:

- construction of a 3,000 m^2 hardstand pad adjacent to Charbon's existing rail loop;
- construction of a link road;
- widening of Charbon's existing haul roads in some areas; and
- construction of powerline poles and an additional 11 kV transmission line for Charbon's existing pump shed.

All construction activities will be undertaken during daytime hours and the duration of construction is likely to be eight weeks. It is considered that any construction-phase dust emissions will be minor compared to emissions related to the proposed importation of CCR and ongoing rehabilitation activities (Section 5.2.3). Given this, the short timeframe and small-scale of the proposed construction activities, construction-related emissions have not been assessed further.

A detailed description of the emission sources associated with operations at Charbon is presented in Chapter 5. The main air pollutants emitted will be:

- Particulate matter, specifically:
  - total suspended particulate matter (TSP);
  - particulate matter less than 10 micrometres (µm) in aerodynamic diameter (PM_{10}); and
  - particulate matter less than 2.5 µm in aerodynamic diameter ($PM_{2.5}$).
- Gaseous pollutants, specifically:
  - oxides of nitrogen (NO_x)[1], including nitrogen dioxide (NO_2);
  - sulphur dioxide (SO_2);
  - carbon monoxide (CO); and
  - volatile organic compounds (VOCs).

1 By convention, NO_x = nitrous oxide (NO) + NO_2.

Of the above listed pollutants, this assessment will focus on emissions and impacts from particulate matter (TSP, PM_{10} and $PM_{2.5}$). Impact assessment criteria applicable to particulate matter are presented in the following sections as defined in the Approved Methods for Modelling (EPA 2016). The impact assessment criteria are designed to maintain ambient air quality that allows for the adequate protection of human health and well-being.

2.2 Applicable air quality assessment criteria

The NSW EPA's impact assessment criteria for particulate matter, as documented in Section 7 of the Approved Methods for Modelling, are presented in Table 2.1. The assessment criteria for PM_{10} and $PM_{2.5}$ are consistent with the National Environment Protection (Ambient Air Quality) Measure (AAQ NEPM) (DoE 2016).

TSP, which relates to airborne particles less than 45 µm in diameter (US EPA 1998a), is used as a metric for assessing amenity impacts (reduction in visibility, dust deposition and soiling of buildings and surfaces) rather than health impacts. Particles less than 10 µm and 2.5 µm in diameter, a subset of TSP, are fine enough to enter the human respiratory system and can lead to adverse human health impacts. The NSW EPA impact assessment criteria for PM_{10} and $PM_{2.5}$ are therefore used to assess the potential impacts on human health of particulate matter concentrations.

The Approved Methods for Modelling classifies TSP, PM_{10}, $PM_{2.5}$ and dust deposition as criteria pollutants. Assessment criteria for criteria pollutants are applied at the nearest existing or likely future off-site sensitive receptor and compared against the 100^{th} percentile (ie the highest) dispersion modelling prediction in the case of 24-hour impacts. Both the incremental (assessed project impacts only) and cumulative (project including background) impacts need to be presented, the latter requiring consideration of existing ambient background concentrations for the criteria pollutants assessed.

For dust deposition, the NSW EPA (2016) specifies criteria for incremental and cumulative dust deposition levels. Dust deposition impacts are derived from TSP emission rates and particle deposition calculations in the dispersion modelling process.

Table 2.1 Impact assessment criteria for particulate matter

PM metric	Averaging period	Impact assessment criterion
TSP	Annual	90 µg/m^3
PM_{10}	24 hour	50 µg/m^3
	Annual	25 µg/m^3
$PM_{2.5}$	24 hour	25 µg/m^3
	Annual	8 µg/m^3
Dust deposition	Annual	2 g/m^2/month (increment only)
		4 g/m^2/month (cumulative)

Notes: µg/m^3: micrograms per cubic metre; g/m^2/month: gram per square metre per month.
Source: EPA 2016.

3 Meteorology and climate

3.1 Introduction

Meteorological mechanisms govern the generation, dispersion, transformation and eventual removal of pollutants from the atmosphere. To adequately characterise the dispersion meteorology of a region, information is needed on the prevailing wind regime, ambient temperature, rainfall, relative humidity, mixing depth and atmospheric stability.

Analysis of meteorology for the local area is presented based on the Centennial-owned Charbon automatic weather station (AWS) (Figure 3.1).

Data from the Charbon AWS has been supplemented with data from the Bureau of Meteorology (BoM) monitoring station at Mudgee Airport, approximately 52 km north-west of Charbon's surface facilities. The Mudgee Airport data were primarily included to obtain parameters not measured by the Charbon AWS but required for modelling (ie cloud and atmospheric pressure).

The locations of the meteorological stations used in the assessment are shown in Figure 3.1.

3.2 Prevailing winds and selection of a representative year

Meteorological data recorded by the Charbon AWS for the period between 2015 and 2019 were analysed for the purposes of characterising the existing environment and selecting a representative year for dispersion modelling.

An overview of the meteorological data for the most important parameters for modelling is presented in Figure A.1 of Appendix A. This shows that data availability for all years was between 96.1% and 100%.

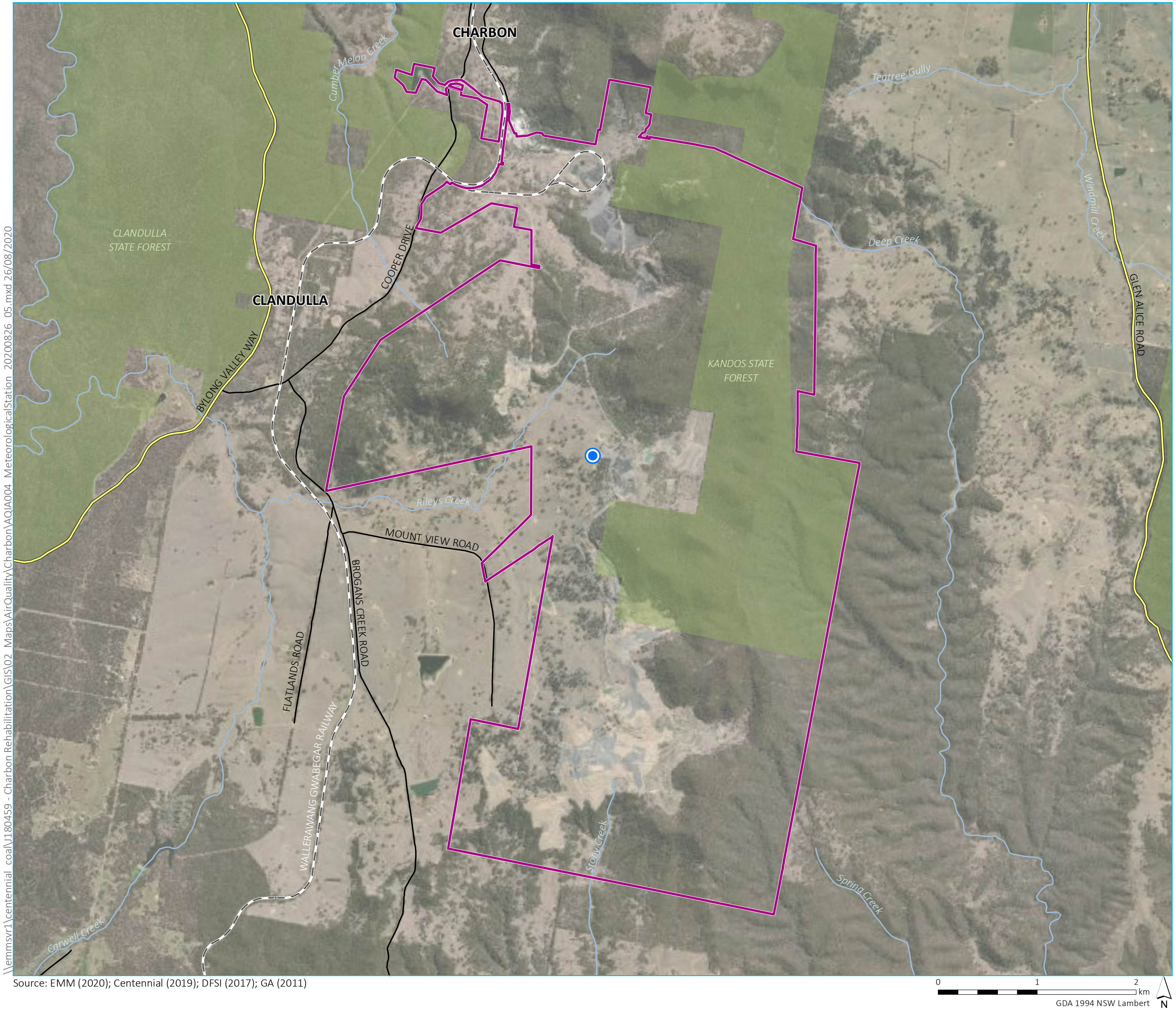
Inter-annual diurnal profiles for wind speed, wind direction, temperature and relative humidity are shown in Figures A.2 to A.5 of Appendix A. The profiles were very similar from year to year, although in 2018 and 2019 the relative humidity was lower than in other years.

Annual wind roses created from wind speed and direction data collected at the Charbon AWS from 2015 to 2019 are presented in Figure A.6. The analysis showed that there was a high degree of consistency in wind direction, average wind speed, and percentage occurrence of calm winds (defined as wind speeds less than or equal to 0.5 m/s) across the five-year period. The prevailing winds in all years are from the eastern quadrant with a smaller percentage of winds from the west. Annual average wind speeds ranged between 2.3 m/s and 2.5 m/s. The annual average frequency of calm conditions ranged between 2.4% and 4.2%.

Seasonal wind roses for the Charbon AWS for 2015 to 2019 are shown in Figure A.7. The mean wind speed ranges from 2.2 m/s in autumn to 2.6 m/s in spring. The seasonal average percentage of calm conditions ranged from 2.4% in spring to 4% in autumn. The wind patterns in all seasons were very similar displaying dominant easterly winds.

Diurnal wind roses for the Charbon AWS are shown in Figure A.8. The dominant easterly alignment evident in the annual wind roses were also present in the daylight and night-time wind roses. The average wind speed during the day was 2.9 m/s compared to 1.9 m/s at night-time. The percentage of calms during the day was 1.9% compared to 4.5% at night.

The 2018 calendar year was adopted as the 12-month modelling period for the purpose of this AQIA given the data availability and consistency of the data. The modelling year was also chosen with regard to background air quality which is discussed in Chapter 4. The annual wind rose for the Charbon AWS for 2018 is shown in Figure 3.2. The wind rose displays the same characteristics as that described above, specifically dominated by winds from the east.



Source: EMM (2020); Centennial (2019); DFSI (2017); GA (2011)

KEY

- Charbon Colliery project site boundary
- Charbon AWS
- Rail line
- Major road
- Minor road
- Watercourse
- State forest

Location of meteorological station

Charbon Colliery Modification 2
Air quality impact assessment
Figure 3.1

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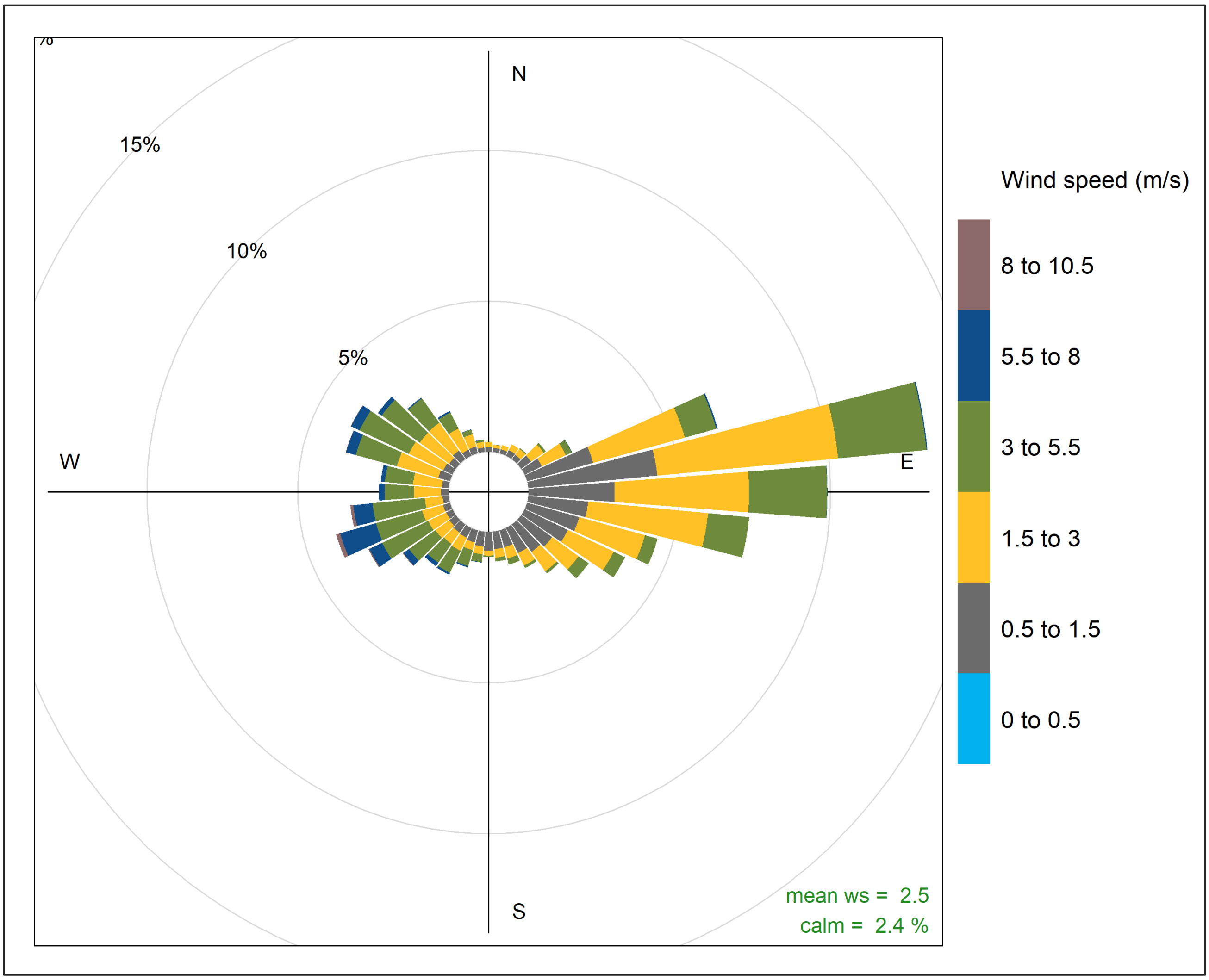


Figure 3.2 Annual wind rose for Charbon AWS – 2018

3.3 Meteorological modelling

3.3.1 Overview

Atmospheric dispersion modelling for this assessment has been completed using The Air Pollution Model (TAPM) and the CALMET/CALPUFF model suite.

Section 4.1 of the Approved Methods for Modelling specifies that meteorological data representative of a site can be used in the absence of suitable on-site observations. The data should cover a period of at least one year with a percentage completeness of at least 90%. Data can be obtained from either a nearby meteorological monitoring station or synthetically generated using the CSIRO prognostic meteorological model, TAPM.

Hourly average meteorological data from the Charbon AWS and BoM Mudgee Airport AWS were used as observations in the TAPM and CALMET modelling.

The observations at the Charbon AWS provide the dominant influence on the derived local wind field and the resultant dispersion meteorology within the model. The radius of influence for input observational data in the meteorological modelling was configured to reflect the local scale topographical features. Further details of the TAPM and CALMET meteorological modelling is presented in Section A.2 of Appendix A.

3.3.2 CALMET-predicted winds

Hourly meteorological predictions were extracted at Charbon's AWS to compare with measured data at the Charbon AWS and verify the performance of CALMET in predicting local meteorological conditions accounting for local terrain features. Adopted CALMET settings, such as the RMAX and R1 factors are further explained in Section A.2 of Appendix A.

An annual wind rose has been created from the CALMET data extract at Charbon's AWS (Figure 3.3).

The annual wind rose created from the CALMET data is similar in pattern to the wind rose created from the observations (Figure 3.2). The annual average wind speed is 2.5 m/s in the observed data and 2.3 m/s in the CALMET extract. The annual percentage of calms is 2.4% in the observed data and 4.2% in the CALMET extracted data.

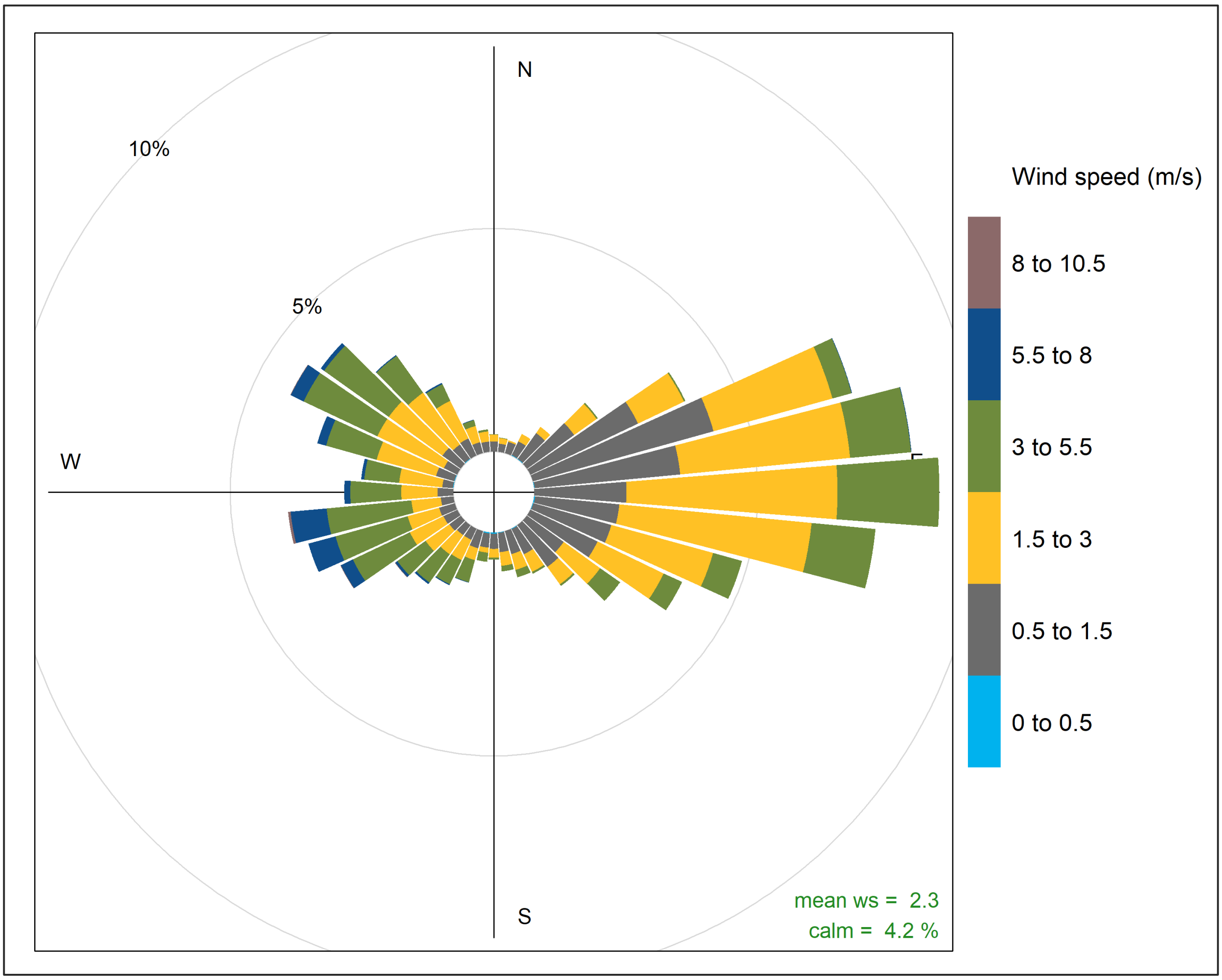


Figure 3.3 CALMET-predicted wind speed and direction – Charbon – 2018

3.3.3 Atmospheric stability and mixing height

Atmospheric stability refers to the degree of turbulence or mixing that occurs within the atmosphere and is a controlling factor in the rate of atmospheric dispersion of pollutants.

The Monin-Obukhov length (L) provides a measure of the stability of the surface layer (ie the layer above the ground in which vertical variation of heat and momentum flux is negligible; typically, about 10% of the mixing height). Negative L values correspond to unstable atmospheric conditions, while positive L values correspond to stable atmospheric conditions. Very large positive or negative L values correspond to neutral atmospheric conditions.

Figure 3.4 illustrates the diurnal variation of atmospheric stability, derived from the Monin-Obukhov length calculated by CALMET, extracted at the Charbon AWS. The diurnal profile shows that atmospheric instability increases during the daylight hours as the sun generated convective energy increases, whereas stable atmospheric conditions prevail during the night-time. This profile indicates that the potential for effective atmospheric dispersion of emissions would be greatest during daytime hours and lowest during evening through to early morning hours.

Mixing depth refers to the height of the atmosphere above ground level within which air pollution can be dispersed. The mixing depth of the atmosphere is influenced by mechanical (associated with wind speed) and thermal (associated with solar radiation) turbulence. Similar to the Monin-Obukhov length analysis above, higher daytime wind speeds and the onset of incoming solar radiation increases the amount of mechanical and convective turbulence in the atmosphere. As turbulence increases, so too does the depth of the boundary layer, generally contributing to higher mixing depths and greater potential for the atmospheric dispersion of pollutants.

Figure 3.4 presents the hourly-varying atmospheric boundary layer depths generated by CALMET. Greater boundary layer depths occur during the daytime hours, peaking in the mid to late afternoon.

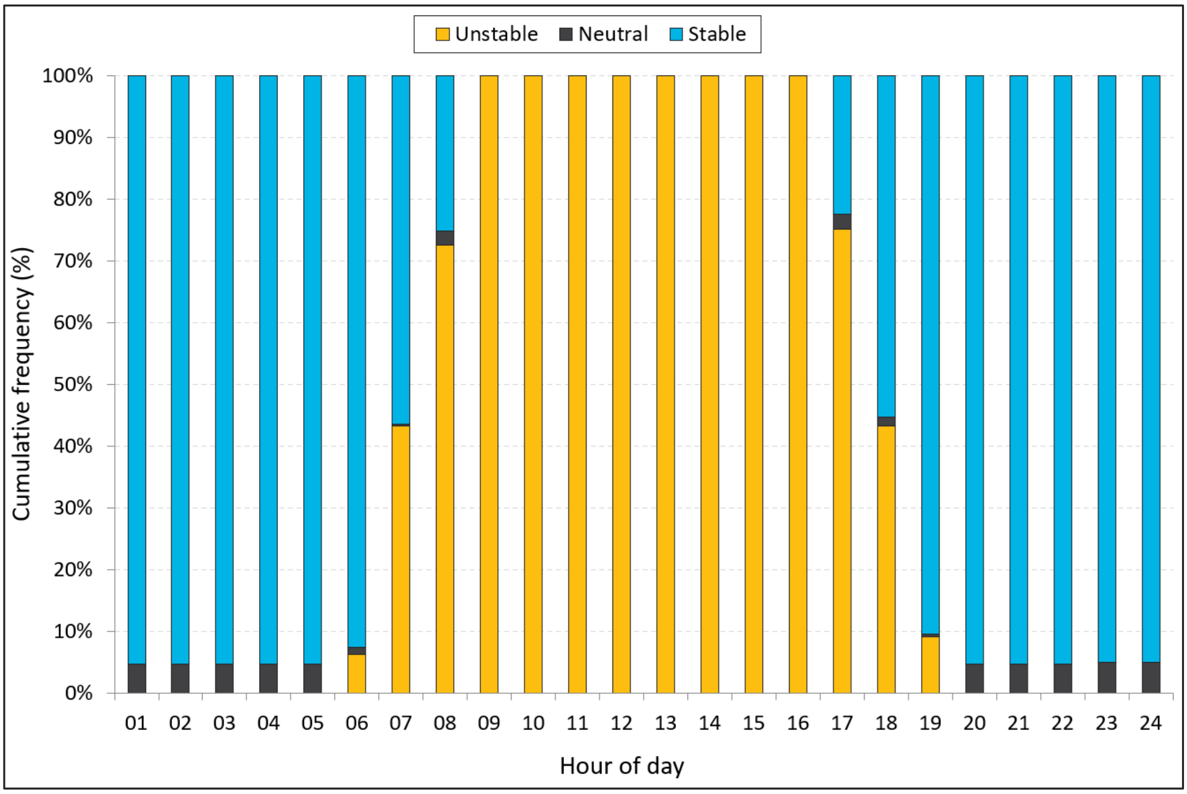


Figure 3.4 Diurnal variation in CALMET-generated atmospheric stability (Charbon AWS 2018)

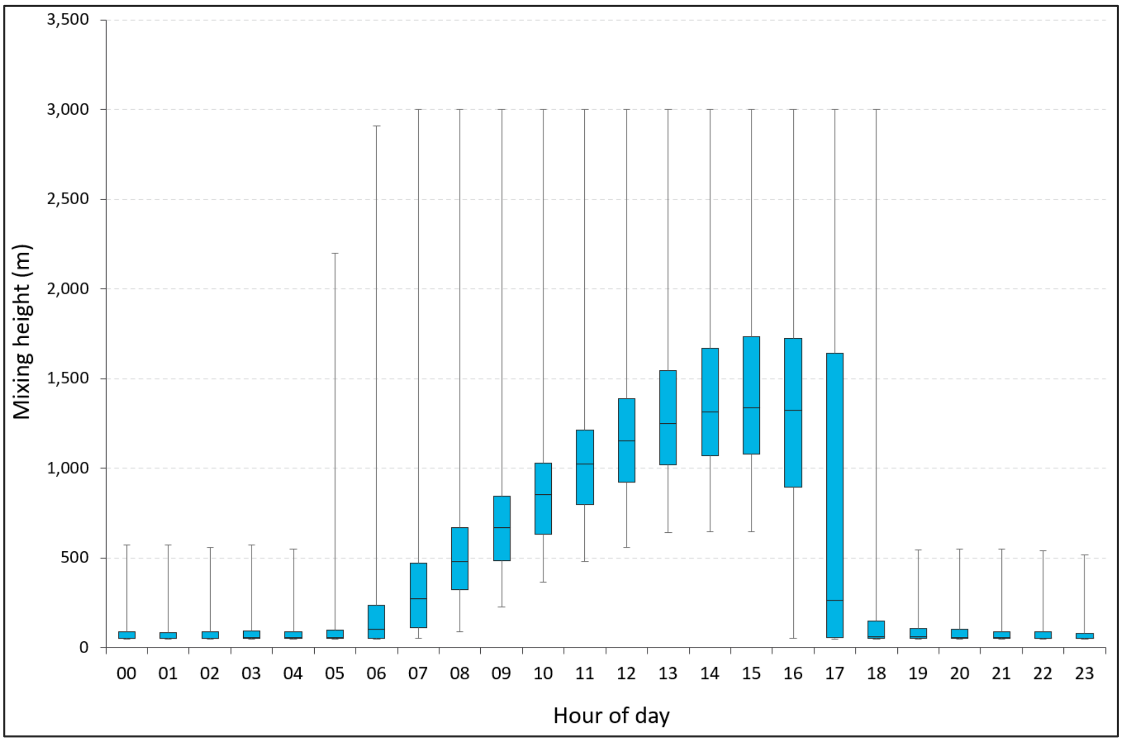


Figure 3.5 Diurnal variation in CALMET-generated mixing heights

4 Baseline air quality

4.1 Introduction

The local airshed will be influenced by:

- emissions from existing activities at Charbon;
- neighbouring industrial emission sources, including the Charbon Lime Works (Figure 1.2);
- wind generated dust from exposed areas;
- dust entrainment and tailpipe emissions from vehicle movements along unsealed and sealed roads;
- seasonal emissions from household wood heaters; and
- long-range transport of fine particles into the region.

More remote sources which contribute episodically to suspended particulates in the region include dust storms and bushfires. It is considered that all of the above emission sources are accounted for in the monitoring data analysed in the following sections of this report.

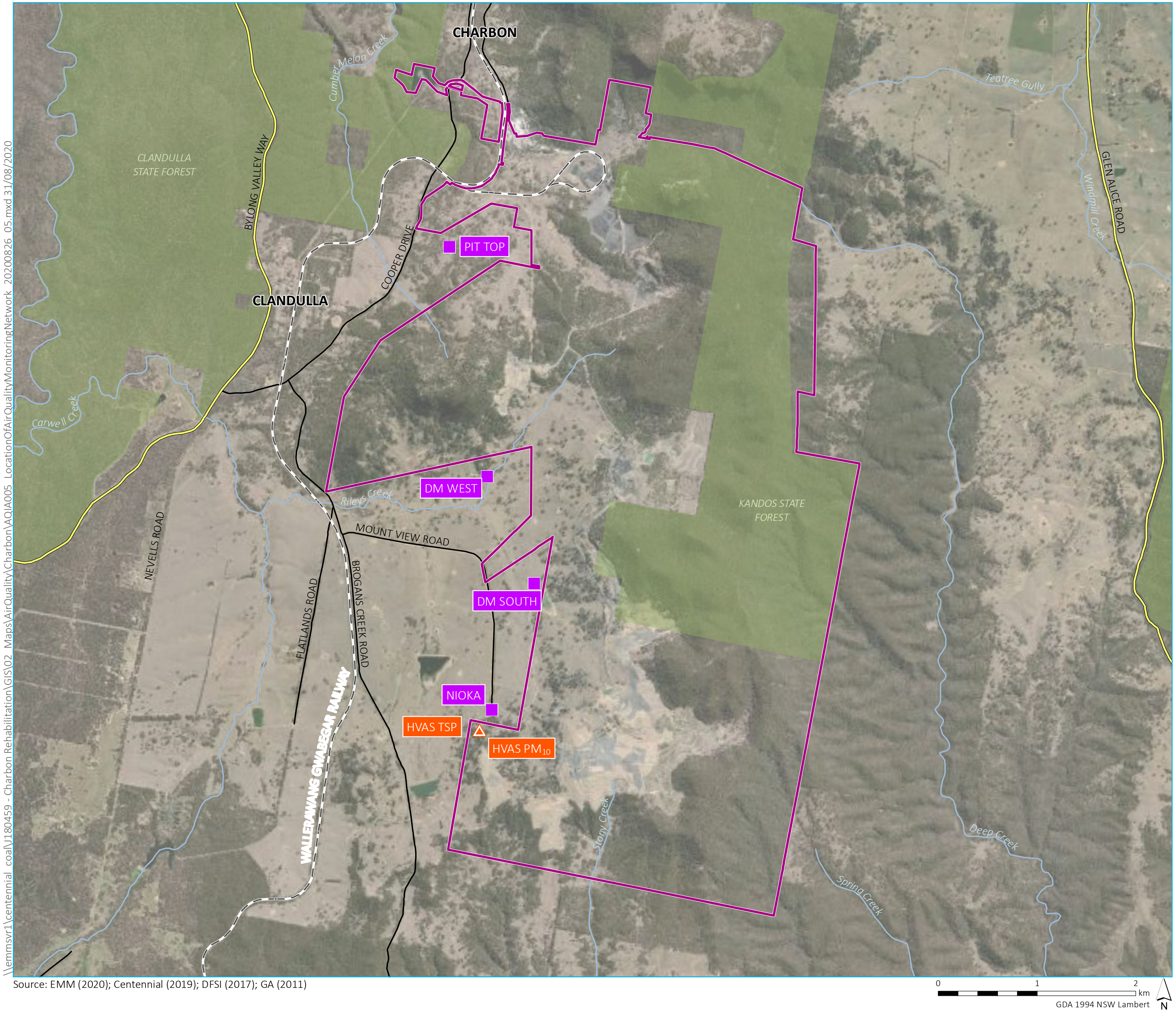
4.2 Air quality monitoring resources

Charbon Coal maintains an air quality monitoring network for its operations. The network consists of the following monitoring equipment:

- one High Volume Air Sampler (HVAS) measuring TSP and PM_{10} concentrations on a one-in-six day cycle;
- four dust deposition gauges for recording monthly dust deposition rates; and
- one meteorological station recording weather conditions, including wind speed and direction, temperature, solar radiation, rainfall, atmospheric pressure and sigma-theta.

The location of Charbon's air quality monitoring equipment is shown in Figure 4.1.

Hourly average concentrations of PM_{10} and $PM_{2.5}$ for the period 2015-2019 were obtained from DPIE's air quality monitoring station at Bathurst (hereafter Bathurst AQMS), approximately 62 km south-west of Charbon.



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Source: EMM (2020); Centennial (2019); DFSI (2017); GA (2011)

Location of air quality monitoring network

Charbon Colliery Modification 2
Air quality impact assessment
Figure 4.1

EMM
creating opportunities

4.3 Background air quality

4.3.1 PM_{10}

i Charbon HVAS data

As stated above, 24-hour average PM_{10} concentrations are recorded by the Charbon HVAS on a one-in-six day cycle. The PM_{10} data from the HVAS for the period between 2015 and 2018 are summarised in Table 4.1.

There were three exceedances of the NSW EPA 24-hour average criterion of 50 µg/m³ recorded in 2018 and nine recorded in 2019. These exceedances are likely to be the result of widespread dust storms and bushfires in the wider region during these periods.

The data also shows concentrations increasing from 2015 to 2019. The increase in concentrations in 2019 are likely attributed to state-wide extreme drought conditions and a high frequency of days influenced by smoke from major bushfires and hazard reduction burn events across Australia during this time.

Table 4.1 Statistics for PM_{10} concentrations – Charbon HVAS – 2015–2019

Monitoring year	PM_{10}		
	Maximum 24-hour average concentration (µg/m³)	Annual average concentration (µg/m³)	Days greater than 50 µg/m³
2015	22.6	8.8	0
2016	25.6	9.3	0
2017	28.3	11.1	0
2018	138.0	17.2	3
2019	291.0	32.1	9

ii Bathurst AQMS

Although PM_{10} concentrations are monitored at Charbon, the data are measured on a one-in-six day run cycle and therefore cannot be used alone in a contemporaneous 24-hour average cumulative analysis consistent with the Approved Methods for Modelling. Reference is therefore made to the Bathurst AQMS, the closest semi-rural, publicly available and long-term continuous monitoring station dataset for PM_{10} and $PM_{2.5}$.

A summary of key statistics for the five years of analysed data from the Bathurst AQMS is presented in Table 4.2. Two exceedances of the NSW EPA 24-hour average criterion of 50 µg/m³ were recorded in 2015, eight were recorded in 2018 and forty were recorded in 2019. The two exceedances that occurred in 2015 were the result of a widespread dust storm and a grassfire in the proximity of the Bathurst AQMS (OEH 2015). As discussed above, the increase in concentrations towards the end of 2018 and during 2019 were likely due to increasing drought conditions across NSW and the occurrence of a number of bushfire events in this period. This is also reflected in the recorded annual average PM_{10} concentration for 2018 (18.8 µg/m³), and 2019 (27.5 µg/m³) which is higher than the three preceding years of data.

A time series of recorded 24-hour average PM_{10} concentrations at the Bathurst AQMS for the period between 2015 and 2019 is presented in Figure 4.2. The recorded 24-hour average PM_{10} concentrations fluctuated throughout the period. Concentrations at Bathurst are typically below the NSW EPA assessment criterion of 50 µg/m³ although as above, a number of days above the criterion were recorded in 2018 (8) and 2019 (40).

It is acknowledged that land use and dust-generating activities surrounding Charbon differ to those at the Bathurst monitoring station. The dominant dust source in the vicinity of Charbon is a mixture of agricultural practices and mining rehabilitation activities, whereas the dominant dust sources in Bathurst are residential activities such as wood heaters and fuel combustion from vehicles. To compare the Charbon HVAS and Bathurst datasets, coincident 24-hour average PM_{10} concentrations recorded at the two locations were extracted for 2018. The coincident concentrations at the two sites are presented in Figure 4.3.

Table 4.2 Statistics for PM_{10} concentrations –Bathurst AQMS – 2015–2019

Monitoring year	PM_{10} concentration (µg/m³)		
	Maximum 24-hour average concentration (µg/m³)	Annual average concentration (µg/m³)	Number of days greater than 50 µg/m³
2015	94.6	13.3	2
2016	34.1	12.4	0
2017	49.9	13.7	0
2018	274.1	18.8	8
2019	298.6	27.5	40

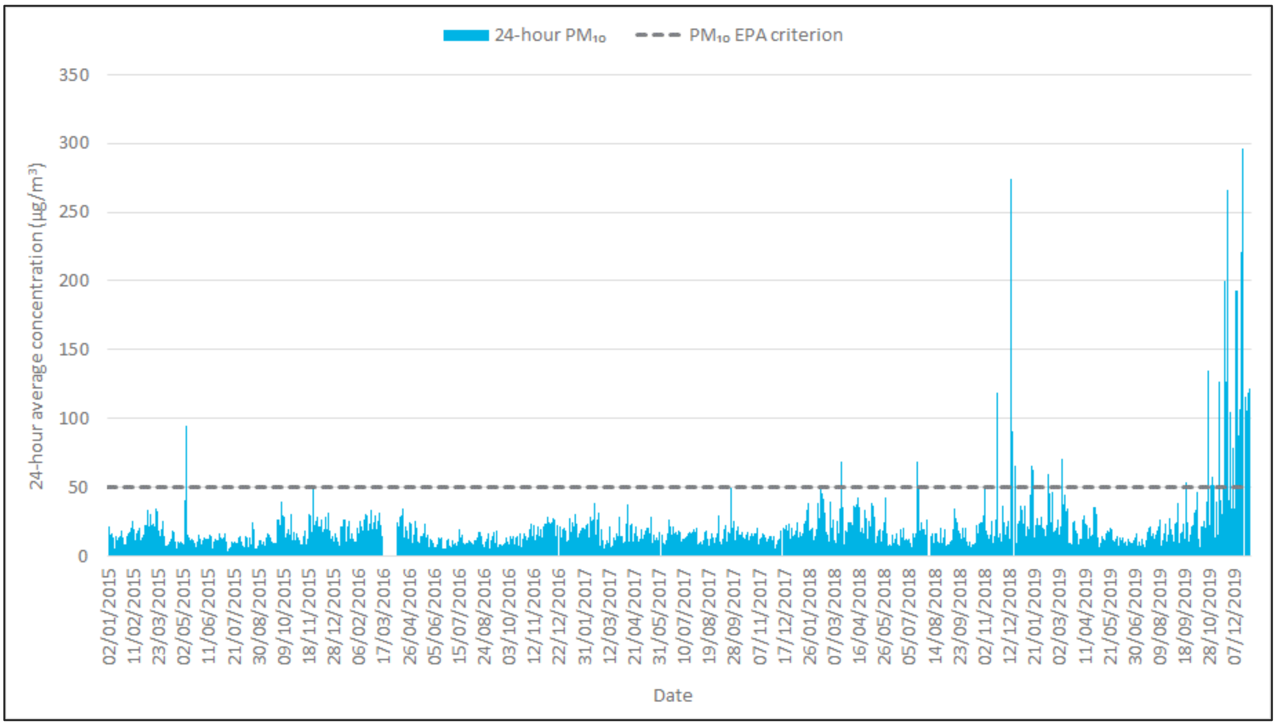


Figure 4.2 Time series of 24-hour average PM_{10} concentrations – Bathurst AQMS – 2015–2019

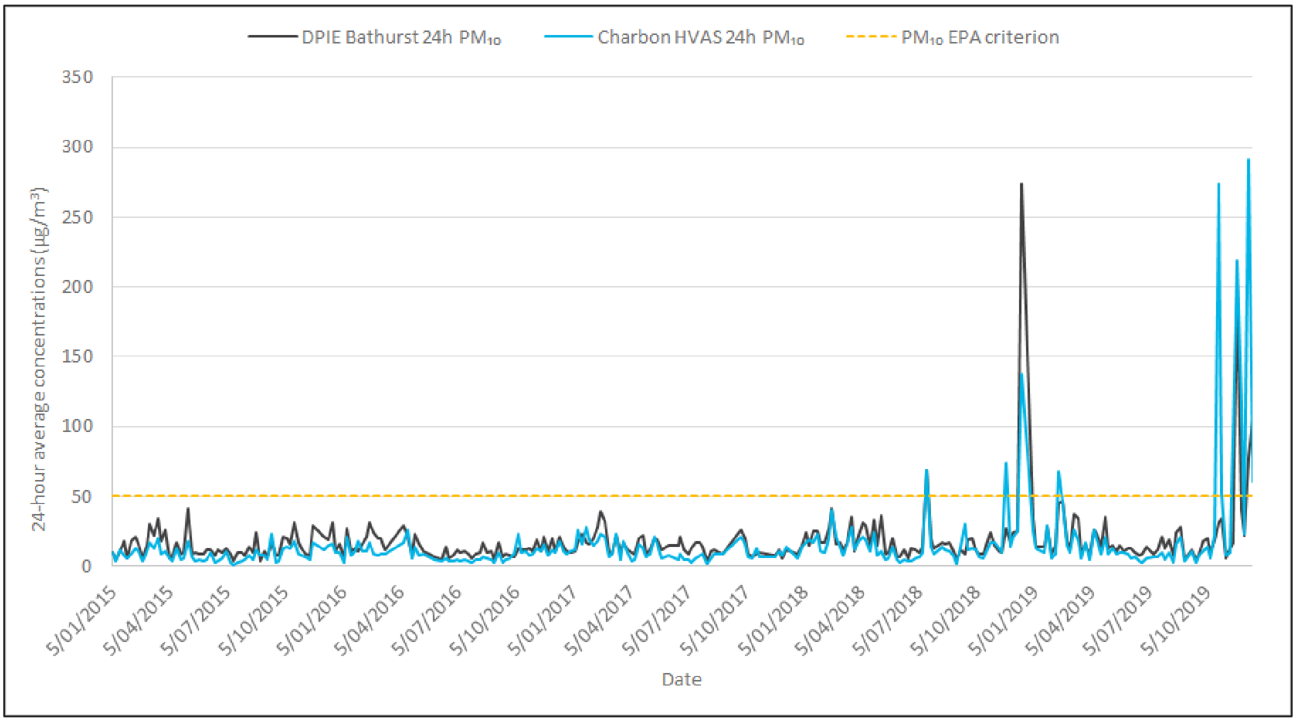


Figure 4.3 Coincident 24-hour average PM_{10} concentrations – Charbon HVAS and Bathurst AQMS – 2018

Note: only dates with co-incident 24-hour average PM_{10} concentrations at both the Charbon HVAS and Bathurst AQMS are shown.

The following points are noted from the comparison:

- there was a similar inter-annual fluctuation in PM_{10} concentrations over the year at the two sites;
- the Bathurst station generally recorded higher average PM_{10} concentrations than the Charbon HVAS for all years of monitoring; and
- on average, the Charbon HVAS recorded concentrations that were approximately 80% of the concentrations recorded at Bathurst. It is noted that concentrations recorded at both monitoring stations at the end of 2019 are influenced by bushfire activity around NSW at that time.

Two main factors are considered to contribute to the higher concentrations recorded at Bathurst:

- Regional-scale events such as dust storms or bushfires can result in elevated concentrations for several days, and these could have been missed by the HVAS monitoring method.
- The Bathurst site features a higher density of urban development and associated emission sources (eg motor vehicles, domestic heating, etc) than the area surrounding Charbon. In particular, the elevated concentrations during the autumn and winter months from the Bathurst AQMS dataset were likely attributable to a higher density of wood heater emissions relative to the Charbon area.

The Bathurst dataset is therefore considered a conservatively high continuous record of 24-hour average PM_{10} concentrations that better meets the data completeness requirements for a Level 2 AQIA[2]. However, as reported in Section 4.3.1, there were eight days in 2018 when the PM_{10} concentrations were already above 50 µg/m³.

4.3.2 $PM_{2.5}$

No monitoring of $PM_{2.5}$ is conducted by the existing air quality monitoring network at Charbon. To provide an analysis of background $PM_{2.5}$ concentrations in the absence of these measurements, $PM_{2.5}$ concentrations recorded by the Bathurst AQMS were reviewed. The Bathurst station commenced measurement of $PM_{2.5}$ concentrations in April 2016.

Key statistics for the analysed $PM_{2.5}$ monitoring data from the Bathurst station are presented in Table 4.3. As was the case for PM_{10}, the presented statistics for 2018 are higher than the 2016 (partial year) and 2017 datasets. Consistent with PM_{10}, the 2018 calendar year $PM_{2.5}$ dataset from the Bathurst AQMS has been adopted to represent background conditions for the assessment.

A time series of the recorded 24-hour average $PM_{2.5}$ concentrations at Bathurst is presented in Figure 4.4. Like the PM_{10} concentrations, the recorded 24-hour average $PM_{2.5}$ concentrations fluctuated throughout the presented period. The recorded $PM_{2.5}$ concentrations were generally below the NSW EPA assessment criterion of 25 µg/m³, although 2 exceedances were recorded in 2018 and 24 exceedances were recorded in 2019.

[2] Defined in the Approved Methods for Modelling as a ‘refined dispersion modelling technique using site-specific input data (EPA 2016).

Table 4.3 Statistics for $PM_{2.5}$ concentrations –Bathurst AQMS – 2016–2019

Monitoring year	$PM_{2.5}$ concentration (µg/m³)		
	Maximum 24-hour average concentration (µg/m³)	Annual average concentration (µg/m³)	Number of days greater than 50 µg/m³
2016	15	5.9	0
2017	17.5	6.1	0
2018	40.5	7	2
2019	199.5	11.3	24

Note: Monitoring of $PM_{2.5}$ at the Bathurst AQMS commenced in April 2016.

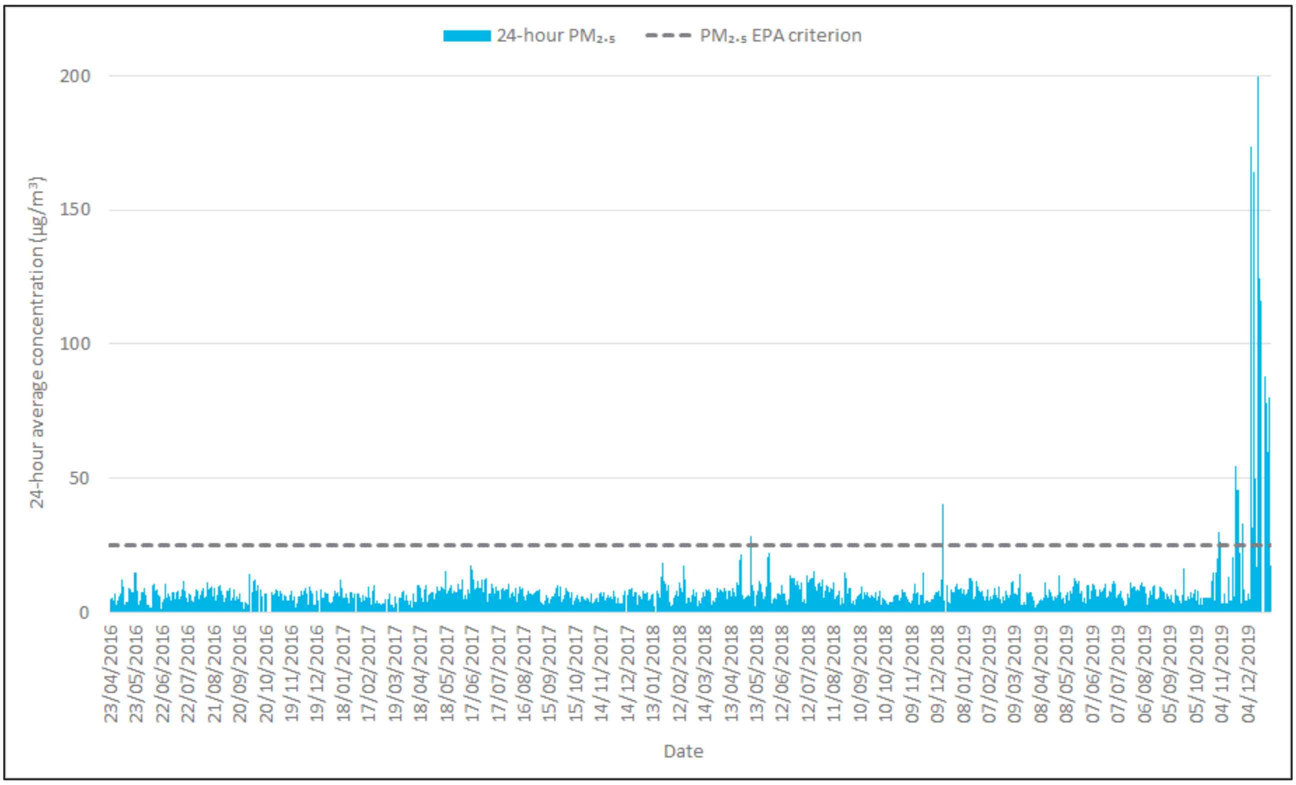


Figure 4.4 Time series of 24-hour average $PM_{2.5}$ concentrations – Bathurst AQMS – 2016–2019

Note: Monitoring of $PM_{2.5}$ at the Bathurst AQMS commenced in April 2016.

4.3.3 TSP

TSP concentrations are recorded at Charbon by HVAS on a one-in-six day run cycle. A summary of key statistics for the five years of analysed data from the Charbon HVAS is presented in Table 4.4. As with the PM_{10} concentrations shown in Section 4.3.1, Table 4.4 shows that measured TSP concentrations have been increasing since 2015 and are highest in 2019. Again, this is likely to be due to drought conditions across the state in these years.

Taking the corresponding Charbon HVAS PM_{10} concentrations into account, the PM_{10}:TSP ratio for each year between 2015 and 2019 was calculated. The average PM_{10}:TSP ratio for these years from the HVAS was 0.60.

As stated previously, in order to undertake a contemporaneous cumulative PM_{10} assessment, the daily PM_{10} concentration dataset from the Bathurst AQMS has been adopted for background concentrations at Charbon rather than the one-in-six day HVAS dataset from Charbon. Using the annual average PM_{10} concentration for 2018 at the Bathurst AQMS of 18.8 µg/m^3 (Section 4.3.1) and a PM_{10}:TSP ratio of 60%, an annual average background value of 31.4 µg/m^3 is derived.

It is noted that the PM_{10}:TSP ratio for rural areas typically range from 0.4 to 0.5 (ie 40–50%). A ratio of 40% is often used to derive TSP where TSP data are unavailable. Although TSP data has been collected at the Charbon HVAS, given the ratio is higher than normally expected (ie 60%), a 40% PM_{10}:TSP ratio has been applied in this case for conservatism. When applying a PM_{10}:TSP ratio of 40% to the annual average PM_{10} concentration for 2018 (ie 18.8 µg/m^3), the resultant derived TSP background concentration is 47.1 µg/m^3.

Table 4.4 Statistics for TSP concentrations – Charbon HVAS – 2015–2019

Monitoring year	TSP concentration (µg/m³)
	Annual average concentration (µg/m³)
2015	15.8
2016	16.8
2017	20.8
2018	28.8
2019	58.8

4.3.4 Dust deposition

Charbon Coal operates a network of four dust deposition gauges within the project site boundary (Figure 4.1).

A summary of the dust deposition monitoring results for Charbon is presented in Table 4.5. Annual average dust deposition ranges from 0.5 g/m^2/month to 2.2 g/m^2/month, with an average across all sites and all years of 0.9 g/m^2/month. The average across all sites for 2018 is 1.3 g/m^2/month. This value has been adopted as the background for the cumulative assessment.

The measured dust deposition levels include contributions from existing operations at Charbon and provide a conservatively high background for cumulative assessment.

Table 4.5 Dust deposition monitoring summary for Charbon

Year	Annual average dust deposition by site (g/m²/month)			
	DM South	DM West	Pit Top	Nioka
2015	0.5	0.6	0.9	0.4
2016	0.9	0.5	0.6	0.5
2017	0.5	0.4	0.7	0.5
2018	2.2	0.9	1.4	0.9
2019	1.9	1.6	1.6	1.5

4.4 Summary of assumed background concentrations

The following background values have been adopted for cumulative assessment:

- 24-hour PM_{10} concentration – daily varying;
- annual average PM_{10} concentration – 18.8 µg/m³;
- 24-hour $PM_{2.5}$ concentration – daily varying;
- annual average $PM_{2.5}$ concentration – 7 µg/m³;
- annual average TSP concentration – 47.1 µg/m³; and
- annual average dust deposition – 1.3 g/m²/month.

5 Emissions inventory

5.1 Introduction

One worst-case emissions scenario has been developed to quantify particulate matter impacts from Charbon. This scenario corresponds to the estimated maximum amount of overburden and CCR material moved around the site as well as the extent of areas exposed to wind erosion. The scenario includes emissions from existing site rehabilitation activities.

As stated in Section 2.1, an 'existing' scenario has not been assessed given the small scale of changes proposed as part of the modification. Mining operations at Charbon have ceased and Charbon Coal will continue to progressively rehabilitate the site.

Given the short timeframe and small-scale of construction activities (Section 1.3.1 and Section 2.1), construction-related emissions have not been assessed further.

5.2 Emissions estimates

5.2.1 Overview

Fugitive dust sources associated with operations at Charbon were quantified through the application of US-EPA AP-42 emission factor equations. Particulate matter emissions were quantified for the three size fractions – TSP, PM_{10} and $PM_{2.5}$. Emission rates for coarse particles (PM_{10}) and fine particles ($PM_{2.5}$) were estimated using ratios for the different particle size fractions available in the literature (principally the US-EPA AP-42).

The calculated annual TSP, PM_{10} and $PM_{2.5}$ emissions for each activity occurring at Charbon are shown in Table 5.1. Each activity has been represented in the modelling as a volume or line-volume source. Site diesel combustion was attributed equally to all activities (except wind erosion). The modelled source locations are shown in Figure 5.1. Activities were modelled for every day of the year between the hours of 7 am and 6 pm with the exception of wind erosion of exposed areas which were modelled for 24 hours a day.

A detailed description of the assumptions and emission factors adopted in the development of the emissions inventory are provided in Appendix B.

5.2.2 Neighbouring operations

Charbon Lime Works is approximately 400 m west of the rail loop (Figure 1.2). It is understood that this site is currently operating in a limited capacity[3]. Information provided by the operator of the Charbon Lime Works indicates that the plant has recently restarted its hydrating processes (following cessation of operations at the end of 2015); however, it is not yet operating the kilns. Full hydrator and kiln operations are proposed to recommence at the end of 2020. The proposed processing rate is unknown at this point and information on specific activities, locations of equipment, haulage and exposed areas is not publicly available.

The National Pollutant Inventory (NPI) provides a record of PM_{10} emissions reported by the facility up to 2015/2016. Annual PM_{10} emissions range from 2,100 kilograms per year (kg/y) to 460,000 kg/y from 2008 to 2016. An analysis of the data implies that some yearly results may be unreliable (reporting error) and it is also unclear what production rates correspond to these emissions.

[3] http://www.npi.gov.au/npidata/action/load/individual-facility-detail/criteria/state/NSW/year/2016/jurisdiction-facility/651

Heggies (2009) provided high-level model screening results for the Charbon Lime Works using emissions data from the NPI. It stated that, as potential peak operations were unknown, only the annual average concentrations could provide a meaningful reflection of impacts from this facility in the local area. When discussing predicted results (annual average PM_{10} concentration of 2.9 µg/m^3 at assessment location R), Heggies (2009) concluded that the background dataset used (ie Bathurst AQMS) was appropriate to account for any cumulative impacts surrounding Charbon.

The processing rate used in Heggies (2009) is unknown. Therefore, a screening model assessment for the Charbon Lime Works was completed using the maximum annual production rate of 100,000 t as specified in the site's Environment Protection Licence[4] (EPL). Emissions were estimated using emission factors for 'crushing with fabric filter' and 'kiln with fabric filter' from the *Emission Estimation Technique Manual for Lime and Dolomite Manufacturing* (NPI 2003).

These activities, and the use of fabric filters, were assumed based on information provided in Heggies (2009) and the NPI summary of the Charbon Lime Works facility. Based on the information available, the emissions estimated for TSP, PM_{10} and $PM_{2.5}$ were 25,050 kg/y, 10,020 kg/y and 1,503 kg/y, respectively. Given the lack of information available relating to the Charbon Lime Works facility, these annual emission estimates are indicative only.

Site-specific source characteristics (eg stack parameters, building dimensions) and daily variation in operations were not available for use in the screening model assessment. Calculated annual emissions were evenly distributed across the Charbon Lime Works site using a series of equivalent volume sources and constant emission rates. The use of ground level volume sources in the screening model conservatively assumes that all operational emissions are treated as fugitive emission releases, which likely underestimates dispersion potential and overpredicts ground level concentrations in the surrounding environment.

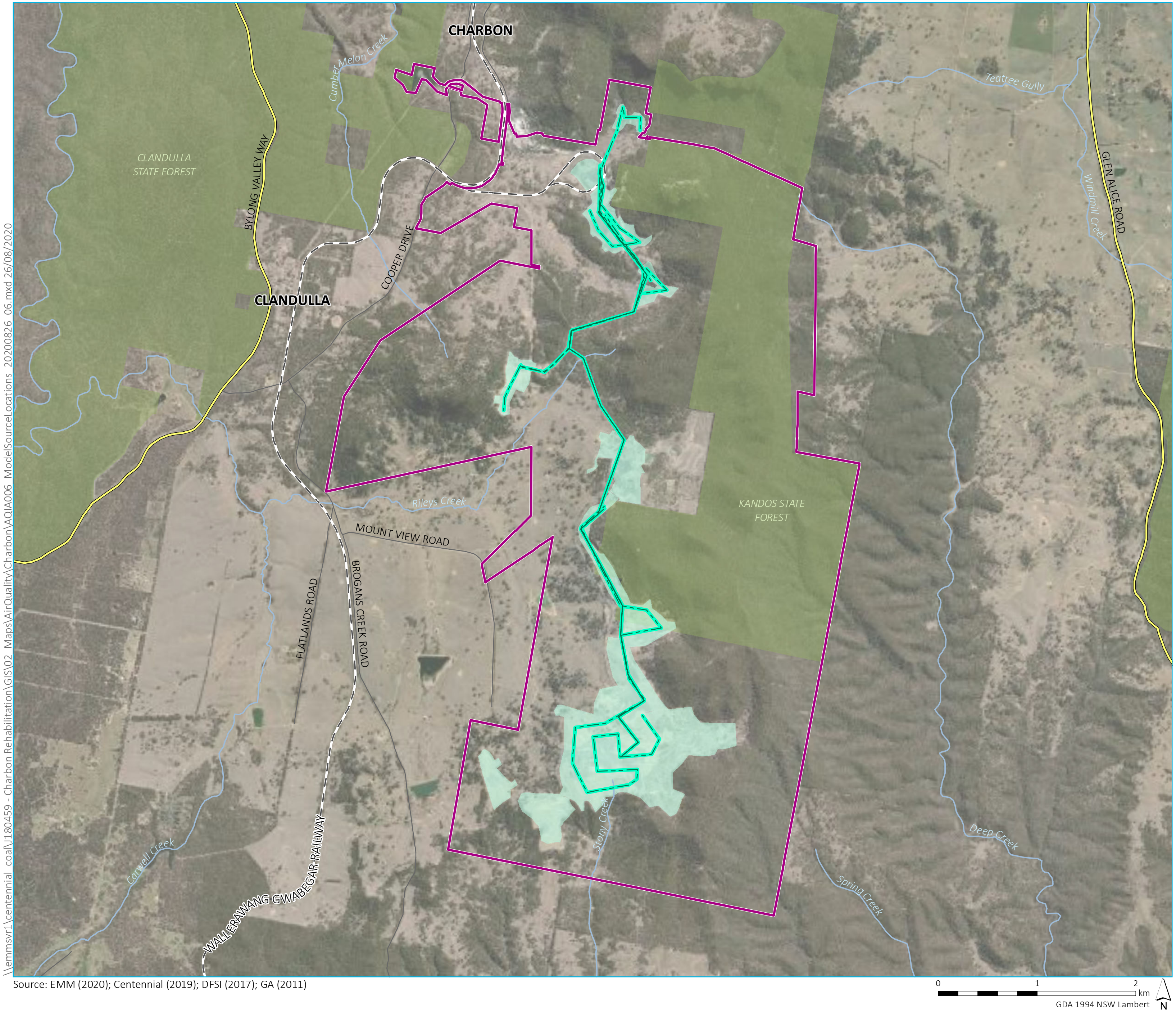
Given the uncertainty in the calculated annual emissions, the configuration of site emission sources in the model and lack of detail on the daily activity rate variations, only annual average model predictions from the Charbon Lime Works facility are considered in this assessment for contribution to background.

The screening model run for the Charbon Lime Works predicted annual average PM_{10} concentrations at assessment locations of between <0.01 µg/m^3 and 1.54 µg/m^3. The highest annual average concentration was predicted at assessment location Q, which is within 500 m of Charbon Lime Works (Figure 1.2).

Based on the results of the screening model and given the uncertainty in annual emission calculations and model configuration, it is considered that the Bathurst background dataset as presented in Section 4.3.1 is appropriately conservative for accounting for potential cumulative impacts from Charbon Lime Works.

The only other operation in the vicinity of Charbon is Cement Australia's production facility (approximately 3 km north of Charbon – Figure 1.2). It is understood that this facility has ceased operations and has therefore not been explicitly modelled in this assessment.

[4] https://apps.epa.nsw.gov.au/prpoeoapp/Detail.aspx?instid=5412&id=5412&option=licence&searchrange=licence&range=POEO%20licence&prp=no&status=Issued



KEY
- Charbon Colliery project site boundary
- Rail line
- Major road
- Minor road
- Watercourse
- State forest

Model source type
- Line-volume
- Volume

Source: EMM (2020); Centennial (2019); DFSI (2017); GA (2011)

\\emmsvr1\centennial_coal\J180459 - Charbon Rehabilitation\GIS\02_Maps\AirQuality\Charbon\AQIA006_ModelSourceLocations_20200826_06.mxd 26/08/2020

Model source locations

Charbon Colliery Modification 2
Air quality impact assessment
Figure 5.1

EMM
creating opportunities

5.2.3 Emissions summary

A graphical summary of the contribution to annual dust emissions by source type is provided in Figure 5.2. Calculated annual emissions by emissions source is presented in Table 5.1. Particulate matter control measures, (Chapter 6) are accounted for in these emission totals.

From the data presented in the following figures and tables, the most significant source of particulate matter emissions from Charbon's operations is associated with wind erosion of exposed areas with a lesser percentage from hauling on unpaved roads.

Further details regarding emission estimation factors and assumptions are provided in Appendix B.

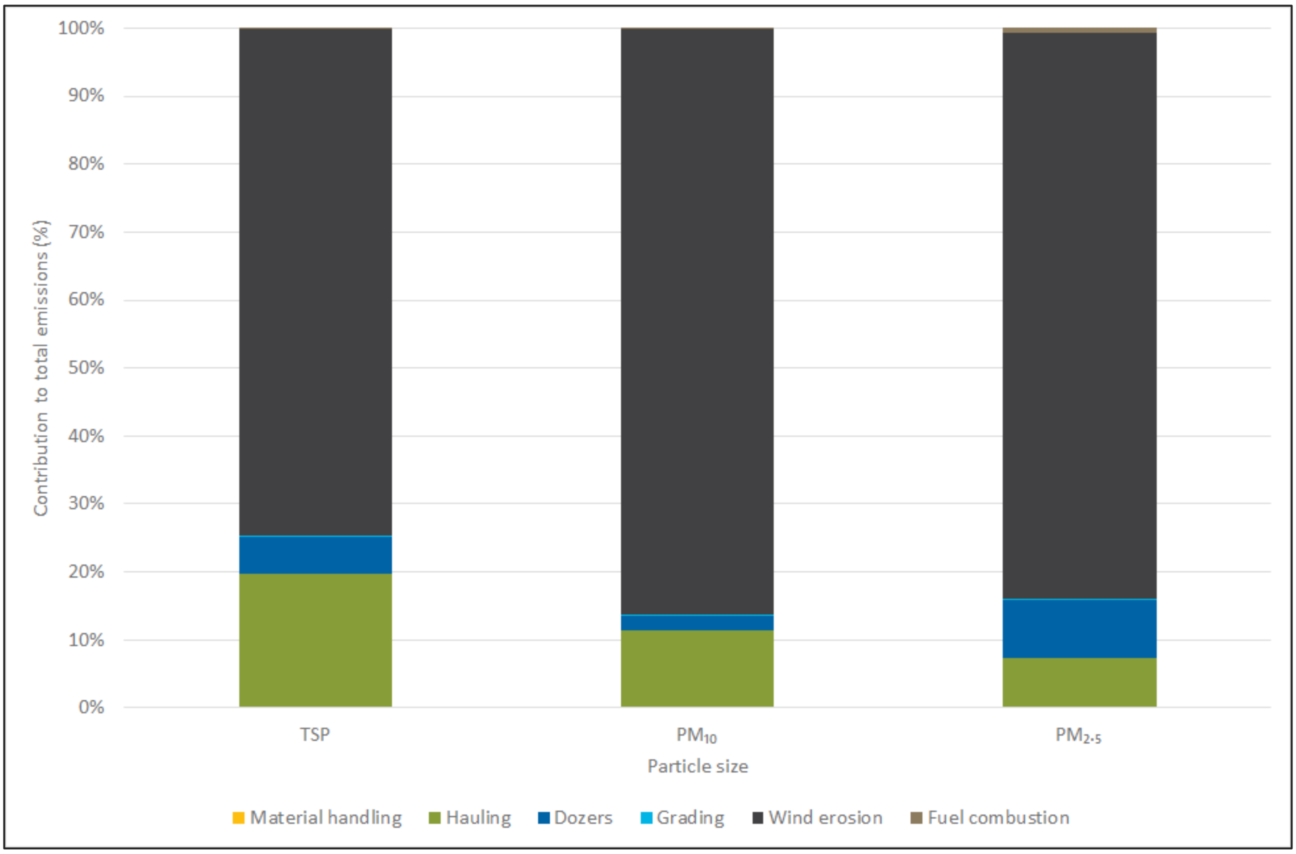


Figure 5.2 Contribution to annual emissions by source type and particle size

Table 5.1 Calculated annual TSP, PM_{10} and $PM_{2.5}$ emissions

Emission source	Calculated annual emissions (kg/annum) by source		
	TSP	PM_{10}	$PM_{2.5}$
Northern REA			
Excavator/front end loader (FEL) loading rejects to trucks for transport to Main REA.	35	17	3
Rail loop			
Excavator/FEL loading CCR to trucks for transport.	144	68	10
Main REA			
Unloading overburden from Southern Open Cut stockpile area.	3	1	0
Unloading rejects from Northern REA from trucks.	35	17	3
2 x dozers working on rejects and overburden.	3,187	571	335
Central Open Cut Box Cut			
Unloading overburden from Southern Open Cut stockpile area.	4	2	0
Unloading CCR from rail loop.	37	18	3
2 x dozers working on spoil.	4,975	571	522
Western Open Cut			
Unloading overburden from Southern Open Cut stockpile area.	9	4	1
Unloading CCR from rail loop.	36	17	3
2 x dozers working on spoil.	4,975	922	522
8 Trunk Open Cut			
Unloading overburden from Southern Open Cut stockpile area.	13	6	1
Unloading CCR from rail loop.	70	33	5
2 x dozers working on spoil.	4,975	922	522
Southern Open Cut stockpile			
FEL loading overburden into trucks.	26	12	2
1 x dozer working on overburden.	398	71	42
Hauling and grading			
Hauling rejects from Northern REA to Main REA.	5,024	1,270	127
Hauling overburden from Southern Open Cut stockpile to 8 Trunk Open Cut.	4,356	1,101	110
Hauling overburden from Southern Open Cut stockpile to Central Open Cut Box Cut.	2,636	666	67
Hauling overburden from Southern Open Cut stockpile to Western Open Cut.	4,968	1,255	126

Table 5.1 Calculated annual TSP, PM_{10} and $PM_{2.5}$ emissions

Emission source	Calculated annual emissions (kg/annum) by source		
	TSP	PM_{10}	$PM_{2.5}$
Hauling overburden from Southern Open Cut stockpile to Main REA.	2,037	515	51
Hauling CCR from rail loop to Central Open Cut.	6,246	1,578	158
Hauling CCR from rail loop to Western Open Cut.	12,172	3,076	308
Hauling CCR from rail loop to 8 Trunk Open Cut.	33,405	8,442	844
Grading roads	1,187	479	37
Active wind erosion areas			
Wind erosion - Northern REA.	4,420	2,210	332
Wind erosion - Stockpile areas.	9,605	4,803	720
Wind erosion - Main REA.	15,725	7,863	1,179
Wind erosion - Central Open Cut area.	6,970	3,485	523
Wind erosion - Western Open Cut area.	10,030	5,015	752
Wind erosion - Coal handling plant (CHP) area.	19,805	9,903	1,485
Wind erosion - 8 Trunk Open Cut area.	47,090	23,545	3,532
Wind erosion - Southern Open Cut and Southern Open Cut extension area.	118,150	59,075	8,861
Wind erosion - Western Outlier.	9,520	4,760	714
Wind erosion - Southern Outlier.	15,470	7,735	1,160
Diesel combustion			
Site diesel combustion.	198	198	182
Total	**347,939**	**150,225**	**23,241**

Note: Emission totals incorporate particulate matter management measures (Chapter 6). The sum of the emissions from activities provided above is slightly different to the totals shown due to rounding.

6 Overview of best practice dust control

A range of mitigation measures and management practices are implemented to manage particulate matter emissions from Charbon. An Air Quality Management Plan (AQMP) is also available which includes a summary of air quality control measures used at Charbon as well as details of the air quality monitoring program, response procedures, data analysis, reporting, review and improvement (Centennial 2018).

Table 6.1 provides an overview of the relevant applicable best practice dust control management measures as listed in the *NSW Coal Benchmarking Study: International Best Practice to Prevent and/or Minimise Emissions of Particulate Matter from Coal Mining* (Katestone 2011). Table 6.1 also includes the percentage control factor applied in the dispersion modelling.

Dust mitigation measures implemented at Charbon and incorporated in the emissions estimation include:

- water carts on unpaved haul roads;
- water carts used on grader routes; and
- water carts used on dozer materials and routes.

There are also a number of other measures employed at Charbon but not explicitly included in the emissions estimation. These include:

- watering exposed areas as needed (eg during periods of high winds);
- exposed areas progressively rehabilitated and stabilised;
- progressive revegetation of completed material placement areas;
- excavator and truck unloading heights minimised; and
- water sprays applied when unloading materials as needed (eg during periods of high winds).

It is considered that the emissions include an element of conservatism by not including some measures such as watering exposed areas during high wind periods.

As shown in Table 6.1, wherever practical to do so, Charbon currently implements dust control measures that are consistent with accepted best practice mitigation measures for all significant operational sources of particulate matter emissions.

Table 6.1 Overview of best practice measures employed at Charbon

Emissions source category	Best practice control measures (Katestone 2011)	Implemented at Charbon	Comments	Effectiveness of reduction in emissions inventory
Haul roads	Surface treatment - watering	Yes	Water trucks used on haul roads.	75%
	Surface treatment - chemical suppressants	No	Water trucks applied on haul roads.	N/A
	Surface improvements - low silt aggregate	Yes	Water sprays assist with the reduction of silt loading.	N/A
	Surface improvements - pave the surface	No	Water trucks applied on haul roads.	N/A
	Reduction in vehicle travel speed	Yes	Truck travel speeds will be maintained below 40 km/hr.	N/A
	Use larger vehicles rather than smaller vehicles to minimise number of trips	Yes	Haul truck mean weight is 37.9 t.	Haul truck weight included. No specific control applied.
	Use conveyors in place of haul roads	No	Not practicable for size and scale of areas.	N/A
Wind erosion - exposed areas (overburden and CCR emplacement)	Surface stabilisation - watering	Yes	Water around the area when in use.	Not applied as this measure will be applied as needed (eg during periods of high winds).
	Surface stabilisation - chemical suppressants	No	Not practicable for size and scale of areas.	N/A
	Surface stabilisation - paving and cleaning	No	Not practicable for size and scale of areas.	N/A
	Surface stabilisation - armour with gravel	No	Not practicable for size and scale of areas.	N/A
	Surface stabilisation - rehabilitation	Yes	Surface is progressively stabilised during rehabilitation.	N/A. Emissions assume rehabilitation is not yet completed.

Table 6.1 Overview of best practice measures employed at Charbon

Emissions source category	Best practice control measures (Katestone 2011)	Implemented at Charbon	Comments	Effectiveness of reduction in emissions inventory
	Wind speed reduction - fencing, bunding, shelterbelts or in-pit dumps	No	Not practicable. The majority of the rehabilitated voids are naturally sheltered by highwalls or within in-pit dumps.	N/A
	Wind speed reduction - vegetative ground cover	Yes	Vegetative ground cover is placed once material placement is completed.	N/A. Emissions assume vegetative ground cover is not yet completed.
Loading and dumping overburden and CCR	Excavator - minimise drop height	Yes	Wherever possible, material drop heights will be minimised.	N/A
	Truck dumping - minimise drop height	Yes	Wherever possible, material drop heights will be minimised when unloading trucks.	N/A
	Truck dumping - water application	Yes	Not applied as this measure will be applied as needed (eg during periods of high winds).	N/A
	Modify activities in windy conditions	Yes	As above.	N/A
Grading roads	Surface stabilisation - watering	Yes	Water around the area when in use.	50%
Dozers on overburden and CCR	Minimise travel speed and distance	Yes	Truck travel speeds will be maintained below 40 km/hr.	N/A
	Keep travel routes and materials moist	Yes	Water carts use on dozers areas.	50%

7 Air dispersion modelling

7.1 Dispersion model selection and configuration

Dispersion modelling for this assessment uses the CALPUFF modelling system, which is commonly used in NSW for applications where non-steady state conditions may occur (ie complex terrain or coastal locations) or when calm wind conditions are important (ie for odour assessment). In the absence of available upper air measurements, CALMET (the meteorological pre-processor for CALPUFF) can be run using prognostic upper air data (as a three-dimensional '3D.dat' file). Gridded upper air data were derived using TAPM, which is then used in CALMET to derive an initial wind field (known as the Step 1 wind field). CALMET then incorporates mesoscale and local scale effects, including surface observations, to adjust the wind field. This modelling approach is known as the 'hybrid' approach (TRC 2011) and has been adopted for this assessment. TAPM and CALMET model settings are described in Section A.2 of Appendix A and selected in accordance with recommendations in EPA (2016) and TRC (2011). Surface observations are included in the modelling (referred to as data assimilation) and are discussed and described in Chapter 3.

In addition to the 19 individual assessment locations (Section 1.5), air pollutant concentrations were predicted over a 10 km by 12 km domain with 500 m resolution.

Specific activities were represented by line-volume and volume sources which were located according to the mine layout. The modelled source locations are shown in Figure 5.1. Simulations were undertaken for the 12-month period of 2018.

7.2 Incremental results

Predicted incremental TSP, PM_{10}, $PM_{2.5}$, and dust deposition levels are presented in Table 7.1 for each of the assessment locations.

The predicted concentrations and deposition rates for all pollutants and averaging periods are below the applicable NSW EPA assessment criterion at all assessment locations. Except for dust deposition, the assessment criteria listed are applicable to cumulative concentrations. Analysis of cumulative impact compliance is presented in Section 7.3.

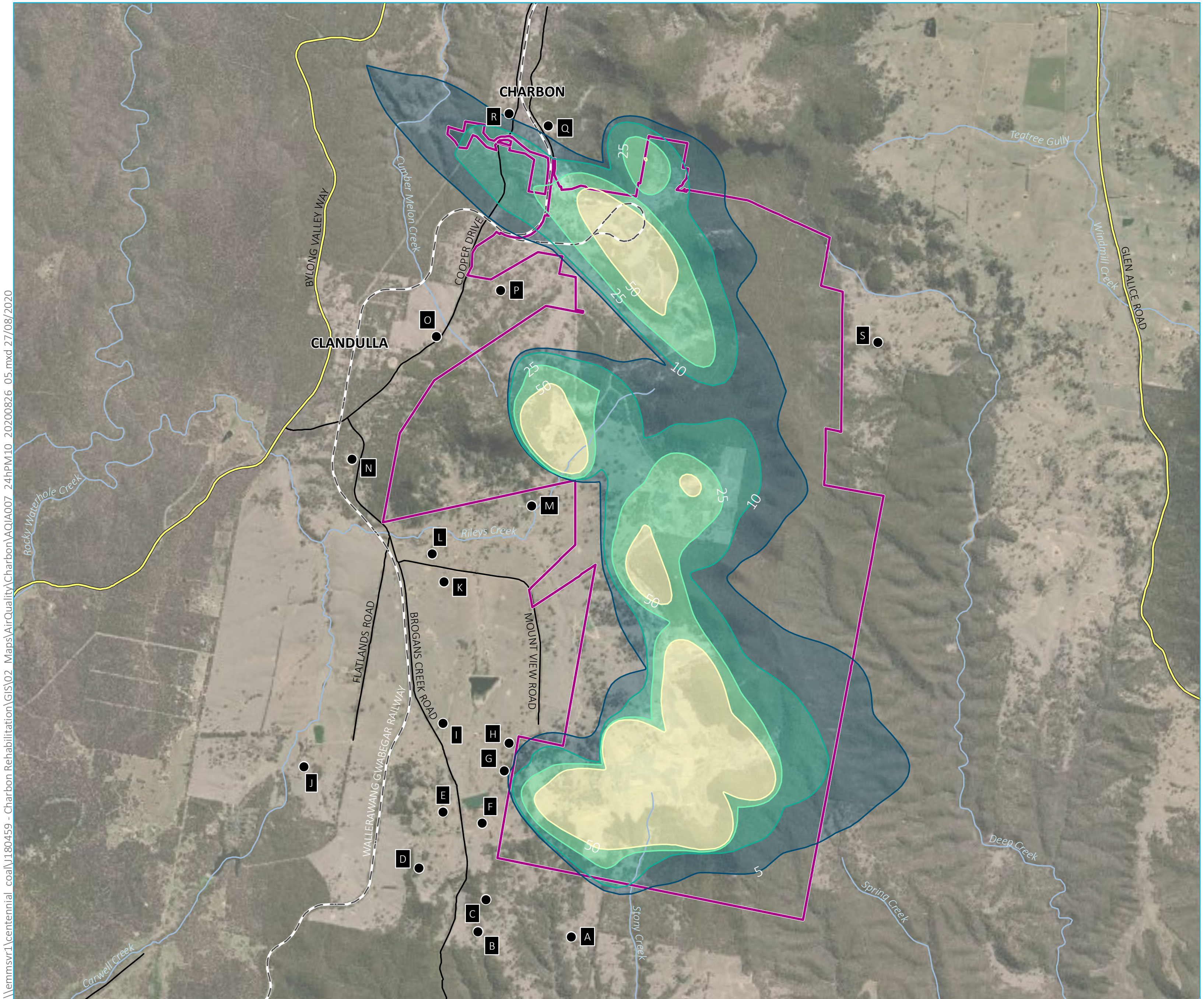
Contour plots, illustrating spatial variations in incremental TSP, PM_{10} and $PM_{2.5}$ concentrations and dust deposition rates are provided in

Figure 7.1 to Figure 7.6 below. Isopleth plots of the maximum 24-hour average concentrations presented do not represent the dispersion pattern on any day, but rather, the maximum daily concentration that was predicted to occur at each model calculation point given the range of meteorological conditions occurring over the 2018 modelling period.

Table 7.1 Incremental concentration and deposition results

Assessment location ID	Predicted incremental concentration (µg/m³) and deposition rate (g/m²/month)					
	TSP	PM_{10}		$PM_{2.5}$		Dust deposition
	Annual	24-hour maximum	Annual	24-hour maximum	Annual	Annual
Criterion	**90**	**50**	**25**	**25**	**8**	**2**
A	<0.1	0.1	<0.1	<0.1	<0.1	<0.1
B	<0.1	0.1	<0.1	<0.1	<0.1	<0.1
C	<0.1	0.1	<0.1	<0.1	<0.1	<0.1
D	<0.1	0.1	<0.1	0.1	<0.1	<0.1
E	<0.1	0.2	<0.1	0.1	<0.1	<0.1
F	<0.1	0.2	<0.1	0.1	<0.1	<0.1
G	0.1	2.5	0.1	0.5	<0.1	<0.1
H	0.1	2.6	0.1	0.4	<0.1	<0.1
I	0.1	1.1	<0.1	0.3	<0.1	<0.1
J	<0.1	0.1	<0.1	<0.1	<0.1	<0.1
K	0.1	1.2	0.1	0.3	<0.1	<0.1
L	0.1	1.2	0.1	0.3	<0.1	<0.1
M	0.3	2.0	0.2	0.4	<0.1	<0.1
N	0.1	0.7	<0.1	0.2	<0.1	<0.1
O	0.1	0.6	0.1	0.1	<0.1	<0.1
P	0.2	1.0	0.1	0.2	<0.1	<0.1
Q	0.1	2.0	0.1	0.4	<0.1	<0.1
R	0.1	3.6	0.1	0.6	<0.1	<0.1
S	0.2	2.1	0.1	0.5	<0.1	<0.1

Note: Criteria for TSP, PM_{10} and $PM_{2.5}$ are applicable to cumulative (increment + background). Criteria is provided for comparison purposes only.

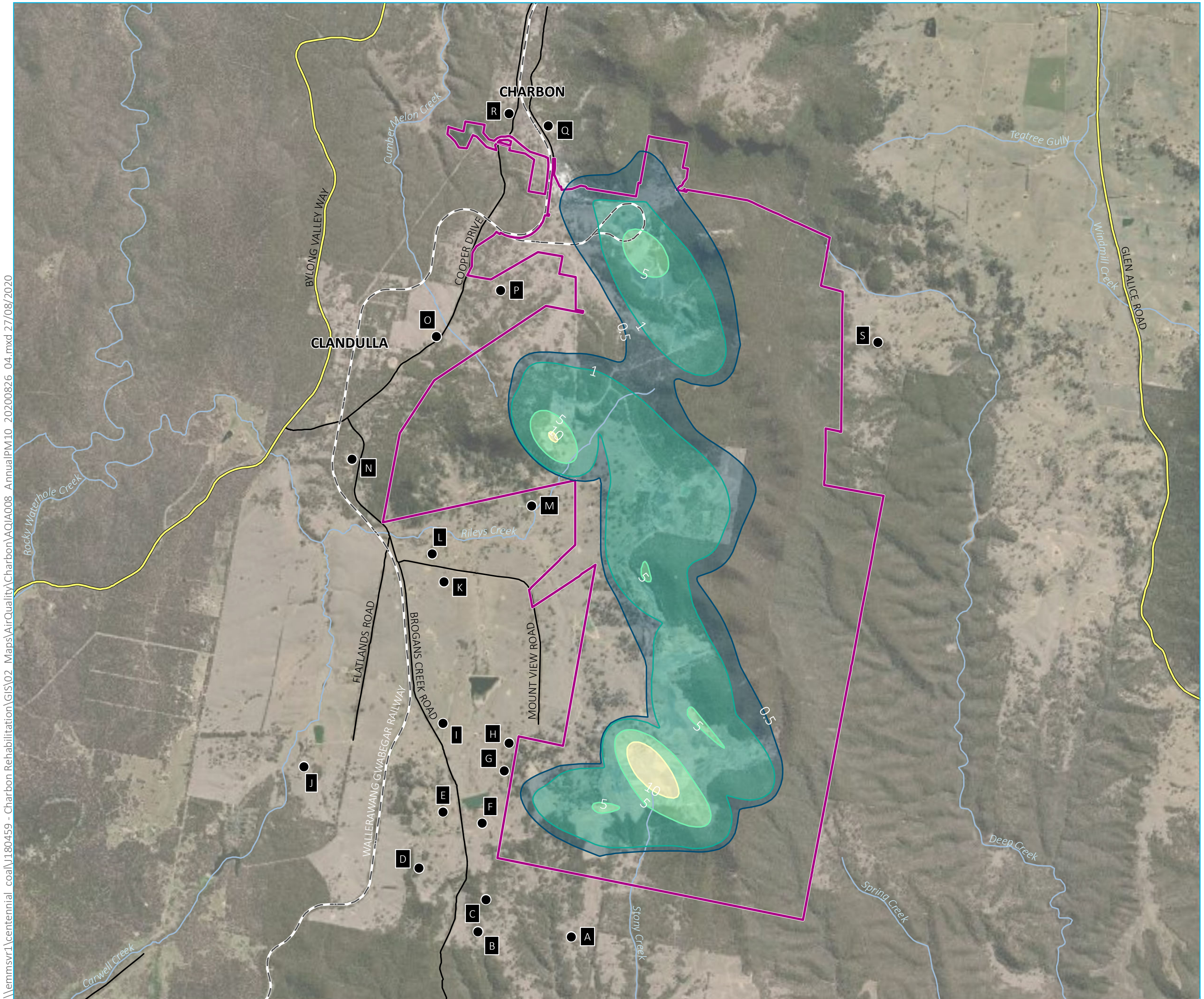


Source: EMM (2020); Centennial (2019); DFSI (2017); GA (2011)

Maximum predicted 24-hour average PM_{10} concentrations – Charbon only

Charbon Colliery Modification 2
Air quality impact assessment
Figure 7.1

EMM
creating opportunities



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Source: EMM (2020);Centennial (2019); DFSI (2017); GA (2011)

KEY

- Charbon Colliery project site boundary
- Assessment location
- Rail line
- Major road
- Minor road
- Watercourse

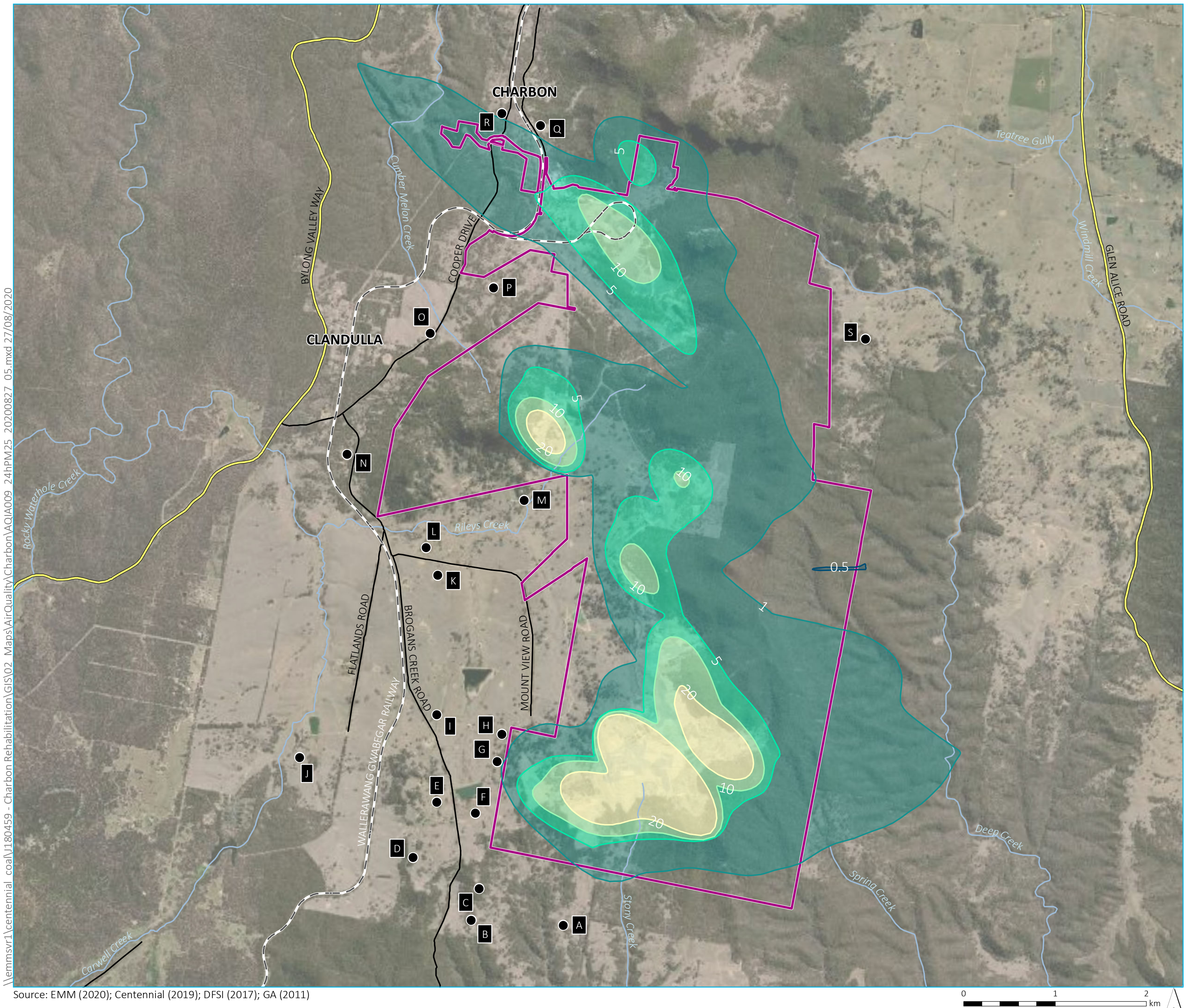
Annual PM_{10} (µg/m³)

- 0.5
- 1
- 5
- 10

Predicted annual average PM_{10} concentrations – Charbon only

Charbon Colliery Modification 2
Air quality impact assessment
Figure 7.2

EMM
creating opportunities

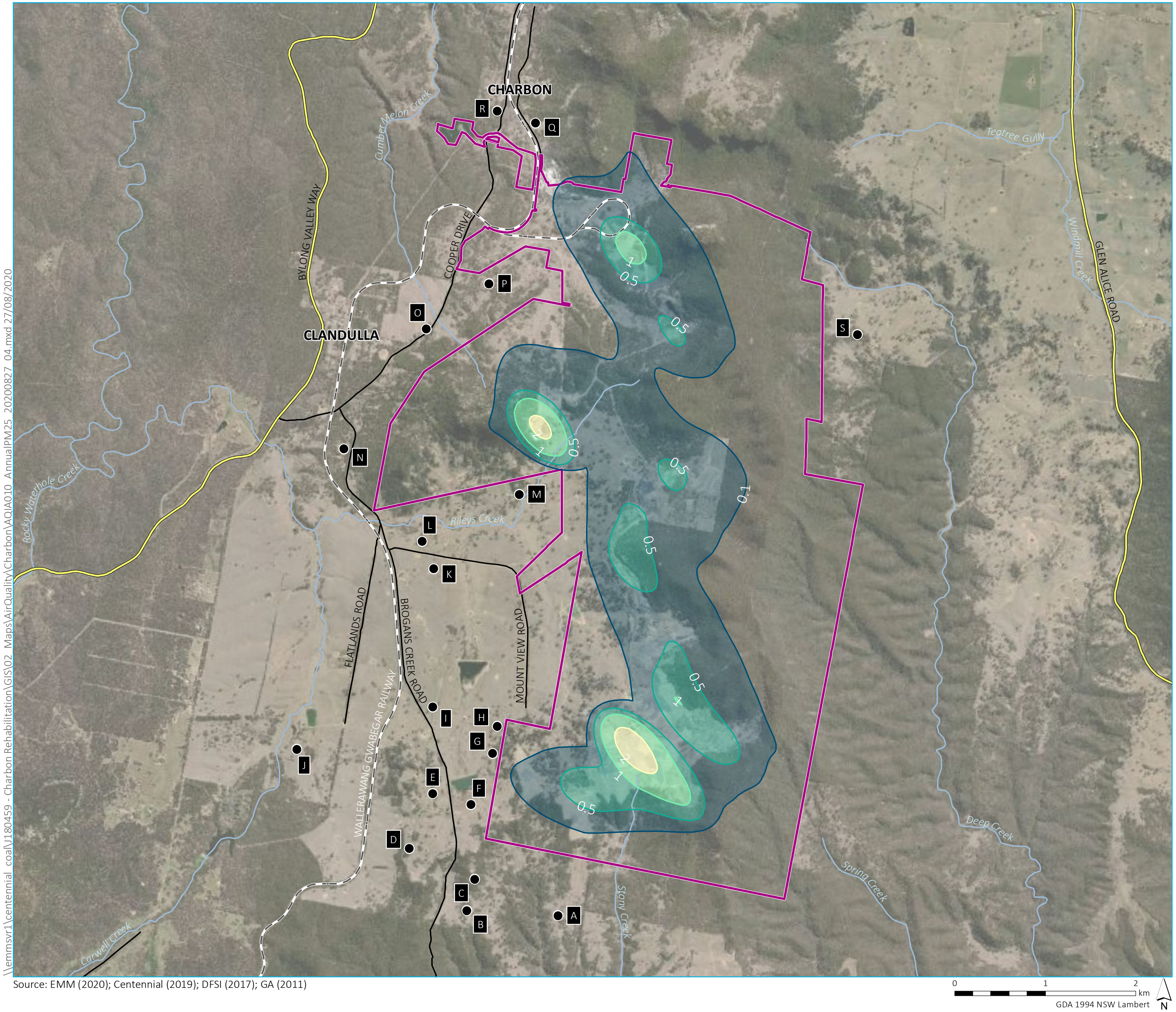


Source: EMM (2020); Centennial (2019); DFSI (2017); GA (2011)

Maximum predicted 24-hour average $PM_{2.5}$ concentrations – Charbon only

Charbon Colliery Modification 2
Air quality impact assessment
Figure 7.3

creating opportunities



KEY

- Charbon Colliery project site boundary
- Assessment location
- Rail line
- Major road
- Minor road
- Watercourse

Annual $PM_{2.5}$ (µg/m³)

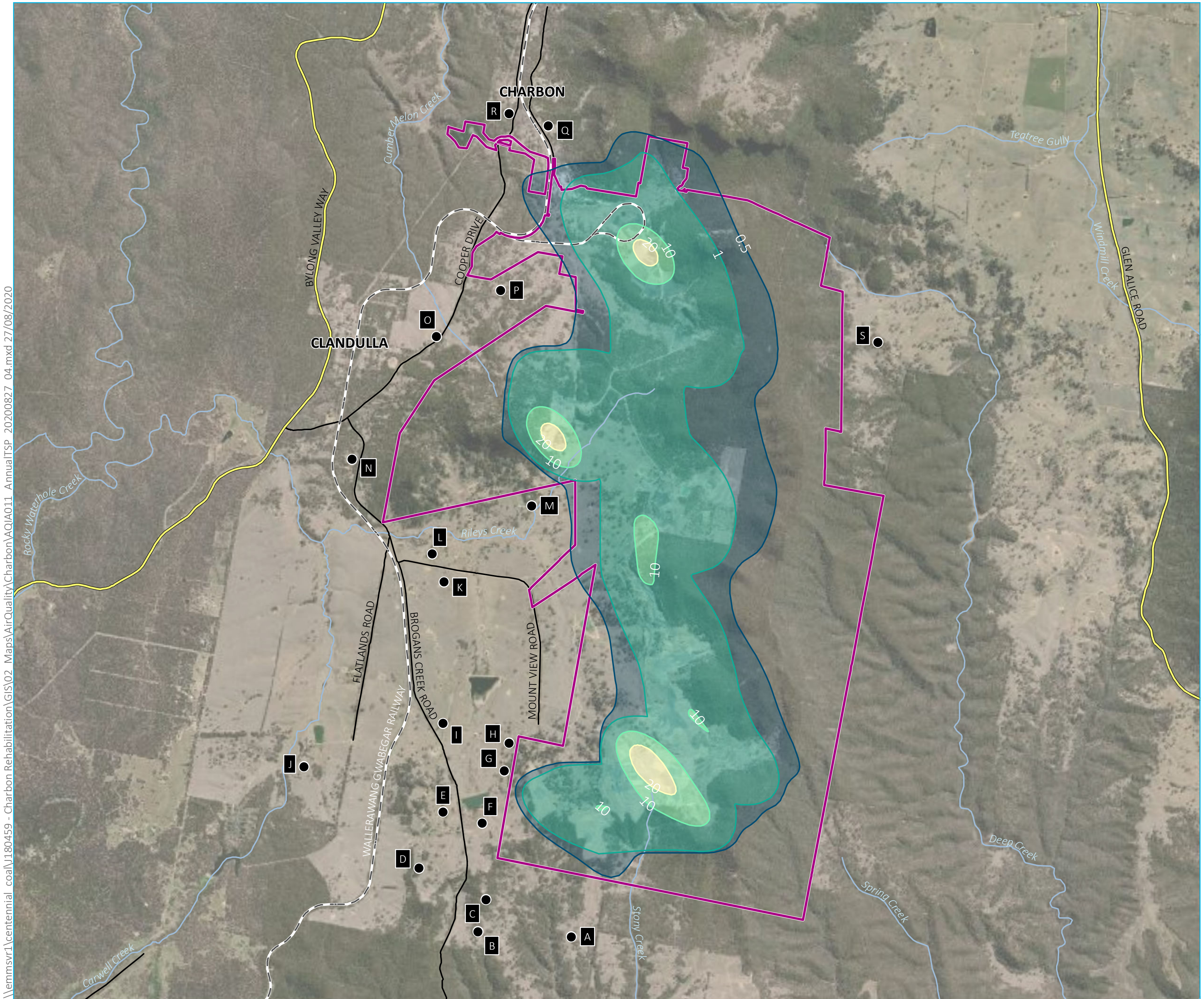
- 0.1
- 0.5
- 1
- 2

Source: EMM (2020); Centennial (2019); DFSI (2017); GA (2011)

Predicted annual average $PM_{2.5}$ concentrations – Charbon only

Charbon Colliery Modification 2
Air quality impact assessment
Figure 7.4

EMM
creating opportunities



Source: EMM (2020);Centennial (2019); DFSI (2017); GA (2011)

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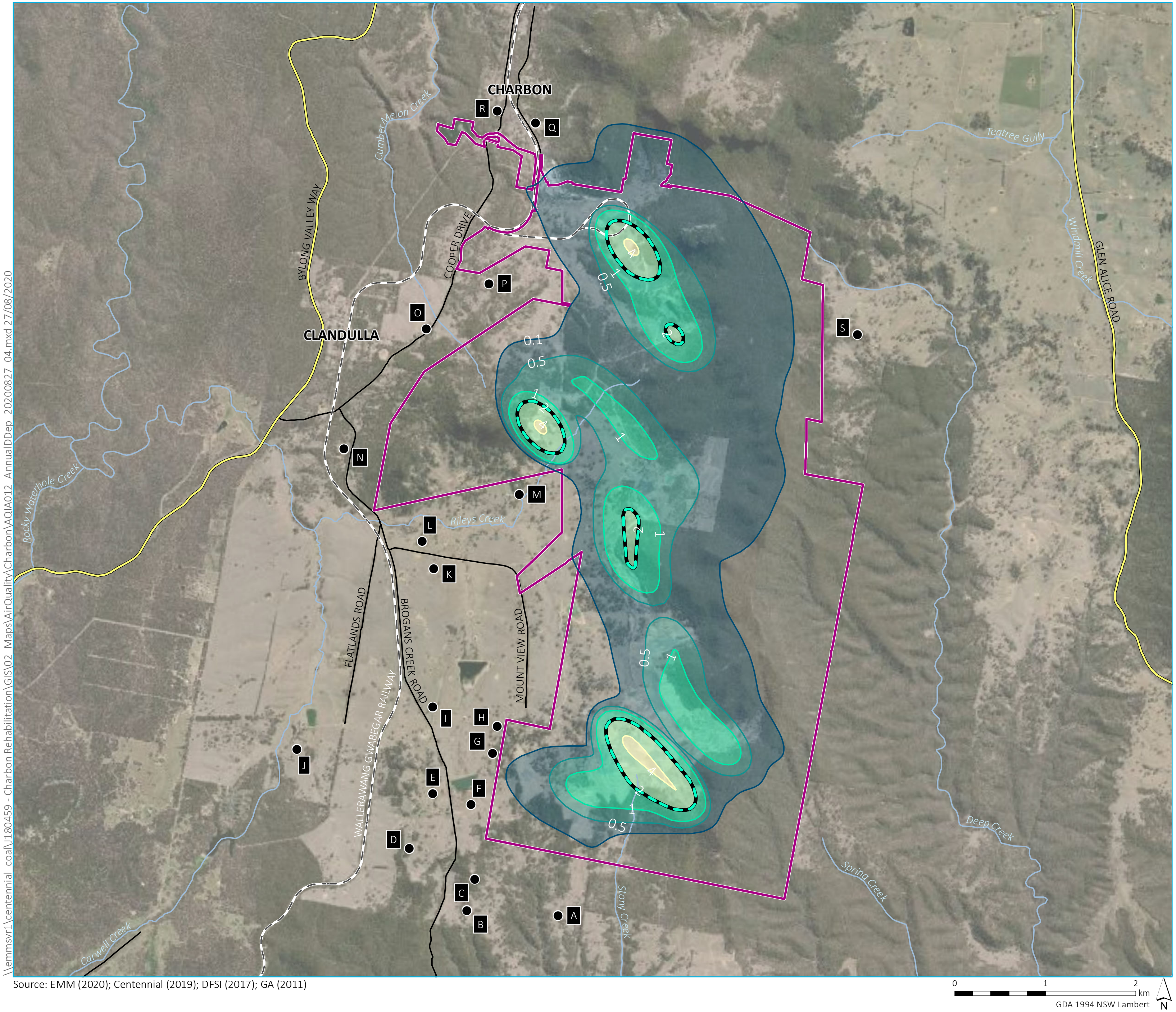
Predicted annual average TSP concentrations – Charbon only

Charbon Colliery Modification 2
Air quality impact assessment
Figure 7.5

EMM
creating opportunities



Source: EMM (2020); Centennial (2019); DFSI (2017); GA (2011)

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Predicted annual average dust deposition level – Charbon only

Charbon Colliery Modification 2
Air quality impact assessment
Figure 7.6

EMM
creating opportunities

7.3 Cumulative results

Cumulative impacts (ie Charbon plus background) at each assessment location have been assessed:

- for 24-hour average concentrations - each daily-varying predicted 24-hour average concentration for PM_{10} and $PM_{2.5}$ has been combined with the corresponding concentrations from the adopted 2018 background concentration datasets (Section 4.3.1 and Section 4.3.2); and

- for annual average concentrations - the predicted annual average concentrations have been paired with the corresponding background annual average concentration.

As stated in Section 4.3.1 and Section 4.3.2, the adopted 24-hour average PM_{10} and $PM_{2.5}$ background datasets contain eight days and two days respectively above the applicable NSW EPA impact assessment criterion. For cumulative impact assessment purposes, these are therefore classed as existing exceedances.

Section 5.1.3 of the Approved Methods for Modelling states that in the event of existing ambient air pollutant concentrations in exceedance of applicable impact assessment criteria, the assessment must:

> …demonstrate that no additional exceedances of the impact assessment criteria will occur as a result of the proposed activity and that best management practices will be implemented to minimise emissions of air pollutants as far as is practical.

As identified in Chapter 6, Charbon currently implements particulate matter control measures that are consistent with accepted industry best practice measures wherever practical to do so.

To demonstrate whether additional exceedances of the applicable criteria will occur as a result of emissions from Charbon, the cumulative analysis presents the 9th highest and 3rd highest cumulative 24-hour average PM_{10} and $PM_{2.5}$ concentrations, respectively. Data has not been removed from the analysis but simply, the next highest result not affected by background above the criterion is shown in this section.

Predicted cumulative TSP, PM_{10}, $PM_{2.5}$, and dust deposition levels as a result of Charbon's operations are presented in Table 7.2 at each of the assessment locations.

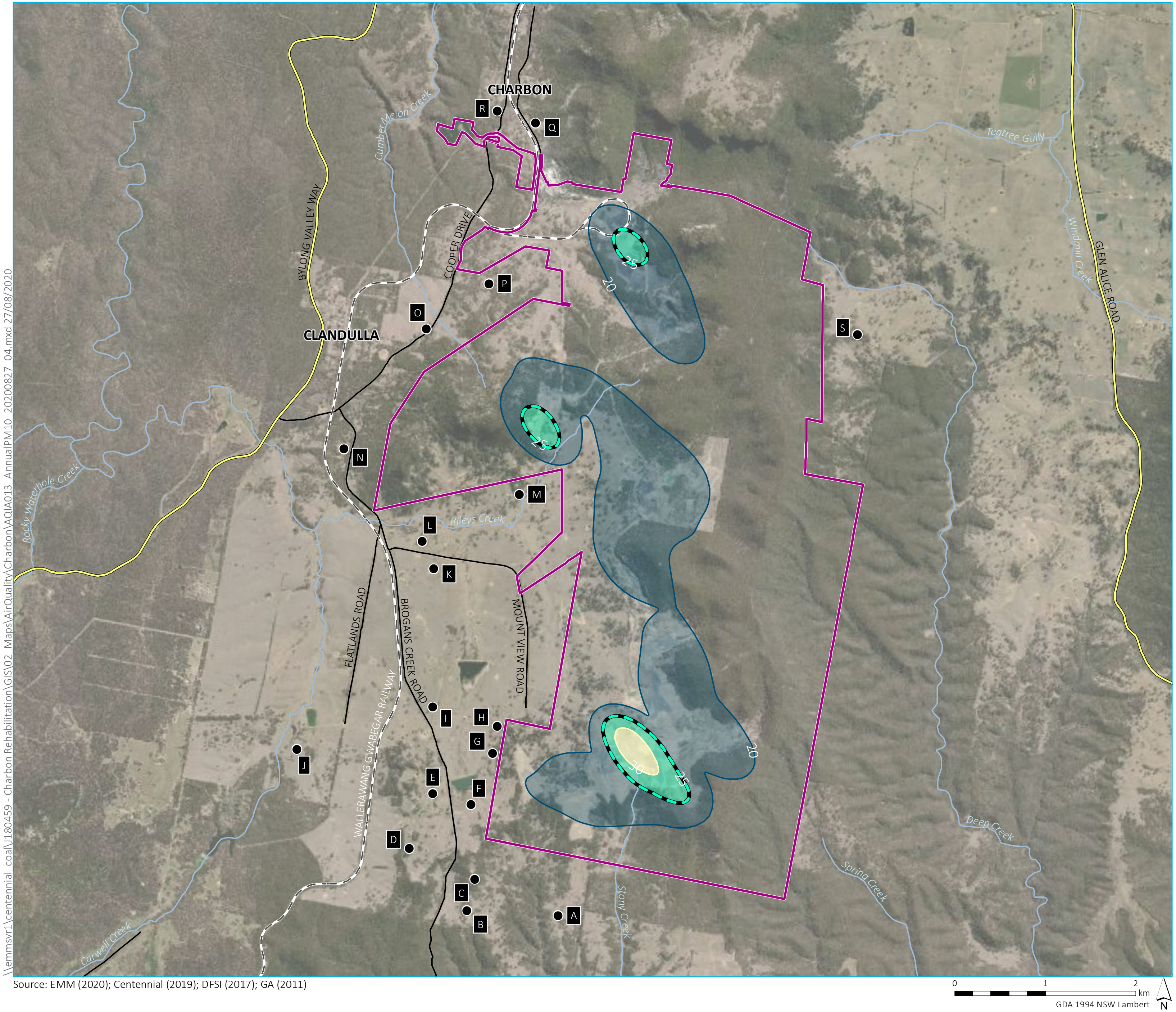
The predicted cumulative concentrations and deposition rates for all pollutants and averaging periods are below the applicable NSW EPA assessment criterion at all assessment locations.

Contour plots, illustrating spatial variations in cumulative TSP, PM_{10} and $PM_{2.5}$ concentrations and dust deposition rates are provided in Figure 7.7 to Figure 7.10 below.

Table 7.2 Cumulative (Charbon plus background) concentration and deposition results

Assessment location ID	Predicted cumulative concentration (µg/m³) and deposition rate (g/m²/month)					
	TSP	PM_{10}		$PM_{2.5}$		Dust deposition
	Annual	9th highest 24-hour[1]	Annual	3rd highest 24-hour[2]	Annual	Annual
Criterion	**90**	**50**	**25**	**25**	**8**	**4**
A	47.1	49.7	18.8	22.1	7.0	1.3
B	47.1	49.7	18.8	22.1	7.0	1.3
C	47.1	49.7	18.8	22.1	7.0	1.3
D	47.1	49.7	18.8	22.1	7.0	1.3
E	47.1	49.7	18.8	22.1	7.0	1.3
F	47.1	49.7	18.8	22.1	7.0	1.3
G	47.2	49.7	18.8	22.1	7.0	1.3
H	47.2	49.7	18.8	22.1	7.0	1.3
I	47.2	49.7	18.8	22.1	7.0	1.3
J	47.1	49.7	18.8	22.1	7.0	1.3
K	47.2	49.7	18.8	22.1	7.0	1.3
L	47.2	49.7	18.8	22.1	7.0	1.3
M	47.4	49.7	18.8	22.1	7.0	1.3
N	47.2	49.7	18.8	22.1	7.0	1.3
O	47.2	49.7	18.8	22.1	7.0	1.3
P	47.3	49.7	18.8	22.1	7.0	1.3
Q	47.2	49.7	18.8	22.1	7.0	1.3
R	47.2	49.7	18.8	22.1	7.0	1.3
S	47.3	49.7	18.8	22.1	7.0	1.3

Note:[1] Due to eight exceedances and exceptional events in the background dataset, the 9th highest cumulative PM_{10} concentration is presented.
[2] Due to two exceedances and exceptional events in the background dataset, the 3rd highest cumulative $PM_{2.5}$ concentration is presented.



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Source: EMM (2020); Centennial (2019); DFSI (2017); GA (2011)

KEY

Charbon Colliery project site boundary

Impact assessment criterion

Assessment location

Rail line

Major road

Minor road

Watercourse

Annual PM_{10} (µg/m^3)

20

25

30

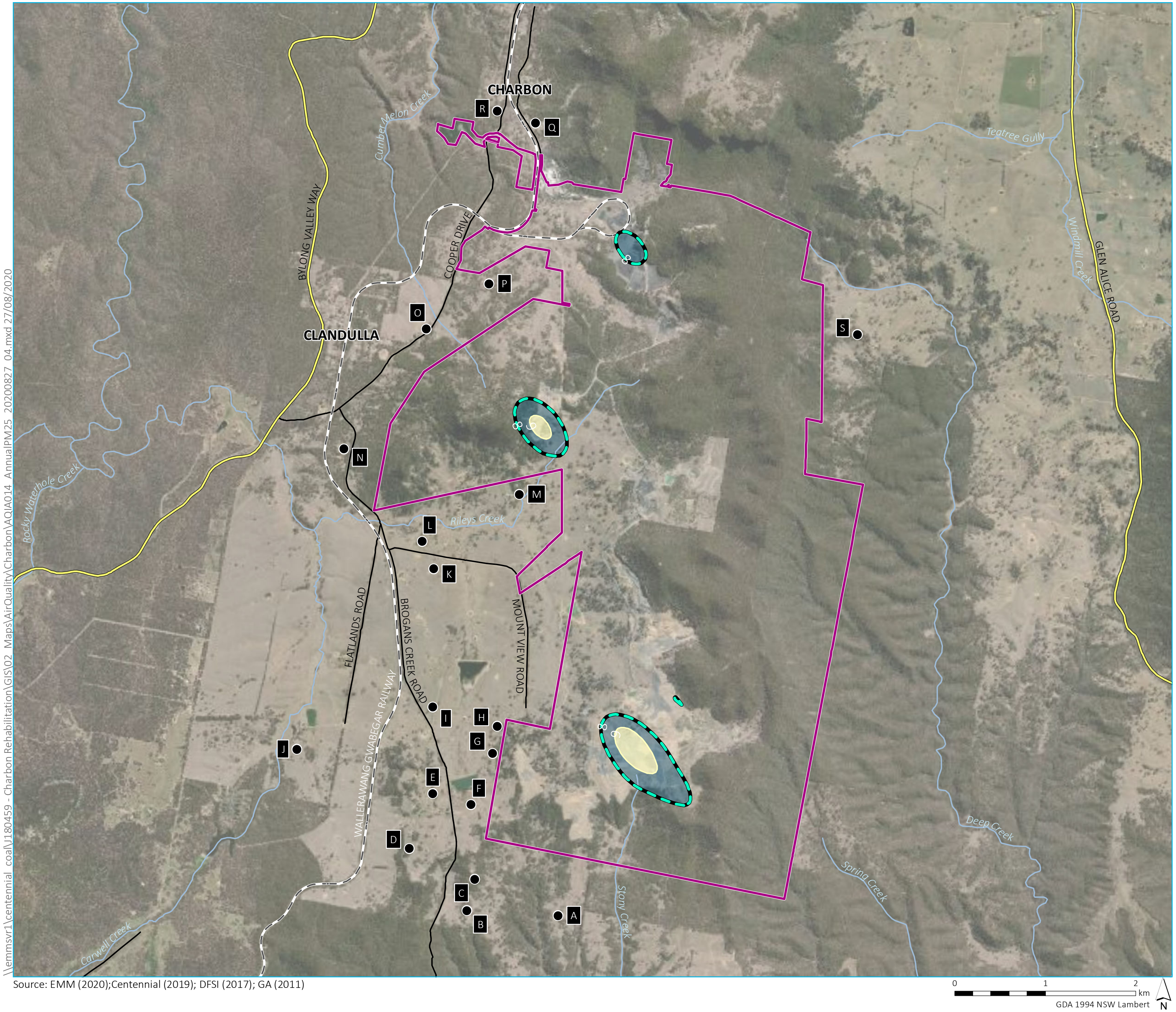
Predicted annual average PM_{10} concentrations – Charbon plus background

Charbon Colliery Modification 2

Air quality impact assessment

Figure 7.7

EMM creating opportunities



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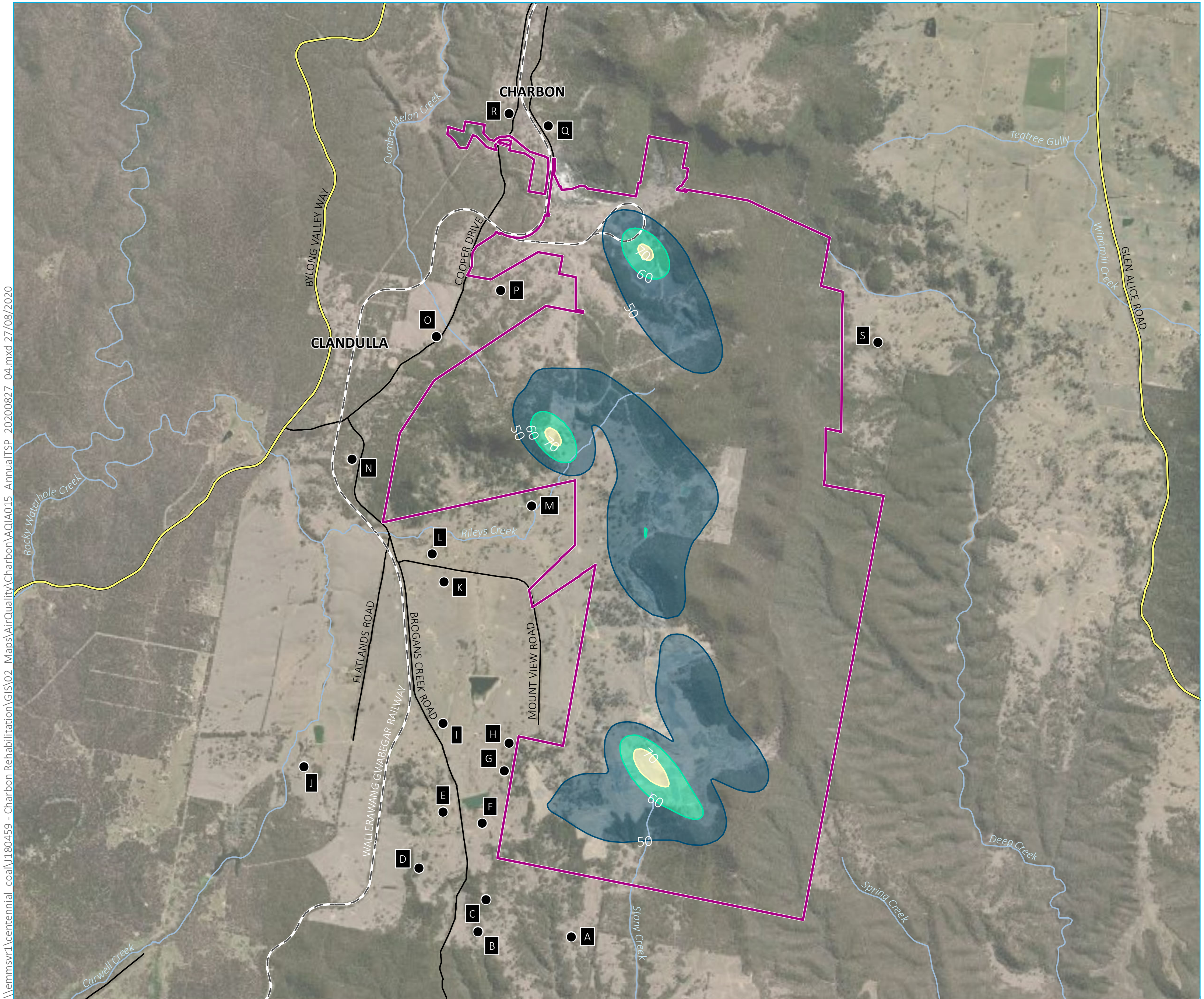
Source: EMM (2020);Centennial (2019); DFSI (2017); GA (2011)

Predicted annual average $PM_{2.5}$ concentrations – Charbon plus background

Charbon Colliery Modification 2
Air quality impact assessment
Figure 7.8

EMM
creating opportunities

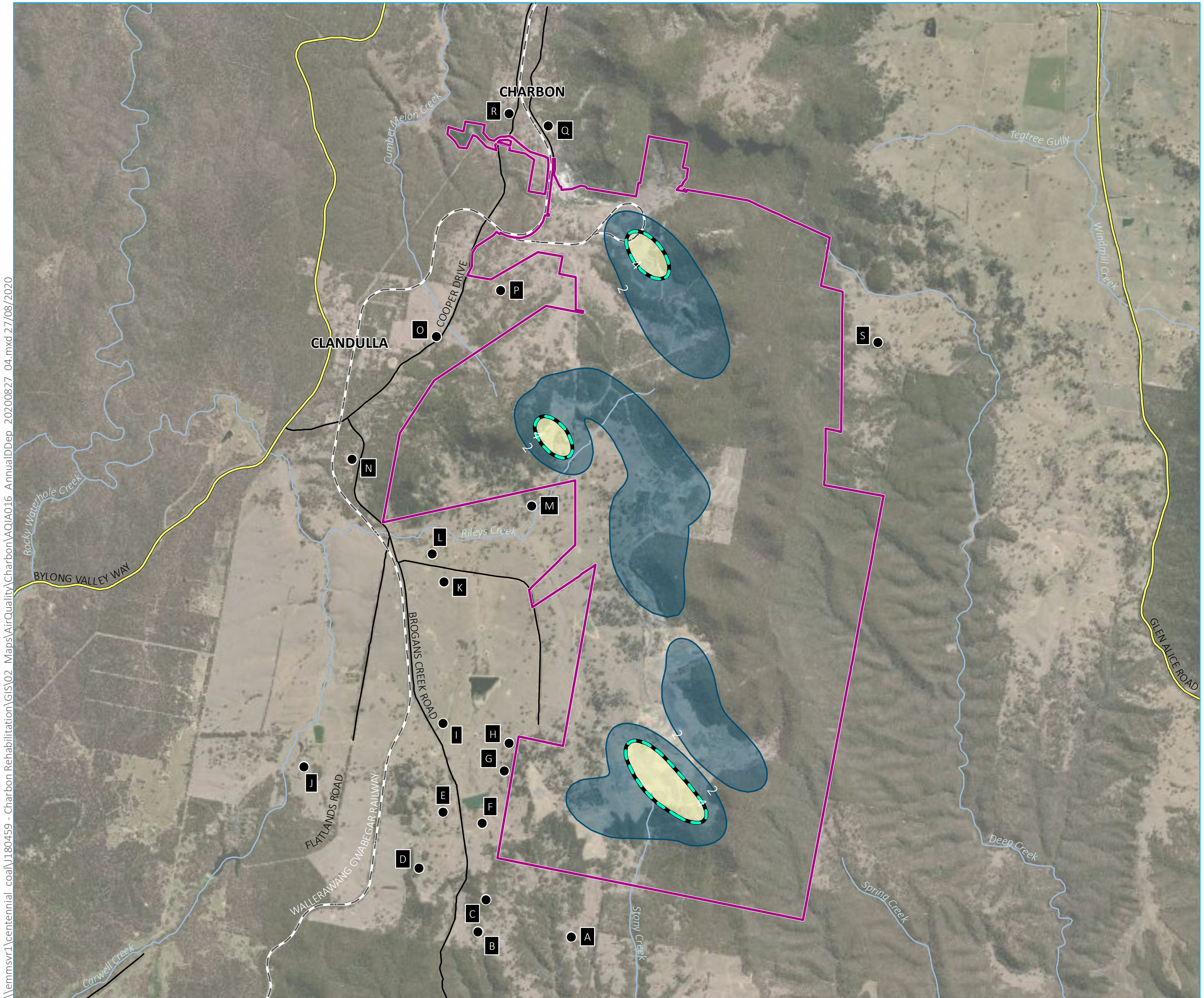


Source: EMM (2020); Centennial (2019); DFSI (2017); GA (2011)

Predicted annual average TSP concentrations – Charbon plus background

Charbon Colliery Modification 2
Air quality impact assessment
Figure 7.9

EMM
creating opportunities



KEY

- Charbon Colliery project site boundary
- Impact assessment criterion
- Assessment location
- Rail line
- Major road
- Minor road
- Watercourse

Annual dust deposition (g/m²/month)

- 2
- 4

Source: EMM (2020); Centennial (2019); DFSI (2017); GA (2011)

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Predicted annual average dust deposition levels – Charbon plus background

Charbon Colliery Modification 2
Air quality impact assessment
Figure 7.10

EMM
creating opportunities

8 Conclusion

Dispersion modelling has been completed for a worst-case rehabilitation scenario at Charbon. This scenario corresponds to existing rehabilitation activities, the estimated maximum amount of overburden and CCR moved around site as well as the maximum extent of areas exposed to wind erosion.

Atmospheric dispersion modelling was completed using the CALPUFF model system. Hourly meteorological observations from 2018, collected at the Charbon AWS and BoM Mudgee Airport AWS, were used as inputs to the dispersion modelling.

The results of the modelling show that the predicted concentrations and deposition rates for incremental particulate matter (TSP, PM_{10}, $PM_{2.5}$ and dust deposition) are below the applicable impact assessment criteria at all assessment locations.

Cumulative impacts were assessed by combining modelled impacts with recorded ambient background levels. The cumulative results showed that compliance with applicable NSW EPA impact assessment criteria is predicted at all assessment locations for all pollutants and averaging periods.

A range of best practice dust mitigation measures are, and will continue to be, employed at Charbon. These include the use of water carts on unpaved roads, grading routes and exposed areas.

9 References

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- 1998a, AP-42 Chapter 11.9.2 – *Bulldozing overburden*

- 1998a, AP-42 Chapter 11.9.4 – *Wind erosion of exposed areas.*

- 2006a, AP-42 Chapter 13.2.4 – *Aggregate handling and storage piles.*
- 2011, AP-42 Chapter 13.2.2 – *Unpaved roads.*
- 2016, *Nonroad Compression-Ignition Engines: Exhaust Emission Standards* (EPA-420-B-16-022, March 2016).

10 Abbreviations

ACARP	Australian Coal Industry's Research Program
AHD	Australian height datum
Approved Methods for Modelling	*Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales*
AQIA	air quality impact assessment
AWS	automatic weather station
BoM	Bureau of Meteorology
CCR	coarse coal reject
CO	carbon monoxide
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DoE	Commonwealth Department of the Environment
DPIE	NSW Department of Planning, Industry and Environment
EPA	Environment Protection Authority
EPL	environment protection licence
LGA	local government area
ML	mining lease
Mt	million tonnes
NO_x	oxides of nitrogen
PM_{10}	Particulate matter less than 10 microns in aerodynamic diameter
$PM_{2.5}$	Particulate matter less than 2.5 microns in aerodynamic diameter
REA	reject emplacement area
SO_2	sulfur dioxide
SSD	State significant development
TAPM	The Air Pollution Model
TSP	total suspected particulates
US-EPA	United States Environmental Protection Agency
VOC	volatile organic compound


Appendix A

Meteorological processing and modelling




A.1 Meteorological data analysis for Charbon AWS

Figure A.1 Data completeness – Charbon AWS (2015–2019)

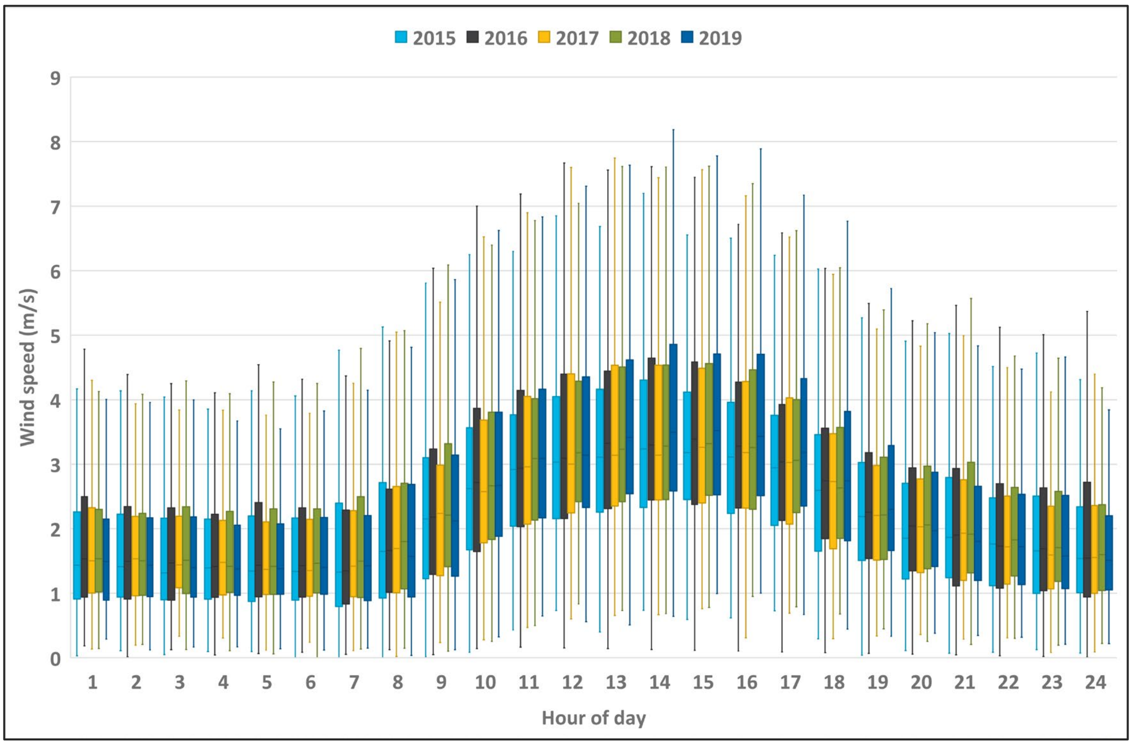

Figure A.2 Inter-annual variability in diurnal wind speed – Charbon AWS (2015–2019)

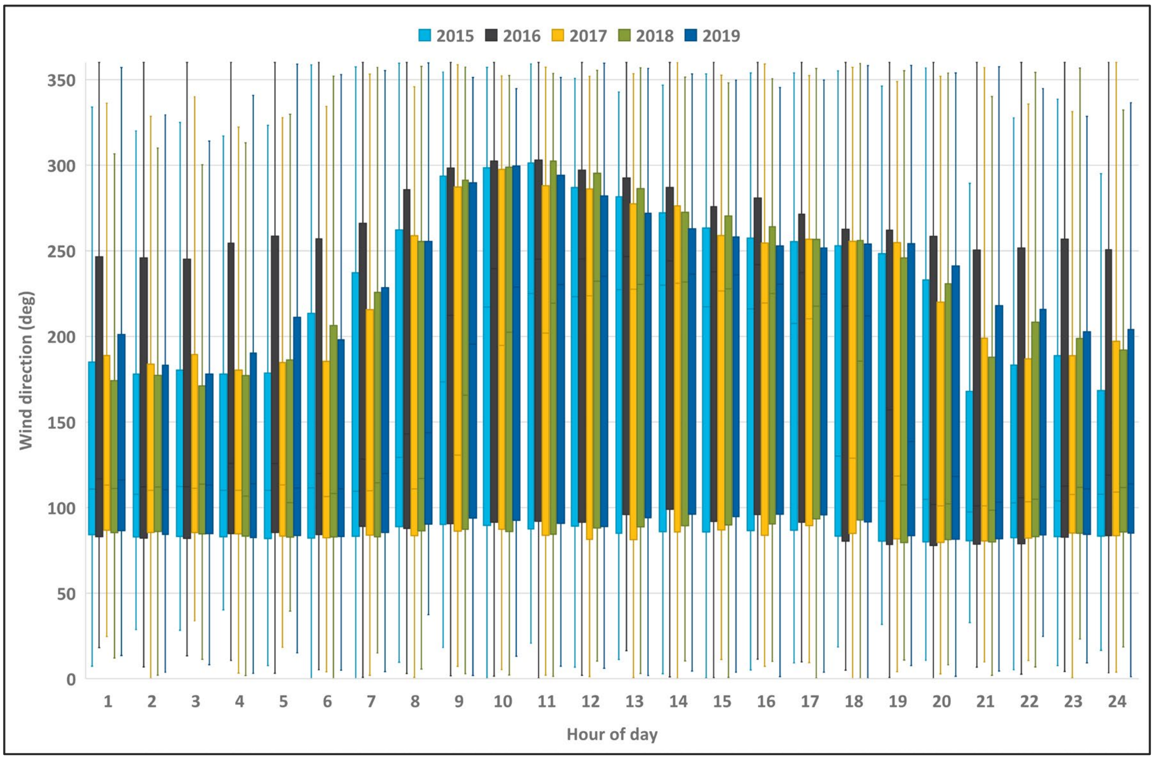

Figure A.3 Inter-annual variability in diurnal wind direction – Charbon AWS (2015–2019)

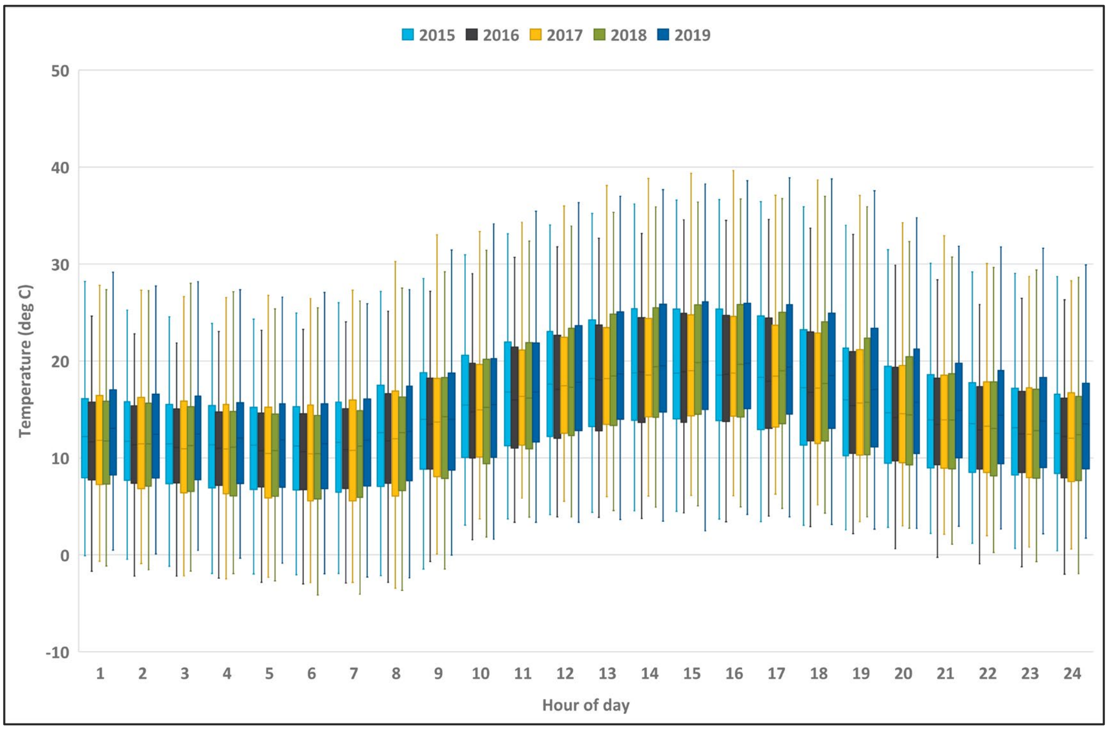

Figure A.4 Inter-annual variability in diurnal temperature – Charbon AWS (2015–2019)

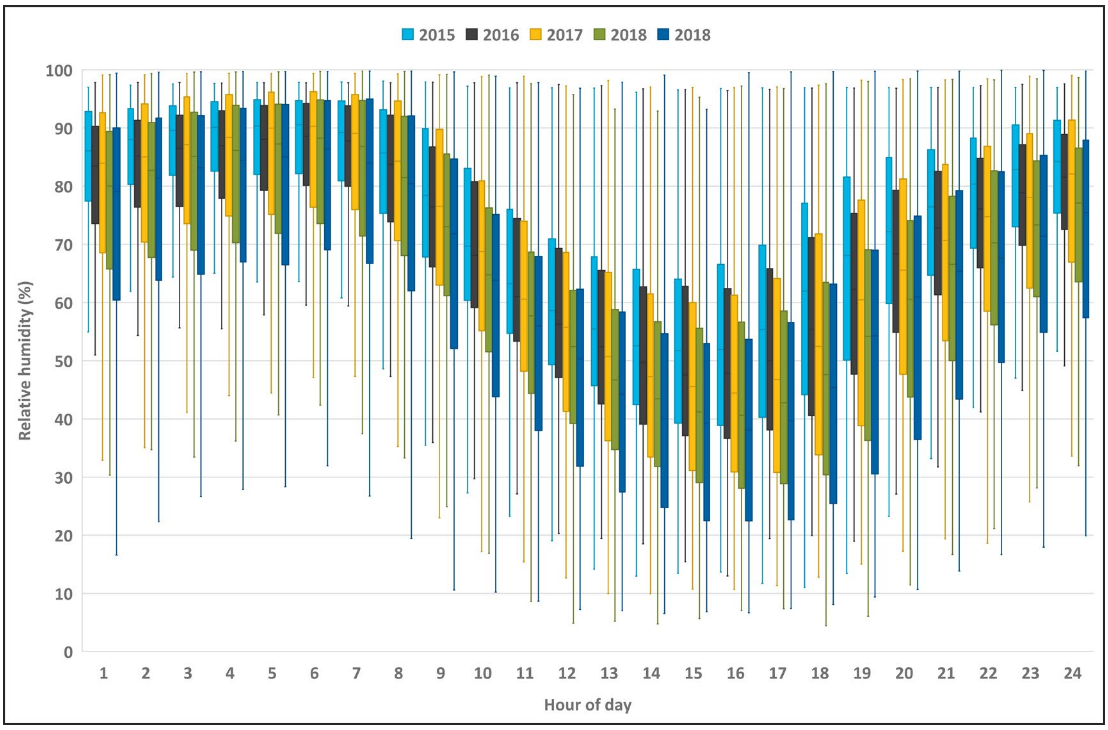

Figure A.5 Inter-annual variability in diurnal relative humidity – Charbon AWS (2015–2019)

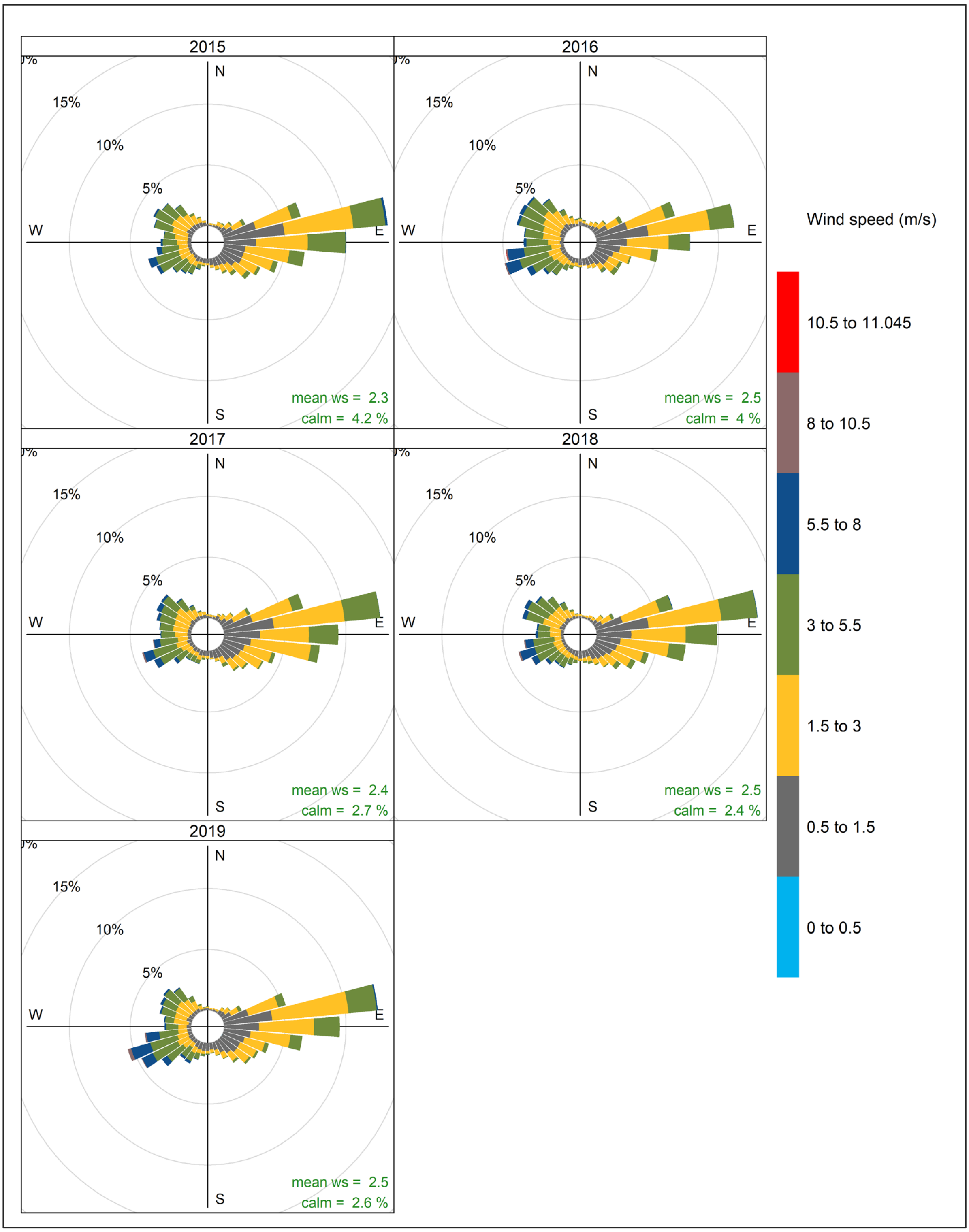

Figure A.6 Annual wind roses for Charbon AWS (2015-2019)

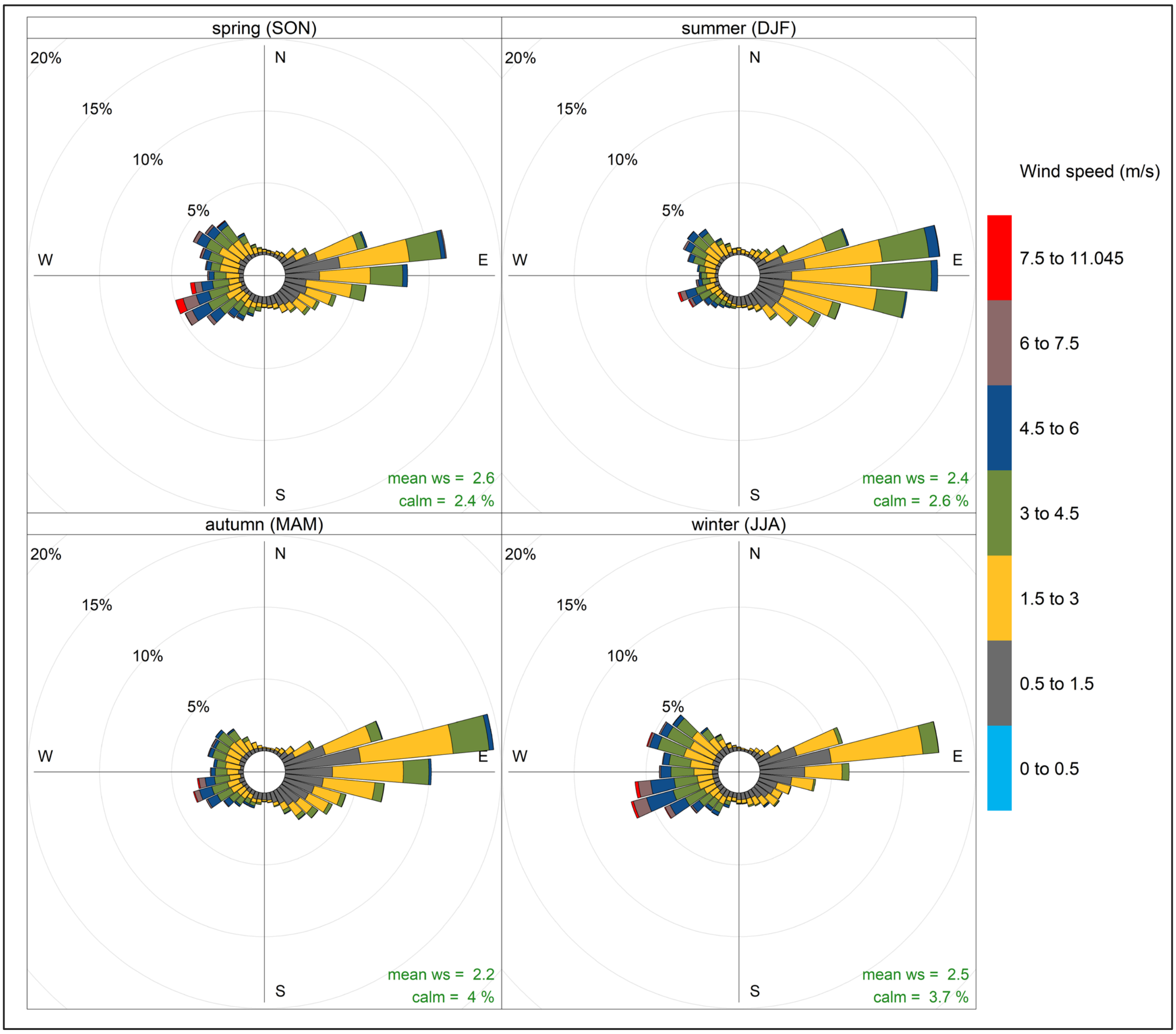

Figure A.7 Seasonal wind speed and direction – Charbon AWS (2015–2019)

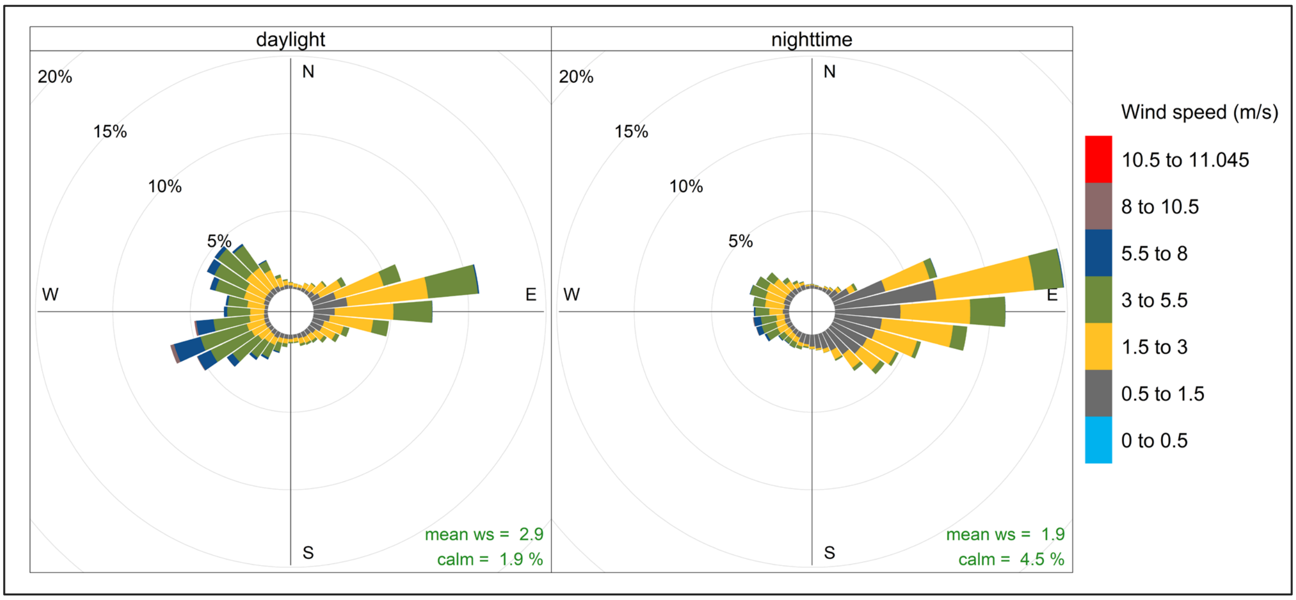

Figure A.8 Diurnal wind speed and direction – Charbon AWS (2015–2019)

A.2 Meteorological modelling

i TAPM modelling

To supplement the meteorological monitoring datasets adopted for this assessment, the Commonwealth Scientific and Industry Research Organisation (CSIRO) prognostic meteorological model TAPM was used to generate required parameters that are not routinely measured, specifically cloud content and height data.

TAPM was configured and run as follows:

- TAPM version 4.0.5;
- inclusion of high resolution (90 m) regional topography (improvement over default 250 m resolution data);
- grid domains with cell resolutions of 30 km, 10 km, 3 km, 1 km and 300 m. Each grid domain features 25 x 25 horizontal grid points and 25 vertical levels;
- TAPM default databases for land use, synoptic analyses and sea surface temperature;
- TAPM defaults for advanced meteorological inputs; and
- two 'spin-up' days allowed at the beginning and end of the run.

A surface observations file was included in TAPM with meteorological data from:

- Charbon AWS; and
- Mudgee Airport AWS, approximately 52 km northwest of Charbon.

ii CALMET

The CALMET/CALPUFF model suite was chosen for this study. CALMET was used to produce 3-dimensional meteorological fields for use in the CALPUFF model.

In the absence of upper air measurements, CALMET can be run using prognostic upper air data (as a three-dimensional '3D.dat' file), which is used to derive an initial wind field (known as the Step 1 wind field in the CALMET model). The model then incorporates mesoscale and local scale effects, including surface observations, to adjust the wind field. This modelling approach is known as the 'hybrid' approach (TRC 2011) and is adopted for this assessment. TAPM was used to generate gridded upper air data for each hour of the model run period, for input into CALMET.

A CALMET grid of 67.5 km by 67.5 km was run with a resolution of 500 m. Surface meteorological data from the Charbon AWS and the BoM Mudgee Airport AWS were incorporated into the modelling. Cloud amount and cloud height data were sourced from the BoM Mudgee Airport AWS.

The observations at the surface stations provided the dominant influence on the derived wind field and the resultant dispersion meteorology within the model. The distance at which the observation influences the model (radius of influence) is determined by the CALMET setting 'RMAX'. The relative importance of the observation in the model (relative weighting of the Step 1 wind field and the observation) is determined by the CALMET setting 'R1'.

An RMAX of 2.5 km and R1 of 1 km was assigned in the model to reflect the likely influence of local scale topographical features.

The detailed CALMET model options used are presented in Table A.1. These were selected in accordance with recommendations in TRC (2011). Surface observations were included in the modelling (referred to as data assimilation) to provide real-world observations and improve the accuracy of the wind fields.

Table A.1 CALMET model options used

Flag	Descriptor	Default	Value used
IEXTRP	Extrapolate surface wind observations to upper layers	Similarity theory	Similarity theory
BIAS (NZ)	Relative weighting given to vertically extrapolated surface observations versus upper air data	No default	NZ * 0 - layers in lower levels of model will have stronger weighting towards surface, higher levels will have stronger weighting to upper air data
TERRAD	Radius of influence of terrain	No default (typically 5-15 km)	5
RMAX1 and RMAX2	Maximum radius of influence over land observations in layer 1 and aloft	No default	2.5, 2.5
R1 and R2	Distance from observations in layer 1 and aloft at which observations and Step 1 wind field are weighted equally	No default	1, 1


Appendix B

Emissions inventory detail




B.1 Introduction

Particulate matter emissions were quantified through the application of accepted published emission estimation factors, collated from a combination of United States Environmental Protection Agency (US-EPA) AP-42 Air Pollutant Emission Factors and US-EPA Exhaust Emissions Standards, including the following:

- US-EPA AP-42 Chapter 13.2.4.4 – Aggregate handling and storage piles (US-EPA 2006a);
- US-EPA AP-42 Chapter 11.9.2 – Bulldozing overburden (US-EPA 1998a);
- US-EPA AP-42 Chapter 13.2.2 – Unpaved roads (US-EPA 2006);
- US-EPA AP-42 Chapter 11, Table 11.9-4 – Wind erosion of exposed areas (US-EPA 1998b); and
- US-EPA Nonroad Compression-Ignition Engines: Exhaust Emission Standards (EPA-420-B-16-022, March 2016).

Annual projections of diesel consumption were sourced from Charbon Coal. Assumptions adopted were:

- the proposed equipment fleet comprised primarily of equipment with an engine power greater than 130 kW;
- for engines greater than 130 kW, the corresponding USEPA (USEPA 2016) Tier 2 emission standards for PM of 0.2 g/kWh was selected;
- the g/kWh emission standard was converted to g per litre of diesel by applying a scaling factor of 3, as per the notes for Table 35 in *NPI Emission Estimation Technique Manual for Combustion Engines* (NPI 2008); and
- the PM emission standard is assumed to correspond to PM_{10}, with $PM_{2.5}$ emissions derived from the relationship between PM_{10} and $PM_{2.5}$ emission factors presented in Table 35 in NPI (2008) (91.7%).

Particulate releases were quantified for TSP, PM_{10} and $PM_{2.5}$ as documented in subsequent sections.

B.2 Particulate matter emissions inventory

An emission inventory developed for Charbon operations is shown in Table B.1.

Table B.1 Emissions inventory

Activity	TSP emission estimate (kg/year)	PM_{10} emission estimate (kg/year)	$PM_{2.5}$ emission estimate (kg/year)	Intensity	Units	TSP emission factor	PM_{10} emission factor	$PM_{2.5}$ emission factor	Unit	Variable 1	Unit	Variable 2	Unit	Variable 3	Unit	Variable 4	Unit	Variable 5	Unit	Control %	Control	Emission factor source
Northern REA																						
Excavator/front end loader (FEL) loading rejects to trucks for transport to Main REA	35	17	3	122,000	t/y	0.00029	0.00014	0.00002	kg/t	1.99	Ave wind speed (m/s)	5	Moisture (%)									USEPA AP-42 13.2.4 - Materials handling
Rail loop																						
Excavator/FEL loading CCR to trucks for transport	144	68	10	500,000	t/y	0.00029	0.00014	0.00002	kg/t	1.99	Ave wind speed (m/s)	5	Moisture (%)									USEPA AP-42 13.2.4 - Materials handling
Main REA																						
Unloading overburden from Southern Open Cut stockpile area	3	1	0	10,750	t/y	0.00029	0.00014	0.00002	kg/t	1.99	Ave wind speed (m/s)	5	Moisture (%)									USEPA AP-42 13.2.4 - Materials handling
Unloading rejects from Northern REA from trucks	35	17	3	122,000	t/y	0.00029	0.00014	0.00002	kg/t	1.99	Ave wind speed (m/s)	5	Moisture (%)									USEPA AP-42 13.2.4 - Materials handling
2 x dozers working on rejects and overburden	3,187	571	335	2,880	h/y	2.21	0.40	0.23	kg/h	5	Moisture (%)	5	Silt (%)							0.5	Water cart	USEPA AP-42 11.9.2 - Dozers on OB
Central Open Cut Box Cut																						
Unloading overburden from Southern Open Cut Stockpile area	4	2	0	15,000	t/y	0.00029	0.00014	0.00002	kg/t	1.99	Ave wind speed (m/s)	5	Moisture (%)									USEPA AP-42 13.2.4 - Materials handling
Unloading CCR from rail loop	37	18	3	130,000	t/y	0.00029	0.00014	0.00002	kg/t	1.99	Ave wind speed (m/s)	5	Moisture (%)									USEPA AP-42 13.2.4 - Materials handling
2 x dozers working on spoil	4,975	571	522	2,880	h/y	3.45	0.40	0.36	kg/h	3.6	Moisture (%)	5	Silt (%)							0.5	Water cart	USEPA AP-42 11.9.2 - Dozers on OB
Western Open Cut																						
Unloading overburden from Southern Open Cut stockpile area	9	4	1	30,667	t/y	0.00029	0.00014	0.00002	kg/t	1.99	Ave wind speed (m/s)	5	Moisture (%)									USEPA AP-42 13.2.4 - Materials handling
Unloading CCR from rail loop	36	17	3	126,667	t/y	0.00029	0.00014	0.00002	kg/t	1.99	Ave wind speed (m/s)	5	Moisture (%)									USEPA AP-42 13.2.4 - Materials handling
2 x dozers working on spoil	4,975	922	522	2,880	h/y	3.45	0.64	0.36	kg/h	3.6	Moisture (%)	5	Silt (%)							0.5	Water cart	USEPA AP-42 11.9.2 - Dozers on OB
8 Trunk Open Cut																						
Unloading overburden from Southern Open Cut stockpile area	13	6	1	45,333	t/y	0.00029	0.00014	0.00002	kg/t	1.99	Ave wind speed (m/s)	5	Moisture (%)									USEPA AP-42 13.2.4 - Materials handling
Unloading CCR from rail loop	70	33	5	243,333	t/y	0.00029	0.00014	0.00002	kg/t	1.99	Ave wind speed (m/s)	5	Moisture (%)									USEPA AP-42 13.2.4 - Materials handling
2 x dozers working on spoil	4,975	922	522	2,880	h/y	3.45	0.64	0.36	kg/h	3.6	Moisture (%)	5	Silt (%)							0.5	Water cart	USEPA AP-42 11.9.2 - Dozers on OB
Southern Open Cut stockpile																						
FEL loading overburden into trucks	26	12	2	91,000	t/y	0.00029	0.00014	0.00002	kg/t	1.99	Ave wind speed (m/s)	5	Moisture (%)									USEPA AP-42 13.2.4 - Materials handling
1 x dozer working on overburden	398	71	42	360	h/y	2.21	0.40	0.23	kg/h	5	Moisture (%)	5	Silt (%)							0.5	Water cart	USEPA AP-42 11.9.2 - Dozers on OB
Hauling and grading																						
Hauling rejects from Northern REA to Main REA	5,024	1,270	127	13,071	VKT/year	1.54	0.39	0.04	kg/VKT	4.6	Silt (%)	3.0	km/return trip	4,357	Loads/year	37.9	Average weight (t)	28	Truck capacity (t)	0.75	Water sprays	USEPA AP-42 13.2.2 - Unpaved roads
Hauling overburden from Southern Open Cut stockpile to 8 Trunk Open Cut	4,356	1,101	110	11,333	VKT/year	1.54	0.39	0.04	kg/t	4.6	Silt (%)	7.0	km/return trip	1,619	Loads/year	37.9	Average weight (t)	28	Truck capacity (t)	0.75	Water sprays	USEPA AP-42 13.2.2 - Unpaved roads
Hauling overburden from Southern Open Cut stockpile to Central Open Cut Box Cut	2,636	666	67	6,857	VKT/year	1.54	0.39	0.04	kg/t	4.6	Silt (%)	12.8	km/return trip	536	Loads/year	37.9	Average weight (t)	28	Truck capacity (t)	0.75	Water sprays	USEPA AP-42 13.2.2 - Unpaved roads
Hauling overburden from Southern Open Cut stockpile to Western Open Cut	4,968	1,255	126	12,924	VKT/year	1.54	0.39	0.04	kg/t	4.6	Silt (%)	11.8	km/return trip	1,095	Loads/year	37.9	Average weight (t)	28	Truck capacity (t)	0.75	Water sprays	USEPA AP-42 13.2.2 - Unpaved roads
Hauling overburden from Southern Open Cut stockpile to Main REA	2,037	515	51	5,298	VKT/year	1.54	0.39	0.04	kg/t	4.6	Silt (%)	13.8	km/return trip	384	Loads/year	37.9	Average weight (t)	28	Truck capacity (t)	0.75	Water sprays	USEPA AP-42 13.2.2 - Unpaved roads
Hauling CCR from rail loop to Central Open Cut	6,246	1,578	158	16,250	VKT/year	1.54	0.39	0.04	kg/t	4.6	Silt (%)	3.5	km/return trip	4,643	Loads/year	37.9	Average weight (t)	28	Truck capacity (t)	0.75	Water sprays	USEPA AP-42 13.2.2 - Unpaved roads
Hauling CCR from rail loop to Western Open Cut	12,172	3,076	308	31,667	VKT/year	1.54	0.39	0.04	kg/t	4.6	Silt (%)	7.0	km/return trip	4,524	Loads/year	37.9	Average weight (t)	28	Truck capacity (t)	0.75	Water sprays	USEPA AP-42 13.2.2 - Unpaved roads
Hauling CCR from rail loop to 8 Trunk Open Cut	33,405	8,442	844	86,905	VKT/year	1.54	0.39	0.04	kg/t	4.6	Silt (%)	10.0	km/return trip	8,690	Loads/year	37.9	Average weight (t)	28	Truck capacity (t)	0.75	Water sprays	USEPA AP-42 13.2.2 - Unpaved roads
Grading roads	1,187	479	37	7,920	km/y	0.30	0.12	0.01	kg/VKT	6	Speed of graders (km/h)	1,320	Grader hours/y							0.5	Water sprays	USEPA AP-42 13.2.2 - Unpaved roads
Active wind erosion areas																						
Wind erosion - Northern REA	4,420	2,210	332	5.2	ha	850	425	64	kg/ha/y													USEPA AP-42 11.9.4 - Wind erosion of exposed areas
Wind erosion - Stockpile areas	9,605	4,803	720	11.3	ha	850	425	64	kg/ha/y													USEPA AP-42 11.9.4 - Wind erosion of exposed areas
Wind erosion - Main REA	15,725	7,863	1,179	18.5	ha	850	425	64	kg/ha/y													USEPA AP-42 11.9.4 - Wind erosion of exposed areas
Wind erosion - Central Open Cut area	6,970	3,485	523	8.2	ha	850	425	64	kg/ha/y													USEPA AP-42 11.9.4 - Wind erosion of exposed areas
Wind erosion - Western Open Cut area	10,030	5,015	752	11.8	ha	850	425	64	kg/ha/y													USEPA AP-42 11.9.4 - Wind erosion of exposed areas
Wind erosion - Coal handling plant (CHP) area	19,805	9,903	1,485	23.3	ha	850	425	64	kg/ha/y													USEPA AP-42 11.9.4 - Wind erosion of exposed areas
Wind erosion - 8 Trunk Open Cut area	47,090	23,545	3,532	55.4	ha	850	425	64	kg/ha/y													USEPA AP-42 11.9.4 - Wind erosion of exposed areas
Wind erosion - Southern Open Cut and Southern Open Cut extension area	118,150	59,075	8,861	139.0	ha	850	425	64	kg/ha/y													USEPA AP-42 11.9.4 - Wind erosion of exposed areas
Wind erosion - Western Outlier	9,520	4,760	714	11.2	ha	850	425	64	kg/ha/y													USEPA AP-42 11.9.4 - Wind erosion of exposed areas
Wind erosion - Southern Outlier	15,470	7,735	1,160	18.2	ha	850	425	64	kg/ha/y													USEPA AP-42 11.9.4 - Wind erosion of exposed areas
Diesel combustion																						
Site diesel combustion	198	198	182																			
Total	**347,939**	**150,225**	**23,241**																			

B.3 Project-related input data used for particulate matter emission estimates

The main inputs used in the emission estimates are summarised in Table B.2. All material volumes and loads per year were provided by Charbon Coal.

Table B.2 Inputs for emission estimation

Material properties	Value	Source of information
Unpaved road silt content (%)	4.6	ACARP Report C20023 (Pacific Environment 2014) - average of uncontrolled haul roads.
Overburden and CCR moisture (%)	3.6% for the Central Open Cut Box Cut, Western Open Cut and 8 Trunk Open Cut (Heggies 2009). 5% used for the Main REA and Southern Open Cut Stockpile (Charbon Coal).	Per Heggies 2009 and provided by Charbon Coal through site testing.
Diesel consumption for 2018 (L/y)	330,000	Diesel use provided by Charbon Coal.
Average wind speed (m/s)	2.0	Calculated from CALMET extract at Charbon.
Average truck gross mass (t)	37.9	Average of full and empty loads (provided by Charbon Coal).

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