


Appendix B

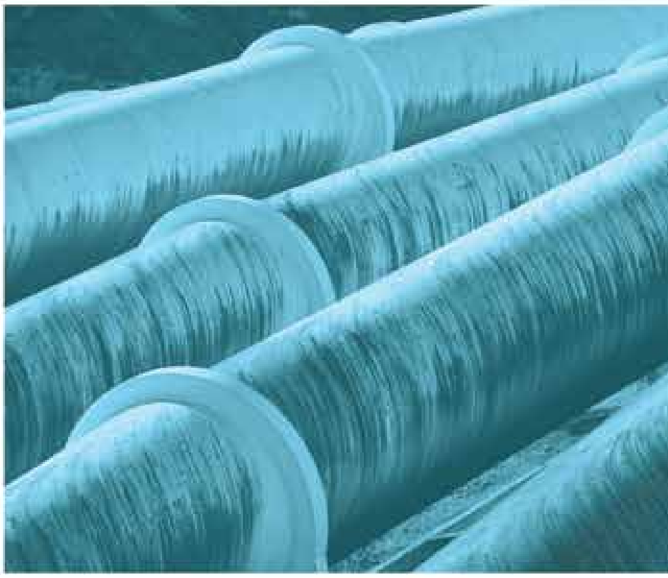
Clarence Colliery - Air quality impact assessment

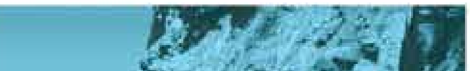



Clarence Colliery - Modification 6

Air quality impact assessment

Prepared for Centennial Coal Company Limited
August 2020





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Clarence Colliery - Modification 6

Air quality impact assessment

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Executive Summary

This air quality impact assessment (AQIA) supports an application for a modification to operations at Clarence Colliery (Clarence), an existing underground coal mine owned and operated by Centennial Coal Company Limited (Centennial). Clarence is approximately 10 kilometres (km) east of Lithgow in the Lithgow local government area (LGA). Centennial is seeking to modify Clarence's approval (DA 504-00) to allow for the transportation of coarse coal reject (CCR) material from reject emplacement area (REA) 6 and Clarence's production stream to Charbon Colliery via rail.

This 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.

This 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 Clarence automatic weather station (AWS). Meteorological modelling for the surrounding region was undertaken using two Bureau of Meteorology-owned weather stations. Background air quality was characterised from Centennial-owned air quality monitoring networks in the local area as well as monitoring data from the NSW Department of Planning, Industry and Environment (DPIE) network.

Emissions estimation and dispersion modelling was completed for an existing operational scenario corresponding to a maximum coal processing rate of 3 million tonnes per annum (Mtpa). The proposed operations scenario included the same maximum processing rate plus activities specific to the proposed modification including CCR handling and transfer from REA6 and loading to trains.

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 for both the existing and proposed scenarios. There was a negligible difference in predicted concentrations and deposition rates between the existing and proposed scenarios, indicating that the proposed modification will not adversely change air quality impacts at Clarence from those associated with existing operations.

Cumulative impacts were assessed by combining modelled impacts with recorded ambient background levels and predictions for the adjacent Hanson sand quarry. The cumulative results showed that concentrations and deposition rates for all pollutants and averaging periods were below the applicable NSW EPA assessment criterion at all assessment locations with the exception of a single additional exceedance of the 24-hour average PM_{10} impact assessment criterion at four assessment locations (R3, R4, R5 and R6) in the existing scenario and three locations (R3, R5 and R6) in the proposed scenario.

Analysis showed that all exceedances occurred on the same day, with the cumulative concentrations dominated by an elevated background level of 49.2 µg/m^3 associated with a regional dust storm event. The corresponding incremental contribution to the exceedance was below 1.2 µg/m^3 at all receptors. It is unlikely that the proposed modification will result in significant adverse air quality impacts at nearby assessment locations.

A range of best practice dust mitigation measures are, and will continue to be, employed at Clarence. These include the use of water carts and sprays, enclosed conveyors, enclosed processing plant and watering of stockpiles and REAs. These measures have been taken into account in the emissions estimation and modelling of each scenario.

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1 Introduction

1.1 Overview

Clarence Colliery (Clarence) is an underground coal mining operation within the Western Coalfield of New South Wales (NSW) approximately 10 kilometres (km) east of Lithgow in the Lithgow local government area (LGA) (Figure 1.1). Clarence has been in operation since the 1980s and is currently owned by Centennial Coal Company Limited (Centennial) and SK Networks Resources Australia Pty Ltd as participants in the Clarence Colliery Joint Venture. Centennial has been appointed as the management entity for the Clarence Colliery Joint Venture. Figure 1.1 shows Clarence in a regional context and Figure 1.2 shows Clarence in a local context.

Clarence operates under three separate development consents:

- an interim development consent issued in 1976 by Blaxland Shire Council (now Lithgow City Council) for the construction of surface facilities (IRM.GE.76);
- a development consent issued in 1994 by Lithgow City Council for the extension of underground coal mining, surface reject emplacement areas (REAs) and water management and ancillary structures (174/93); and
- development consent issued in 2005 (DA 504-00) by the NSW Department of Infrastructure, Planning and Natural Resources (now the NSW Department of Planning, Industry and Environment (DPIE)) to expand site operations into Mining Lease (ML) 1583.

Clarence extracts coal from the Katoomba Seam and has the facilities on-site to wash run-of-mine (ROM) coal in order to maximise coal quality. A by-product of the washing process is coarse coal reject (CCR), which is approved under the aforementioned development consents to be emplaced in six REAs at Clarence's surface facilities, including:

- REA1, REA2 and REA4, which are rehabilitated but not closed (under the High Risk Activity (HRA) notification process);
- REA3, which is in care and maintenance;
- REA5, which is currently being constructed within the rail loop; and
- REA6, which is operational.

Centennial has identified an opportunity to use CCR material from Clarence to enhance rehabilitation at Charbon Colliery (Charbon) (Figure 1.1). Charbon is an underground and open cut coal mine owned and operated by Charbon Coal Pty Limited (Charbon Coal). In 2015, mining operations at Charbon ceased following the depletion of the mine'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.

Centennial is seeking to modify DA 504-00 pursuant to Section 4.55(2) of the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act) to allow for the transportation of CCR from REA6 and Clarence's production stream to Charbon via rail. If approved, the modification will authorise:

- extraction of CCR from REA6;
- transfer of CCR from REA6 and Clarence's production stream to the existing train load out (TLO);

- loading of CCR into train-based containers via the existing TLO; and
- export of CCR off-site to Charbon via rail.

At the same time Centennial is seeking to modify DA 504-00, Charbon Coal will submit a modification application for SSD 08_0211 to allow for the importation of CCR from Clarence by rail and its use in ongoing rehabilitation activities at Charbon.

This air quality impact assessment (AQIA) has been prepared by EMM Consulting Pty Limited (EMM) on behalf of Centennial, to assess the potential air quality impacts of 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'.

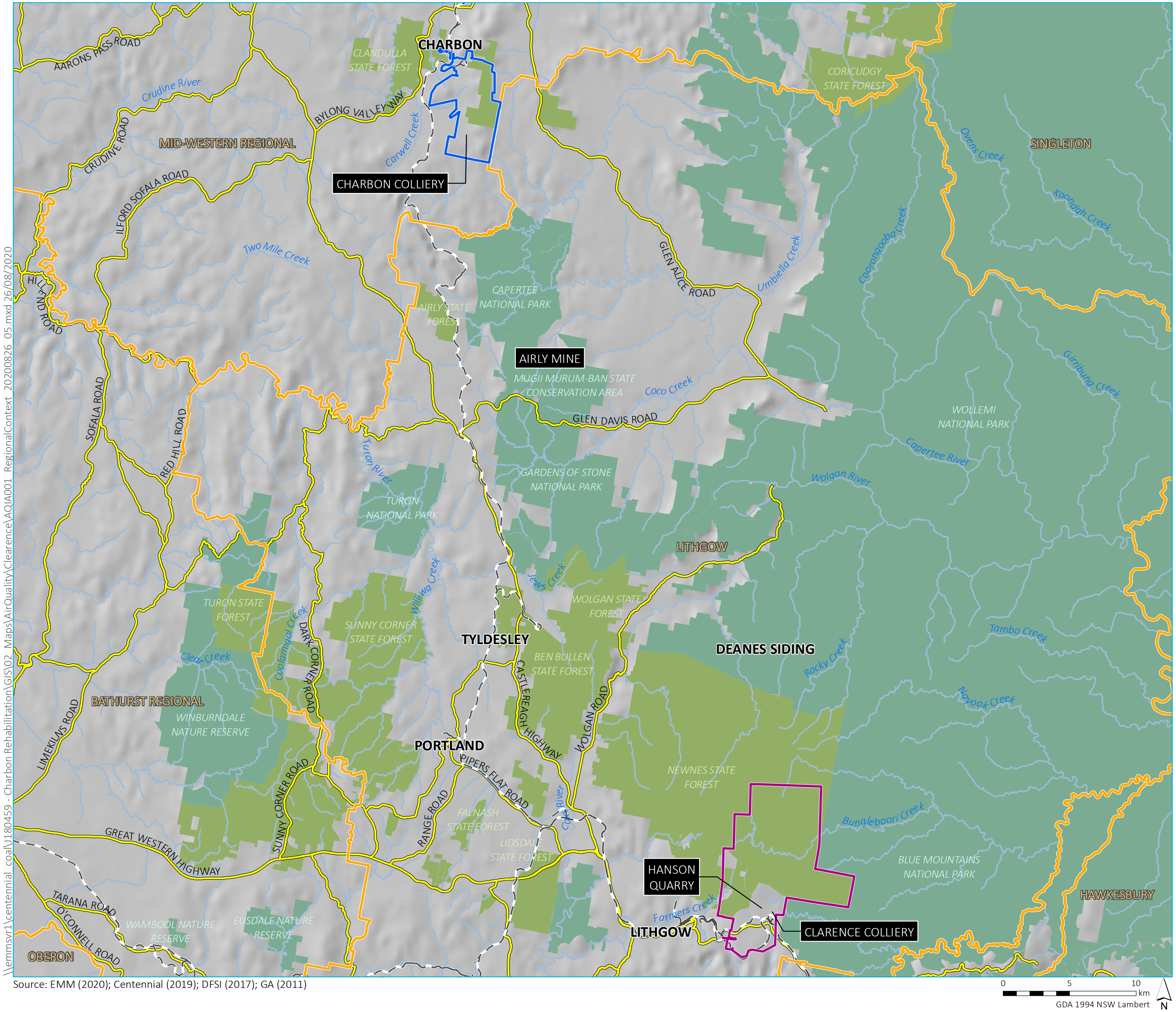
In 2013, SLR Consulting prepared an AQIA for a proposed modification to Clarence, which sought approval for an additional REA, upgrade and relocation of the sewage effluent irrigation system and an increase in the workforce (SLR 2013). In September 2018, SLR Consulting prepared an AQIA for the decommissioning and rehabilitation of REA3 (SLR 2018). Information for this assessment has been sourced from these assessments, where appropriate.

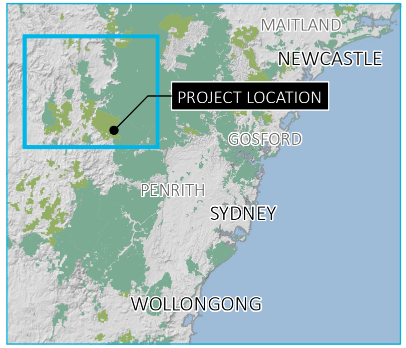
1.2 Purpose of this report

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 Clarence;
- 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 Clarence;
- 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.





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

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

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Regional context

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Figure 1.1

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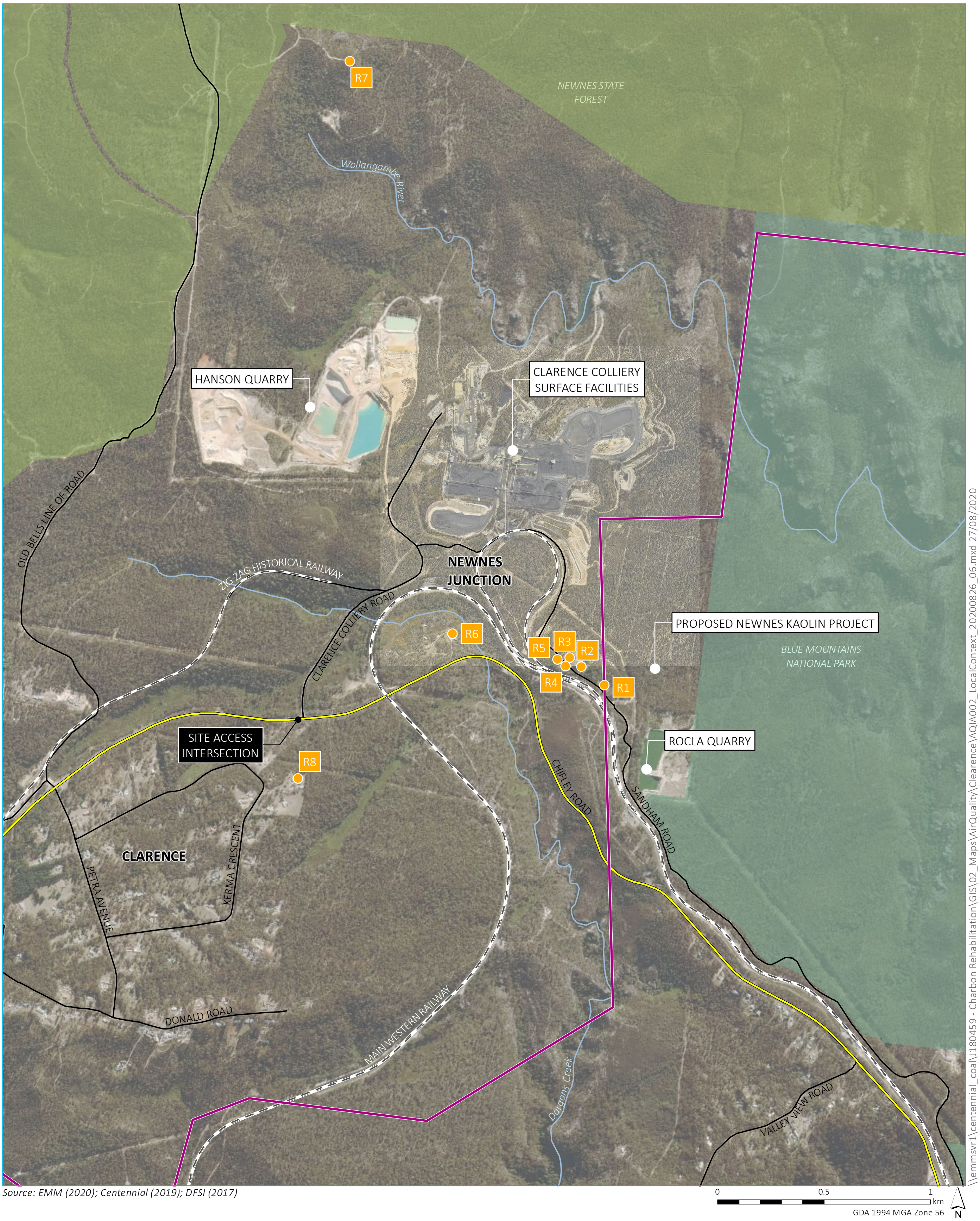


Source: EMM (2020); Centennial (2019); DFSI (2017)

KEY

- Clarence Colliery holding boundary
- Assessment location
- Rail line
- Main road
- Local road
- Watercourse
- NPWS reserve
- State forest

Local context

Clarence Colliery – Modification 6
Air quality impact assessment
Figure 1.2

1.3 Proposed modification

1.3.1 Overview

Centennial is seeking to modify DA 504-00 pursuant to Section 4.55(2) of the EP&A Act to allow for the transportation of CCR from REA6 and Clarence's production stream to Charbon via rail. 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 at Charbon. The proposed modification includes:

- extraction of CCR from REA6;
- transfer of CCR from REA6 and Clarence's production stream to the existing TLO;
- loading of CCR into train-based containers via the existing TLO; and
- export of CCR off-site to Charbon via rail.

There will be no change to currently approved extraction limits, coal handling and preparation or coal dispatch via rail or road as part of the proposed modification.

Clarence's existing surface facilities are shown on Figure 1.3.

1.3.2 Construction activities

No construction activities are required on-site at Clarence to facilitate the proposed modification. No additional plant, equipment or fixed infrastructure is required.

1.3.3 Material handling

An excavator currently operating on-site at the REA3 complex will be used (as required) to excavate CCR from REA6. Excavated material will be loaded into trucks that will be used to transfer this material to Clarence's product stockpile area. From the stockpile, CCR will be transferred via Clarence's existing reclaim system and TLO to containers on trains. The containers will not have a roof allowing them to be loaded directly from the TLO and will have a rear opening to assist with the discharge of material on-site at Charbon.

CCR from Clarence's production stream will also be transferred from the CHPP to the product stockpile area before it is transferred via the existing reclaim system and TLO onto containers on trains.

Excavation and stockpiling of CCR will occur between 7 am and 6 pm. Train loading activities will occur 24 hours, 7 days per week, as for coal loading currently approved under DA 504-00.

No changes to the approved status of REAs 1, 2, 3, 4 or 5 are proposed as part of this modification.

1.3.4 Proposed rail movements

A spur rail line connects Clarence's surface facilities to the Main Western Rail Line. Centennial has approval to transport up to 3 million tonnes per annum (Mtpa) of coal via rail, which can take place 24 hours per day, seven days per week.

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 t of CCR. Therefore, each train will have the ability to transport up to approximately 1,500 t of CCR.

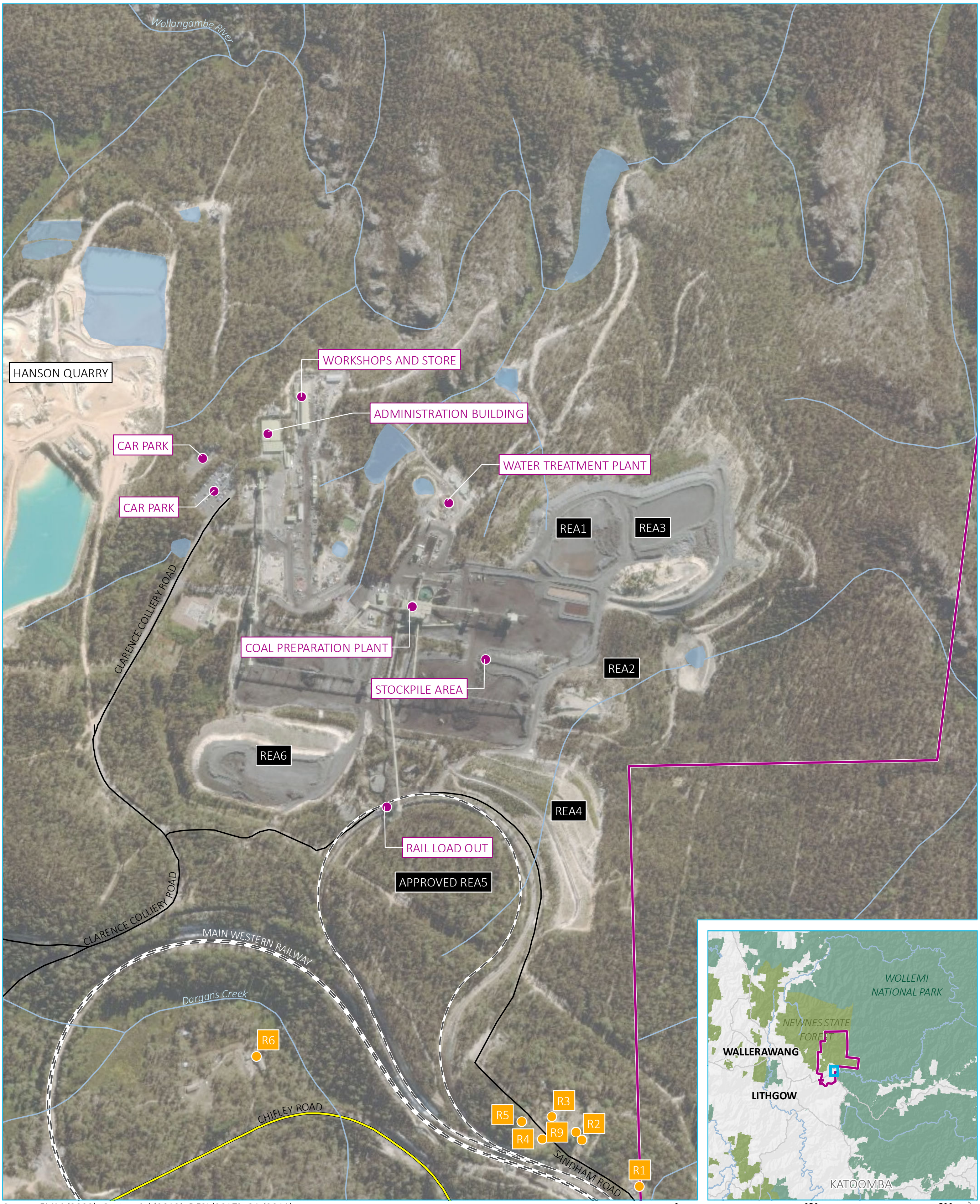
Over a period of five years, it is anticipated that up to 1.5 Mt of CCR will be transported from Clarence to Charbon with an average annual transfer of between 300,000 t and 350,000 t.

1.4 Site and surrounding area

Clarence Colliery's holding boundary is the existing development consent boundary applicable to DA 504-00. Surface facilities at Clarence are on Crown and free-hold land north of Chifley Road (a continuation of Bells Line of Road) and the Main Western Rail Line. A spur rail line also connects the surface facilities to the Main Western Rail Line. Road access to Clarence is directly from Clarence Colliery Road.

Clarence is bordered by the Blue Mountains National Park to the east and Newnes State Forest to the north and west. The residential areas of Newnes Junction and Clarence Village are 900 metres (m) south-east and 1.5 km south-west of Clarence, respectively (refer Figure 1.2). A number of extractive industries are in proximity, including Hanson Quarry to the west and the disused Rocla Quarry to the south-east (refer Figure 1.2). The proposed Newnes Kaolin Project is also to the south.

The area surrounding Clarence is characterised by elevated terrain. Elevations ranges from approximately 920 m AHD to 1,160 mAHD within approximately 10 km of Clarence. A three-dimensional representation of the local topography is shown in Figure 1.4.



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

0 250 500 m

GDA 1994 MGA Zone 56

N

KEY

- Clarence Colliery holding boundary
- Clarence Colliery surface facilities
- Assessment location
- Rail line
- Main road
- Local road
- Watercourse/drainage line
- Waterbody
- NPWS reserve (see inset)
- State forest (see inset)

Existing surface facilities

Clarence Colliery – Modification 6
Air quality impact assessment
Figure 1.3

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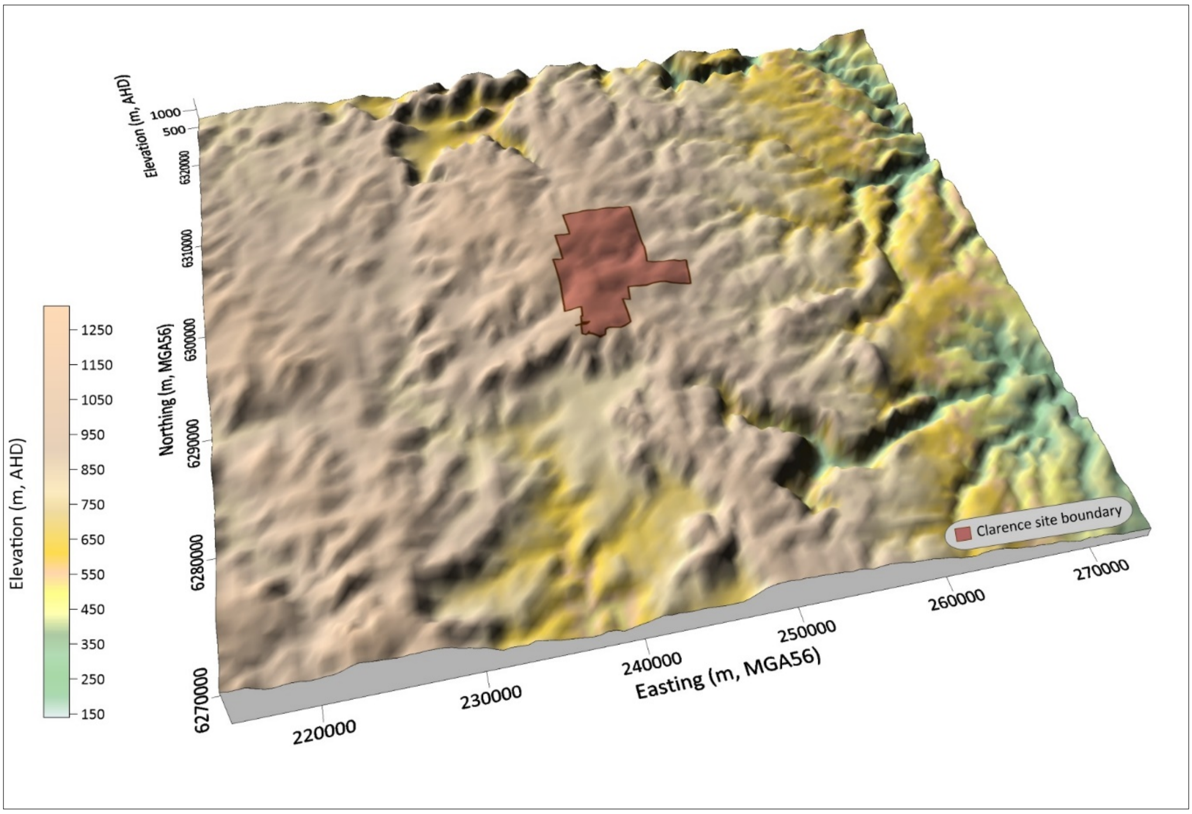


Figure 1.4 3-dimensional topography surrounding Clarence

1.5 Assessment locations

Clarence is approximately 2.5 km northeast of the Clarence township, with scattered rural residential properties also situated at varying distances from Clarence's surface facilities area. The closest residential property is approximately 0.9 km south-east of Clarence's surface facilities area.

The nearest representative air quality sensitive locations to Clarence 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

Figure ID	Description	Assessment location type	Easting	Northing
R1	12 Sandham Road, Dargan	Residential	244554	6292906
R2	576 Sandham Road, Dargan	Residential	244447	6292992
R3	588-602 Sandham Road, Dargan	Residential	244391	6293035
R4	Sandham Road, Clarence	Residential	244373	6292994
R5	Sandham Road, Clarence	Residential	244335	6293026
R6	590 Chiefly Road, Dargan	Residential	243842	6293147
R7	Newnes State Forest	Recreation	243358	6295836
R8	Kerma Crescent, Clarence village	Residential	243115	6292469

2 Pollutants and assessment criteria

2.1 Potential air pollutants

This assessment includes consideration of potential impacts from operational emissions at Clarence for existing and proposed scenarios (Chapter 5).

Emissions will principally consist of particulate matter emissions from the conveying and transfer of ROM coal, coal sizing, hauling of coal and coarse coal rejects (CRR), combustion of diesel, dozers on stockpiles, wind erosion of exposed area and upcast ventilation shaft emissions.

A detailed description of the emission sources associated with the existing and proposed operations at Clarence 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).

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.

It is also noted that the AQIA prepared by SLR (2013) included an assessment of odour emissions from the upcast ventilation shaft. Clarence is approved to extract and process up to 3 Mtpa of ROM coal and this will not change for proposed operations. Consequently, no change to the potential for odour emissions or impacts associated with underground coal extraction operations are anticipated from the AQIA prepared by SLR (2013). No further consideration of odour emissions or impacts is presented within this report.

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

2.2 Applicable air quality assessment criteria

2.2.1 Particulate matter

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) national reporting standards (DoE 2016).

TSP, which relates to airborne particles less than around 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 100th 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: grams 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 Clarence automatic weather station (AWS), approximately 200 m east of the main surface activities (Figure 3.1).

Data from the Clarence AWS has been supplemented with data from the closest Bureau of Meteorology (BoM) monitoring stations as follows:

- Marrangaroo (Defence) AWS, approximately 11 km north-west of Clarence's surface facilities area; and
- Mt Boyce AWS, approximately 17 km south of Clarence's surface facilities area.

The BoM data are primarily included to obtain parameters not measured by the local monitoring site but required for modelling (ie cloud amount and atmospheric pressure).

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

3.2 Prevailing winds and selection of a representative year

Meteorological data recorded by the Clarence 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.

Figure A.1 shows that data availability for 2015 and 2017 to 2019 was between 90.1% and 99.9% across the most important parameters for modelling. Data availability in 2016 was below 70% and temperature for 2015 and 2016 was mostly unavailable.

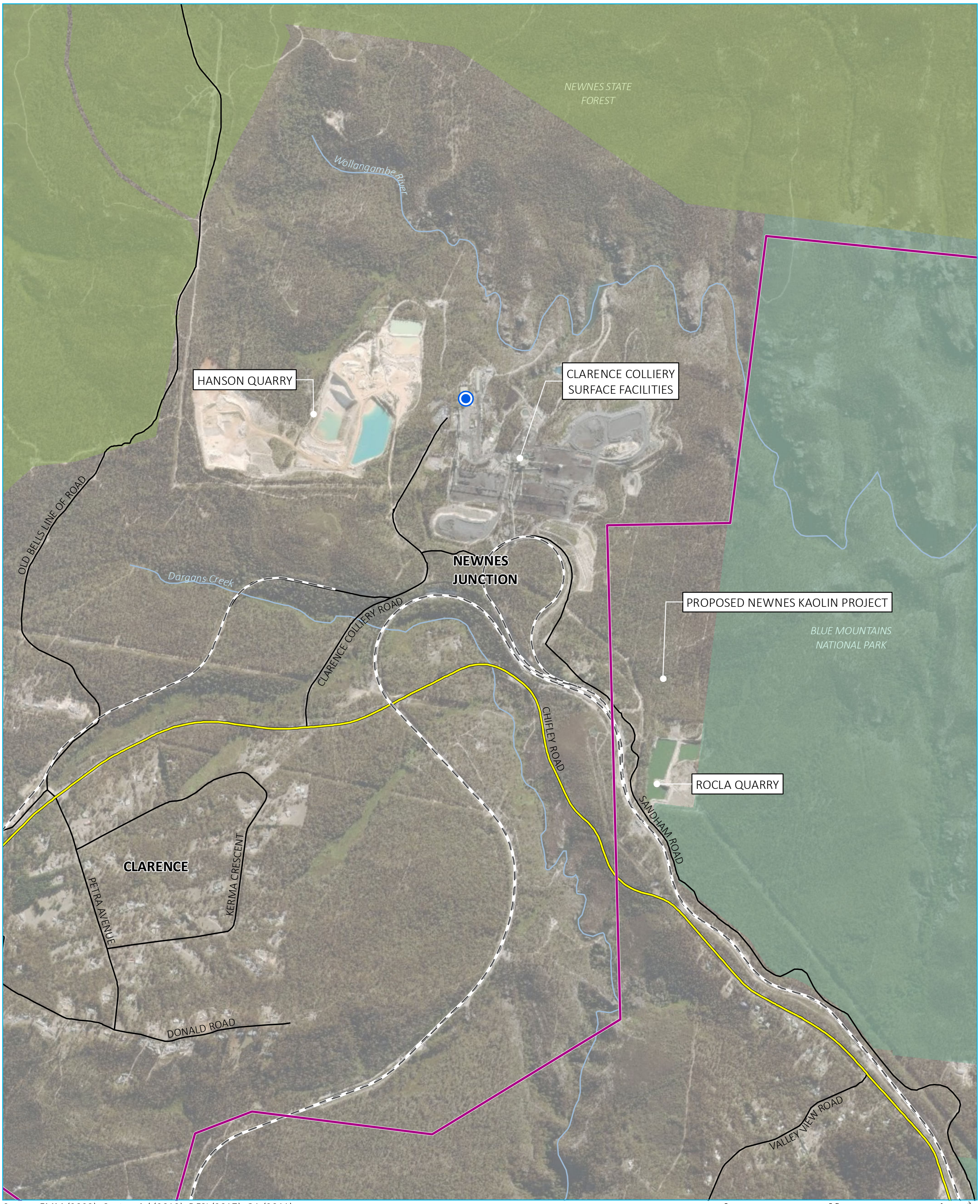
Inter-annual diurnal variation profiles for wind speed, wind direction, air temperature and relative humidity for 2015 to 2019 are shown in Figure A.3 to Figure A.6. The analysis shows consistency in wind direction for 2015 to 2019. There is a noticeable increase in recorded wind speeds for the years 2017 to 2019 relative to 2015 and 2016. The temperature and relative humidity data for 2017 to 2019 (due to data availability) shows consistency across those three years.

Annual wind roses created from wind speed and direction data collected at the Clarence AWS from 2015 to 2019 are presented in Figure A.6. The wind roses show a similar dominant south-westerly and north-easterly alignment in air flow across all years of data; however, there is a notable shift in wind speeds after 2016. The Clarence AWS was upgraded in September 2016 and the new instrumentation is the cause of the shift in recorded conditions for the years 2017 to 2019. In years 2017 to 2019, the south-westerly quadrant flow is shifted slightly more towards the west and increased in wind speeds. Annual average wind speeds in years 2017 to 2019 ranged between 2.9 and 3 m/s, while the annual average frequency of calm conditions (wind speeds less than 0.5 m/s) ranged between 0.8% and 1.6%.

Seasonal wind roses for the Clarence AWS for 2015 to 2019 are shown in Figure A.7. The mean wind speed ranges from 2.2 m/s in autumn to 3 m/s in winter. The seasonal average percentage of calm conditions ranged from 0.8% in spring to 2.9% in autumn. The wind patterns in all seasons were very similar displaying dominant south-westerly and north-easterly alignment. In winter there was a lower occurrence of winds from the north-east.

Diurnal wind roses for the Clarence AWS are shown in Figure A.8. The dominant south-westerly and north-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 2.2 m/s at night-time. The percentage of calms during the day was 0.8% compared to 2.6% 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 between 2017 to 2019. The modelling year was also chosen with regard to background air quality which is discussed in Section 4.4. The annual wind rose for the Clarence 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 south-western and north-eastern quadrants.



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

0 0.5 1 km
GDA 1994 MGA Zone 56
N

KEY

- Clarence Colliery holding boundary
- Clarence AWS
- Major road
- Minor road
- Rail line
- Watercourse
- NPWS reserve
- State forest

Location of meteorological station

Clarence Colliery – Modification 6
Air quality impact assessment
Figure 3.1

EMM
creating opportunities

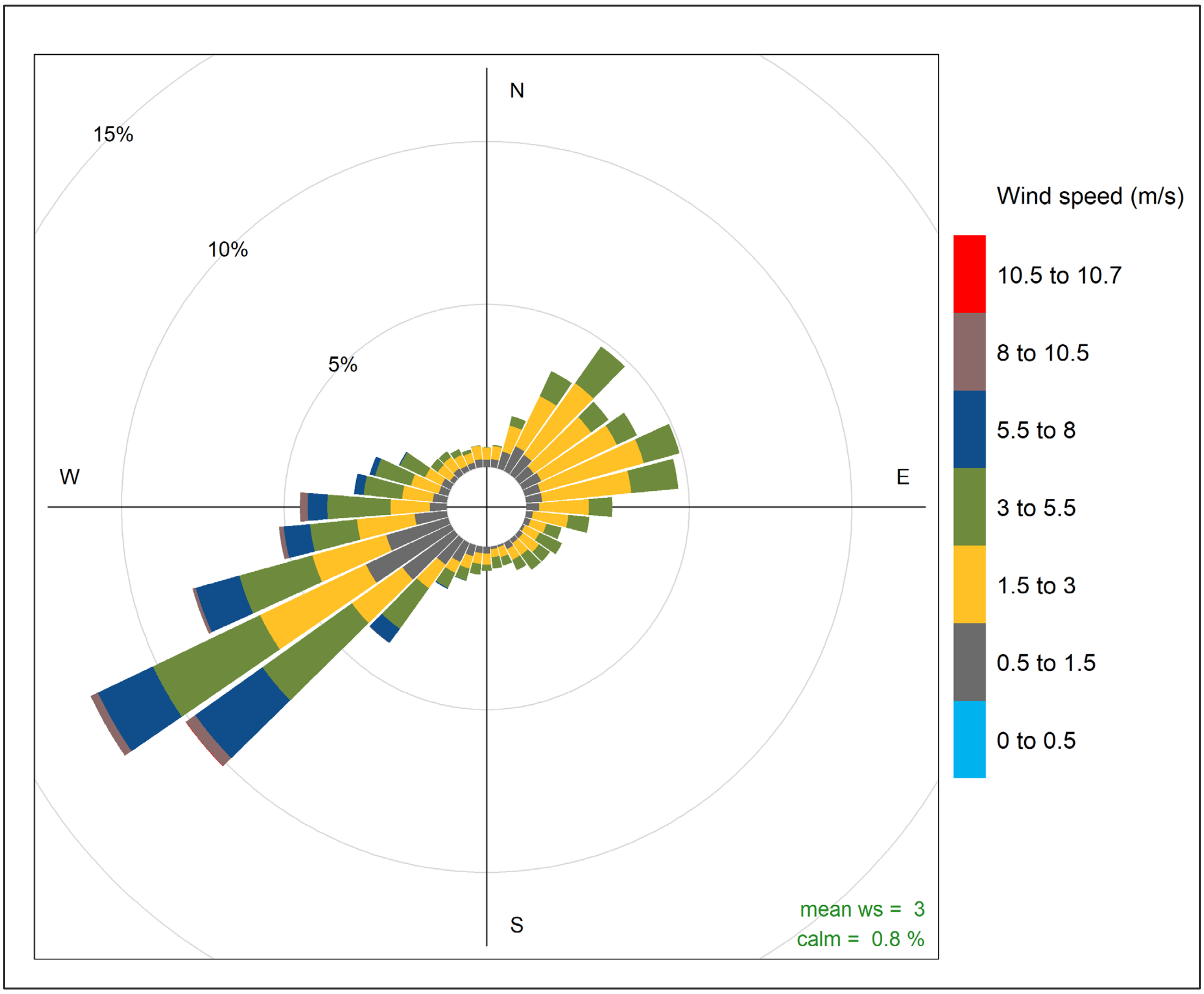


Figure 3.2 Annual wind rose for Clarence AWS

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 Clarence AWS, the BoM Marrangaroo (Defence) AWS and Mt Boyce AWS were used as observations in the TAPM and CALMET modelling.

The observations at the Clarence 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 Appendix A.

3.3.2 CALMET predicted winds

Hourly meteorological predictions were extracted at the Clarence AWS to compare with the measured data at the Clarence 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 Appendix A.

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

The annual wind rose created from the CALMET data is very similar in pattern to the wind rose created from the observations as shown in Figure 3.3. The annual average wind speed for both datasets is between 2.9 and 3 m/s. The annual percentage of calms is 0.8% in both the observed data and the CALMET extracted data.

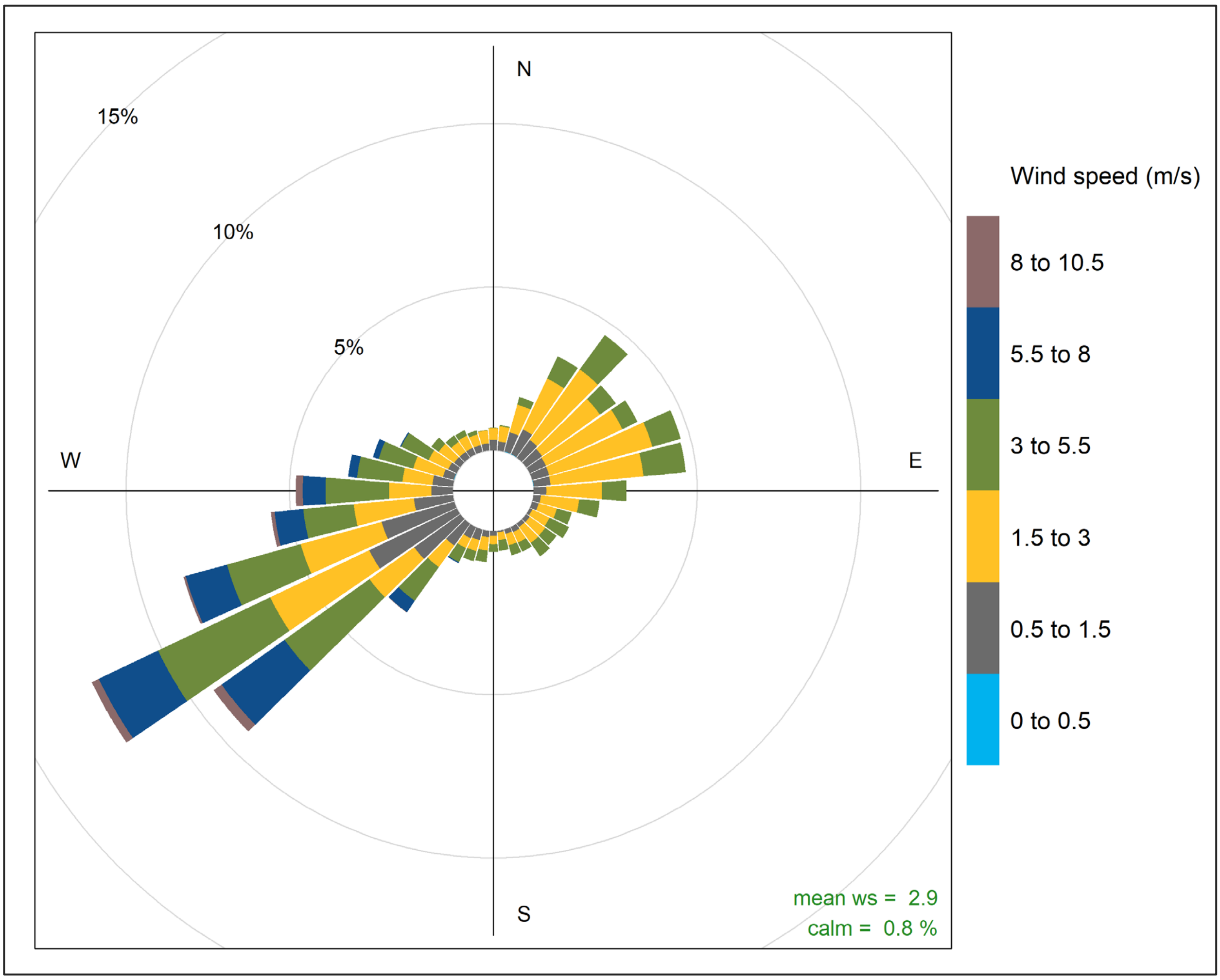


Figure 3.3 CALMET-predicted wind speed and direction – Clarence – 2018

3.3.3 Atmospheric boundary layer heights

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 Clarence 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 the dispersion of 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 3.5 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.

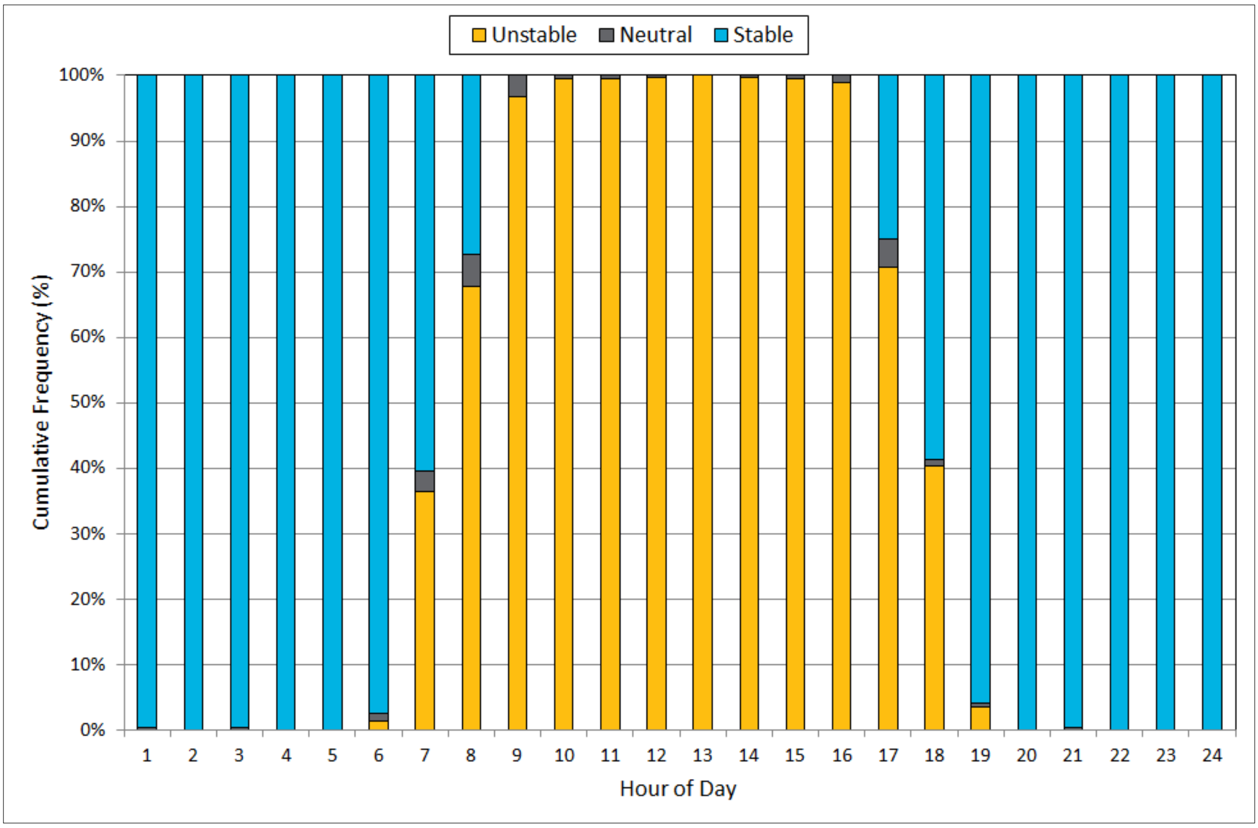


Figure 3.4 Diurnal variations in CALMET-generated atmospheric stability – Clarence AWS 2018

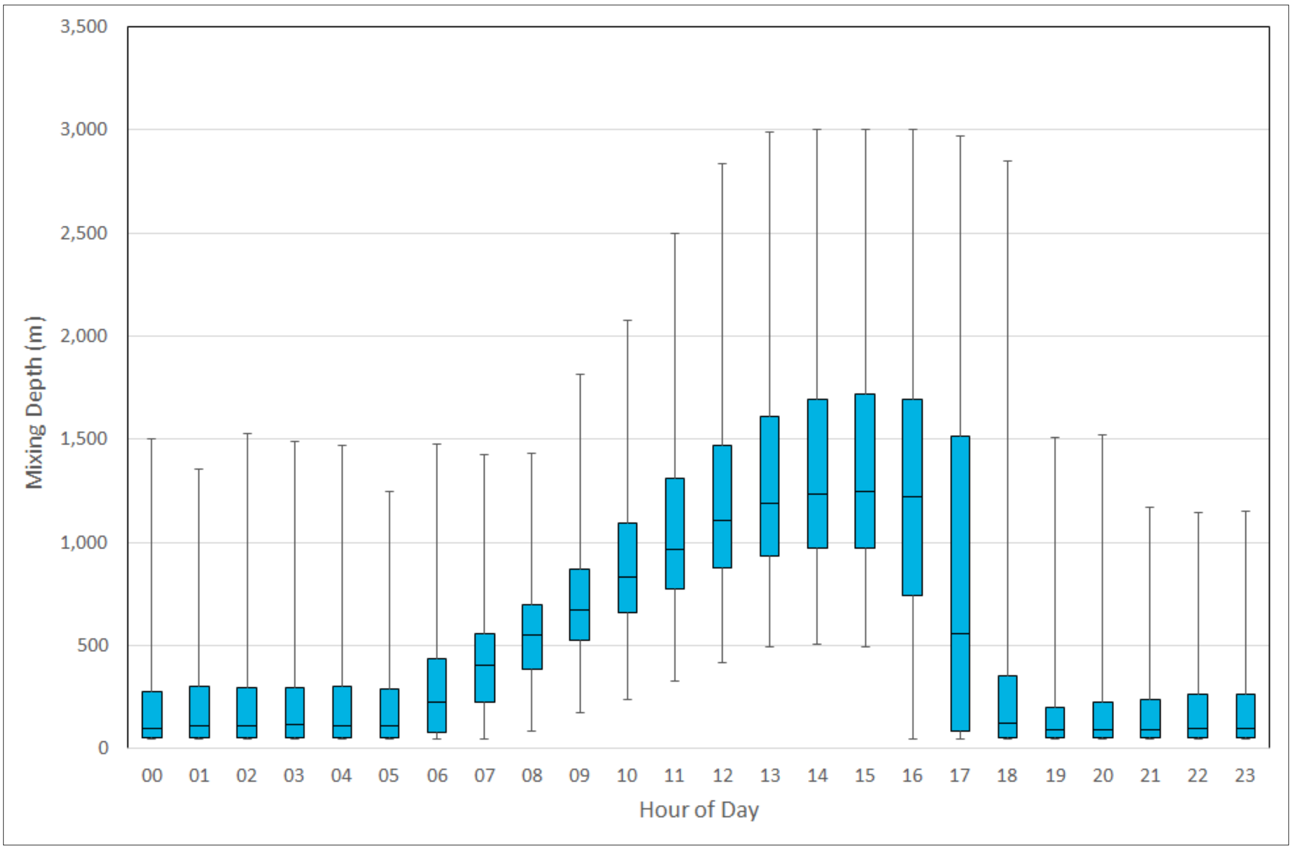


Figure 3.5 Diurnal variation in CALMET-generated mixing heights – Clarence AWS 2018

4 Baseline air quality

4.1 Introduction

The local airshed will be influenced by:

- emissions from existing operations at Clarence including Hanson's Clarence sand quarry;
- neighbouring industrial emission sources, including the Hanson sand quarry;
- 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.

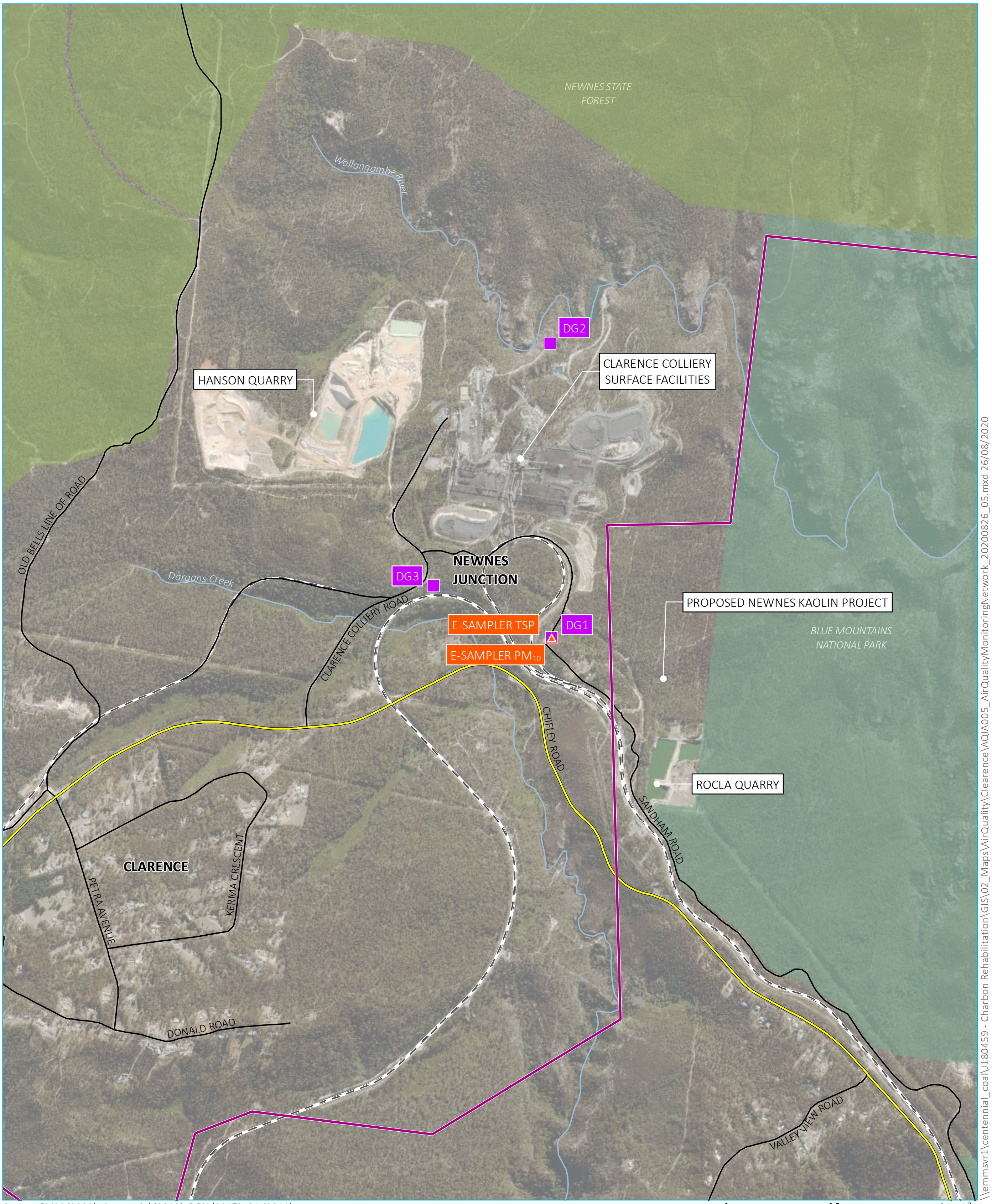
4.2 Air quality monitoring data resources

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

- two E-Samplers (measuring TSP and PM_{10}) operating on a campaign basis (two months in a year);
- three 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 locations of Clarence's monitoring equipment are shown in Figure 4.1.

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



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

0 0.5 1 km
GDA 1994 MGA Zone 56
N

KEY

- Clarence Colliery holding boundary
- Major road
- Minor road
- Rail line
- Watercourse
- NPWS reserve
- State forest
- Dust deposition gauge
- E-sampler

Location of air quality monitoring network

Clarence Colliery – Modification 6
Air quality impact assessment
Figure 4.1

EMM
creating opportunities

4.3 Background air quality

4.3.1 PM_{10}

i Clarence E-sampler data

As stated above, PM_{10} concentrations are recorded by the Clarence E-samplers which are run on a campaign basis (24-hour period every sixth day for two months of the year). The monitoring results therefore do not represent a true indication of the annual average or daily maximum concentrations but are shown here for completeness and to provide an indication of concentrations at Clarence.

A summary of key statistics for five years of analysed data from the E-samplers is presented in Table 4.1.

The data also shows concentrations increasing from 2015 to 2019. The increase in concentrations in 2019 are 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. It is noted that there were only three days of sampling data available in 2019.

Table 4.1 Statistics for PM_{10} concentrations – Clarence E-sampler – 2015–2019

Monitoring year	PM_{10} concentration ($\mu g/m^3$)		
	Maximum 24-hour average concentration ($\mu g/m^3$)	Average concentration ($\mu g/m^3$)	Number of days greater than 50 $\mu g/m^3$
2015	5.1	2.5	0
2016	5.1	3.0	0
2017	20.0	1.2	0
2018	16.0	7.5[1]	0
2019[2]	194.4	43.3	24

Note: [1] The measurement period is different for PM_{10} and TSP, which explains why PM_{10} concentrations are greater than TSP shown for the same year in Table 4.4.

[2] Only three days of sampling were available for 2019.

ii Bathurst AQMS

Although PM_{10} concentrations are monitored at Clarence, the data are measured on a campaign basis and therefore cannot be used alone in a contemporaneous cumulative analysis for Clarence. 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 4.3. Two exceedances of the NSW EPA 24-hour average criterion of 50 µg/m³ were recorded in 2015, eight were recorded in 2018 and 40 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 and 2019.

It is acknowledged that land use and dust-generating activities surrounding the Clarence E-sampler differ to those at the Bathurst monitoring station. The dominant dust source in the vicinity of Clarence is mining, whereas the dominant dust sources in Bathurst are residential activities such as wood heaters and fuel combustion from vehicles. To compare the Clarence E-sampler and Bathurst datasets, coincident 24-hour average PM_{10} concentrations recorded at the two locations were extracted for the 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

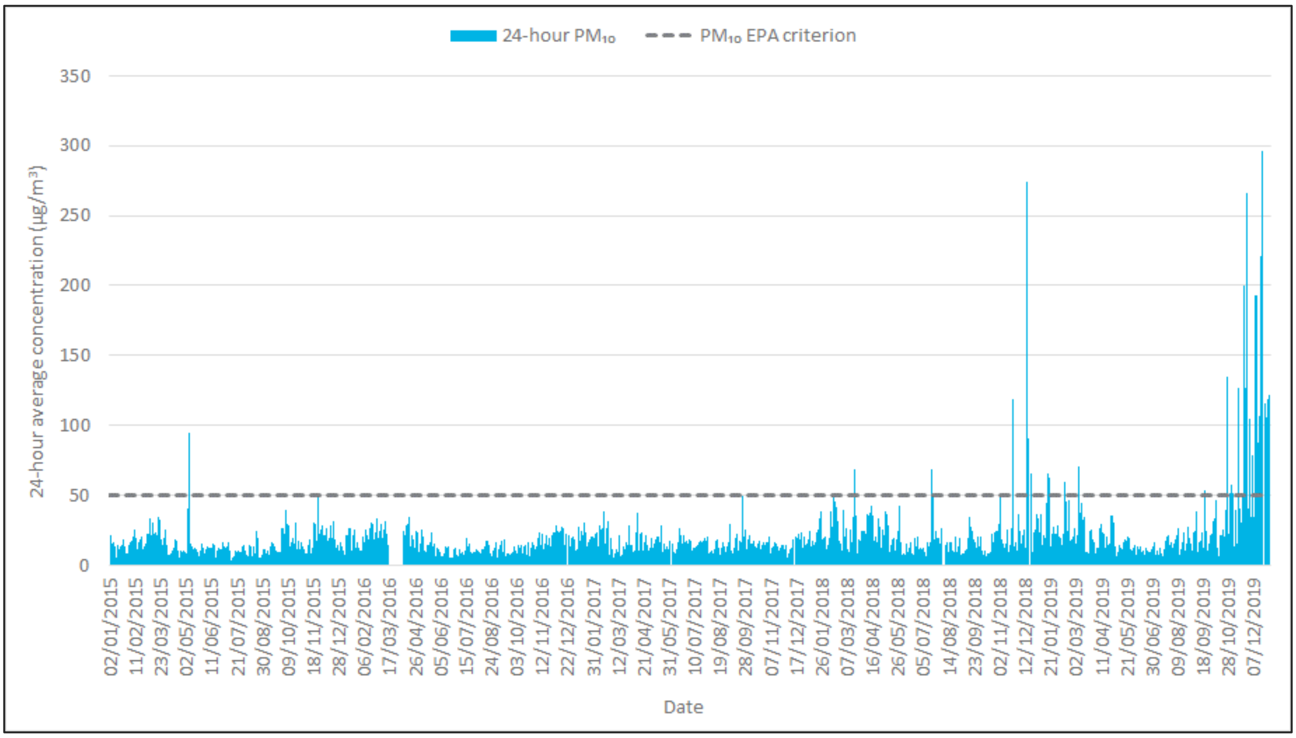


Figure 4.2 Time series of 24-hour average PM_{10} concentrations – Bathurst AQMS – 2015–2019

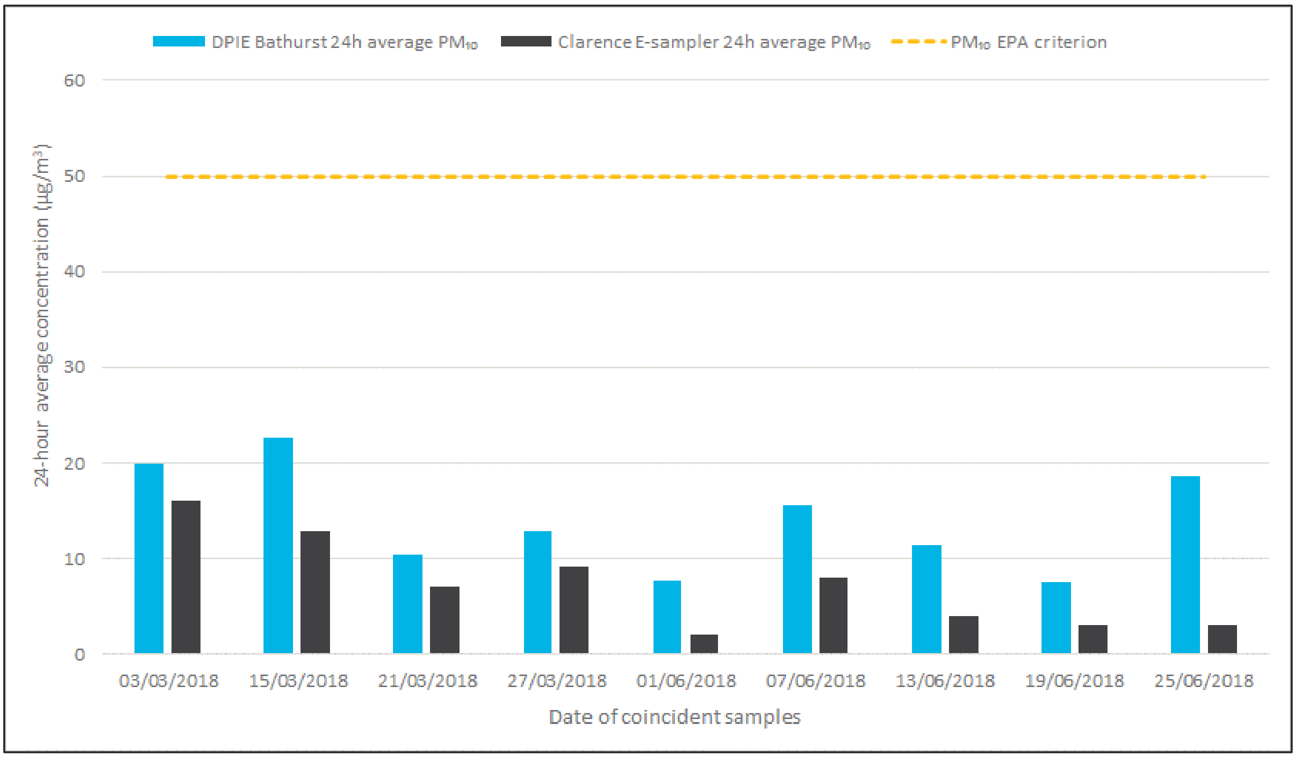


Figure 4.3 Coincident 24-hour average PM_{10} concentrations – Clarence E-sampler and Bathurst AQMS – 2018

Note: Only dates with co-incident 24-hour average PM_{10} concentrations at both the Clarence E-sampler 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 recorded higher average PM_{10} concentrations than the Clarence E-sampler for all coincident days of monitoring in 2018; and
- on average, the Clarence E-sampler recorded concentrations that were approximately 50% of the concentrations recorded at Bathurst.

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 E-sampler monitoring method.
- The Bathurst site features a higher density of urban development and associated emission sources (motor vehicles, domestic heating, etc) than the area around surrounding Clarence. In particular, the elevated concentrations during the autumn and winter months were likely attributable to wood heater emissions.

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 Table 4.2, there were eight days in 2018 when the PM_{10} concentrations were already above 50 µg/m³.

iii Katoomba AQMS

DPIE currently monitors pollutants at a 'special project air quality monitoring station' at Katoomba approximately 28 km south of Clarence. The Katoomba AQMS commenced monitoring of particulate matter and other pollutants from April 2019. The AQMS is on a plateau at an elevation of approximately 1,048 mAHD. This is not dissimilar to the altitude of Clarence (1,043 mAHD). The Katoomba AQMS is surrounded by bushland to the west and the town of Katoomba to the east which would include urban development emission sources such as motor vehicles and domestic heating.

Measurements of 24-hour average PM_{10} concentrations from the Bathurst and Katoomba AQMSs for April to December 2019 have been compared in Figure 4.4. The comparison shows that for the majority of the monitoring period, PM_{10} concentrations recorded at the Katoomba AQMS are lower than those recorded at the Bathurst AQMS. The elevated concentrations seen towards the end of 2019 at both stations coincide with widespread bushfire events that occurred across NSW at this time. It is noted that concentrations recorded at the Katoomba AQMS in late 2019 are generally higher than those recorded at the Bathurst AQMS due to notable localised bushfire activity in the Blue Mountains region.

Excluding the influence of local bushfires to the Katoomba AQMS, it is considered that the comparison of concurrent measurements from the Bathurst AQMS and Katoomba AQMS demonstrates that the use of the Bathurst dataset is conservative for representing background concentrations at Clarence on a day-to-day basis.

It is noted that at the time of modelling commencement, there was insufficient data collected at the Katoomba AQMS to meet the requirements of the Approved Methods for Modelling. The Katoomba AQMS data is not referenced further in this assessment.

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

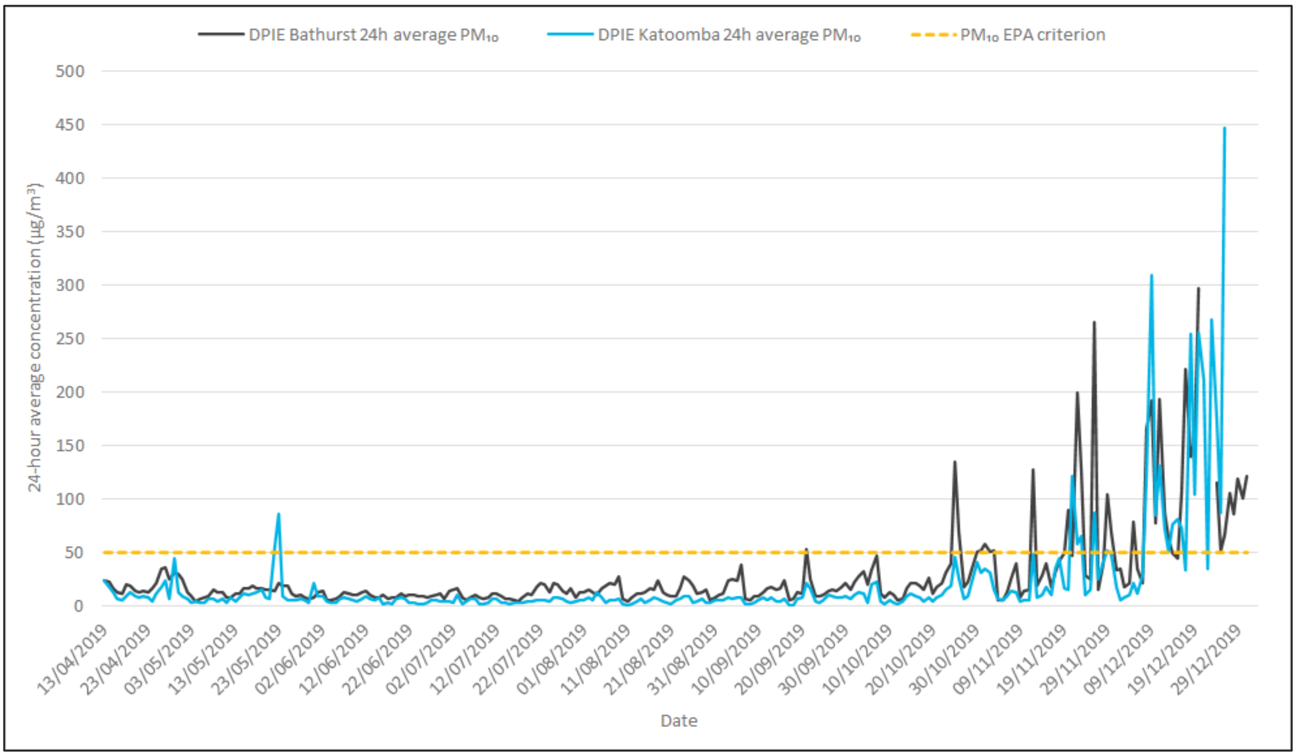


Figure 4.4 **24-hour average PM_{10} concentrations - Bathurst and Katoomba – April–December 2019**

4.3.2 $PM_{2.5}$

No monitoring of $PM_{2.5}$ is conducted by the existing air quality monitoring network at Clarence. To provide an analysis of background $PM_{2.5}$ concentrations in the absence of these measurements, $PM_{2.5}$ concentrations recorded by the Bathurst station 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 station 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 4.5. 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 two exceedances were recorded in 2018 and 24 exceedances were recorded in 2019.

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 25 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.

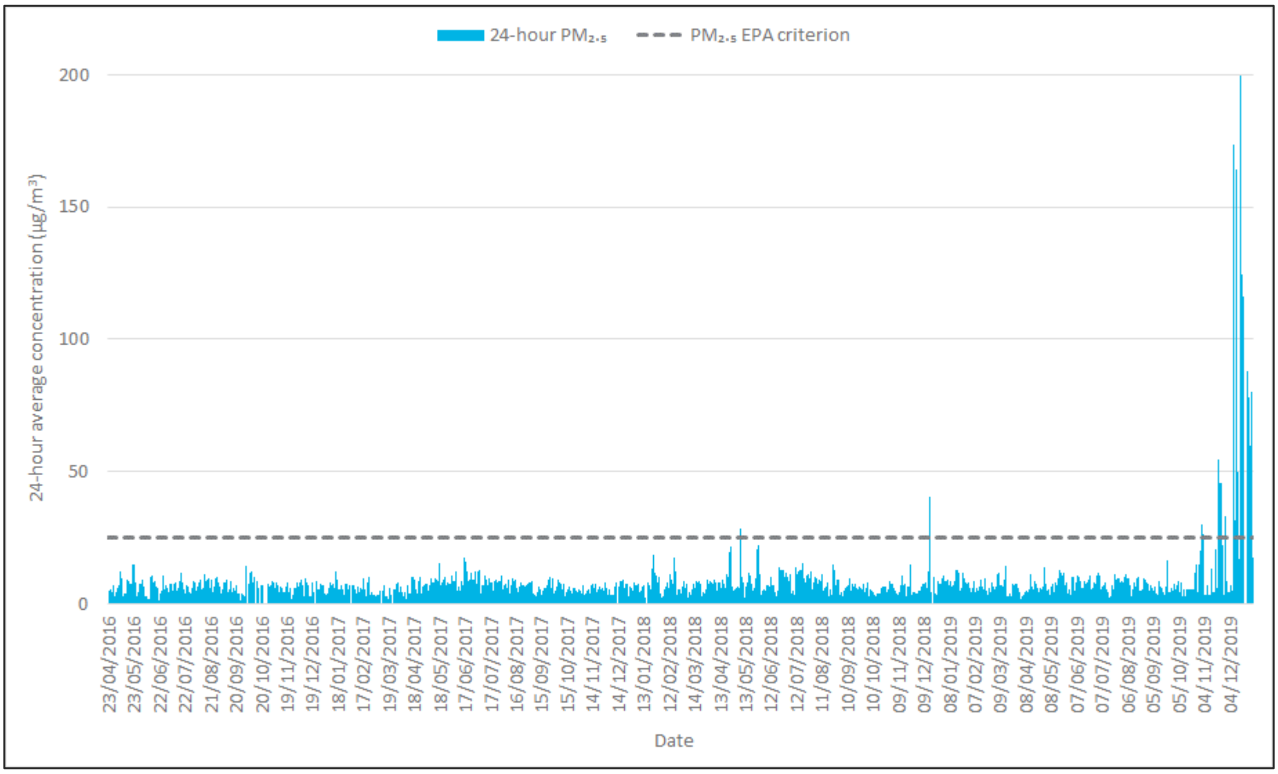


Figure 4.5 Time series of 24-hour average $PM_{2.5}$ concentrations – Bathurst AQMS – 2016–2019

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

4.3.3 TSP

Concentrations of TSP are recorded by the Clarence E-samplers for a 24-hour period every sixth day for two months of the year.

A summary of key statistics for five years of analysed data from the E-samplers is presented in Table 4.4.

Similar to the PM_{10} data, TSP concentrations have increased from 2015 to 2019 with elevated concentrations in 2019 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. It is noted that there were only three days of sampling data available in 2019.

The average TSP concentration for 2019 is elevated due to the bushfire events that occurred during the period of measurement (ie November and December 2019).

Table 4.4 Statistics for TSP concentrations – Clarence E-sampler – 2015–2019

Monitoring year	TSP concentration (µg/m³)
	Average concentration (µg/m³)
2015	9.0
2016	12.2
2017	6.8
2018	5.7
2019[1]	57.6

Note: 1 Only three days of sampling were available for 2019.

Although TSP concentrations are measured at Clarence, there are insufficient data to derive an annual average concentration for background. As the TSP and PM_{10} data were also recorded on different days, a ratio of PM_{10}/TSP cannot be derived from the E-sampler data. Further, TSP concentrations are not measured at the Bathurst AQMS. The ratio of PM_{10}/TSP for rural areas typically ranges from 0.4 to 0.5. In the absence of appropriate local TSP monitoring data, the annual average TSP concentration has been derived by applying a PM_{10}/TSP ratio of 0.4 to the annual average PM_{10} concentration for 2018 (of 18.8 µg/m³). The resultant derived TSP background concentration is 47.1 µg/m³.

4.3.4 Dust deposition

Centennial operates a network of three dust deposition gauges in the vicinity of Clarence's surface facilities.

A summary of the dust deposition monitoring results for Clarence is presented in Table 4.5, showing that the annual average dust deposition ranges from 0.6 g/m²/month to 3.5 g/m²/month, with an average across all sites and all years of 1.3 g/m²/month. The average across all sites for 2018 is 1.2 g/m²/month. This value has been adopted as background for the cumulative assessment.

The measured dust deposition levels include contribution from existing operations at Clarence, therefore provide a conservatively high background for cumulative assessment.

Table 4.5 Dust deposition monitoring summary for Clarence

Year	DG1	DG2	DG3
2015	0.7	0.9	3.5
2016	0.6	0.5	0.7
2017	0.8	0.7	1.9
2018	1.1	1.5	1.1
2019	1.5	2.7	1.1
Average	**0.9**	**1.3**	**1.7**

4.4 Adopted background for cumulative assessment

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 – 7.0 µg/m³;
- annual average TSP concentration – 47.1 µg/m³; and
- annual average dust deposition – 1.2 g/m²/month.

5 Emission inventory

5.1 Introduction

Two emission scenarios have been developed to quantify particulate matter impacts from Clarence and to understand the significance of the proposed modification to approved operations. These scenarios are:

- existing scenario – processing of a maximum of 3 Mtpa of coal; and
- proposed scenario – existing scenario plus the proposed modification, including:
  - extraction of CCR from REA6;
  - transfer of CCR from REA6 and Clarence's production stream to the existing TLO;
  - loading of CCR into train-based containers via the existing TLO; and
  - export of CCR off-site to Charbon via rail.

5.2 Emissions estimates

5.2.1 Overview

Fugitive dust sources associated with existing and proposed operations at Clarence 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 Clarence are shown in Table 5.1 and Table 5.2 below. Each activity has been represented in the modelling as a point, volume or line-volume source. Site diesel combustion was attributed to all activities (except wind erosion) using a breakdown of diesel used for surface transport and diesel used for stationary equipment as provided by Centennial. The modelled source locations for the existing and proposed scenarios are shown in Figure 5.1 and Figure 5.2 respectively.

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

Hanson's Clarence sand quarry is approximately 200 m west of Clarence's surface facilities. Given its proximity to Clarence and the surrounding assessment locations, emissions from this site were calculated and sources included in the cumulative dispersion modelling.

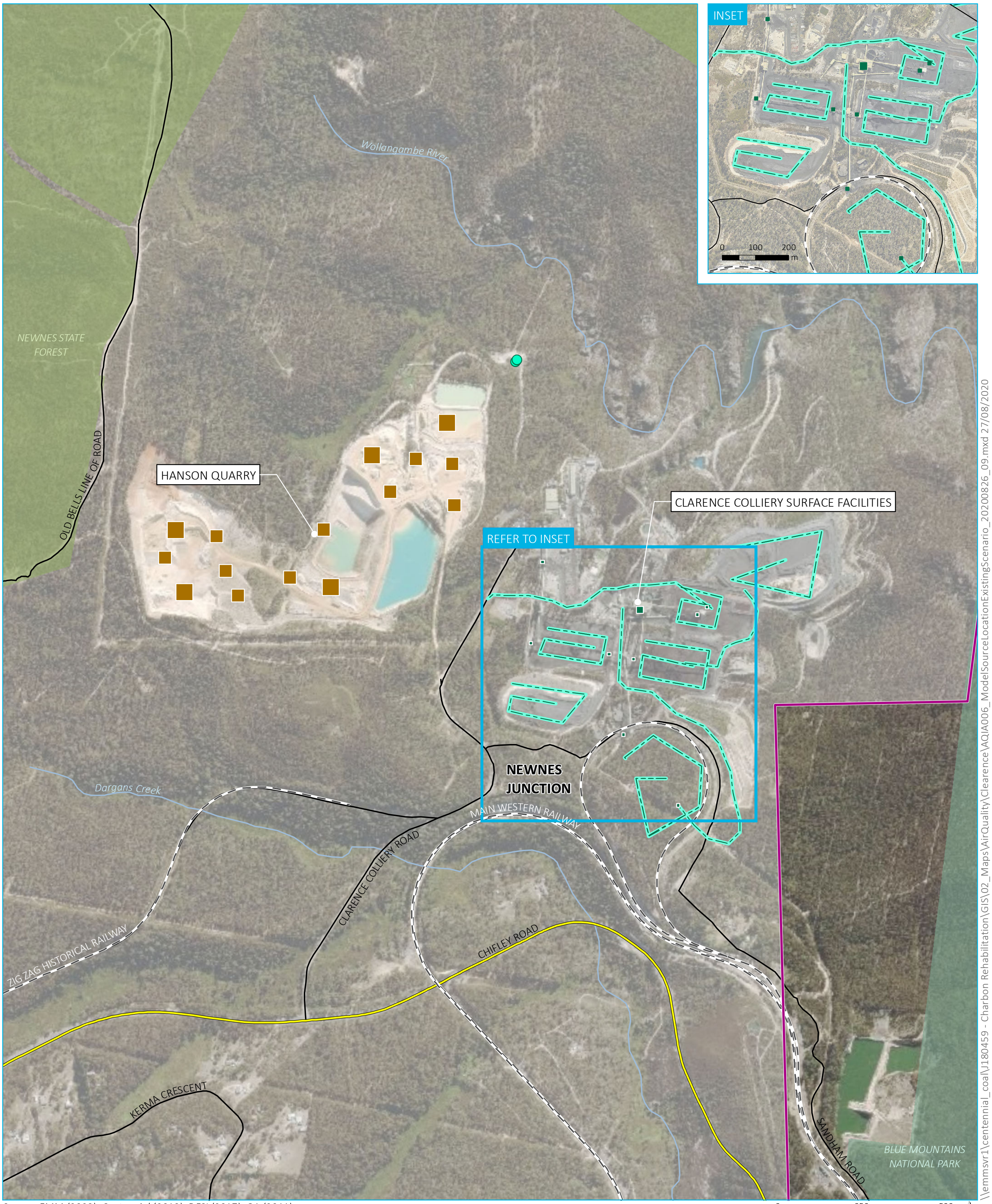
As there are no AQIAs available for this site, emissions were estimated by taking the maximum production rate of 500,000 t of sand from the site's Environment Protection Licence (EPL) and apportioning TSP, PM_{10} and $PM_{2.5}$ emissions based on ratios of extraction rates to emissions from five other quarries[3] with publicly available data. Fifteen sources were distributed across the quarry based on a Google Earth aerial and an estimation of the location of site activities. The estimated emissions for Hanson's Clarence quarry are provided in Table 5.3 and the source locations are shown in Figure 5.1 and Figure 5.2.

Rocla Quarry, approximately 820 m south-east of Clarence (Figure 1.2), is no longer operational and therefore has not been considered further in this AQIA.

The Newnes Kaolin project is a proposed sand and kaolin processing plant, south of Clarence (Figure 1.2). The project was issued with revised Planning Secretary's Environmental Assessment Requirements (SEARs) in September 2018 and is currently at the 'Prepare EIS' stage according to the NSW Government's Major Projects website[4]. As the project is still in its planning stages and not approved, it has not been included further in this AQIA.

3 Data sourced from EMM (2019), Ramboll (2019), Ramboll (2018a), Ramboll (2018b) and Pacific Environment Limited (2016).

4 https://www.planningportal.nsw.gov.au/major-projects/project/9926



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

0 250 500 m
GDA 1994 MGA Zone 56
N

KEY

- Clarence Colliery holding boundary
- Hanson Quarry volume source
- Major road
- Minor road
- Rail line
- Watercourse
- NPWS reserve
- State forest

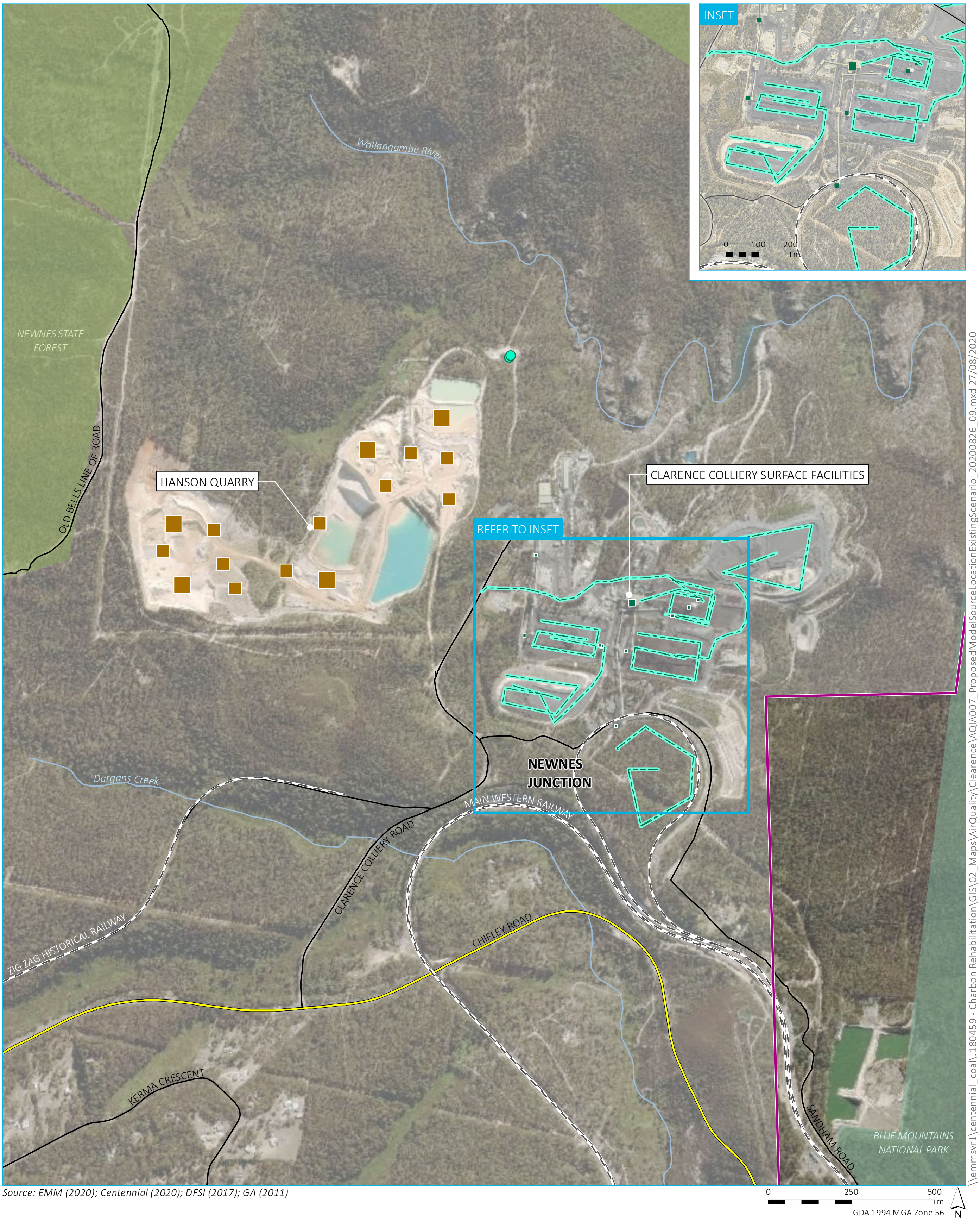
Model source type

- Point
- Line
- Volume

Model source locations - existing scenario

Clarence Colliery – Modification 6
Air quality impact assessment
Figure 5.1

EMM
creating opportunities



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

KEY

- Clarence Colliery holding boundary
- Hanson Quarry volume source
- Major road
- Minor road
- Rail line
- Watercourse
- NPWS reserve
- State forest

Model source type

- Point
- Line
- Volume

Model source locations - proposed scenario

Clarence Colliery – Modification 6
Air quality impact assessment
Figure 5.2

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 5.3 for the existing scenario and Figure 5.4 for the proposed scenario. Calculated annual emissions by emissions source are presented in Table 5.1 and Table 5.2 for the existing and proposed scenarios respectively. Particulate matter control measures, as documented in 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 Clarence's operations (existing and proposed) is associated with dozer activities and wind erosion of exposed areas. The data shows that there is an increase in emissions under the proposed scenario of 4%. This increase relates to the additional material handling and hauling activities associated with proposed modification (Section 5.1).

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

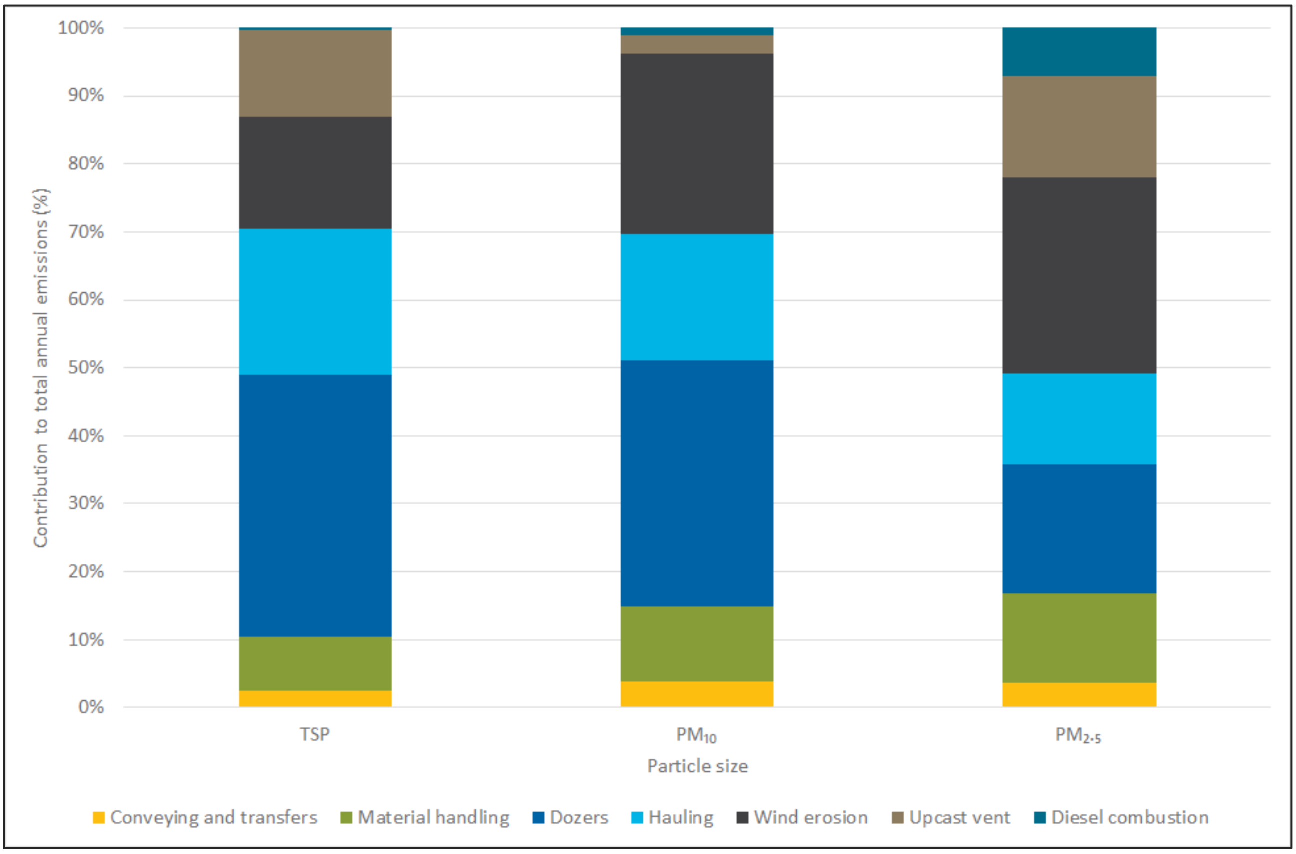


Figure 5.3 Contribution to annual emissions by source type and particle size – existing scenario

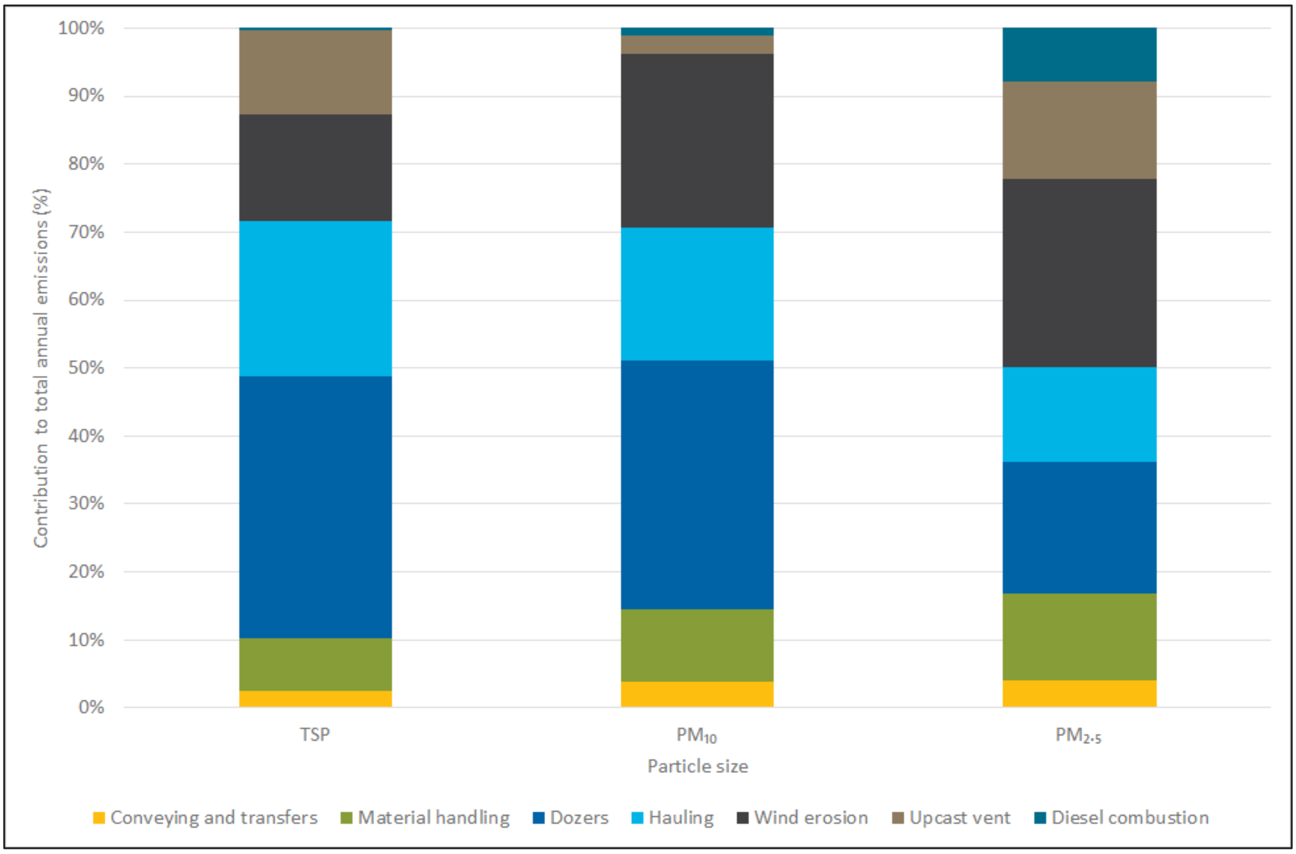


Figure 5.4 Contribution to annual emissions by source type and particle size – proposed scenario

Table 5.1 Calculated annual TSP, PM_{10} and $PM_{2.5}$ emissions – existing operational scenario

Emission source	Calculated annual emissions (kg/annum) by source		
	TSP	PM_{10}	$PM_{2.5}$
Coal handling and processing			
Conveyor transfer - ROM coal to breaker	148	70	11
Breaker	2,440	1,090	209
Crusher	2,440	1,090	209
Conveyor transfer - ROM coal to ROM stockpile	500	240	42
Loading coal to conveyor	500	240	42
Conveyor transfer - ROM coal to CHPP (90%)	133	63	10
Loading washed coal stockpile	297	144	27
Conveyor transfer - washed coal to banana screen	7	3	1
Screening washed coal	760	268	11
Loading secondary product stockpile	32	19	8
Dozer on ROM stockpile	17,355	5,287	388
Dozer on washed coal stockpile	7,981	2,156	182
Dozer on secondary product stockpile	1,336	365	36
Coal transport			
Conveyor transfer - ROM to train loading bin (10%)	15	7	1
Loading trains - ROM coal (10%)	30	14	2
Conveyor transfer - washed coal to train loading bin	87	41	6
Loading trains - washed coal	174	82	12
FEL loading trucks - secondary product	49	23	4
Trucks hauling -secondary product offsite	6,372	1,700	172
CCR handling			
Loading trucks with CCR at CHPP	33	16	2
Hauling CCR from CHP to REA5	4,811	1,284	130
Unloading CCR at REA5	33	16	2
Dozer on REA5	1,304	402	35
Excavator recovering fines and loading trucks at REA3	102	48	7
Hauling fines from REA3 to washed coal stockpile	4,448	1,187	121
Unloading fines to washed coal stockpile	33	19	8
Wind erosion			

Table 5.1 Calculated annual TSP, PM_{10} and $PM_{2.5}$ emissions – existing operational scenario

Emission source	Calculated annual emissions (kg/annum) by source		
	TSP	PM_{10}	$PM_{2.5}$
Wind erosion - REA3	2,550	1,275	191
Wind erosion - REA4 (not active)	0	0	0
Wind erosion - REA5	2,550	1,275	191
Wind erosion - REA6	1,700	850	128
Wind erosion - ROM stockpile	2,043	1,022	153
Wind erosion - Washed coal stockpile	2,043	1,022	153
Wind erosion - Secondary product stockpile	1,022	511	77
Ventilation fans			
Ventilation fans	9,253	618	460
Total	**72,580**	**22,448**	**3,033**

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

Table 5.2 Calculated annual TSP, PM_{10} and $PM_{2.5}$ emissions – proposed operational scenario

Emission source	Calculated annual emissions (kg/annum) by source		
	TSP	PM_{10}	$PM_{2.5}$
Coal handling and processing			
Conveyor transfer - ROM coal to breaker	148	70	11
Breaker	2,440	1,090	209
Crusher	2,440	1,090	209
Conveyor transfer - ROM coal to ROM stockpile	500	240	42
Loading coal to conveyor	500	240	42
Conveyor transfer - ROM coal to CHPP (90%)	133	63	10
Loading washed coal stockpile	297	144	27
Conveyor transfer - washed coal to banana screen	7	3	1
Screening washed coal	760	268	11
Loading secondary product stockpile	32	19	8
Dozer on ROM stockpile	17,355	5,287	388
Dozer on washed coal stockpile	7,981	2,156	182
Dozer on secondary product stockpile	1,336	365	36
Coal transport			
Conveyor transfer - ROM to train loading bin (10%)	15	7	1
Loading trains - ROM coal (10%)	30	14	2
Conveyor transfer - washed coal to train loading bin	87	41	6
Loading trains - washed coal	174	82	12
FEL loading trucks - secondary product	49	23	4
Trucks hauling -secondary product offsite	6,372	1,700	172
CCR handling			
Loading trucks with CCR at CHP	33	16	2
Dozer on REA5	1,304	402	35
Excavator recovering fines and loading trucks at REA3	102	48	7
Hauling fines from REA3 to washed coal stockpile	4,448	1,187	121
Unloading fines to washed coal stockpile	33	19	8
Wind erosion			
Wind erosion - REA3	2,550	1,275	191
Wind erosion - REA4 (not active)	0	0	0

Table 5.2 Calculated annual TSP, PM_{10} and $PM_{2.5}$ emissions – proposed operational scenario

Emission source	Calculated annual emissions (kg/annum) by source		
	TSP	PM_{10}	$PM_{2.5}$
Wind erosion - REA5	2,550	1,275	191
Wind erosion - REA6	1,700	850	128
Wind erosion - ROM stockpile	2,043	1,022	153
Wind erosion - Washed coal stockpile	2,043	1,022	153
Wind erosion - Secondary product stockpile	1,022	511	77
Ventilation fans			
Ventilation fans	9,253	618	460
Modification-specific activities			
Hauling CCR from CHP to product stockpile	3,368	899	92
Unloading CCR at product stockpile	24	15	8
Excavator recovering CCR and loading trucks at REA6	81	38	6
Hauling CCR from REA6 to ROM stockpile	3,106	800	82
Dozer recovering CCR to trains	1,304	402	35
Conveyor transfer - CCR to train loading bin	11	5	1
Loading coarse rejects to trains	32	21	11
Total	**75,663**	**23,329**	**3,134**

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

Table 5.3 Calculated annual TSP, PM_{10} and $PM_{2.5}$ emissions for Hanson sand quarry

Emission source	Calculated annual emissions (kg/annum)		
	TSP	PM_{10}	$PM_{2.5}$
Hanson sand quarry	77,134	28,316	6,133

6 Overview of best practice dust control

A range of mitigation measures and management practices are implemented to manage particulate matter emissions from Clarence.

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.

Measures implemented at Clarence and included in the emissions estimation for both the existing and proposed scenarios include:

- enclosures at conveyor transfer points;
- water sprays at conveyor transfer points;
- water sprays on stockpiles;
- water sprays on dozer materials;
- watering and sweeping on paved haul roads;
- water sprays on REAs when needed;
- enclosure of coal crusher and screen; and
- watering at coal crusher and screen.

As shown in Table 6.1, wherever practical to do so, Clarence 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 Clarence

Emissions source category	Best practice control measures (Katestone 2011)	Currently adopted or proposed for implementation at Clarence	Comments	Effectiveness of reduction in emissions inventory
Conveyors and transfers	Application of watering at transfer points	Yes	Watering applied at transfer points.	50%
	Enclosure of transfer points	Yes	All transfer points enclosed.	70%
	Wind shielding of conveyor belts – roof and/or side wall	Yes	Enclosed as above.	As above.
	Belt cleaning and spillage minimisation	Yes	Enclosed and water sprays applied as above.	As above.
Haul roads	Surface treatment - watering	Yes	Water trucks used on haul roads.	75%
	Surface treatment - chemical suppressants	No	Water trucks and sweeping applied on haul roads.	N/A
	Surface improvements - low silt aggregate	Yes	Regular sweeping and water sprays assist with the reduction of silt loading.	Water carts in operation as above.
	Surface improvements - pave the surface	No	Water trucks and sweeping 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 40 t.	Haul truck weight included. No specific control applied.
	Use conveyors in place of haul roads	Yes	Conveyors used around site.	Conveyors used in place of hauling where practicable to do so.
Wind erosion from coal stockpiles	Avoidance - bypassing stockpiles	No	Not practical. The stockpiles at Clarence are necessary for routine operations and cannot be avoided.	N/A
	Surface stabilisation - watering	Yes	Watering stockpiles when in use	50%

Table 6.1 Overview of best practice measures employed at Clarence

Emissions source category	Best practice control measures (Katestone 2011)	Currently adopted or proposed for implementation at Clarence	Comments	Effectiveness of reduction in emissions inventory
	Surface stabilisation - chemical suppressants and crusting agents	No	Not practicable for implementation as coal stockpiles are regularly disturbed through loading and unloading.	N/A
	Surface stabilisation - carry over from wetting from load in	Yes	Water sprays applied.	N/A
	Enclosure - silo with baghouse	No	Not practicable for the operation of Clarence.	N/A
	Enclosure - cover storage pile with tarp during high winds	No	Not practicable for implementation as coal stockpiles are regularly disturbed through loading and unloading.	N/A
	Wind speed reduction - vegetative wind breaks	No	Not specific to this project however it is noted that Clarence activities are surrounded vegetation.	N/A
Wind erosion from coal stockpiles	Wind speed reduction - reduced pile height	Partial	Height of stockpiles limited by the capacity of the stockpile area.	N/A
	Wind speed reduction - wind screens/wind fences	No	Not practicable for the constraints of site.	N/A
	Wind speed reduction - pile shaping/orientation	No	Not practicable for the constraints of site.	N/A
	Wind speed reduction - three-sided enclosure around storage piles	No	Not practicable. The constraints of site and safe operation of equipment around stockpiles.	N/A
	Avoidance - bypassing stockpiles	No	Not practicable. The stockpiles at Clarence are necessary for the routine operation of site and cannot be avoided.	N/A
Loading and dumping ROM coal	Truck dumping - minimise drop height	Yes	Wherever possible, material drop heights will be minimised when unloading trucks.	N/A

Table 6.1 Overview of best practice measures employed at Clarence

Emissions source category	Best practice control measures (Katestone 2011)	Currently adopted or proposed for implementation at Clarence	Comments	Effectiveness of reduction in emissions inventory
	Truck dumping - water sprays at ROM pad	Yes	Water sprays are applied unloading to the product stockpile.	50%
	Truck dumping - three sided enclosure at truck unloading ROM hopper	N/A	Conveyor unload ROM coal directly to the breaker.	N/A
Crushing/screening	Water spays	No	Crushing/screening occurs in an enclosed building.	N/A
	Enclosed building	Yes	Crushing/screening occurs in an enclosed building.	70%

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 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 Section 3.3.2.

In addition to the eight individual assessment locations (Section 1.5), air pollutant concentrations were predicted over a 5 km by 5 km domain with 250 m resolution.

Specific activities (listed in Section 5.2) were represented by line-volume, volume and point sources which were located according to the layout of Clarence's surface facilities. The modelled source locations for the existing and proposed scenarios are shown in Figure 5.1 and Figure 5.2, respectively. 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 from the existing and proposed scenarios are presented in Table 7.1 and Table 7.2 respectively 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.

Figure 7.1 shows a comparison of the predicted maximum 24-hour average PM_{10} concentrations at each assessment location for the existing and proposed scenarios. The results are very similar between the two scenarios with each assessment location either showing a minor increase or decrease between the two scenarios. Although the overall emissions have increased slightly as a result of the proposed modification (Section 5.2.3), some assessment locations may show a small decrease dependent on where they are in relation to activities changing with the proposed modification (ie a spatial redistribution of some emission sources as a result of the proposed modification). All incremental results are below 50 µg/m^3.

Contour plots, illustrating spatial variations in incremental TSP, PM_{10} and $PM_{2.5}$ concentrations and dust deposition rates for the proposed scenario are provided in Figure 7.2 to Figure 7.7 below.

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

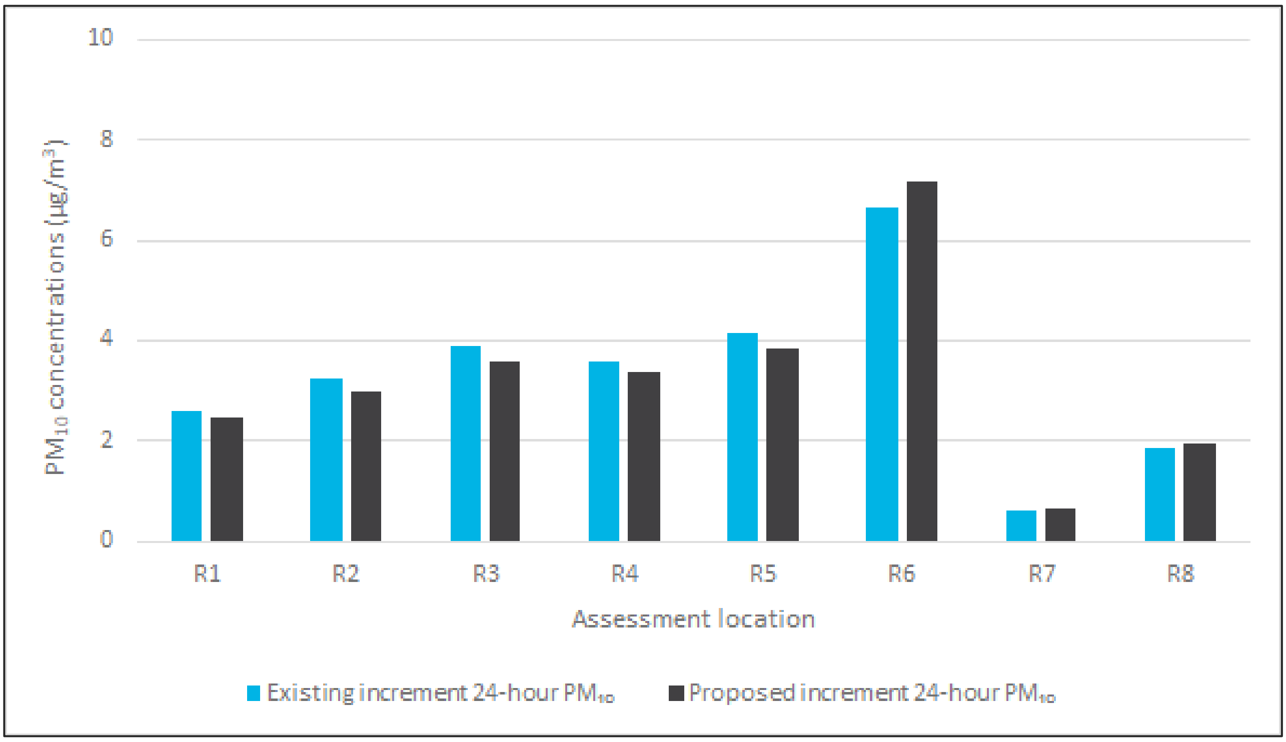


Figure 7.1 Comparison of predicted maximum 24-hour average PM_{10} concentrations for the existing and proposed scenarios

Table 7.1 Incremental (existing scenario only) concentration and deposition results

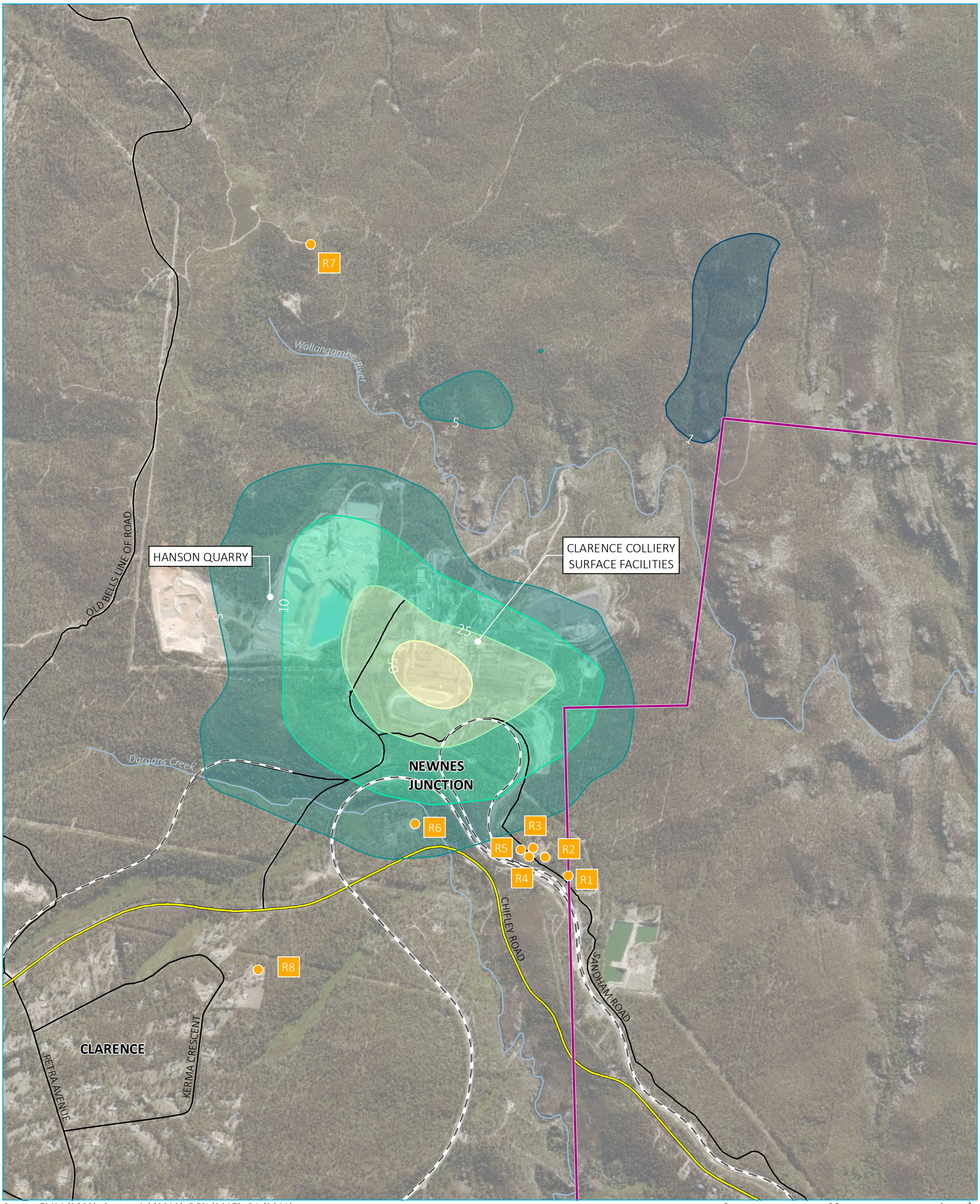
Assessment location ID	Predicted incremental concentration (µg/m³) and deposition rate (g/m²/month)					
	TSP	PM_{10}		$PM_{2.5}$		Dust deposition
	Annual	24-hour maximum	Annual	24-hour maximum	Annual	Annual
Criterion	**90**	**50**	**25**	**25**	**8**	**2**
R1	0.5	2.6	0.3	0.6	<0.1	<0.1
R2	0.7	3.2	0.4	0.7	0.1	0.1
R3	0.9	3.9	0.4	0.7	0.1	0.1
R4	0.8	3.6	0.4	0.7	0.1	0.1
R5	1.0	4.2	0.5	0.7	0.1	0.1
R6	1.9	6.7	0.9	1.4	0.1	0.2
R7	0.1	0.6	<0.1	0.2	<0.1	<0.1
R8	0.4	1.9	0.2	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.

Table 7.2 Incremental (proposed scenario only) 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**
R1	0.4	2.5	0.2	0.6	<0.1	<0.1
R2	0.6	3.0	0.3	0.7	0.1	<0.1
R3	0.7	3.6	0.4	0.7	0.1	0.1
R4	0.7	3.4	0.3	0.7	0.1	<0.1
R5	0.8	3.9	0.4	0.7	0.1	0.1
R6	1.9	7.2	0.9	1.5	0.1	0.2
R7	0.1	0.7	<0.1	0.2	<0.1	<0.1
R8	0.4	2.0	0.2	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)

0 0.5 1 km
GDA 1994 MGA Zone 56
N

\\emmsvr1\centennial_coal\J180459 - Charbon Rehabilitation\GIS\02_Maps\AirQuality\Clarence\AQIA008_PredictedMax24HourAveragePM10_20200826_06.mxd 27/08/2020

KEY

- Clarence Colliery holding boundary
- Assessment location
- Major road
- Minor road
- Rail line
- Watercourse

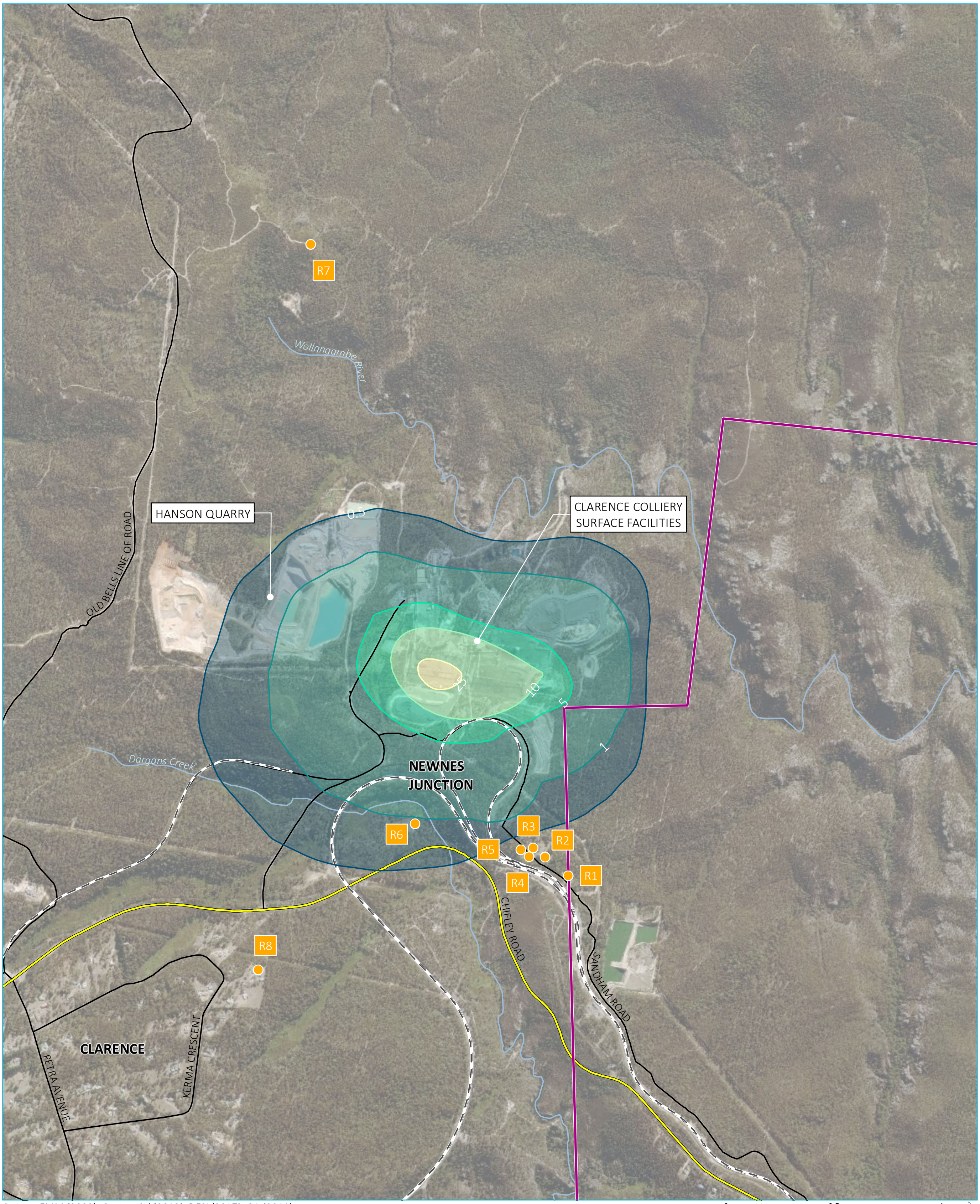
24h PM_{10} ($\mu g/m^3$)

- 1
- 5
- 10
- 25
- 50

Maximum predicted 24-hour average PM_{10} concentrations – mine only (proposed scenario)

Clarence Colliery – Modification 6
Air quality impact assessment
Figure 7.2

EMM
creating opportunities



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

0 0.5 1 km

GDA 1994 MGA Zone 56

N

KEY

- Clarence Colliery holding boundary
- Assessment location
- Major road
- Minor road
- Rail line
- Watercourse

Annual PM_{10} ($\mu g/m^3$)

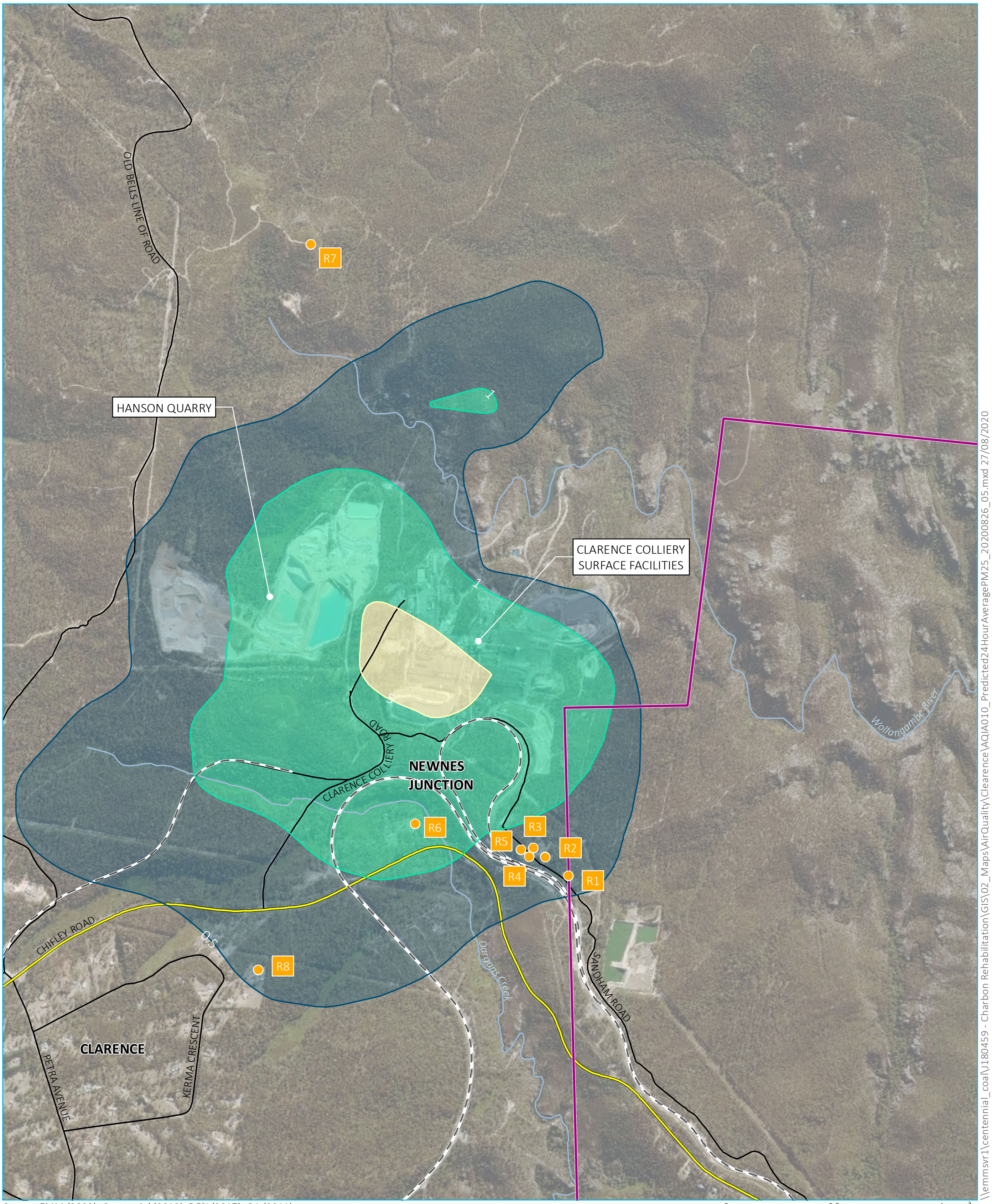
- 0.5
- 1
- 5
- 10
- 25

Predicted annual average PM_{10} concentrations – mine only (proposed scenario)

Clarence Colliery – Modification 6
Air quality impact assessment
Figure 7.3

EMM
creating opportunities

\\emmsvr1\centennial_coal\J180459 - Charbon Rehabilitation\GIS\02_Maps\AirQuality\Clearence\AQIA009_PredictedAnnualAveragePM10_20200826_05.mxd 27/08/2020



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

KEY

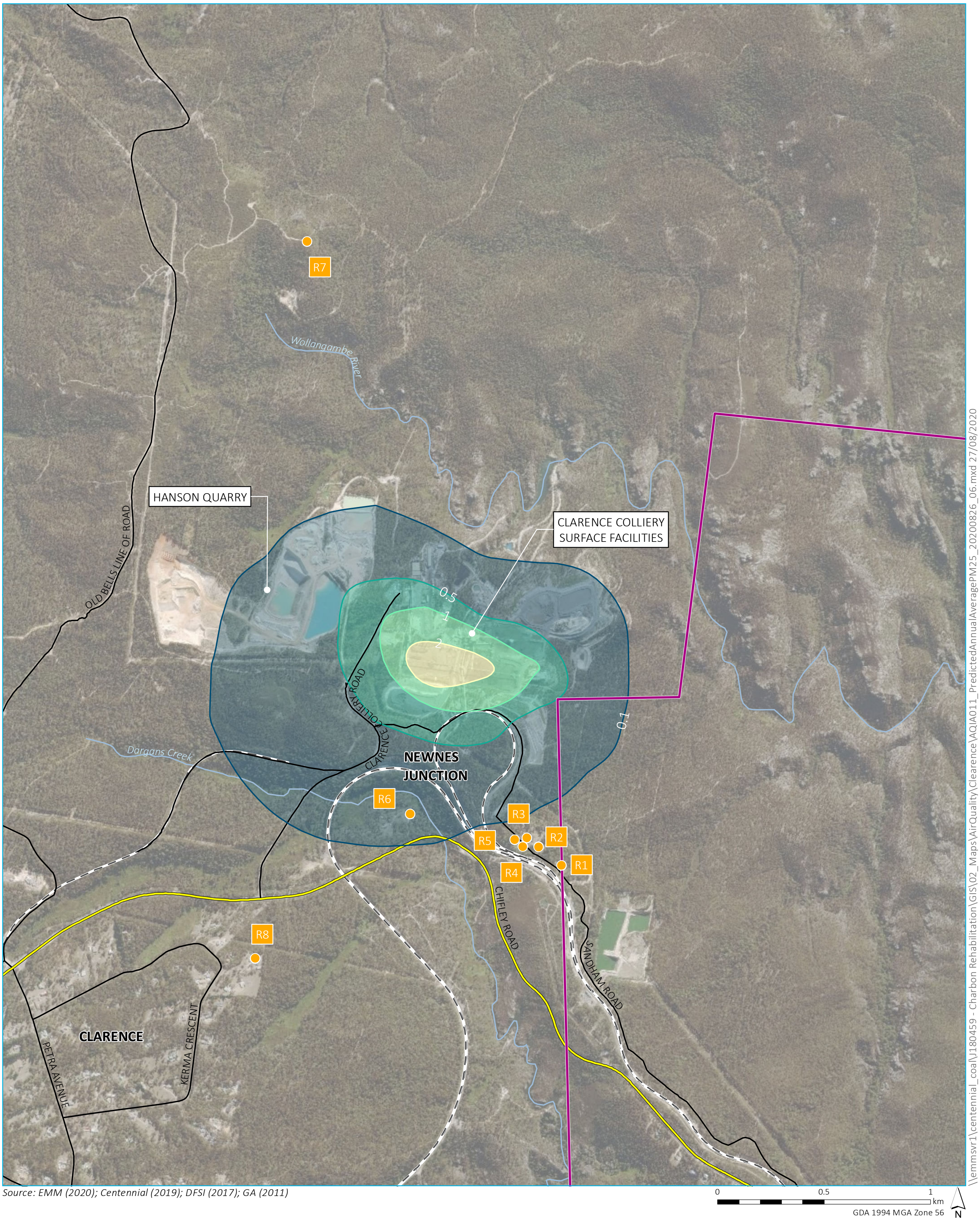
Clarence Colliery holding boundary
Assessment location
Major road
Minor road
Rail line
Watercourse

24h $PM_{2.5}$ ($\mu g/m^3$)
0.5
1
5

Maximum predicted 24-hour average $PM_{2.5}$ concentrations – mine only (proposed scenario)

Clarence Colliery – Modification 6
Air quality impact assessment
Figure 7.4

EMM
creating opportunities



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

KEY

- Clarence Colliery holding boundary
- Assessment location
- Major road
- Minor road
- Rail line
- Watercourse

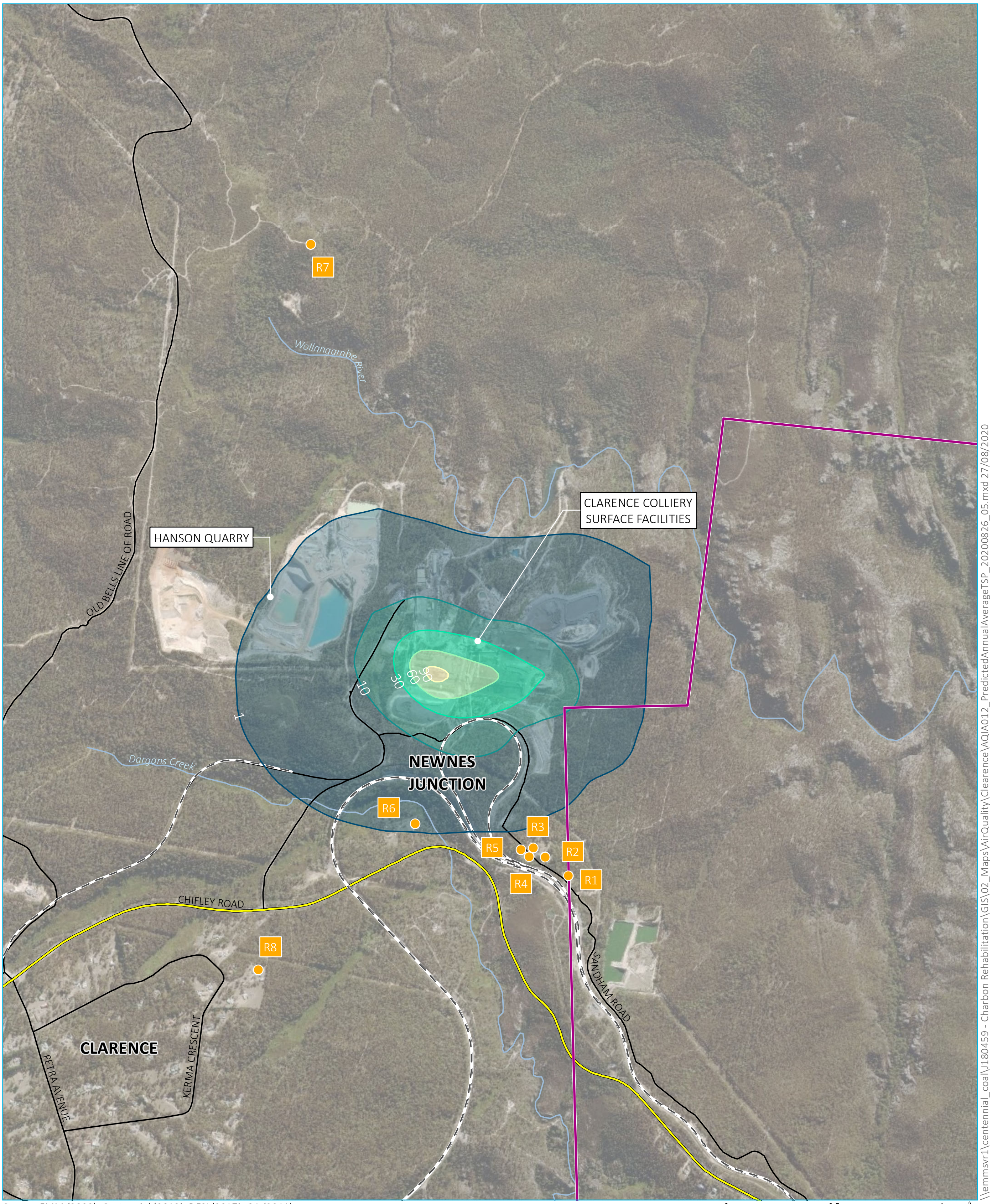
Annual $PM_{2.5}$ ($\mu g/m^3$)

- 0.1
- 0.5
- 1
- 2

Predicted annual average $PM_{2.5}$ concentrations – mine only (proposed scenario)

Clarence Colliery – Modification 6
Air quality impact assessment
Figure 7.5

EMM
creating opportunities



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

0 0.5 1 km

GDA 1994 MGA Zone 56

N

KEY

Clarence Colliery holding boundary

Assessment location

Major road

Minor road

Rail line

Watercourse

Annual TSP (μg/m³)

1

10

30

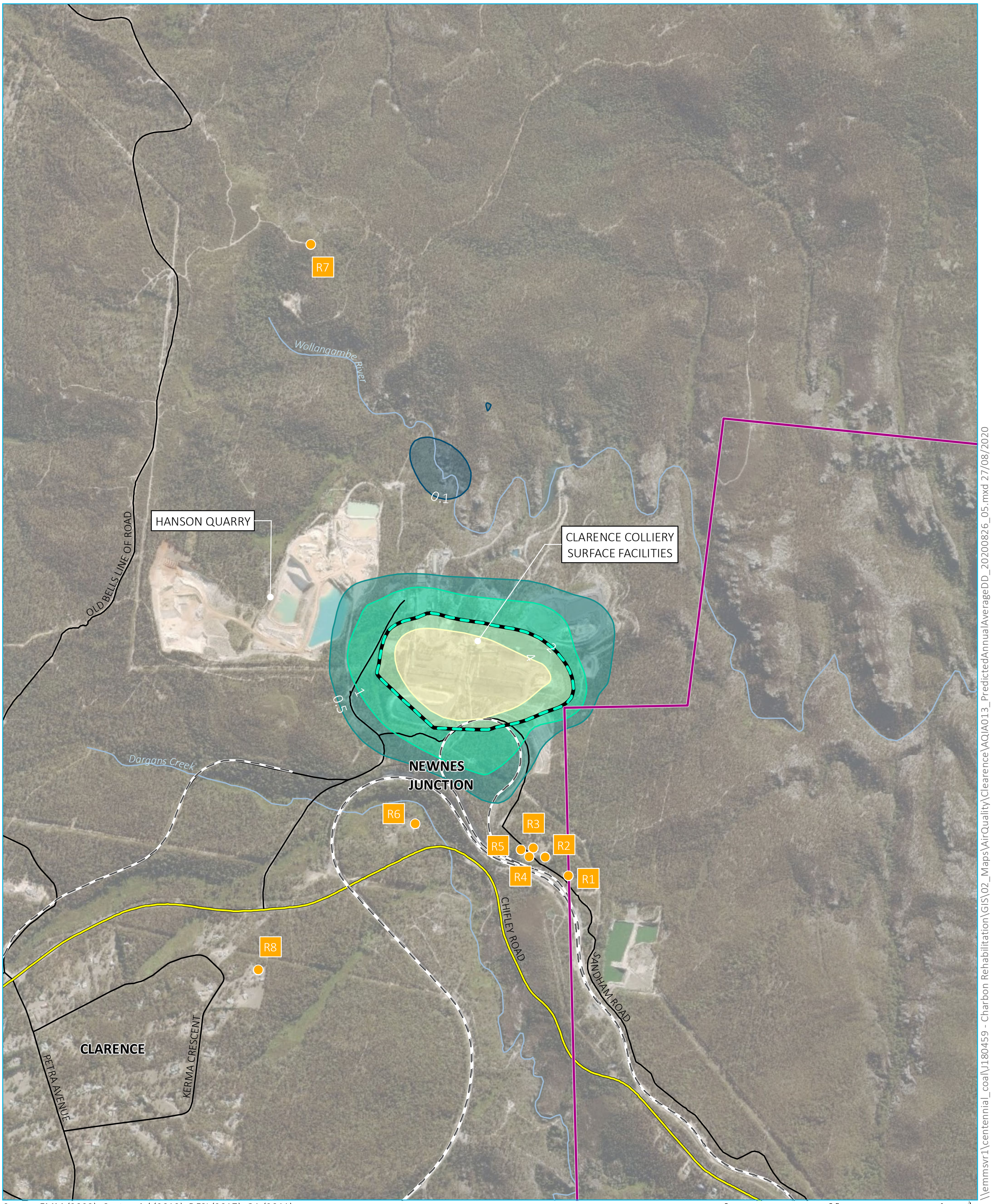
60

90

Predicted annual average TSP concentrations – mine only) (proposed scenario)

Clarence Colliery – Modification 6
Air quality impact assessment
Figure 7.6

EMM
creating opportunities



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

KEY

- Clarence Colliery holding boundary
- Impact assessment criterion
- Assessment location
- Major road
- Minor road
- Rail line
- Watercourse

Annual dust deposition ($g/m^2/month$)

- 0.1
- 0.5
- 1
- 2
- 4

Predicted annual average dust deposition levels - mine only (proposed scenario)

Clarence Colliery – Modification 6
Air quality impact assessment
Figure 7.7

EMM creating opportunities

7.3 Cumulative results

Cumulative impacts (ie Clarence operations plus background) at each of the assessment locations surrounding Clarence have been assessed:

- for 24-hour average concentrations - each daily-varying predicted 24-hour average concentration for PM_{10} and $PM_{2.5}$ from Clarence 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 (Section 4.4).

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, Clarence 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 Clarence, 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 from the existing and proposed scenarios are presented in Table 7.3 and Table 7.4 respectively for 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 with the exception of predicted 24-hour average PM_{10} concentrations at assessment locations R3, R4, R5 and R6. A **bold** value indicates an exceedance of the impact assessment criterion.

Table 7.3 Cumulative (existing scenario 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**
R1	47.6	49.8	19.2	22.5	7.1	1.2
R2	47.9	50.0	19.3	22.5	7.1	1.2
R3	48.1	**50.2**	19.4	22.5	7.1	1.2
R4	48.0	**50.1**	19.3	22.5	7.1	1.2
R5	48.2	**50.2**	19.4	22.5	7.1	1.2
R6	49.2	**50.6**	19.9	22.4	7.2	1.3
R7	47.2	49.7	19.0	22.2	7.0	1.1
R8	47.6	49.7	19.2	22.2	7.1	1.1

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.

Table 7.4 Cumulative (proposed scenario 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**
R1	47.6	49.7	19.2	22.5	7.1	1.1
R2	47.8	49.9	19.3	22.5	7.1	1.2
R3	47.9	**50.1**	19.3	22.5	7.1	1.2
R4	47.8	50.0	19.3	22.5	7.1	1.2
R5	47.9	**50.2**	19.3	22.5	7.1	1.2
R6	49.2	**50.7**	19.9	22.4	7.2	1.3
R7	47.2	49.7	19.0	22.2	7.0	1.1
R8	47.6	49.7	19.2	22.2	7.1	1.1

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.

The exceedance days have been analysed in further detail to provide context of the predicted concentrations. Table 7.5 (existing) and Table 7.6 (proposed) provide a breakdown of the cumulative concentrations predicted at assessment locations R3 to R6. The results show that incremental concentrations (ie Clarence only) contribute to less than 1.2 µg/m³ in each case of exceedance.

The background day of 49.2 µg/m^3 is the dominating factor in each cumulative result. The *Dust Watch Report* (OEH 2018) for February 2018 indicates that widespread dust storms occurred on 10 and 11 February. Consequently, assessment locations R3 to R6 are predicted to experience one day over the impact assessment criterion (50 µg/m^3). The difference in results between the existing and proposed scenarios is between 0.2 and 0.3 µg/m^3.

To further demonstrate the contribution of concentrations from Clarence compared to the background, Figure 7.8 shows the cumulative concentration at the highest assessment location in the existing scenario (ie R6). The plot shows the separate contributions of Clarence, Hanson's Clarence Quarry and the background. The figure shows that throughout the year, the incremental contribution from Clarence is minor when compared to the background.

For the reasons described above, it is unlikely that the proposed modification will result in significant adverse air quality impacts at nearby assessment locations.

Contour plots, illustrating spatial variations in cumulative TSP, PM_{10} and $PM_{2.5}$ concentrations and dust deposition rates for the proposed scenario are provided in Figure 7.9 to Figure 7.12 below.

Table 7.5 PM_{10} exceedance summary – existing scenario

Assessment location	24-hour average PM_{10} concentration – Clarence (µg/m^3)	24-hour average PM_{10} concentration – Hanson Quarry (µg/m^3)	24-hour background (µg/m^3) (Section 4.4)	Total predicted cumulative concentration (µg/m^3)	Days over 50 µg/m^3
R3	0.9	0.1	49.2	50.2	1
R4	0.8	0.1	49.2	50.1	1
R5	1.0	0.1	49.2	50.2	1
R6	1.1	0.3	49.2	50.6	1

Table 7.6 PM_{10} exceedance summary – proposed scenario

Assessment location	24-hour average PM_{10} concentration – Clarence (µg/m^3)	24-hour average PM_{10} concentration – Hanson Quarry (µg/m^3)	24-hour background (µg/m^3) (Section 4.4)	Total predicted cumulative concentration (µg/m^3)	Days over 50 µg/m^3
R3	0.8	0.1	49.2	50.1	1
R5	0.9	0.1	49.2	50.2	1
R6	1.2	0.3	49.2	50.7	1

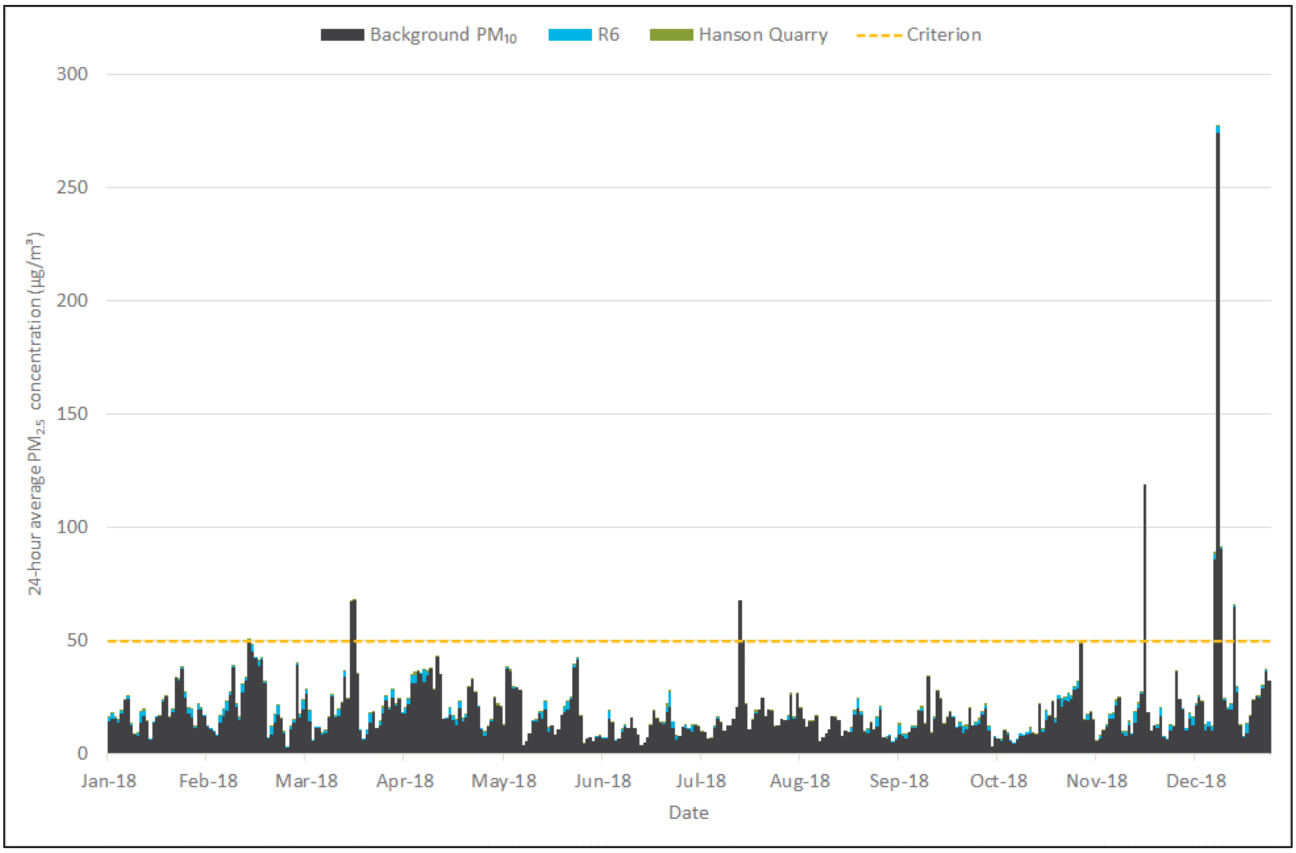
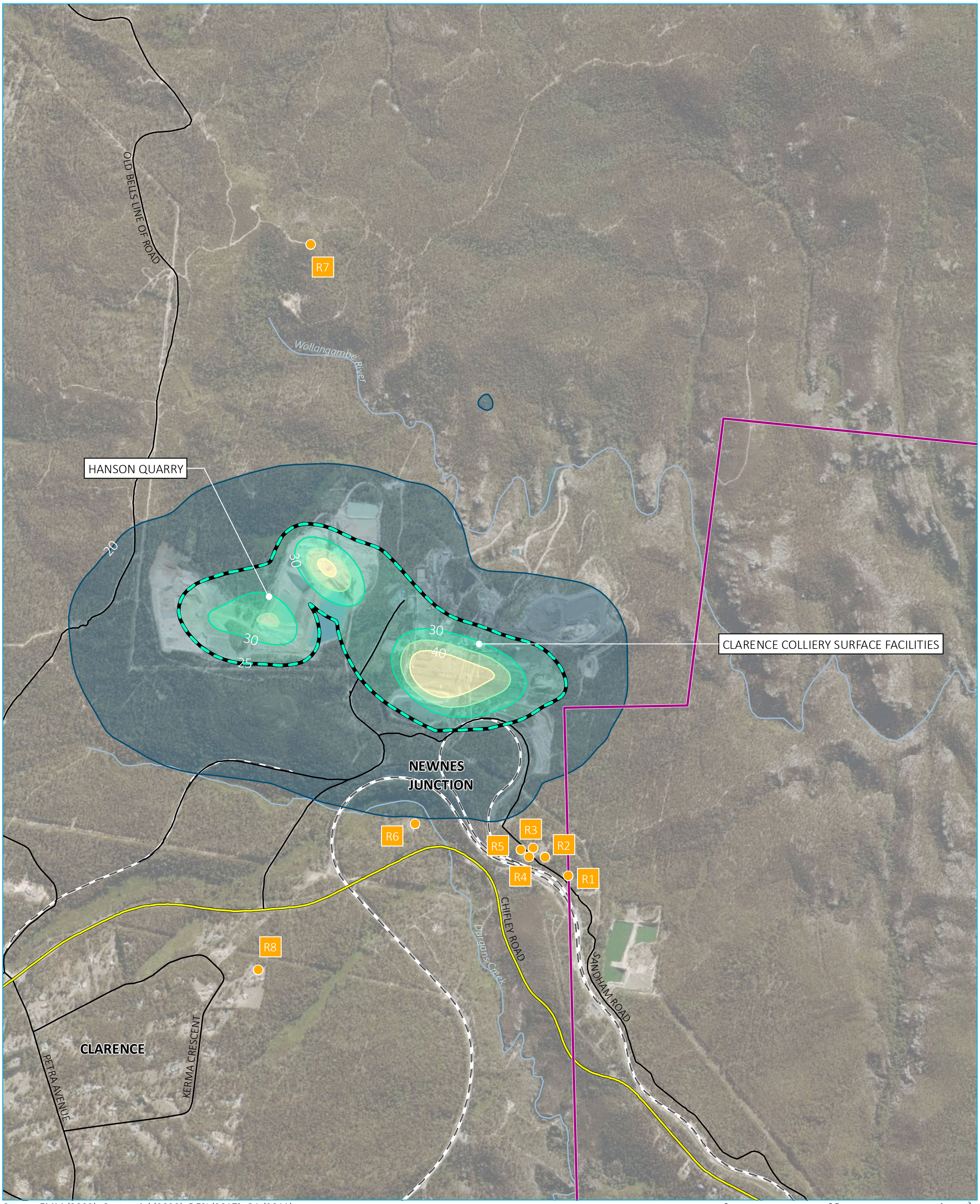


Figure 7.8 Cumulative 24-hour PM_{10} concentration at assessment location R6 – existing scenario



\\emmsvr1\centennial_coal\J180459 - Charbon Rehabilitation\GIS\02_Maps\AirQuality\Clearence\AQIA014_PredictedAnnualAveragePM10_20200826_05.mxd 27/08/2020

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

0 0.5 1 km
GDA 1994 MGA Zone 56
N

KEY

- Clarence Colliery holding boundary
- Impact assessment criterion
- Assessment location
- Major road
- Minor road
- Rail line
- Watercourse

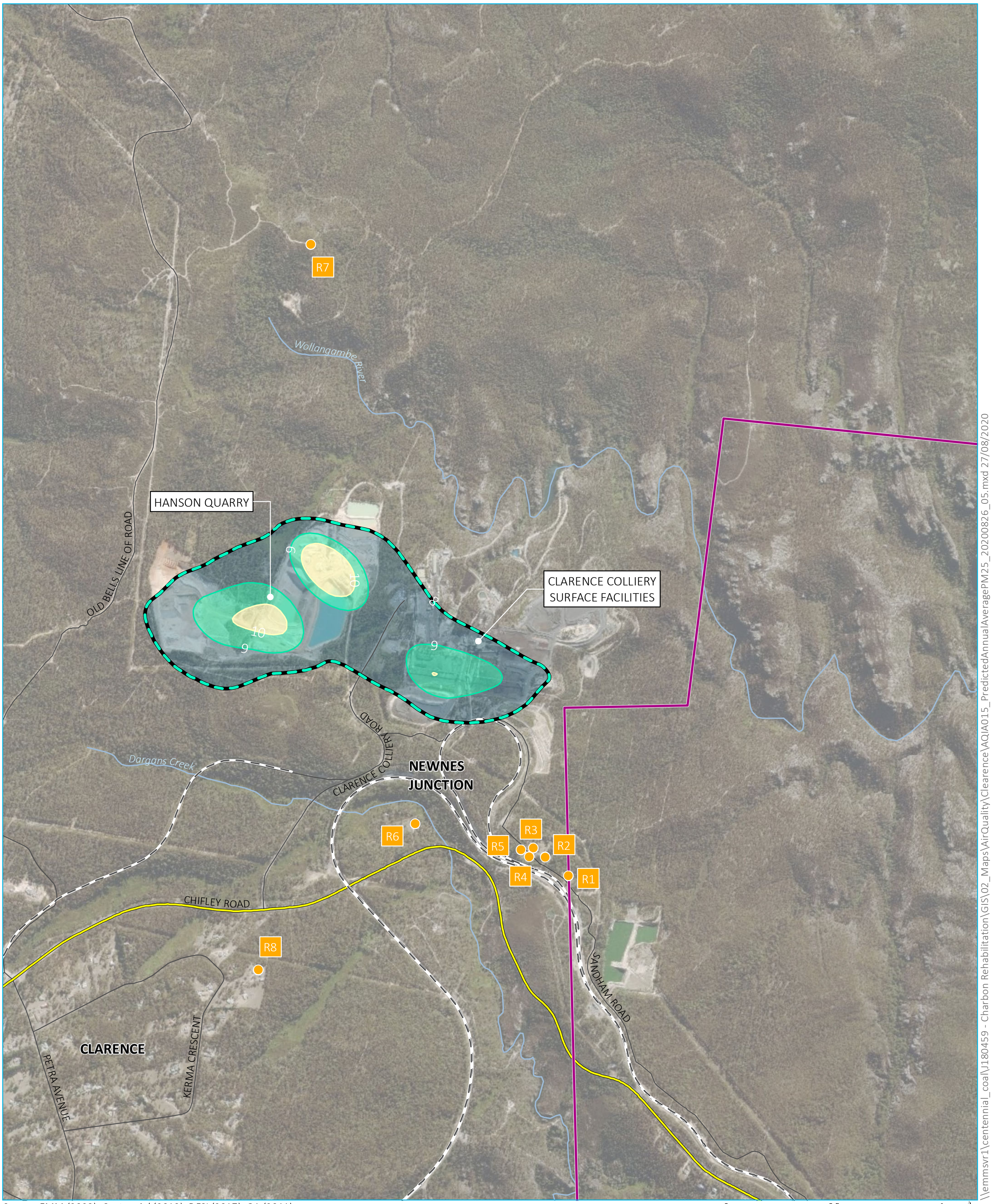
Annual PM_{10} ($\mu g/m^3$)

- 20
- 25
- 30
- 35
- 40

Predicted annual average PM_{10} concentrations – mine plus other sources (proposed scenario)

Clarence Colliery – Modification 6
Air quality impact assessment
Figure 7.9

EMM
creating opportunities



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

KEY

- Clarence Colliery holding boundary
- Impact assessment criterion
- Assessment location
- Major road
- Minor road
- Rail line
- Watercourse

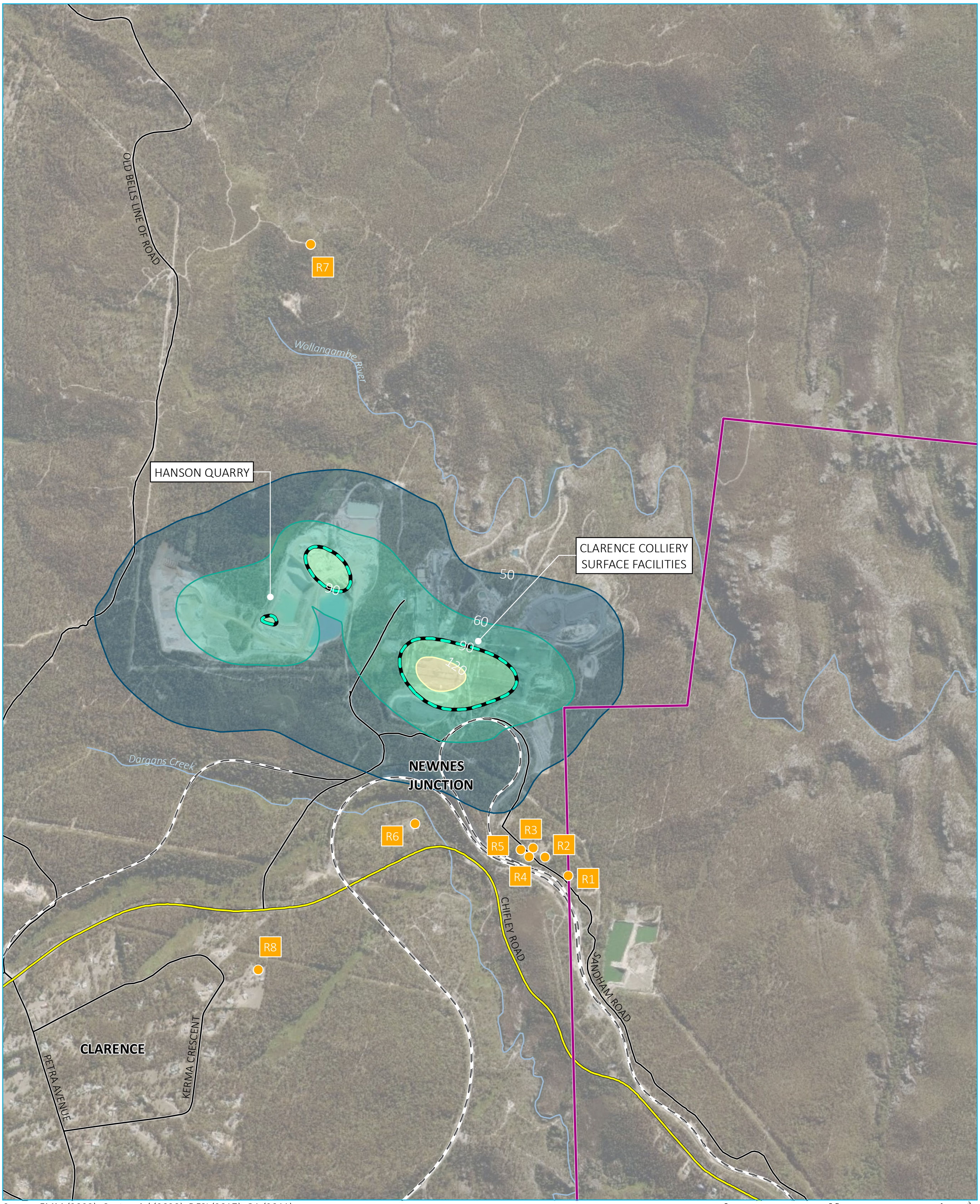
Annual $PM_{2.5}$ ($\mu g/m^3$)

- 8
- 9
- 10

Predicted annual average PM_{10} concentrations – mine plus other sources (proposed scenario)

Clarence Colliery – Modification 6
Air quality impact assessment
Figure 7.10

EMM
creating opportunities



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

0 0.5 1 km

GDA 1994 MGA Zone 56

N

KEY

Clarence Colliery holding boundary

Impact assessment criterion

Assessment location

Major road

Minor road

Rail line

Watercourse

Annual TSP (µg/m³)

50

60

90

120

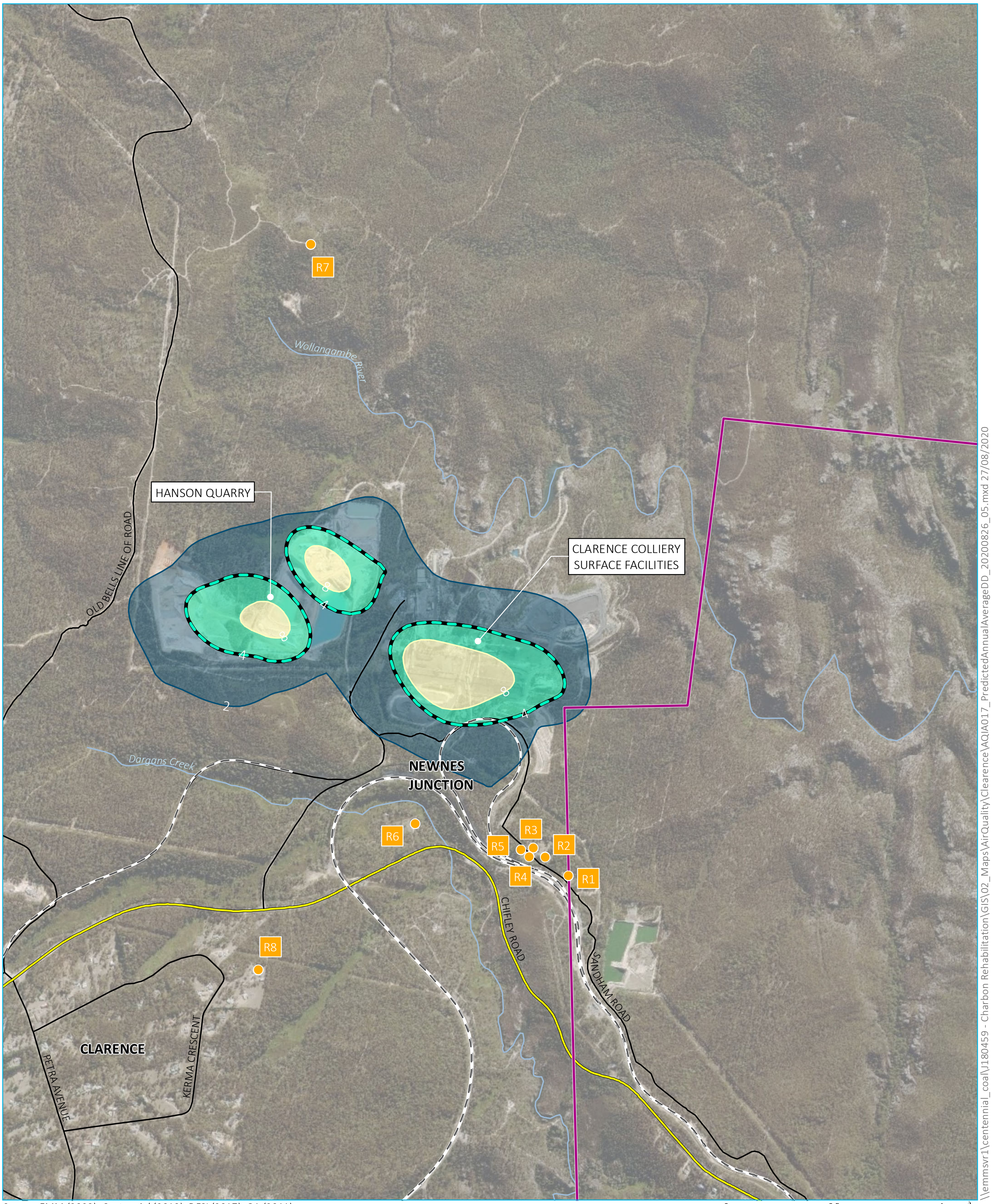
Predicted annual average TSP concentrations – mine plus other sources (proposed scenario)

Clarence Colliery – Modification 6

Air quality impact assessment

Figure 7.11

EMM creating opportunities



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

KEY

- Clarence Colliery holding boundary
- Impact assessment criterion
- Assessment location
- Major road
- Minor road
- Rail line
- Watercourse

Annual dust deposition (g/m^2/month)

- 2
- 4
- 8

Predicted annual average dust deposition levels - mine plus other sources (proposed scenario)

Clarence Colliery – Modification 6
Air quality impact assessment
Figure 7.12

EMM
creating opportunities

8 Conclusion

Dispersion modelling has been completed for two operational emission scenarios:

- existing scenario – processing of a maximum of 3 Mtpa of coal; and
- proposed scenario – existing scenario plus the proposed modification:
  - extraction of CCR from REA6;
  - transfer of CCR from REA6 and Clarence's production stream to the existing TLO;
  - loading of CCR into train-based containers via the existing TLO; and
  - export of CCR off-site to Charbon via rail.

Atmospheric dispersion modelling was completed using the CALPUFF model system. Hourly meteorological observations from 2018, collected at the Clarence AWS and two BoM operated monitoring stations, were used as input 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 for both the existing and proposed scenarios. There was a negligible difference in predicted concentrations and deposition rates between the existing and proposed scenarios, indicating that the proposed modification will not adversely change air quality impacts from those associated with existing operations.

Cumulative impacts were assessed by combining modelled impacts with recorded ambient background levels and predictions for the adjacent Hanson sand quarry. The cumulative results showed that concentrations and deposition rates for all pollutants and averaging periods were below the applicable NSW EPA assessment criterion at all assessment locations with the exception of a single additional exceedance of the 24-hour average PM_{10} impact assessment criterion at four assessment locations (R3, R4, R5 and R6) in the existing scenario and three locations (R3, R5 and R6) in the proposed scenario.

Analysis showed that all exceedances occurred on the same day, with the cumulative concentrations dominated by an elevated background level of 49.2 $\mu g/m^3$ associated with a regional dust storm event. The corresponding incremental contribution to the exceedance was below 1.2 $\mu g/m^3$ at all receptors. It is unlikely that the proposed modification will result in significant adverse air quality impacts at nearby assessment locations.

A range of best practice dust mitigation measures are, and will continue to be, employed at Clarence. These include the use of water carts and sprays, enclosed conveyors and processing plant and watering of stockpiles and REAs.

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- 1998a, AP-42 Chapter 11.9.2 – *Bulldozing coal.*
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- 2004, AP-42 Chapter 11.19.2 – *Tertiary crushing.*
- 2006a, AP-42 Chapter 13.2.4 – *Aggregate handling and storage piles.*
- 2006b, AP-42 13.2.5 – *Industrial wind erosion*.
- 2011, AP-42 Chapter 13.2.2 – *Unpaved roads.*
- 2016, *Nonroad Compression-Ignition Engines: Exhaust Emission Standards* (EPA-420-B-16-022, March 2016)

Abbreviations

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 rejects
CHP	coal handling plant
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
HRA	high risk activity
LGA	local government area
ML	mining lease
Mtpa	million tonnes per annum
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
ROM	run-of-mine
SEARs	Secretary's Environmental Assessment Requirements
SO_2	sulfur dioxide
TAPM	The Air Pollution Model
TLO	train load out
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 the Clarence AWS, 2015-2019

Figure A.1 Data completeness analysis plot – Clarence AWS – 2015–2019

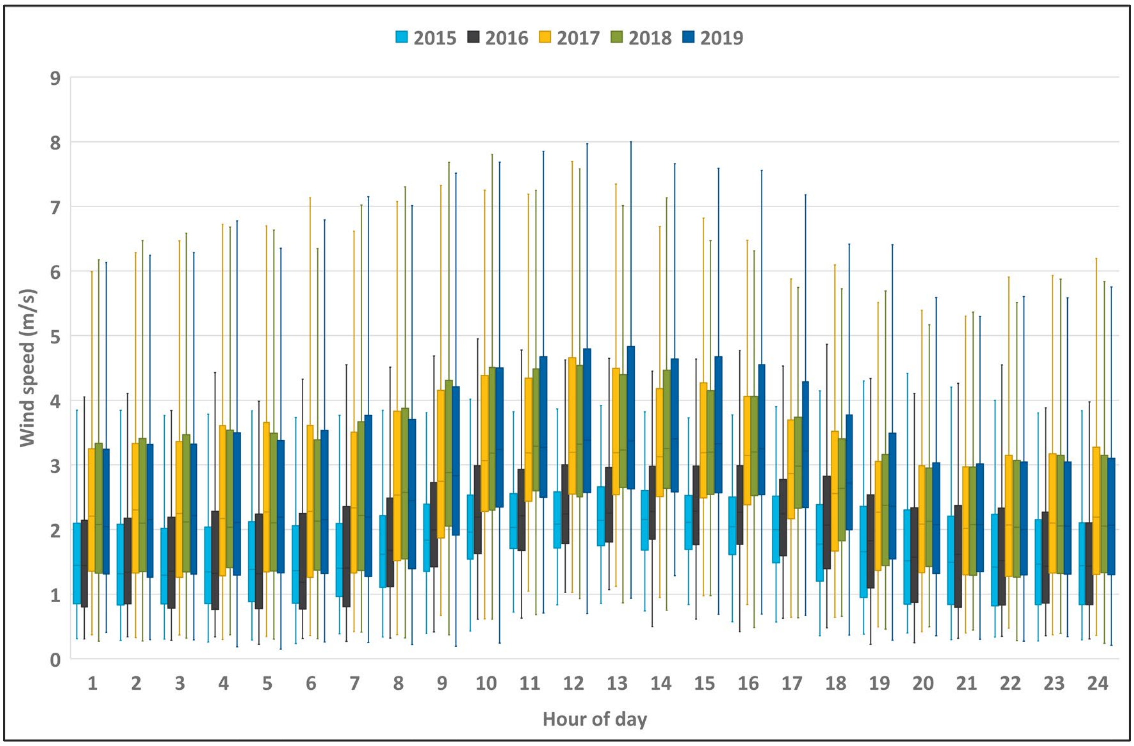


Figure A.2 Inter-annual variability in diurnal wind speed – Clarence AWS – 2015–2019

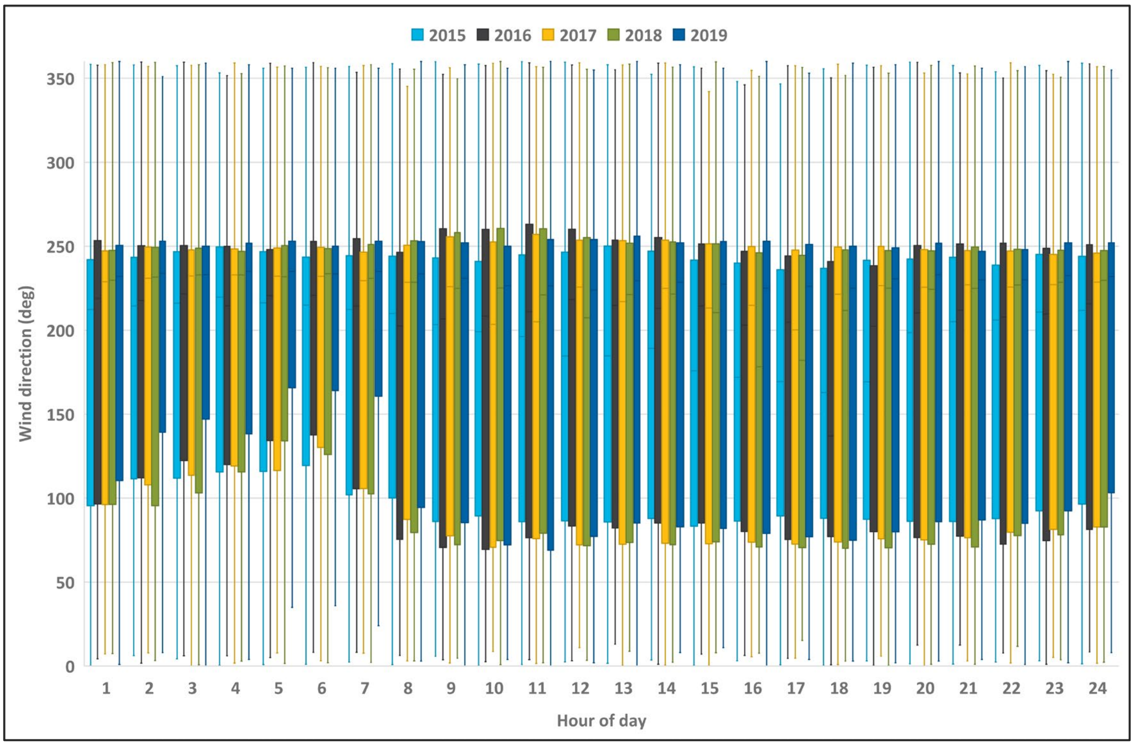


Figure A.3 Inter-annual variability in diurnal wind direction – Clarence AWS – 2015–2019

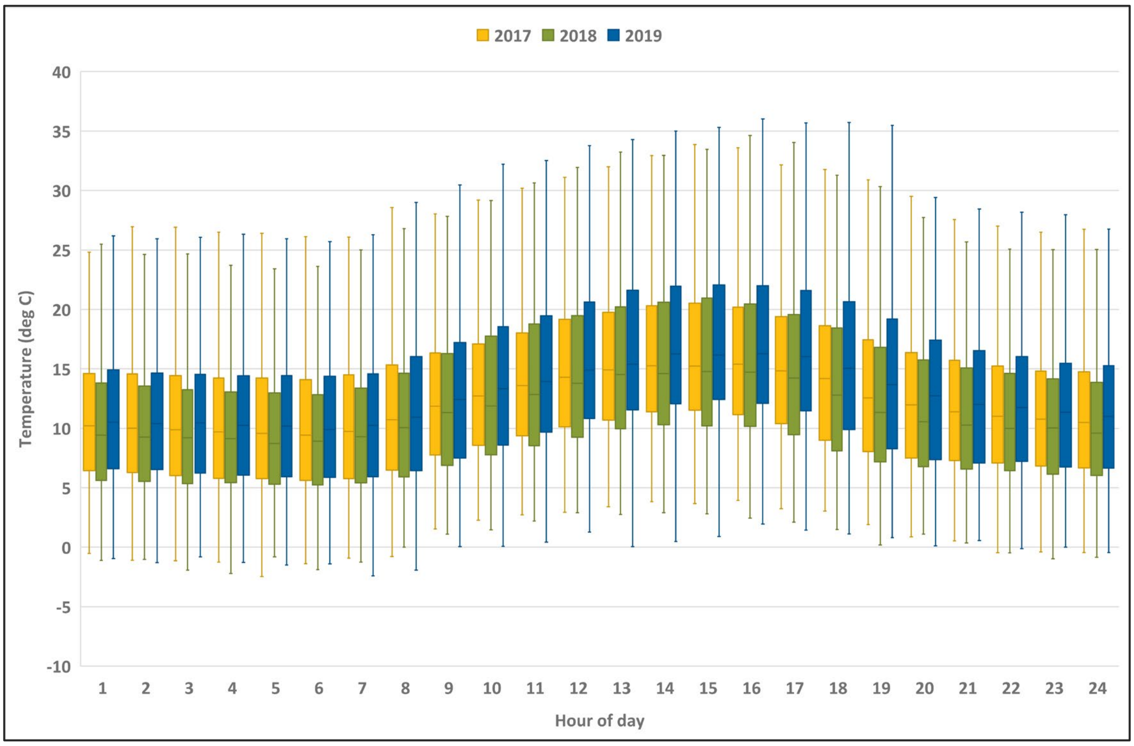


Figure A.4 Inter-annual variability in diurnal air temperature – Clarence AWS – 2015–2019

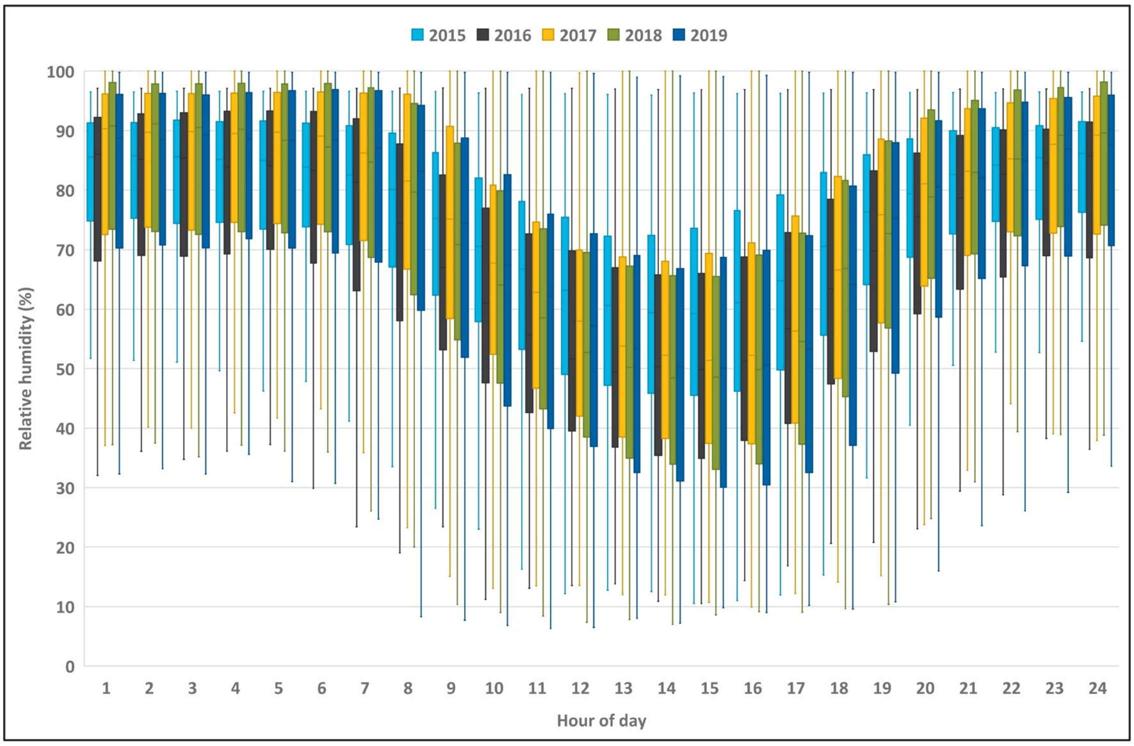


Figure A.5 Inter-annual variability in diurnal relative humidity – Clarence AWS – 2015–2019

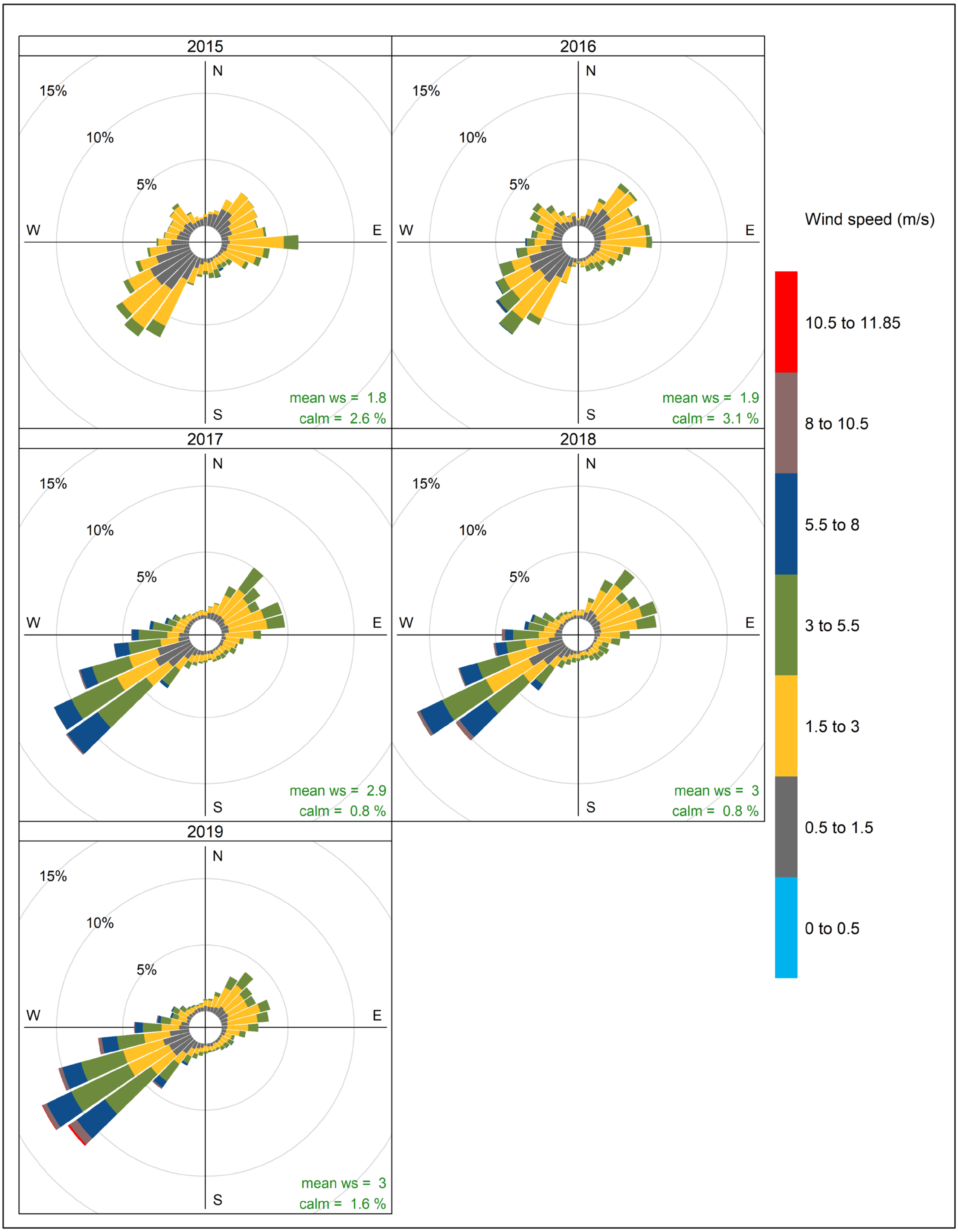


Figure A.6 Inter-annual comparison of recorded wind speed and direction – Clarence AWS – 2015–2019

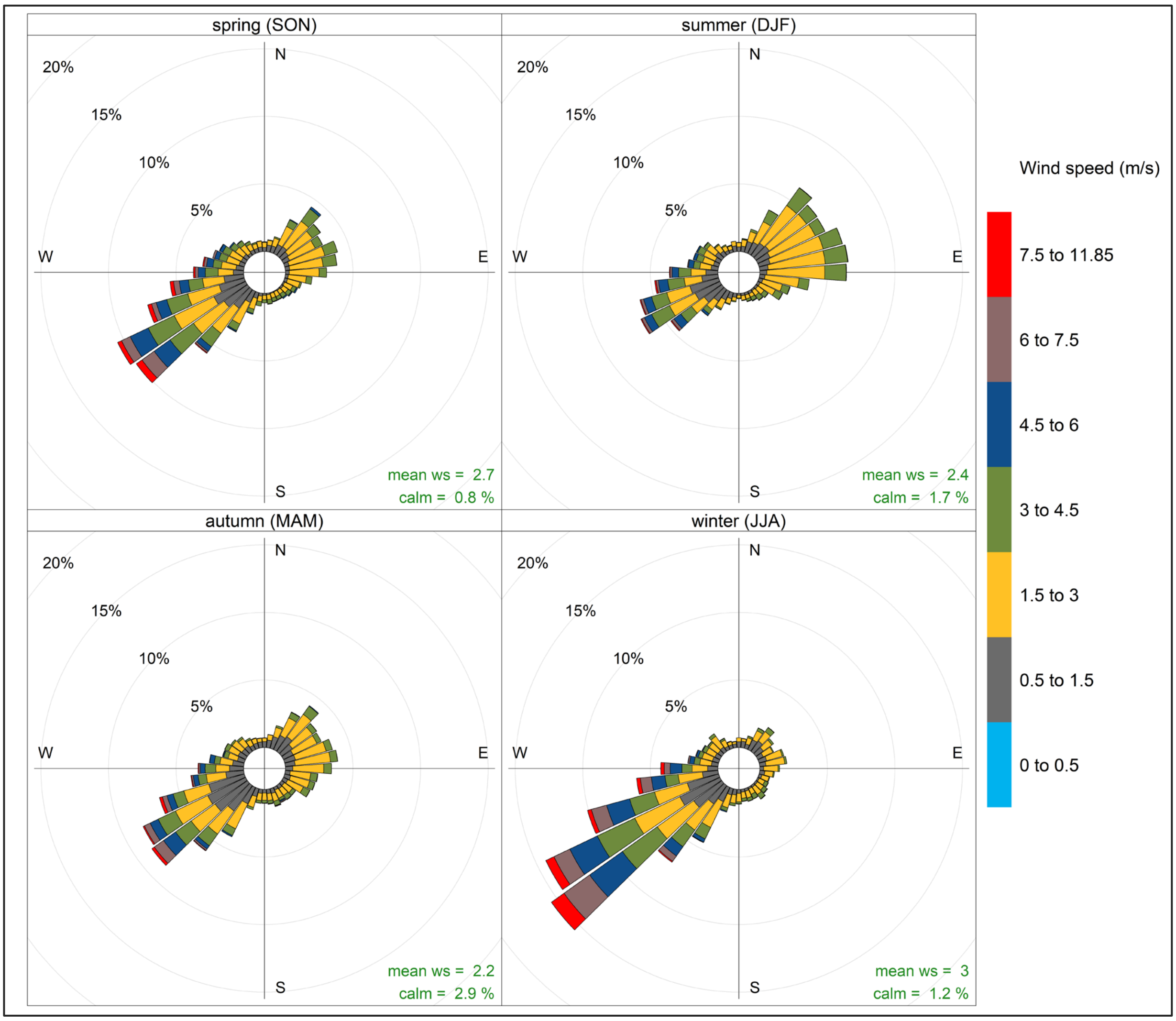


Figure A.7 Seasonal wind speed and direction – Clarence AWS – 2015-2019

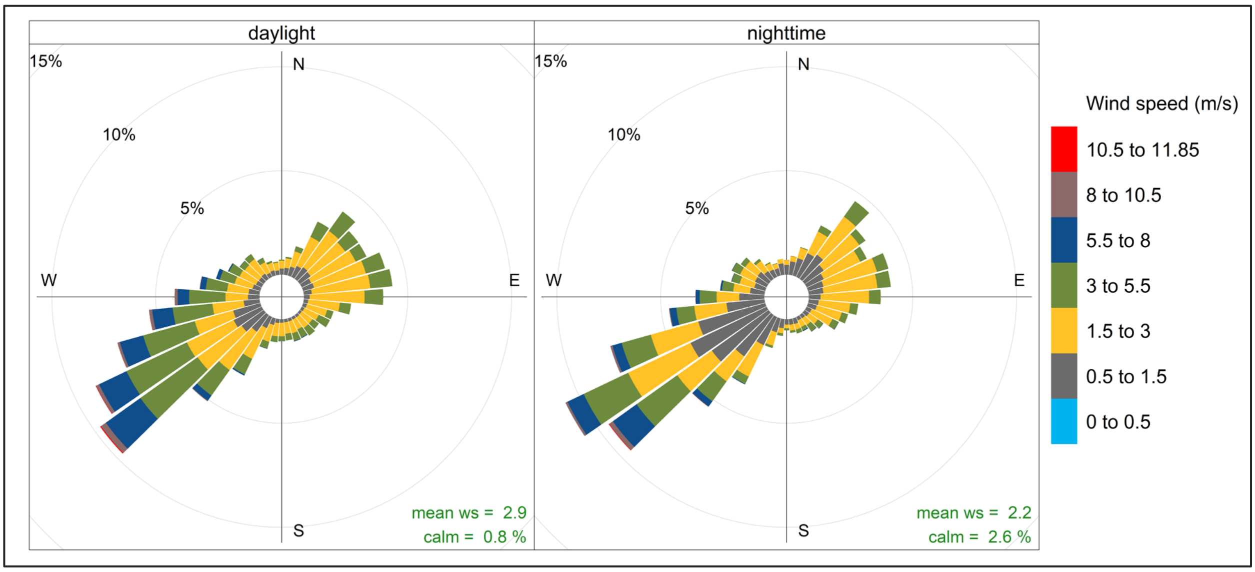


Figure A.8 Diurnal wind speed and direction – Clarence AWS – 2015-2019

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:

- Clarence AWS;
- Marrangaroo (Defence) AWS, approximately 11 km north-west of Clarence's surface facilities area; and
- Mt Boyce AWS, approximately 17 km south of Clarence's surface facilities area.

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 60 km by 60 km run with a resolution of 500 m. Surface meteorological data from the Clarence AWS, the BoM Marrangaroo (Defence) AWS and the Mt Boyce AWS was incorporated into the modelling. Cloud amount and cloud height data were incorporated in CALMET through the use of the prognostic 3-dimensional data extracted from TAPM.

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 5 km and R1 of 2.5 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 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 the 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	5, 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	2.5, 2.5


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, Table 11.9-2 – Bulldozing coal (US-EPA 1998a);
- US-EPA AP-42 Chapter 13.2.2 – Unpaved roads (US-EPA 2006);
- US-EPA AP-42 Chapter 11, Table 11.19.2-1 – Tertiary crushing (controlled) (US-EPA 2004);
- US-EPA AP-42 Chapter 13.2.5.3 – Industrial wind erosion (US-EPA 2006b);
- 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 Centennial. 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

Emissions inventories developed for the existing and proposed scenarios are presented in Table B.1 and Table B.2.

Table B.1 Existing scenario 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	Units	Variable 1		Variable 2		Variable 3		Variable 4		Variable 5		Control %	Control	Emission factor source
Coal handling and processing																						
Conveyor transfer - ROM coal to breaker	148	70	11	3,000,000	t/y	0.00033	0.00016	0.00002	kg/t	6.5	Moisture (%)	2.9	Ave wind speed (m/s)							85	Water sprays and enclosure	USEPA AP-42 13.2.4 - Materials handling equation
Breaker	2,440	1,090	209	3,000,000	t/y	0.00270	0.00120	0.00022	kg/t											70	Enclosure	USEPA AP-42 11.19.2-1 - Tertiary crushing
Crusher	2,440	1,090	209	3,000,000	t/y	0.00270	0.00120	0.00022	kg/t											70	Enclosure	USEPA AP-42 11.19.2-1 - Tertiary crushing
Conveyor transfer - ROM coal to ROM stockpile	500	240	42	3,000,000	t/y	0.00033	0.00016	0.00002	kg/t	6.5	Moisture (%)	2.9	Ave wind speed (m/s)							50	Water sprays	USEPA AP-42 13.2.4 - Materials handling equation
Loading coal to conveyor	500	240	42	3,000,000	t/y	0.00033	0.00016	0.00002	kg/t	6.5	Moisture (%)	2.9	Ave wind speed (m/s)							50	Water sprays	USEPA AP-42 13.2.4 - Materials handling equation
Conveyor transfer - ROM coal to CHPP (90%)	133	63	10	2,700,000	t/y	0.00033	0.00016	0.00002	kg/t	6.5	Moisture (%)	2.9	Ave wind speed (m/s)							85	Water sprays and enclosure	USEPA AP-42 13.2.4 - Materials handling equation
Loading washed coal stockpile	297	144	27	2,365,000	t/y	0.00025	0.00012	0.00002	kg/t	8	Moisture (%)	2.9	Ave wind speed (m/s)							50	Water sprays	USEPA AP-42 13.2.4 - Materials handling equation
Conveyor transfer - washed coal to banana screen	7	3	1	200,000	t/y	0.00025	0.00012	0.00002	kg/t	8	Moisture (%)	2.9	Ave wind speed (m/s)							85	Water sprays and enclosure	USEPA AP-42 13.2.4 - Materials handling equation
Screening washed coal	760	268	11	200,000	t/y	0.01250	0.00430	0.00003	kg/t											70	Enclosure	USEPA AP-42 11.19.2-1 - Screening
Loading secondary product stockpile	32	19	8	200,000	t/y	0.00025	0.00012	0.00002	kg/t	8	Moisture (%)	2.9	Ave wind speed (m/s)							50	Water sprays	USEPA AP-42 13.2.4 - Materials handling equation
Dozer on ROM stockpile	17,355	5,287	388	1,560	h/y	22.2	6.8	0.5	kg/h	6.5	Moisture (%)	6	Silt (%)							50	Water sprays	USEPA AP-42 11.9-1 - Bulldozing coal
Dozer on washed coal stockpile	7,981	2,156	182	1,560	h/y	10.2	2.8	0.2	kg/h	8	Moisture (%)	4	Silt (%)							50	Water sprays	USEPA AP-42 11.9-1 - Bulldozing coal
Dozer on secondary product stockpile	1,336	365	36	260	h/y	10.2	2.8	0.2	kg/h	8	Moisture (%)	4	Silt (%)							50	Water sprays	USEPA AP-42 11.9-1 - Bulldozing coal
Coal transport																						
Conveyor transer - ROM to train loading bin (10%)	15	7	1	300,000	t/y	0.00033	0.00016	0.00002	kg/t	6.5	Moisture (%)	2.9	Ave wind speed (m/s)							85	Water sprays and enclosure	USEPA AP-42 13.2.4 - Materials handling equation
Loading trains - ROM coal (10%)	30	14	2	300,000	t/y	0.00033	0.00016	0.00002	kg/t	6.5	Moisture (%)	2.9	Ave wind speed (m/s)							70	Enclosure	USEPA AP-42 13.2.4 - Materials handling equation
Conveyor transfer - washed coal to train loading bin	87	41	6	2,365,000	t/y	0.00025	0.00012	0.00002	kg/t	8	Moisture (%)	2.9	Ave wind speed (m/s)							85	Water sprays and enclosure	USEPA AP-42 13.2.4 - Materials handling equation
Loading trains - washed coal	174	82	12	2,365,000	t/y	0.00025	0.00012	0.00002	kg/t	8	Moisture (%)	2.9	Ave wind speed (m/s)							70	Partial enclosure	USEPA AP-42 13.2.4 - Materials handling equation
FEL loading trucks - secondary product	49	23	4	200,000	t/y	0.00025	0.00012	0.00002	kg/t	8	Moisture (%)	2.9	Ave wind speed (m/s)									USEPA AP-42 13.2.4 - Materials handling equation
Trucks hauling -secondary product offsite	6,372	1,700	172	200,000	t/y	0.13	0.03	0.00	kg/t	32	t/load	36	Ave vehicle gross mass	1.5	km/return trip	0.7	kg/VKT	6	Silt (%)	75	Water sprays	USEPA AP-42 13.2.2 - Unpaved roads
CCR handling																						
Loading trucks with CCR at CHPP	33	16	2	135,000	t/y	0.00025	0.00012	0.00002	kg/t	8	Moisture (%)	2.9	Ave wind speed (m/s)									USEPA AP-42 13.2.4 - Materials handling equation
Hauling CCR from CHPP to REA5	4,811	1,284	130	135,000	t/y	0.14	0.04	0.00	kg/t	40	t/load	40	Ave vehicle gross mass	2	km/return trip	0.8	kg/VKT	6	Silt (%)	75	Water sprays	USEPA AP-42 13.2.2 - Unpaved roads
Unloading CCR at REA5	33	16	2	135,000	t/y	0.00025	0.00012	0.00002	kg/t	8	Moisture (%)	2.9	Ave wind speed (m/s)									USEPA AP-42 13.2.4 - Materials handling equation
Dozer on REA5	1,304	402	35	156	h/y	16.6	5.1	0.4	kg/h	8	Moisture (%)	6	Silt (%)							50	Water sprays	USEPA AP-42 11.9-1 - Bulldozing coal
Excavator recovering fines and loading trucks at REA3	102	48	4	208,000	t/y	0.00025	0.00012	0.00002	kg/t	8	Moisture (%)	2.9	Ave wind speed (m/s)	2	times rehandle							USEPA AP-42 13.2.4 - Materials handling equation
Hauling fines from REA3 to washed coal stockpile	4,448	1,187	121	208,000	t/y	0.09	0.02	0.00	kg/t	40	t/load	40	Ave vehicle gross mass	1.2	km/return trip	0.8	kg/VKT	6	Silt (%)	75	Water sprays	USEPA AP-42 13.2.2 - Unpaved roads
Unloading fines to washed coal stockile	33	19	8	208,000	t/y	0.00025	0.00012	0.00002	kg/t	8	Moisture (%)	2.9	Ave wind speed (m/s)							50	Water sprays	USEPA AP-42 13.2.4 - Materials handling equation
Wind erosion																						
Wind erosion - REA3	2,550	1,275	191	6	ha	850	425	64	kg/ha/yr											50	Water sprays	USEPA AP-42 11.9.2 - Wind erosion of exposed areas
Wind erosion - REA4 (not active)	0	0	0	5	ha	850	425	64	kg/ha/yr													USEPA AP-42 11.9.2 - Wind erosion of exposed areas
Wind erosion - REA5	2,550	1,275	191	6	ha	850	425	64	kg/ha/yr											50	Water sprays	USEPA AP-42 11.9.2 - Wind erosion of exposed areas
Wind erosion - REA6	1,700	850	128	4	ha	850	425	64	kg/ha/yr											50	Water sprays	USEPA AP-42 11.9.2 - Wind erosion of exposed areas
Wind erosion - ROM stockpile	2,043	1,022	153	4	ha	1,022	511	77	kg/ha/yr											50	Water sprays	USEPA AP-42 11.9.2 - Wind erosion of exposed areas
Wind erosion - Washed coal stockpile	2,043	1,022	153	4	ha	1,022	511	77	kg/ha/yr											50	Water sprays	USEPA AP-42 11.9.2 - Wind erosion of exposed areas
Wind erosion - Secondary product stockpile	1,022	511	77	2	ha	1,022	511	77	kg/ha/yr											50	Water sprays	USEPA AP-42 11.9.2 - Wind erosion of exposed areas
Ventilaiton fans																						
Ventilation fans	9,253	618	460	8760	hr/y	0.53	0.04	0.03	kg/hr													
Total	**72,580**	**22,448**	**3,029**																			

Table B.2 Proposed scenario 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	Units	Variable 1		Variable 2		Variable 3		Variable 4		Variable 5		Control %	Control	Emission factor source
Coal handling and processing																						
Conveyor transfer - ROM coal to breaker	148	70	11	3,000,000	t/y	0.00033	0.00016	0.00002	kg/t	6.5	Moisture (%)	2.9	Ave wind speed (m/s)							85	Water sprays and enclosure	USEPA AP-42 13.2.4 - Materials handling equation
Breaker	2,440	1,090	209	3,000,000	t/y	0.00270	0.00120	0.00022	kg/t											70	Enclosure	USEPA AP-42 11.19.2-1 - Tertiary crushing
Crusher	2,440	1,090	209	3,000,000	t/y	0.00270	0.00120	0.00022	kg/t											70	Enclosure	USEPA AP-42 11.19.2-1 - Tertiary crushing
Conveyor transfer - ROM coal to ROM stockpile	500	240	42	3,000,000	t/y	0.00033	0.00016	0.00002	kg/t	6.5	Moisture (%)	2.9	Ave wind speed (m/s)							50	Water sprays	USEPA AP-42 13.2.4 - Materials handling equation
Loading coal to conveyor	500	240	42	3,000,000	t/y	0.00033	0.00016	0.00002	kg/t	6.5	Moisture (%)	2.9	Ave wind speed (m/s)							50	Water sprays	USEPA AP-42 13.2.4 - Materials handling equation
Conveyor transfer - ROM coal to CHPP (90%)	133	63	10	2,700,000	t/y	0.00033	0.00016	0.00002	kg/t	6.5	Moisture (%)	2.9	Ave wind speed (m/s)							85	Water sprays and enclosure	USEPA AP-42 13.2.4 - Materials handling equation
Loading washed coal stockpile	297	144	27	2,365,000	t/y	0.00025	0.00012	0.00002	kg/t	8	Moisture (%)	2.9	Ave wind speed (m/s)							50	Water sprays	USEPA AP-42 13.2.4 - Materials handling equation
Conveyor transfer - washed coal to banana screen	7	3	1	200,000	t/y	0.00025	0.00012	0.00002	kg/t	8	Moisture (%)	2.9	Ave wind speed (m/s)							85	Water sprays and enclosure	USEPA AP-42 13.2.4 - Materials handling equation
Screening washed coal	760	268	11	200,000	t/y	0.01250	0.00430	0.00003	kg/t											70	Enclosure	USEPA AP-42 11.19.2-1 - Screening
Loading secondary product stockpile	32	19	8	200,000	t/y	0.00025	0.00012	0.00002	kg/t	8	Moisture (%)	2.9	Ave wind speed (m/s)							50	Water sprays	USEPA AP-42 13.2.4 - Materials handling equation
Dozer on ROM stockpile	17,355	5,287	388	1,560	h/y	22.2	6.8	0.5	kg/h	6.5	Moisture (%)	6	Silt (%)							50	Water sprays	USEPA AP-42 11.9-1 - Bulldozing coal
Dozer on washed coal stockpile	7,981	2,156	182	1,560	h/y	10.2	2.8	0.2	kg/h	8	Moisture (%)	4	Silt (%)							50	Water sprays	USEPA AP-42 11.9-1 - Bulldozing coal
Dozer on secondary product stockpile	1,336	365	36	260	h/y	10.2	2.8	0.2	kg/h	8	Moisture (%)	4	Silt (%)							50	Water sprays	USEPA AP-42 11.9-1 - Bulldozing coal
Coal transport																						
Conveyor transer - ROM to train loading bin (10%)	15	7	1	300,000	t/y	0.00033	0.00016	0.00002	kg/t	6.5	Moisture (%)	2.9	Ave wind speed (m/s)							85	Water sprays and enclosure	USEPA AP-42 13.2.4 - Materials handling equation
Loading trains - ROM coal (10%)	30	14	2	300,000	t/y	0.00033	0.00016	0.00002	kg/t	6.5	Moisture (%)	2.9	Ave wind speed (m/s)							70	Enclosure	USEPA AP-42 13.2.4 - Materials handling equation
Conveyor transfer - washed coal to train loading bin	87	41	6	2,365,000	t/y	0.00025	0.00012	0.00002	kg/t	8	Moisture (%)	2.9	Ave wind speed (m/s)							85	Water sprays and enclosure	USEPA AP-42 13.2.4 - Materials handling equation
Loading trains - washed coal	174	82	12	2,365,000	t/y	0.00025	0.00012	0.00002	kg/t	8	Moisture (%)	2.9	Ave wind speed (m/s)							70	Partial enclosure	USEPA AP-42 13.2.4 - Materials handling equation
FEL loading trucks - secondary product	49	23	4	200,000	t/y	0.00025	0.00012	0.00002	kg/t	8	Moisture (%)	2.9	Ave wind speed (m/s)									USEPA AP-42 13.2.4 - Materials handling equation
Trucks hauling -secondary product offsite	6,372	1,700	172	200,000	t/y	0.13	0.03	0.00	kg/t	32	t/load	36	Ave vehicle gross mass	1.5	km/return trip	0.7	kg/VKT	6	Silt (%)	75	Water sprays	USEPA AP-42 13.2.2 - Unpaved roads
CCR handling																						
Loading trucks with CCR at CHPP	33	16	2	135,000	t/y	0.00025	0.00012	0.00002	kg/t	8	Moisture (%)	2.9	Ave wind speed (m/s)									USEPA AP-42 13.2.4 - Materials handling equation
Dozer on REA5	1,304	402	35	156	h/y	16.6	5.1	0.4	kg/h	8	Moisture (%)	6	Silt (%)							50	Water sprays	USEPA AP-42 11.9-1 - Bulldozing coal
Excavator recovering fines and loading trucks at REA3	102	48	4	208,000	t/y	0.00025	0.00012	0.00002	kg/t	8	Moisture (%)	2.9	Ave wind speed (m/s)	2	times rehandle							USEPA AP-42 13.2.4 - Materials handling equation
Hauling fines from REA3 to washed coal stockpile	4,448	1,187	121	208,000	t/y	0.09	0.02	0.00	kg/t	40	t/load	40	Ave vehicle gross mass	1.2	km/return trip	0.8	kg/VKT	6	Silt (%)	75	Water sprays	USEPA AP-42 13.2.2 - Unpaved roads
Unloading fines to washed coal stockile	33	19	8	208,000	t/y	0.00025	0.00012	0.00002	kg/t	8	Moisture (%)	2.9	Ave wind speed (m/s)							50	Water sprays	USEPA AP-42 13.2.4 - Materials handling equation
Wind erosion																						
Wind erosion - REA3	2,550	1,275	191	6	ha	850	425	64	kg/ha/yr											50	Water sprays	USEPA AP-42 11.9.2 - Wind erosion of exposed areas
Wind erosion - REA4 (not active)	0	0	0	5	ha	850	425	64	kg/ha/yr													USEPA AP-42 11.9.2 - Wind erosion of exposed areas
Wind erosion - REA5	2,550	1,275	191	6	ha	850	425	64	kg/ha/yr											50	Water sprays	USEPA AP-42 11.9.2 - Wind erosion of exposed areas
Wind erosion - REA6	1,700	850	128	4	ha	850	425	64	kg/ha/yr											50	Water sprays	USEPA AP-42 11.9.2 - Wind erosion of exposed areas
Wind erosion - ROM stockpile	2,043	1,022	153	4	ha	1,022	511	77	kg/ha/yr											50	Water sprays	USEPA AP-42 11.9.2 - Wind erosion of exposed areas
Wind erosion - Washed coal stockpile	2,043	1,022	153	4	ha	1,022	511	77	kg/ha/yr											50	Water sprays	USEPA AP-42 11.9.2 - Wind erosion of exposed areas
Wind erosion - Secondary product stockpile	1,022	511	77	2	ha	1,022	511	77	kg/ha/yr											50	Water sprays	USEPA AP-42 11.9.2 - Wind erosion of exposed areas
Ventilaiton fans																						
Ventilation fans	9,253	618	460	8760	hr/y	0.53	0.04	0.03	kg/hr													
Modification-specific activities																						
Loading trucks with CCR at CHP - included in base model																						USEPA AP-42 11.9.2 - Wind erosion of exposed areas
Hauling CCR from CHP to product stockpile	3,368	899	92	135000	t/y	0.10	0.03	0.003	kg/t	40.00	t/load	40	Ave vehicle gross mass	1.4	km/return trip	2.8495	kg/VKT	6	Silt (%)	75	Water sprays	USEPA AP-42 13.2.2 - Unpaved roads
Unloading CCR at product stockpile	24	15	8	135000	t/y	0.00025	0.00012	0.00002	kg/t	8.00	Moisture (%)	2.92	Ave wind speed (m/s)							50	Water sprays	USEPA AP-42 11.9.2 - Wind erosion of exposed areas
Excavator recovering CCR and loading trucks at REA6	81	38	3	165000	t/y	0.00025	0.00012	0.00002	kg/t	8.00	Moisture (%)	2.92	Ave wind speed (m/s)	2	times rehandle							USEPA AP-42 11.9.2 - Wind erosion of exposed areas
Hauling CCR from REA6 to ROM stockpile	3,106	800	82	165000	t/y	0.08	0.02	0.002	kg/t	40.00	t/load	40	Ave vehicle gross mass	1.2	km/return trip	2.5081	kg/VKT	5	Silt (%)	75	Water sprays	USEPA AP-42 13.2.2 - Unpaved roads
Dozer recovering CCR to trains	1,304	402	35	156	h/y	16.63	5.06	0.366	kg/h	8.00	Moisture (%)	6	Silt (%)							50	Water sprays	USEPA AP-42 11.9-1 - Bulldozing coal
Conveyor transfer - CCR to train loading bin	11	5	1	300000	t/y	0.00025	0.00012	0.00002	kg/t	8.00	Moisture (%)	2.92	Ave wind speed (m/s)							85	Water sprays and enclosure	USEPA AP-42 11.9.2 - Wind erosion of exposed areas
Loading coarse rejects to trains	32	21	11	300000	t/y	0.00025	0.00012	0.00002	kg/t	8.00	Moisture (%)	2.92	Ave wind speed (m/s)							70	Partial enclosure	USEPA AP-42 11.9.2 - Wind erosion of exposed areas
Total	**75,663**	**23,329**	**3,128**																			

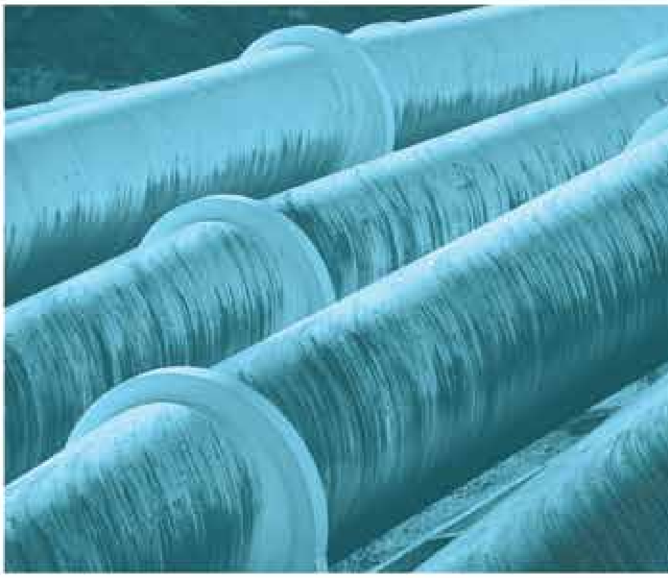
B.3 Project-related input data used for particulate matter emission estimates

The main inputs used in the emission estimates are summarised in Table B.3. All material volumes and loads per year were provided by Centennial.

Table B.3 Inputs for emission estimation

Material properties	Value	Source of information
Unpaved road silt content (%)	6	Per SLR (2013).
Coal moisture (%)	6.5	Per SLR (2013).
Product coal moisture (%)	8	Per SLR (2013).
Coarse coal rejects moisture (%)	8	Per SLR (2013).
Diesel consumption for 2018 (L/y)	Transport diesel = 25,814 L Stationary diesel = 454,852 L	Diesel use provided by Centennial. Same quantity assumed for the existing and proposed scenarios per Centennial.
Average wind speed (m/s)	2.7	Calculated from CALMET extract at Clarence.
Average truck gross mass (t)	40	Average of full and empty loads.
Industrial wind erosion parameters	Number of disturbances per year = 8,760 Erosion potential (fastest mile of wind) (m/s) = 1.27 Threshold friction velocity at 10 m (m/s) = 1.12	No. of disturbances - The entire pile area is conservatively assumed to be disturbed every hour. Erosion potential (fastest mile) - (SKM 2005) 'Uncrusted coal pile' threshold friction velocity per Table 13.2.5-2 of US-EPA AP-42.



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