# Roy Hill Additional Port Infrastructure

## Air Quality Modelling Assessment

Final Report
Version 2

**Prepared for Roy Hill Pty Ltd**

**June 2023**

**Project Number: 1368**

# Roy Hill Additional Port Infrastructure

## Final Report

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# Executive Summary

Roy Hill Holdings Pty Ltd (Roy Hill) own, and operate, an integrated iron ore mining, rail and port operation in the Pilbara region of Western Australia. The Roy Hill port operation, located in Port Hedland, currently has an approved throughput of 70 million tonnes per annum (Mtpa). Roy Hill is proposing to increase this port operation throughput, up to 110 Mtpa, by the addition of the following infrastructure:

- Inload circuit:
  - Car dumper
  - Stacker
  - Associated conveyors and transfer stations
- Outload circuit:
  - Reclaimer
  - Surge bin
  - Shiploader
  - Associated conveyors and transfer stations.

The tonnage for the proposed increase will comprise 90 Mtpa of ore from Roy Hill or that is consistent with current Roy Hill products (Mulga and McPhee) and 20 Mtpa from Mineral Resources Limited (MRL).

As the additional infrastructure will support the development of the SP3 berth in South West Creek, it will supersede the proposed development by North West Infrastructure (NWI). The NWI operations can therefore be removed as an emissions source from within the Port Hedland Industries Council (PHIC) Cumulative Air Model (CAM) as it will not be developed.

This report presents the air dispersion modelling assessment of the potential air quality impacts associated with the increase in port throughput through the expansion of the Roy Hill Port Facility (the Project).

## Overview of assessment

The potential impacts were determined through a dispersion modelling study, which incorporated site-specific meteorological data, emissions information, source characteristics, and the location of model receptors. An inventory of particulate (dust) emissions from the current operations was developed, and projected for the increased throughput.

Emission rates for the Roy Hill and MRL products were undertaken using source specific emission factors. The study adopted a conservative approach, consistent with similar assessments in the region, using AERMOD software (version 9.4). Emission reductions were applied for the installation of a belt wash station (BWS) at the head of conveyor CVR105.

Ground-level particulates (as $PM_{10}$ concentrations) were predicted at sensitive receptors and the surrounding environment using the Port Hedland Industries Council Cumulative Air Model (AERMOD) and were compared with the relevant air quality assessment criteria. Predicted project contributions were presented in isolation of non-project related emission sources, and with the inclusion of background and existing concentrations to represent the potential changes in cumulative impacts in the Port Hedland area.

## Key findings

Modelling was undertaken for two scenarios:

- Base case – 70 Mtpa (Roy Hill) in isolation of other sources, and cumulative with other sources.
- Expansion scenario – 110 Mtpa (Roy Hill) in isolation of other sources and cumulative with other sources.

For this assessment, the cumulative scenario has removed the historically modelled North West Infrastructure (NWI) development as this allocation is now assigned to Roy Hill for this Project. Therefore the cumulative scenario includes:

- 330 Mtpa from the BHP operations at Nelson Point and Finucane Island.
- 28 Mtpa from the PPA operations at Utah Point.
- 210 Mtpa from the Fortescue operations

The results of the modelling, for the Roy Hill expansion scenario, at the Taplin St receptor, predict for the:

- Standalone scenario (i.e. Roy Hill operations with increased throughput, and in isolation of other emission sources):
    - a predicted decrease of 1 $\mu g/m^3$ in the maximum predicted ground level concentration at Taplin St.
    - a predicted decrease of 0.3 $\mu g/m^3$ in the annual average concentration at Taplin St.
    - The modelling also indicates that there will be reductions in the predicted ground level concentrations at other receptors within Port Hedland including those west of Taplin St including the Richardson St and Kingsmill St receptors.
- For the cumulative scenario (i.e. Roy Hill operations with increased throughput, in conjunction with other emission sources):
    - there is no predicted change to the maximum concentration at Taplin St.
    - a predicted reduction in the lower percentile concentrations at Taplin St, including the annual average, though this is likely due to changes with the PHIC CAM cumulative sources rather than the Roy Hill emission sources.
    - a predicted reduction in the number of excursions of the criteria at the Taplin St receptor, though this is likely attributable to changes with the PHIC CAM cumulative sources rather than the Roy Hill emission sources.

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# 1 Introduction

## 1.1 Background

Roy Hill Holdings Pty Ltd (Roy Hill) own and operate an integrated mining, rail and port operation in the Pilbara region of Western Australia. The port facility, which is located to the west of Port Hedland (see Figure 1-1), consists of:

- Inload circuit
  - Car Dumper
  - 2 Stackers
  - Associated conveyors and transfer stations
- Outload circuit
  - Reclaimer
  - Lump re-screening plant
  - Shiploader
  - Associated conveyors and transfer stations.

The Roy Hill port operation currently has an assessed operating throughput of 70 million tonnes per annum (Mtpa). Roy Hill is proposing to increase this throughput to 110 Mtpa by the addition of the following infrastructure:

- Inload circuit:
  - Car dumper
  - Stacker
  - Associated conveyors and transfer stations
- Outload circuit:
  - Reclaimer
  - Surge bin
  - Shiploader
  - Associated conveyors and transfer stations.

The tonnage for the proposed increase will comprise 90 Mtpa of ore from Roy Hill or that is consistent with current Roy Hill products (Mulga and McPhee) and 20 Mtpa from Mineral Resources Limited (MRL).

In addition to these changes Roy Hill is proposing to incorporate the currently approved North West Infrastructure (NWI) into their facility. This requires Roy Hill to remove the emissions, and associated impact, resulting from the NWI approved project, from the Port Hedland Industries Council (PHIC) Cumulative Air Model (CAM) as a separate source, and be taken into account as part of the overall Roy Hill emissions and predicted impacts.

## 1.2 Scope of work

This report outlines the methodology for the emission estimation and atmospheric modelling of the predicted dust impacts associated with the proposed increase in throughput to 110 Mtpa. The report presents the predicted ground level concentrations of dust with the proposed changes and makes comparison to the dust performance targets specified in the Port Hedland Regulatory Strategy (DWER, 2021). Further reference is also made to the Department of Water and Environmental Regulation (DWER) Industry Regulation fact sheet 'Managing dust in Port Hedland' (DWER, 2018).

Modelling of potential cumulative emissions was also undertaken as part of this assessment. Emissions from the BHP operations at Nelson Point and Finucane Island, Pilbara Ports Authority (PPA) Utah Point (multi-user) operations, and the Fortescue Metals Group (Fortescue) operations at Anderson Point.

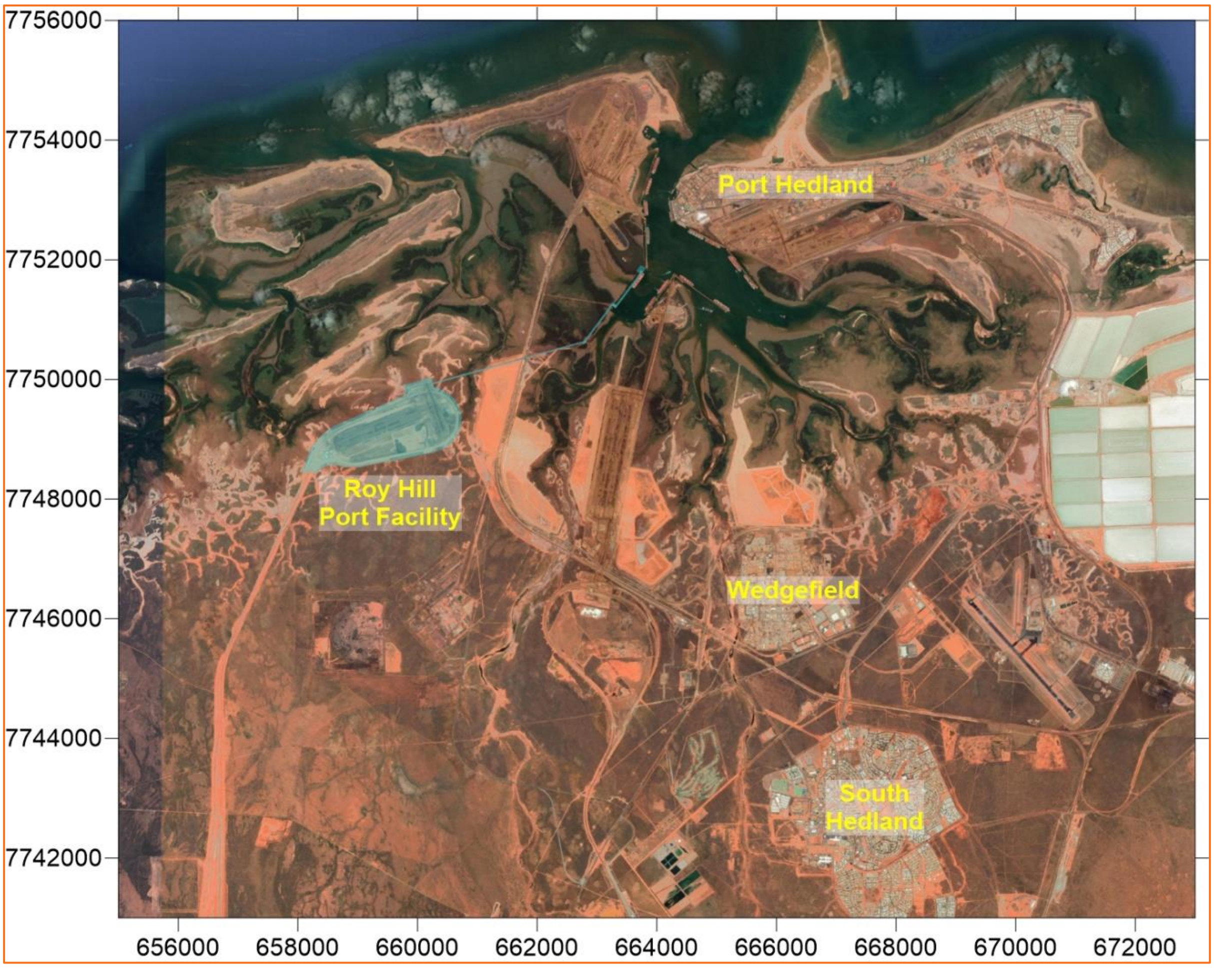


**Figure 1-1: Project location and setting**

## 1.3 Structure of report

This report describes the methods and findings of an assessment of the potential impacts to the air environment arising from the Project. The assessment includes:

- The study approach and methodology in Section 2.
- Project emission estimation and inventory in Section 3.
- An evaluation of the predicted ground-level concentrations and interpretation of the potential impact of the Project (Section 4)
- Conclusions of the assessment presented in Section 5.

The appendices contain supporting information.

# 2 Assessment methodology

The following section outlines the methodology utilised in the assessment of the potential changes in the air quality resulting from the proposed Roy Hill Port Operations increase in throughput tonnage.

## 2.1 Dispersion Modelling

During 2014 and 2015 the Port Hedland Industries Council (PHIC) undertook an extensive atmospheric dispersion model validation project where it was determined that both AERMOD and CALPUFF were suitable models to determine the potential impact from industrial sources in the area. In brief:

- AERMOD is the acronym or common name for the AERMIC Dispersion Model. It was designed by the AERMIC Committee (the American Meteorological Society/Environmental Protection Agency Regulatory Model Improvement Committee) to treat elevated and surface emission sources in terrain that is simple or complex (Perry, Cimorelli et al, 2005). In 2013 AERMOD replaced AUSPLUME as the regulatory model for air quality assessments in Victoria by the Victorian Environmental Protection Authority (EPAV).
- CALPUFF is the dispersion module of the CALMET/CALPUFF suite of models. It is a multi-layer, multi species, non-steady-state puff dispersion model that can simulate the effects of time-varying and space-varying meteorological conditions on pollutant transport, transformation and removal. The model contains algorithms for near-source effects such as building downwash, partial plume penetration, sub-grid scale interactions as well as longer range effects such as pollutant removal, chemical transformation, vertical wind shear and coastal interaction effects. The model employs dispersion equations based on a Gaussian distribution of pollutants across released puffs and considers the complex arrangement of emissions from point, area, volume and line sources (Scire et al., 2011).

## 2.2 AERMOD Modelling

For this assessment, the dispersion model AERMOD (version 9.4) was used. The primary reason for using this model is that other proponents in the region, particularly BHP and Fortescue, are using AERMOD for their own approvals process. By using AERMOD this assessment ensures consistency in evaluating cumulative impact predictions with other assessments within the region.

The model was configured in accordance with the work undertaken as a part of the PHIC Cumulative Air Model (CAM) (PEL, 2015). As noted in the PHIC CAM report (PEL, 2015) there are some constraints that need to be considered when using the PHIC CAM (AERMOD) including:

- The model may over-predict concentrations at Richardson Street.
- At the Kingsmill Street and Taplin Street receptors the model results are considered to be reasonable reflections of actual monitored air quality.
- The number of excursions of the interim target at Taplin Street are considered to be reasonable reflections.

To undertake the air quality assessment, emission estimation and modelling were undertaken for the following scenarios:

- Base case – 70 Mtpa (Roy Hill)
- Expansion – 110 Mtpa (90 Mtpa Roy Hill or similar, 20 Mtpa Mineral Resources Limited (MRL))

For each of these scenarios, the results were presented as:

- Standalone without background concentrations.
- Cumulative, with other existing, approved and planned operations in the region including;
    - BHP at 330 Mtpa
    - PPA at 28 Mtpa
    - Fortescue at 210 Mtpa

## 2.3 Meteorological File

The AERMOD modelling incorporated the meteorological file developed as part of the PHIC (CAM) project which has been accepted for use by the Western Australian (WA) Department of Environment Regulation (DER) – now DWER.

A summary of the stability and mixing heights of the PHIC CAM meteorological file is provided in Appendix A.

## 2.4 Grid system

The modelling undertaken as part of this assessment utilised the same receptors, and their locations, as that contained within the PHIC CAM report (PEL, 2015). These receptors, and their coordinates, are listed in Table 2-1 and presented graphically in Figure 2-1. Note that due to the number of receptors within the Town of Port Hedland the name of each receptor was not incorporated into the figure, instead each receptor has been assigned a number. These numbers correspond to those listed in Table 2-1.

**Table 2-1: Receptors, and locations, used in assessment**

| Number | Receptor | Easting (m) | Northing (m) |
|---|---|---|---|
| 1 | Harbour | 664,350 | 7,753,240 |
| 2 | Richardson Street | 664,763 | 7,753,402 |
| 3 | BMX | 665,281 | 7,753,352 |
| 4 | Kingsmill Street | 665,508 | 7,753,450 |
| 5 | Historic Hospital Site | 665,870 | 7,753,420 |
| 6 | Taplin Street | 667,030 | 7,753,435 |
| 7 | St Celia's School | 667,292 | 7,753,390 |
| 8 | Holiday Inn | 667,780 | 7,753,480 |
| 9 | Shop | 668,050 | 7,753,280 |
| 10 | All Seasons Inn | 668,140 | 7,753,530 |
| 11 | Council | 668,450 | 7,753,640 |
| 12 | Neptune Place | 669,441 | 7,754,077 |
| 13 | Primary School | 670,631 | 7,754,008 |
| 14 | South Hedland | 666,600 | 7,743,439 |
| 15 | Wedgefield | 665,526 | 7,747,107 |

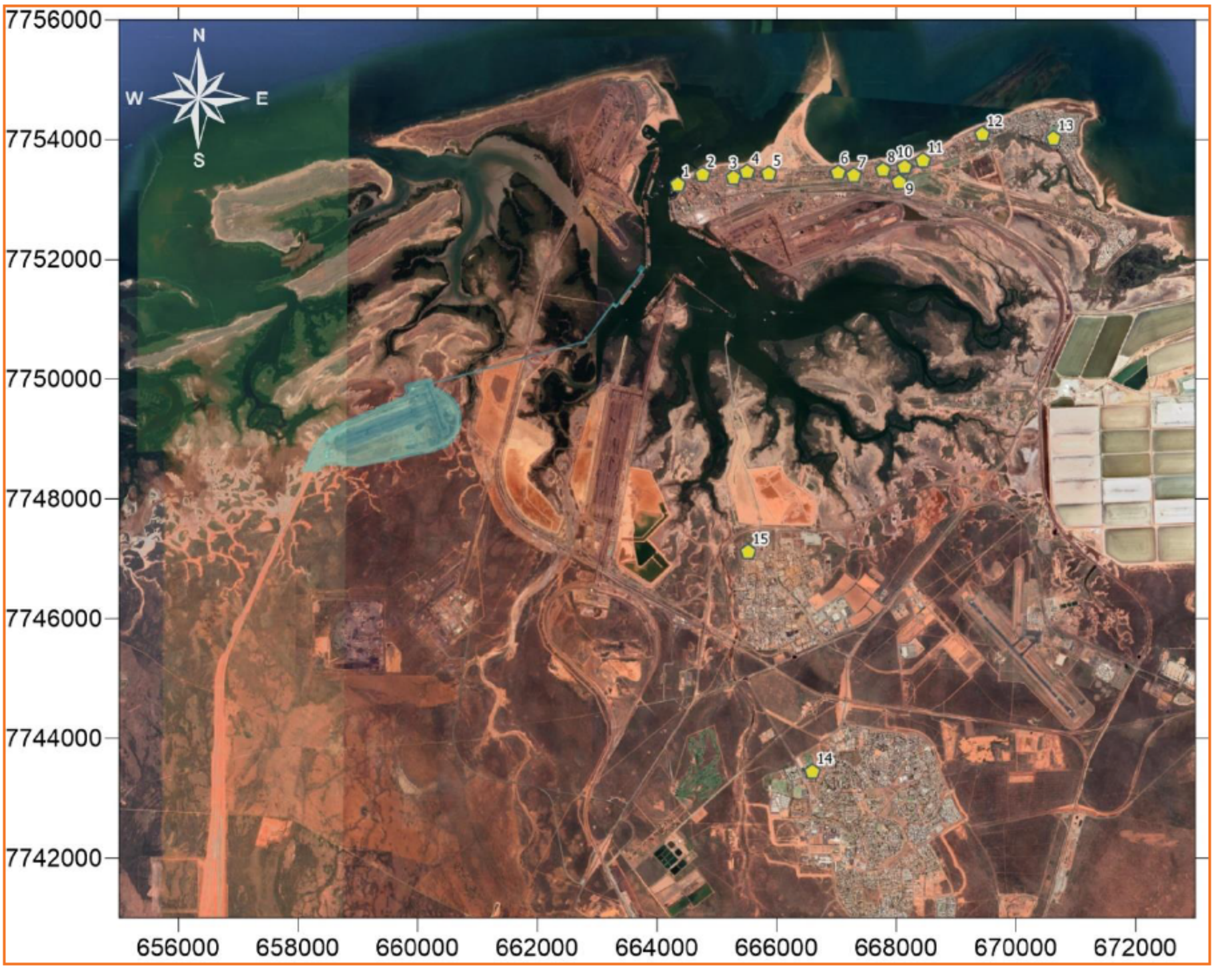


**Figure 2-1: Location of receptors used in assessment**

## 2.5 Air quality assessment criteria

To control air pollution and achieve what is regarded as acceptable air quality, environmental authorities set air quality standards or guidelines for several common air pollutants.

For Port Hedland specifically, the Port Hedland Regulatory Strategy (DWER, 2021) adopted the Dust Management Taskforce (Taskforce) interim guideline value of 70 µg/m³ for $PM_{10}$ (24-hour average) as an Air Guideline Value (AGV) and the criteria used in this assessment is presented in Table 2-2. This AGV applies to residential areas in Port Hedland, wherever people live on a permanent basis.

**Table 2-2: Ambient Air Quality Standards and Goals**

| Pollutant | Criteria | Averaging Period | Comment |
|---|---|---|---|
| Particulate (as $PM_{10}$) | 70 µg/m³ | 24-hour | At Taplin Street with 10 excursion per year |

## 2.6 Background concentrations

It has long been recognised that the Pilbara region, due to its semi-arid climate, is a naturally dusty environment. This was highlighted in the aggregated emission study undertaken by SKM in 2000 (SKM, 2003) which calculated that the Pilbara region emitted approximately 170,000 tonnes of windblown particulates for the financial year 1999/2000. The naturally dusty environment is also apparent from the monitoring data from the PHIC Yule River monitor. This monitor is located approximately 42 kilometres (km) south-west of Port Hedland and is indicative of regional concentrations. The number of excursions of the 50 µg/m³ NEPM criteria for particulates (as $PM_{10}$) for each financial year since 2012/2013 (FY13) are presented in Table 2-3.

From Table 2-3 it is apparent that there can be a large annual variation in the number of excursions of the NEPM criteria ranging from 24 in FY13 down to 1 in FY17 and FY22. This indicates that the quantity of particulates can vary significantly from year to year and that the background file used in the assessment should be considered as indicative only.

**Table 2-3: Number of annual excursions of NEPM criteria at Yule River**

| Financial Year | FY13 | FY14 | FY15 | FY16 | FY17 | FY18 | FY19 | FY20 | FY21 | FY22 |
|---|---|---|---|---|---|---|---|---|---|---|
| Number of excursions | 24 | 8 | 18 | 5 | 1 | 8 | 15 | 13 | 8 | 1 |

For this assessment the PHIC CAM background file was utilised and the methodology for the development of this file is outlined in PEL (2015). The PEL (2015) report also noted that due to the way the file was calculated there is a high probability that not all fugitive sources within the Port Hedland region were accounted for. This provides further indication that the file should be considered as indicative only. The 24-hour statistics for the PHIC CAM background file are presented in Table 2-4 and presented graphically in Figure 2-2. From this table it is apparent that the maximum 24-hour concentration higher than the criteria which will affect the analysis of the modelling results, particularly when the maximum predicted concentrations, with background, are presented.

**Table 2-4: Statistics of 24-hour $PM_{10}$ PHIC CAM background file**

| Statistic | Concentration (µg/m³) |
|---|---|
| Maximum | 183 |
| 99th Percentile | 53 |
| 95th Percentile | 36 |
| 90th Percentile | 32 |
| 70th Percentile | 25 |
| Average | 22 |
| Count >50 µg/m³ | 5 |
| Count >70 µg/m³ | 1 |

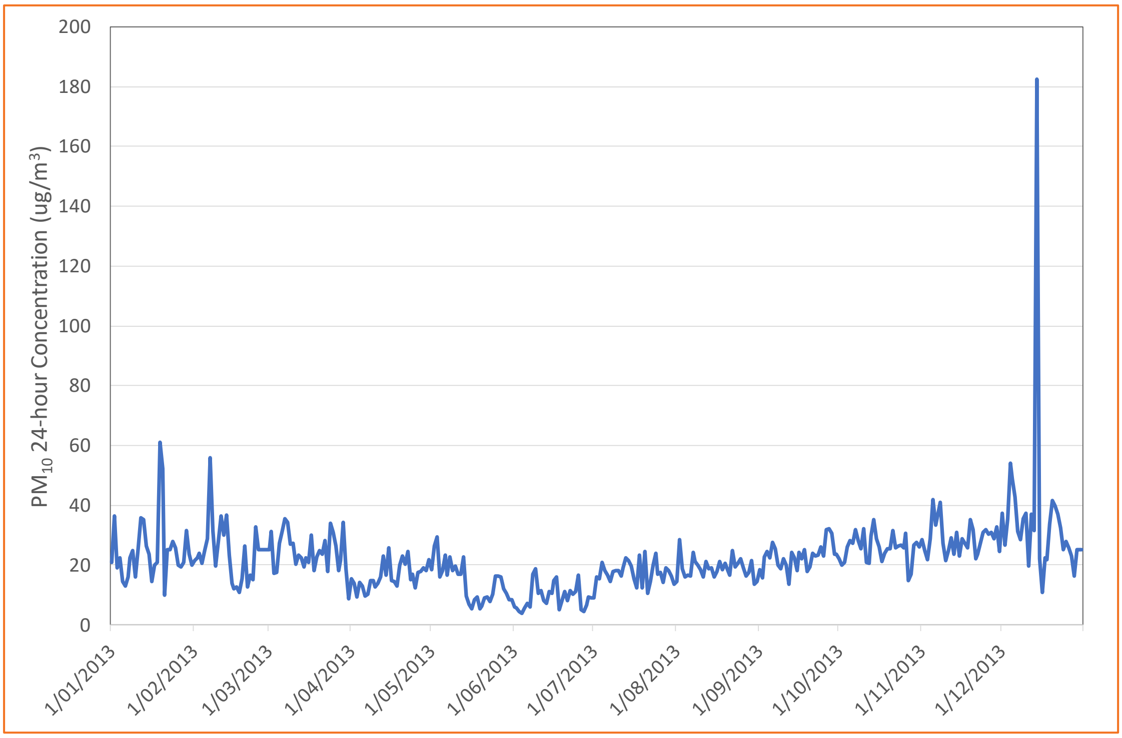


**Figure 2-2: PHIC CAM background $PM_{10}$ 24-hour concentrations (µg/m$^3$) (PEL, 2015)**

## 2.7 Model uncertainty

Atmospheric dispersion models represent a simplification of the many complex processes involved in approximating ground-level concentrations of substances. The model uncertainties are associated with model chemistry and physics, data, and stochastic uncertainties. There are also inherent uncertainties in the behaviour of the random turbulence of the atmosphere.

Factors contributing to the general uncertainty in model results include:

- the turbulent (random) nature of dispersion in the turbulent atmosphere.
- inaccuracies in the mathematical description of the physical and chemical processes that occur in the atmosphere (i.e. uncertainties in the numerical solutions).
- stochastic uncertainties, as models predict 'ensemble mean' concentrations (i.e. they predict the mean concentrations that would result from a large set of observations under the specific conditions being modelled).
- data uncertainty or variability, particularly in emission information and meteorological data inputs.

Regarding emissions information in particular, as predicted concentrations are proportional to emission rates, any errors in the emission rates will cause a proportional error in the model's predictions.

The uncertainty in modelling of extreme events, such as the maximum 1-hour ground-level concentration, is greater than the uncertainty in predicting concentrations averaged over a longer time period. Similarly, uncertainty in modelling the maximum predicted ground-level concentration at a discrete location is greater than the uncertainty in the maximum concentration predicted across the entire modelled domain. This is because the modelled concentration at a particular location is very sensitive to small changes in wind direction.

To ensure that potential air quality impacts are not underestimated, conservative assumptions have been applied as appropriate, to address key areas of uncertainty to provide over-predictions rather than under-predictions of ground-level concentrations.

# 3 Emissions to air estimation

When determining the potential impact of a facility, either existing or proposed, one of the critical inputs is the source emission file. The following sections outline the process whereby potential sources are identified, and quantified, based on the forecast throughput tonnage of the facility.

## 3.1 Emission Sources

The location of the existing sources, as used in the 70 Mtpa model, at the Roy Hill Port Operations are displayed in Figure 3-1, with the new sources associated with the expansion scenario being presented in Figure 3-2. The coordinates for each of the modelled sources, along with the model parameters, is presented in Appendix B.

Please note that the sources presented in both Figure 3-1 and Figure 3-2 are included in the 110 Mtpa expansion scenario modelling.

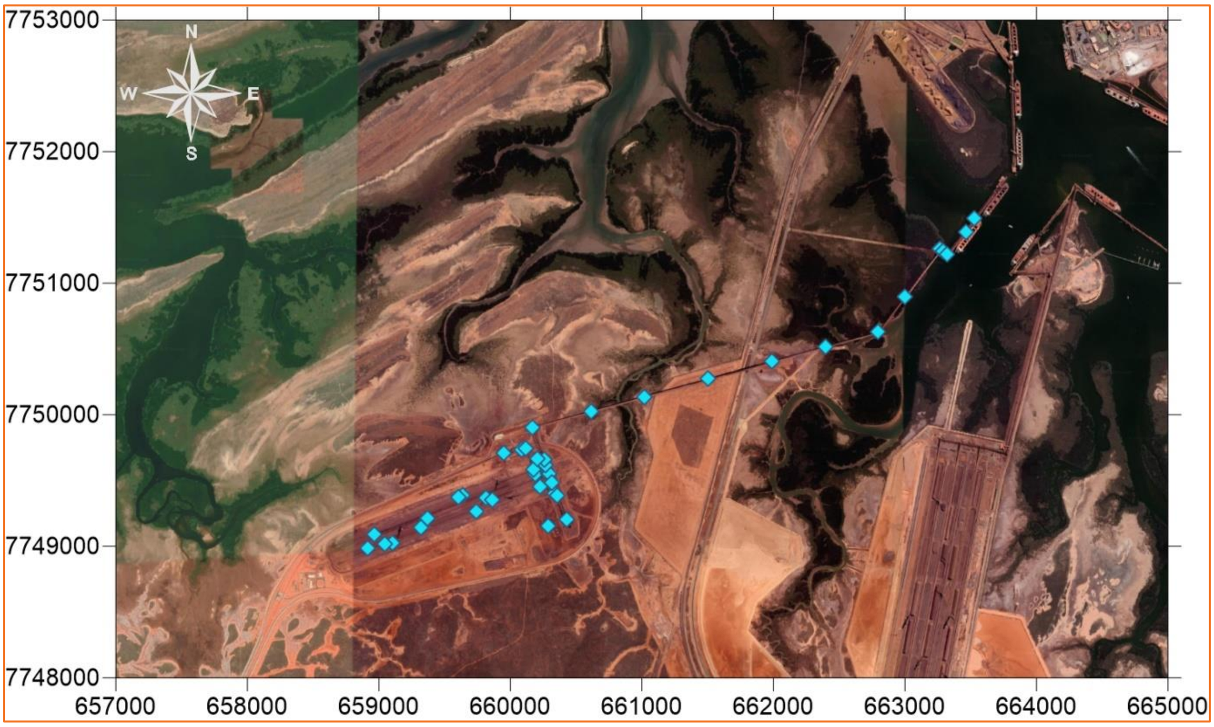


**Figure 3-1: Location of existing sources at the Roy Hill Port operations**

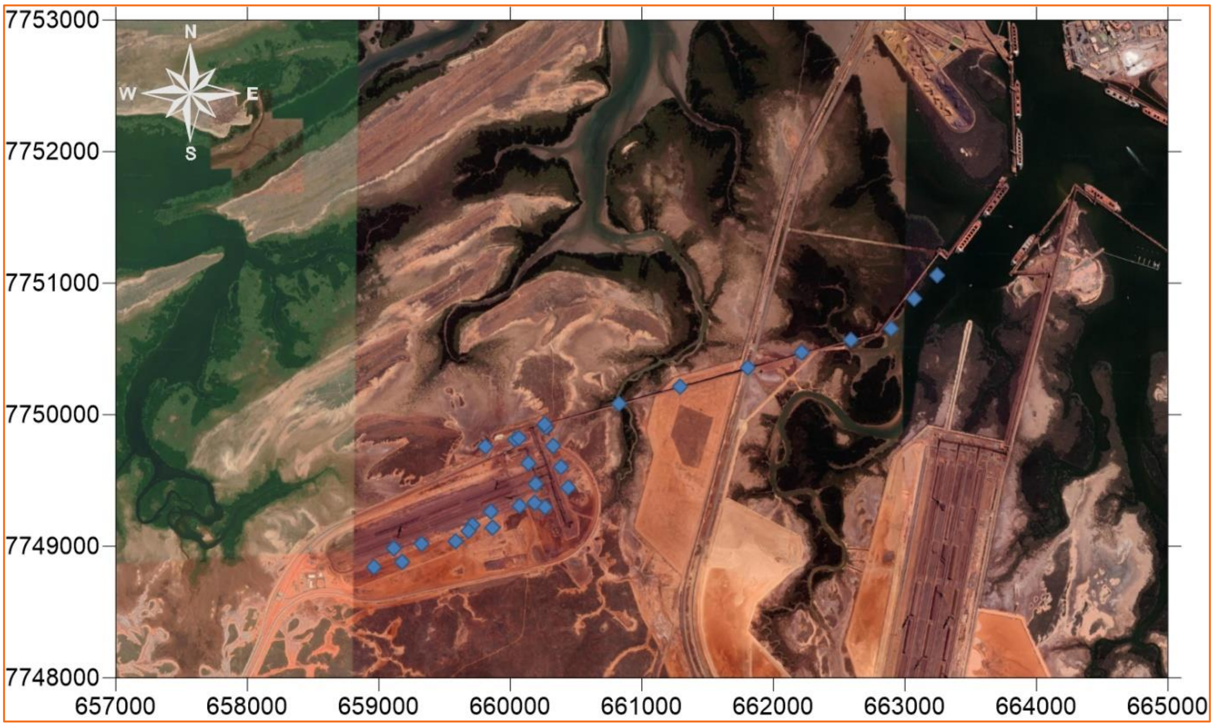


**Figure 3-2: Location of new/additional sources at the Roy Hill Port operations**

## 3.2 Site specific emission factors

Since 2018 Roy Hill has undertaken site specific measurement surveys of particulate emissions from sources within their port facility (ETA, 2020). The purpose of the surveys is to derive source-specific emission factors for each material handling process (conveying, transfer stations, stacking, reclaiming, shiploading) based on the incoming and outgoing ore types and their associated moisture level. Determining source specific emission factors, for each individual source, allows Roy Hill to transfer from generic emission factors, such as those outlined in the National Pollutant Inventory (NPI) Emission Estimation Technique Manual for Mining Version 3.1 (EETM for Mining Ver3.1) (Environment Australia, 2012), to ones that are more applicable to the operation. The updated emission factors for all sources, except for wind erosion, are outlined in Appendix C.

For the expansion scenario, the emissions associated with the MRL were assumed to be similar to those determined for the Roy Hill fines product. As both products will be beneficiated, it is assumed that both will therefore arrive at the port facility at moisture concentrations above the dust extinction moisture (DEM).

For wind erosion the modified Shao equation was utilised which is consistent with the methodology outlined in the PHIC CAM flowchart (PEL, 2015). This equation is presented as Equation 1 and for this assessment a value of 6.5 m/s was assigned for $WS_0$ along with a constant (k) of $1.8 \times 10^{-7}$. This constant results in an estimated annual emission rate of 0.27 kg/ha/hr, which is larger than the default emission of 0.2 kg/ha/hr which is recommended in the EETM for Mining Ver3.1. This overestimation is considered to be valid as the default emission rate is potentially derived for the Hunter Valley region of NSW (SKM, 2005) and is considered to be specific to both locations and ore types.

For this assessment, a control factor of 50% has been applied to account for stockpile water cannons (for stockpiles) and watering (for open areas).

Equation 1 was used to calculate the rate of emission of $PM_{10}$ from wind erosion.

$$EF_{PM10} = k\left[WS^3 \times \left(1 - \frac{WS_0^{\,2}}{WS^2}\right)\right] \qquad where \;\; WS > WS_0 \qquad \textbf{Equation 1}$$

$$EF_{PM10} = 0 \qquad where \;\; WS < WS_0$$

Where:

$EF_{PM10}$ = Emission factor for $PM_{10}$ ($g/m^2/s$)

$WS$ = Wind speed (m/s)

$WS_0$ = Threshold wind speed for dust lift off (m/s)

$k$ = Constant

## 3.3 Emission estimates

The following sections outline how the hourly emission file for both scenarios (70 Mtpa and 110 Mtpa) were calculated.

### 3.3.1 Base case: 70 Mtpa

In 2020 Roy Hill undertook atmospheric dispersion modelling of the increase in their operational throughput up to 70 Mtpa (ETA, 2020b). To achieve the goal of no increase in emissions (DWER, 2021) the recommendation was made to install a Belt Wash Station (BWS) at the head end of conveyor CVR121 to reduce fugitive emissions from the return side of the conveyor, commonly known as carry-back emissions. The emission estimation for this scenario assumed a conservative 70% reduction with a 90% availability, which is lower than the 80% recommended in the PHIC CAM report (PEL, 2015). The 90% availability has been incorporated into the estimation process for new abatement options to allow for potential periods when the active abatement is out of service.

This scenario, used as the base scenario in this assessment, was derived from an indicative daily forecast tonnage provided by Roy Hill, and converted to an hourly annual tonnage using a random distribution basis. The forecast tonnages are presented in Table 3-1. Note that both the stackers and reclaimers are predicted to have a total throughput higher than 70 Mtpa due to the process whereby lump is screened and excess fines, known as re-screened fines (RSF), are sent back to the stockpiles.

**Table 3-1: Nominal process tonnage for the 70 Mtpa expansion**

| Source | Lump | Fines | Total |
|---|---|---|---|
| Car dumper | 25,971,000 | 44,051,000 | 70,022,000 |
| Stacker | 25,971,000 | 50,803,000 | 76,774,000 |
| Reclaimer | 32,513,000 | 47,588,000 | 80,101,000 |
| Shiploader | 25,760,000 | 43,878,000 | 69,638,000 |

The hourly process file was used in conjunction with the emission factors listed in Appendix C to create an hourly variable file for all emission sources at the Roy Hill Port operations.

The statistics of the top 20 calculated sources, by the annual average emission rate, for this scenario are presented in Figure 3-3. In this figure it is apparent that the annual average emission for CVR121 has reduced. Due to the 90% availability applied to the BWS there is no change to either the maximum or 99th percentile. The statistics of the hourly emissions, for each source, are presented in Appendix D.

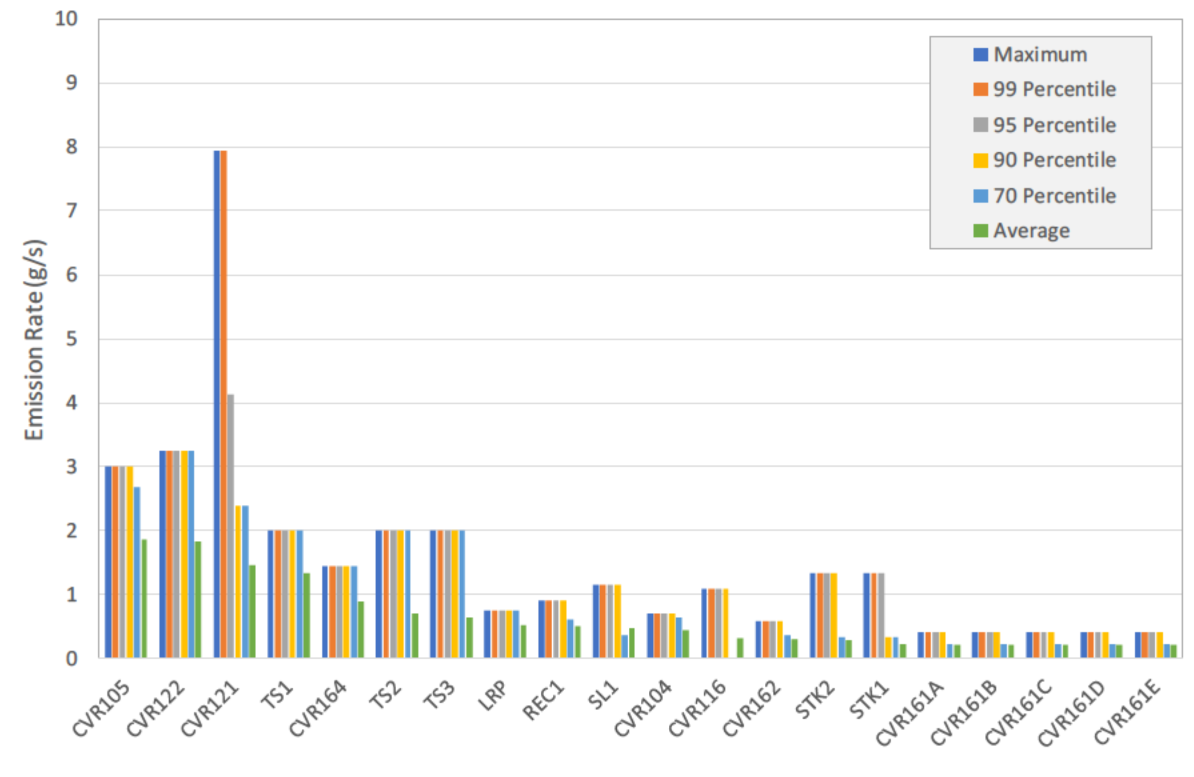


**Figure 3-3: Statistics of top 20 sources from the 70 Mtpa hourly variable emission file (g/s)**

### 3.3.2 Expansion Scenario: 110 Mtpa

For the 110 Mtpa expansion an indicative annual forecast tonnage was provided by Roy Hill, and this was converted to an hourly annual tonnage using a random distribution basis. The forecast tonnages for this assessment are presented in Table 3-2.

The products for the 110 Mtpa differ from those in the 70 Mtpa scenario (Table 3-1) in that there is an allowance for 20 Mtpa from MRL – noting that MRL product will be beneficiated fines only.

**Table 3-2: Nominal process tonnage for the 110 Mtpa expansion**

| Source | Roy Hill | | MRL Fines | Total |
|---|---|---|---|---|
| | Lump | Fines | | |
| Car dumper 1 | 20,707,317 | 39,292,683 | - | 60,000,000 |
| Car dumper 2 | 10,353,659 | 19,646,341 | 20,000,000 | 50,000,000 |
| Stacker 1 | 15,530,488 | 24,469,512 | - | 40,000,000 |
| Stacker 2 | 15,530,488 | 24,469,512 | - | 40,000,000 |
| Stacker 3 | | 10,000,000 | 20,000,000 | 30,000,000 |

| Source | Roy Hill | | MRL | Total |
|---|---|---|---|---|
| | Lump | Fines | Fines | |
| Reclaimer 1 | 31,060,976 | 23,939,024 | - | 55,000,000 |
| Reclaimer 2 | - | 35,000,000 | 20,000,000 | 55,000,000 |
| Shiploader 1 | 19,194,985 | 36,422,993 | - | 55,617,978 |
| Shiploader 2 | 11,865,991 | 22,516,032 | 20,000,000 | 54,382,023 |

The hourly process file was used in conjunction with the emission factors listed in Appendix C to create an hourly variable file for all Roy Hill emission sources. As outlined in Section 3.2 the emissions estimation process was divided into two separate phases as follows:

- Roy Hill: Source specific emission factors derived from extensive field measurements.
- MRL: Source specific emission factors derived from field measurements for Roy Hill products (beneficiated material).

As outlined in Section 3.3.1 Roy Hill committed to installing a BWS at the head end of conveyor CVR121 as part of the 70 Mtpa assessment. This BWS was installed in early 2022 and an on-site field sampling program was undertaken in May 2022 with the aim of validating the 70 Mtpa model assumption that the BWS would not result in an increase in emissions. During the period of the field sampling only fines products were sampled with the end result of a reduction of 81% being achieved, which is greater than that initially assumed.

For the 110 Mtpa scenario the following additional abatement was utilised for the operation of a BWS at the head end of CVR121:

- Fines: 80% reduction in emissions, with a 90% availability.
- Lump: 70% reduction in emissions, with a 90% availability.

An additional abatement was included in the 110 Mtpa scenario, namely a BWS at the head end of CVR105.

The statistics of the top 20 calculated sources, by the annual average emission rate, for this scenario are presented in Figure 3-4. When these ranked emission sources are compared to those for the 70 Mtpa scenario (Figure 3-3) it is evident that there has been a significant reduction in emissions from CVR105 due to the installation of the BWS.

The statistics of the hourly emissions, for each source, are presented in Appendix D.

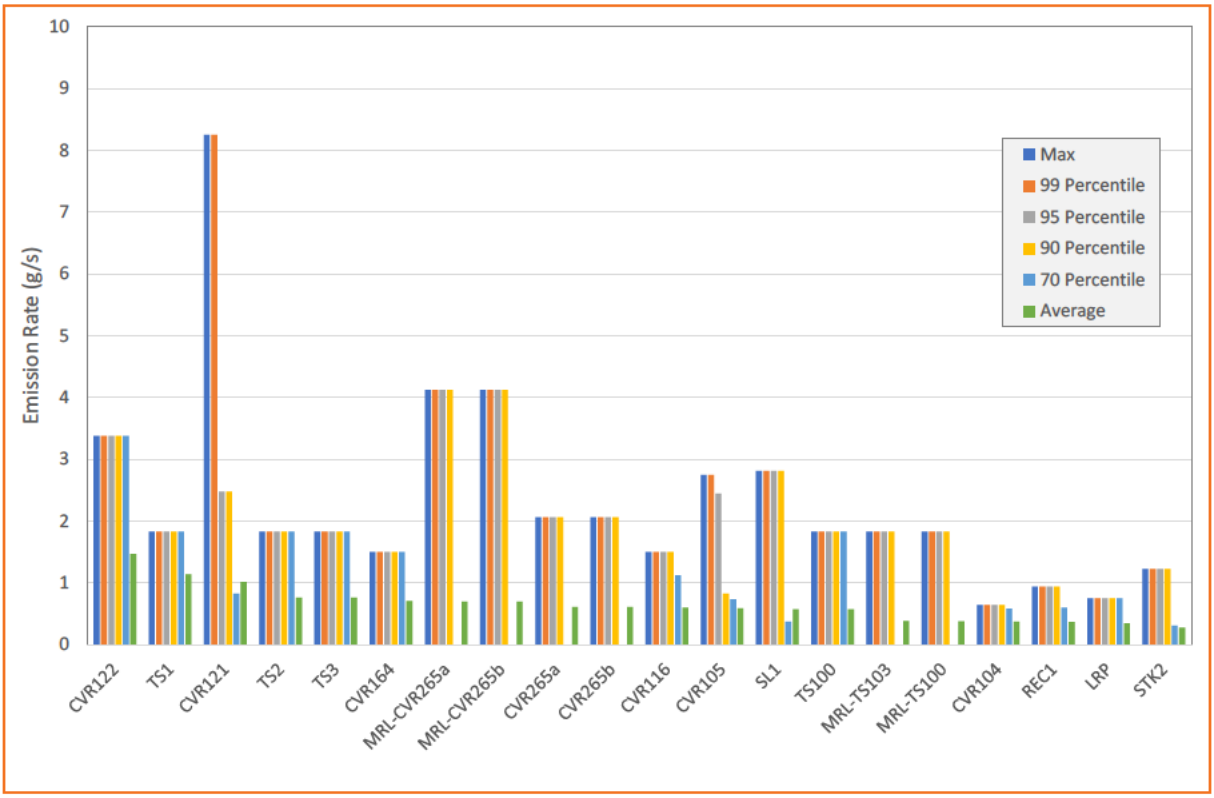


**Figure 3-4: Statistics of top 20 sources from the 110 Mtpa hourly variable emission file (g/s)**

### 3.3.3 Emission summary

As outlined in Section 1.1 Roy Hill is incorporating the tonnage, and associated emissions, previously allocated to the NWI facility into their own facility as part of this expansion. As such, the emissions for both the currently approved 70 Mtpa at the Roy Hill facility and the 50 Mtpa at the proposed NWI are presented in Table 3-3 along with the combined emissions from both facilities as well as the predicted emissions from the proposed 110 Mtpa expansion.

From this table it can be seen that the proposed expansion scenario, while higher than the base case with Roy Hill at (70 Mtpa), is significantly lower than the combined Roy Hill and NWI estimated emissions.

**Table 3-3: Total estimated emissions for modelled scenarios**

| Scenario | Estimated Emissions (kg/yr) | Comment |
|---|---|---|
| Base case – 70 Mtpa | 457,804 | Estimated emissions for Roy Hill at 70 Mtpa |
| NWI 50 Mtpa | 374,646 | Estimated emissions for NWI at 50 Mtpa – from PHIC assessment |
| Roy Hill + NWI | 832,450 | Combined Roy Hill (70 Mtpa) and NWI (50 Mtpa) |
| Expansion scenario – 110 Mtpa | 643,359 | Estimated emissions for Roy Hill at 110 Mtpa |

## 3.4 Cumulative Scenario

The modelling of cumulative emissions is a requirement of DWER (DoE, 2006). The cumulative emission sources for this study include both the current and planned export operations in the Port Hedland region including:

- 330 Mtpa from the BHP operations at Nelson Point and Finucane Island.
- 28 Mtpa from the PPA operations at Utah Point.
- 210 Mtpa from the Fortescue operations

Emissions for existing and planned operations with the Port Hedland airshed were obtained from PHIC and the full emission estimation process is outlined in the PEL (2015) report.

# 4 Predicted air quality impact

As outlined in Section 2.1 this assessment utilised the PHIC CAM to determine the potential impact associated with the proposed increase in handled tonnage through the Roy Hill Port operations. The modelling focus is on particulates, primarily as $PM_{10}$, and this section outlines the results.

For this assessment, the following Roy Hill port facility scenarios were modelled:

- Base case – Roy Hill at 70 Mtpa, with NWI at 50 Mtpa
- Expansion scenario – 110 Mtpa

For each of these scenarios the results were presented as:

- Standalone without background air quality.
- With the cumulative operations (BHP, Fortescue and PPA) with the 2013 CAM background file.

## 4.1 Base Case - 70 Mtpa (Roy Hill) in isolation and cumulative

For reference purposes the predicted ground level concentrations at the Taplin Street receptor, for the Roy Hill operations at 70 Mtpa, are presented in Table 4-1. This table presents the results for Roy Hill as a standalone operation (without background) as predicted for the 70 Mtpa scenario (ETA, 2020), the 70 Mtpa scenario with the predicted concentrations for the NWI 50 Mtpa scenario and the cumulative scenario.

The predicted results at all receptors in the region are contained in Appendix E.

**Table 4-1: Predicted 24-hour ground level concentrations of $PM_{10}$ at Taplin St for Roy Hill – 70 Mtpa**

| Statistic | Roy Hill – no background (µg/m$^3$) | Roy Hill including NWI – no background (µg/m$^3$) | Cumulative – with background (µg/m$^3$) |
|---|---|---|---|
| Maximum | 9 | 12 | 200 |
| 99$^{th}$ percentile | 6 | 9 | 81 |
| 95$^{th}$ percentile | 4 | 5 | 61 |
| 90$^{th}$ percentile | 2 | 4 | 54 |
| 75$^{th}$ percentile | 1 | 2 | 45 |
| Average | 0.9 | 1.5 | 36.0 |
| Count >70 µg/m$^3$ | 0 | 0 | 9 |

The isopleths for the predicted maximum $PM_{10}$ 24-hour concentrations for the Roy Hill operations at 70 Mtpa, without background, are presented in Figure 4-1, while Figure 4-2 presents the isopleths for the predicted maximum $PM_{10}$ 24-hour concentrations for the Roy Hill operations at 70 Mtpa and the NWI operations at 50 Mtpa, without background.

The isopleths for the cumulative predicted maximum $PM_{10}$ 24-hour concentrations with Roy Hill operations at 70 Mtpa and the NWI operations at 50 Mtpa (including CAM and background) are presented in Figure 4-3 while the isopleths for the $PM_{10}$ annual average concentrations from the cumulative scenario are presented in Figure 4-4. The red contour line indicates the relevant assessment criteria.

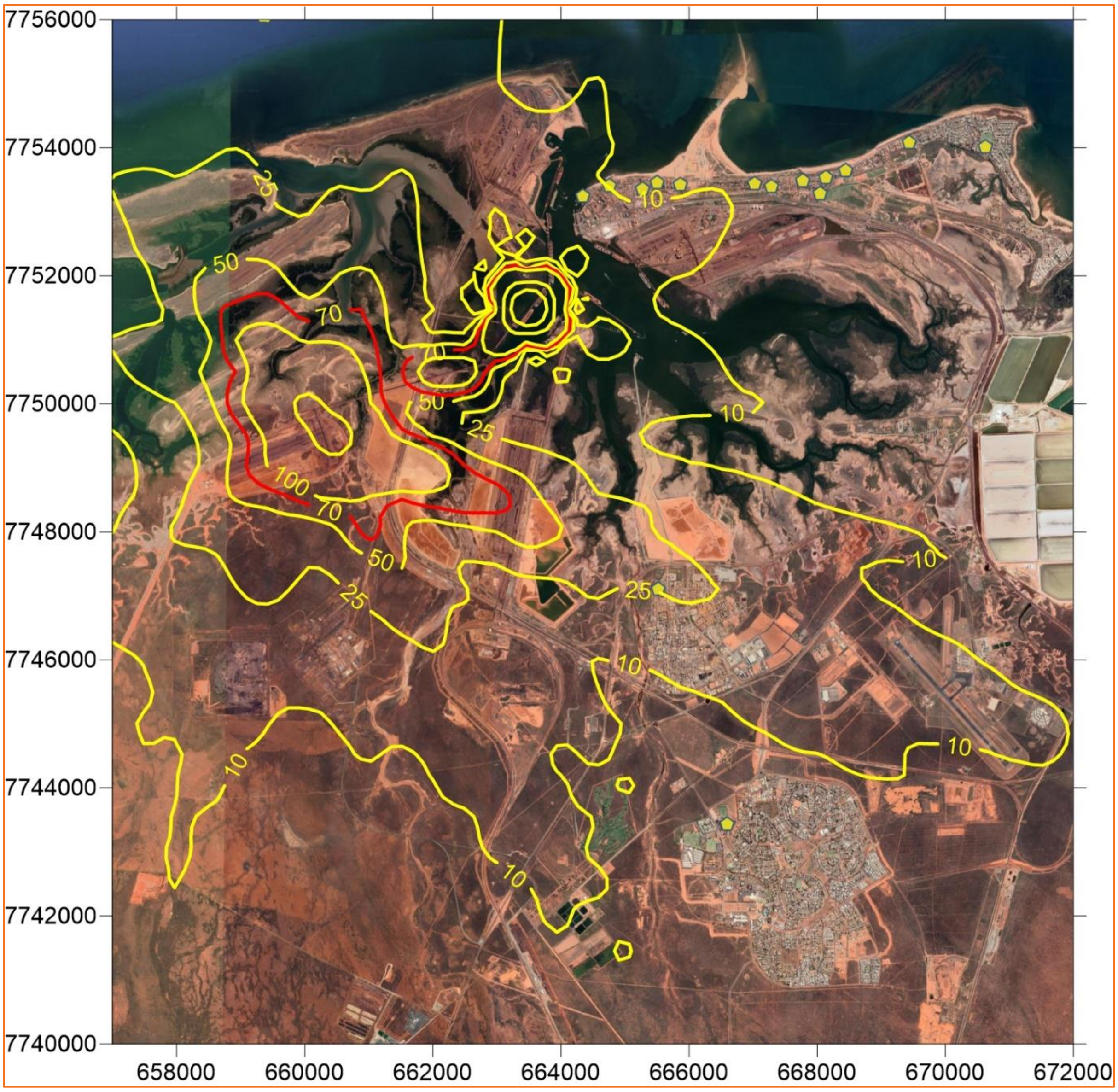


**Figure 4-1: Maximum 24-hour $PM_{10}$ concentrations for Roy Hill at 70 Mtpa (µg/m$^3$)**

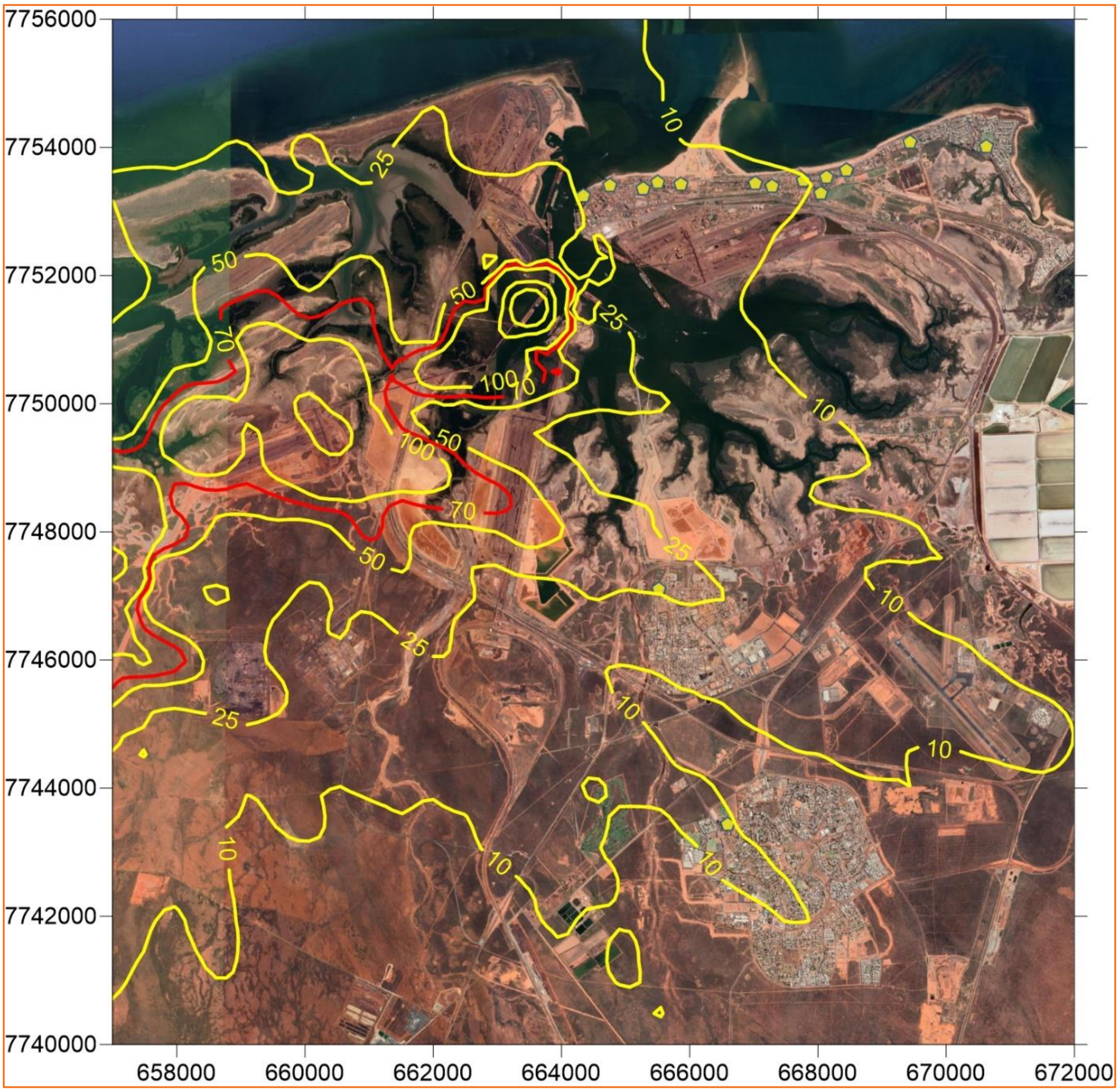


**Figure 4-2: Maximum 24-hour $PM_{10}$ concentrations for Roy Hill at 70 Mtpa and the NWI 50 Mtpa scenario ($\mu g/m^3$)**

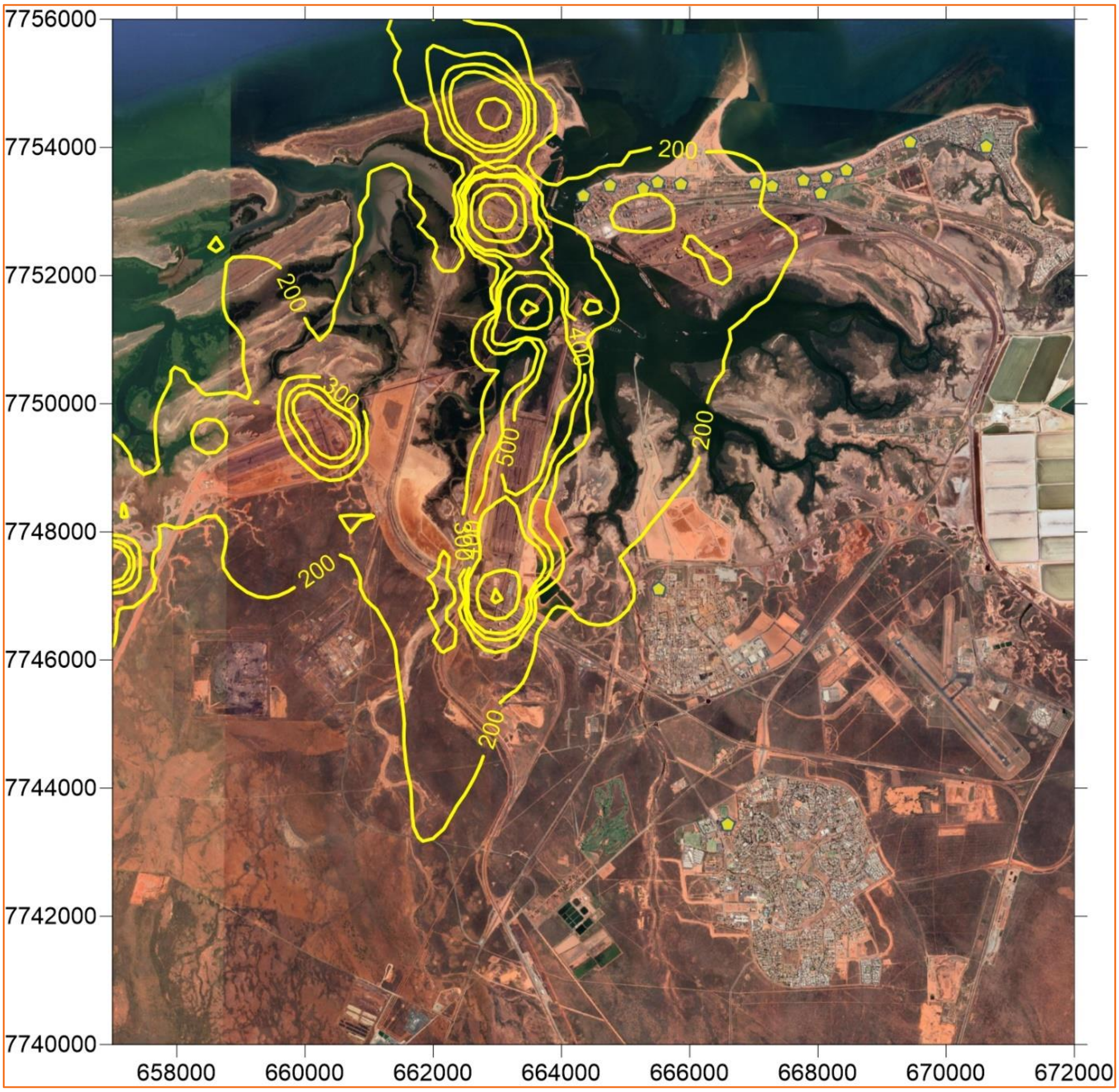


**Figure 4-3: Maximum 24-hour $PM_{10}$ concentrations for Roy Hill (70 Mtpa) and NWI (50 Mtpa) with CAM cumulative – including background ($\mu g/m^3$)**

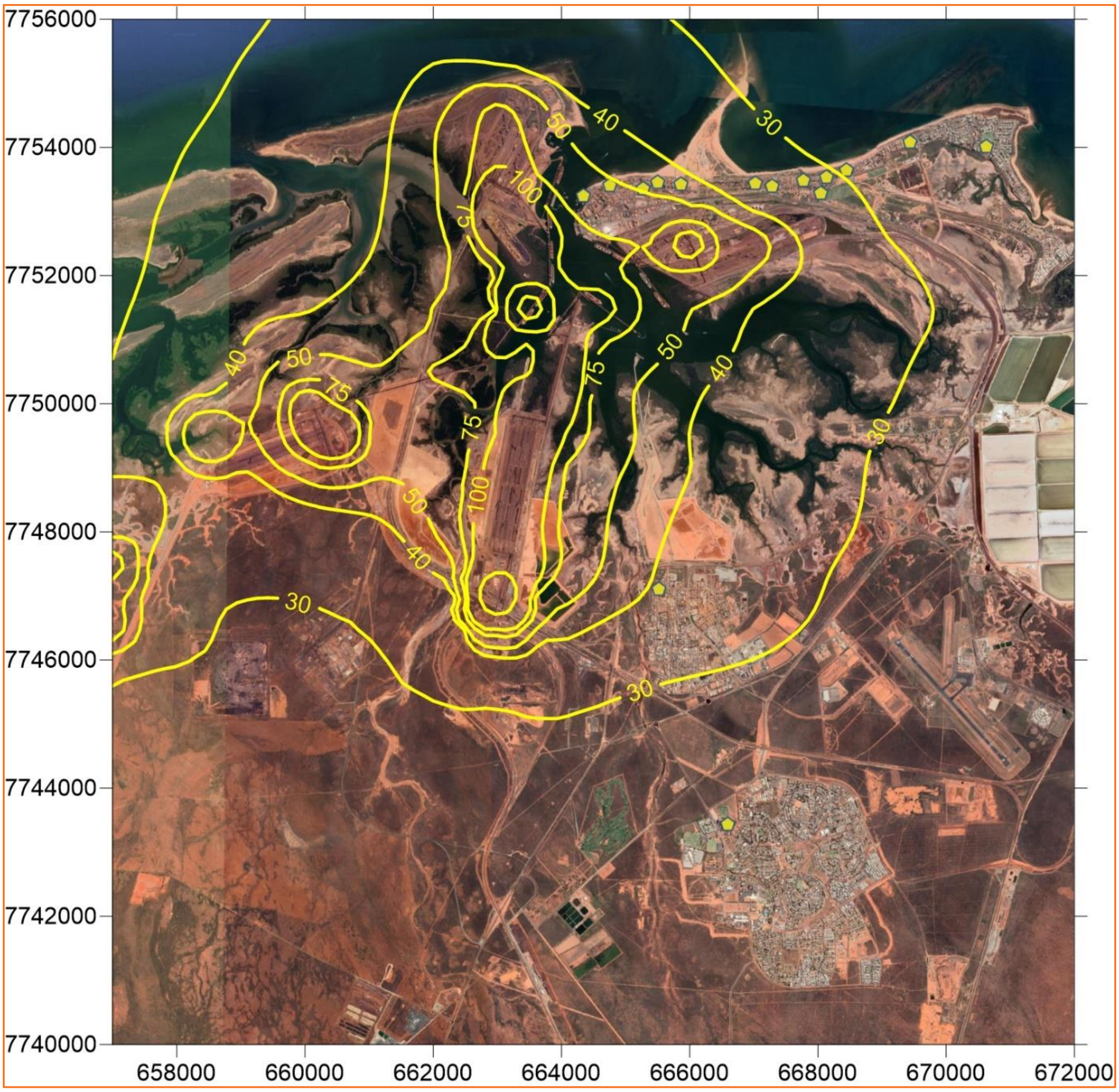


**Figure 4-4: Annual Average $PM_{10}$ concentrations for Roy Hill (70 Mtpa) and NWI (50 Mtpa) with CAM cumulative – including background (µg/m³)**

## 4.2 Expansion Scenario - 110 Mtpa (Roy Hill) in isolation and cumulative

For reference purposes the predicted ground level concentrations at the Taplin Street receptor, for the Roy Hill operations at 110 Mtpa, are presented in Table 4-2. This table presents the results for Roy Hill as a standalone operation (without background) as predicted for the 110 Mtpa scenario and cumulatively with approved operations in the airshed (Section 3.4).

The predicted results at all receptors in the region are contained in Appendix E.

The results of the increased throughput (expansion scenario) modelling, when compared to the base 70 Mtpa scenario (with NWI at 50 Mtpa), indicate that:

- On a standalone basis:
  - The model is predicting a decrease of 1 µg/m³ in the maximum ground level concentration at Taplin St.
  - The model is predicting a decrease of 0.3 µg/m³ in the annual average concentration at Taplin St.
  - The modelling also indicates that there will be reductions in the predicted ground level concentrations at other receptors within Port Hedland including those west of Taplin St including the Richardson St and Kingsmill St receptors.
- For the cumulative scenario:
  - There is no predicted change to the maximum concentration at Taplin St.
  - There is a predicted reduction in the lower percentile concentrations at Taplin St, including the annual average, though this is likely due to changes at the BHP operations (DWER, 2021b).
  - There will be a reduction in the number of excursions of the criteria at the Taplin St receptor, though this likely due to changes at the BHP operations (DWER, 2021b).

**Table 4-2: Predicted 24-hour ground level concentrations of $PM_{10}$ at Taplin St for Roy Hill – 110 Mtpa**

| Statistic | Roy Hill – no background (µg/m³) | Cumulative – with background (µg/m³) |
|---|---|---|
| Maximum | 11 | 200 |
| 99th percentile | 7 | 72 |
| 95th percentile | 4 | 56 |
| 90th percentile | 3 | 51 |
| 75th percentile | 2 | 43 |
| Average | 1.2 | 34.1 |
| Count >70 µg/m³ | 0 | 7 |

The isopleths for the predicted maximum $PM_{10}$ 24-hour concentrations for the Roy Hill operations at 110 Mtpa, without background, are presented in Figure 4-5. The isopleths for the cumulative predicted maximum $PM_{10}$ 24-hour concentrations (including background) are presented in Figure 4-6 while the isopleths for the $PM_{10}$ annual average concentrations from the cumulative scenario is presented in Figure 4-7.

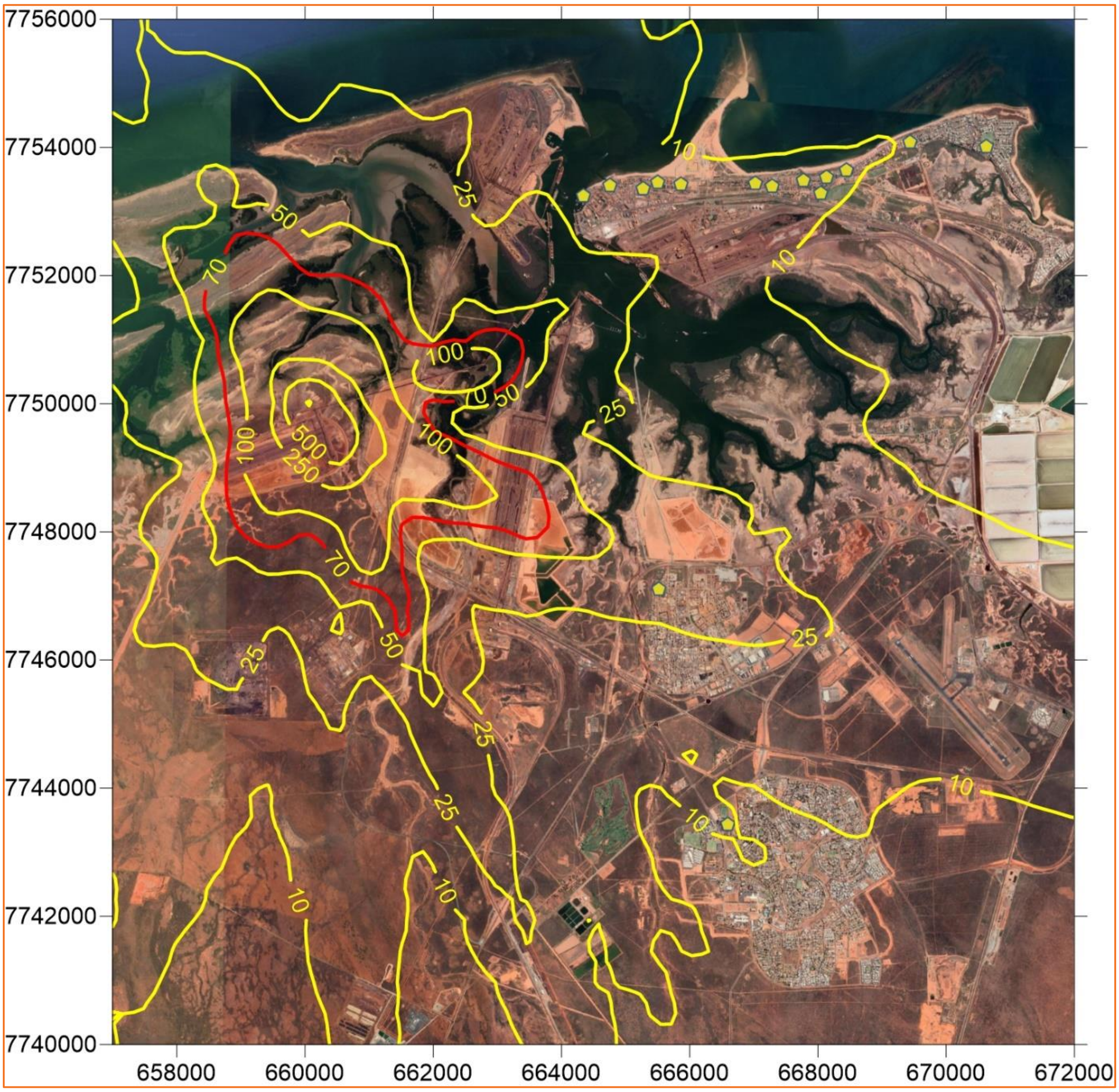


**Figure 4-5: Maximum 24-hour $PM_{10}$ concentrations for Roy Hill at 110 Mtpa ($\mu g/m^3$)**

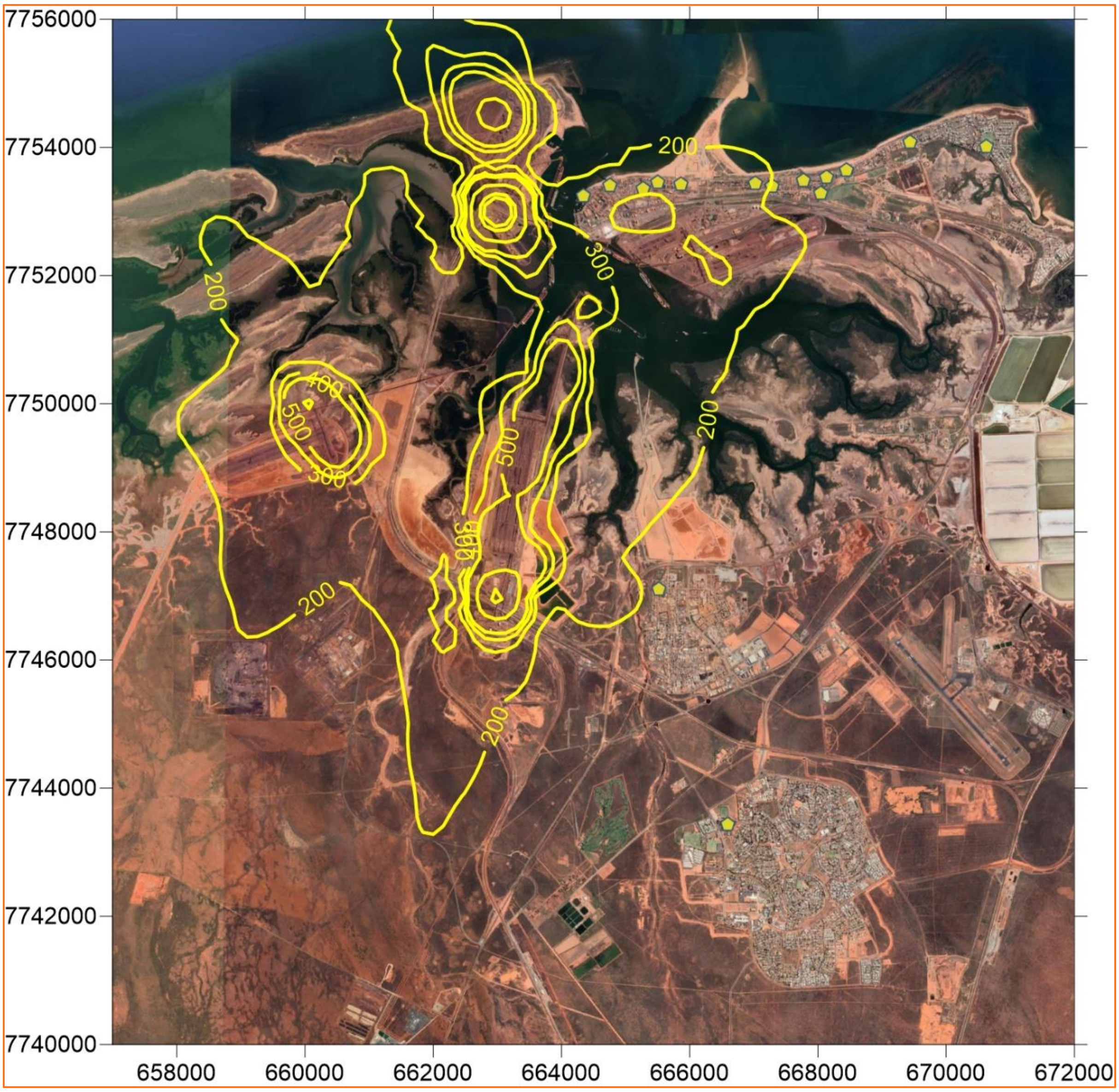


**Figure 4-6: Maximum 24-hour $PM_{10}$ concentrations for Roy Hill (110 Mtpa) with CAM cumulative – including background (µg/m$^3$)**

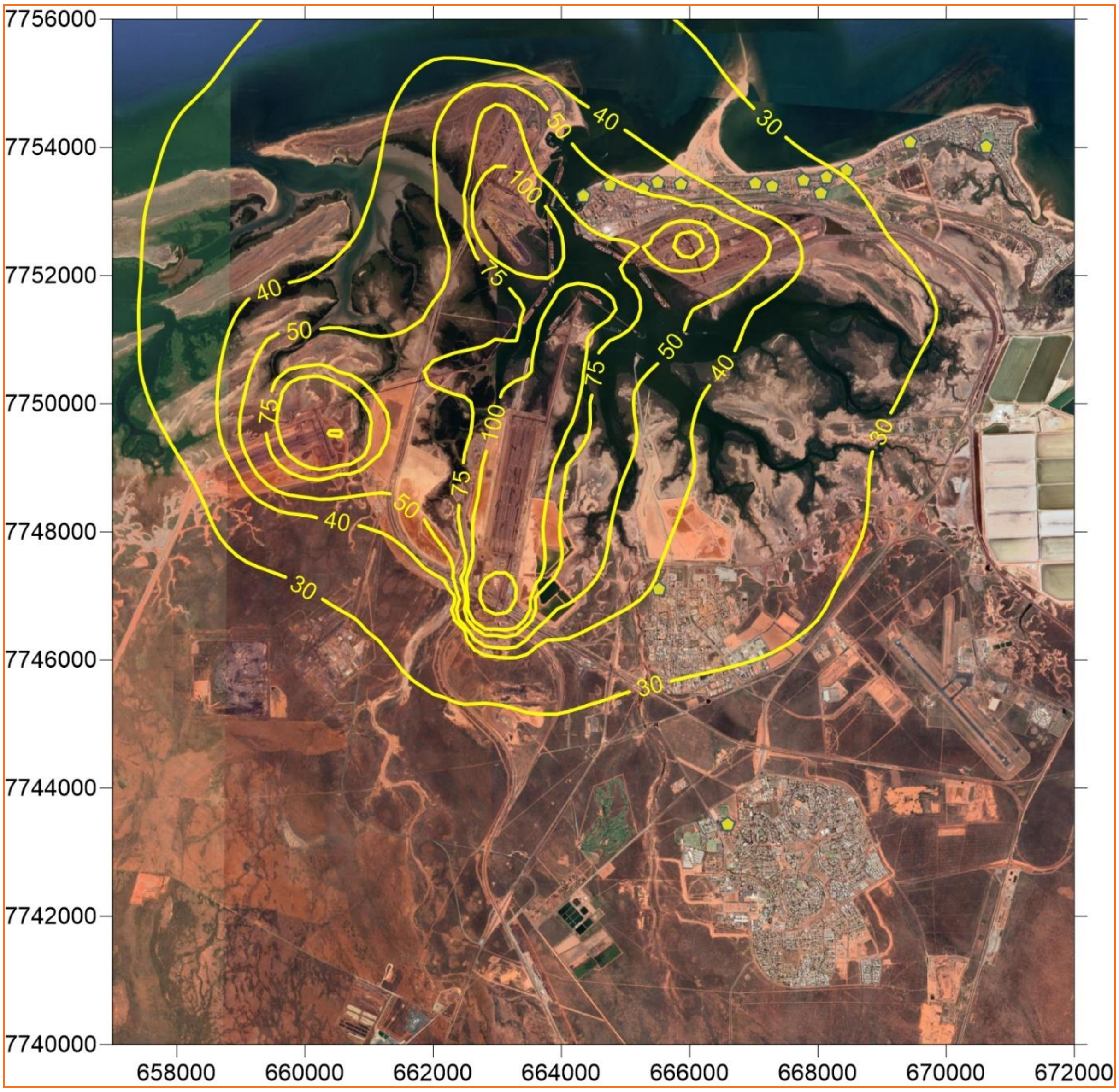


**Figure 4-7: Annual Average $PM_{10}$ concentrations for Roy Hill (110 Mtpa) with CAM cumulative – including background (µg/m$^3$)**

# 5 Conclusions

Roy Hill own, and operate, an integrated mining, rail and port operation in the Pilbara region of Western Australia. The Roy Hill Port operations located with the Port Hedland region consist of car dumping, stockpiling, reclaiming and ship loading facilities. These port operations are in close proximity to the town of Port Hedland and other ore handling and export operations.

Roy Hill is proposing to increase their export capacity from 70 Mtpa to 110 Mtpa by the addition of the following infrastructure:

- Inload circuit:
    - Car dumper
    - Stacker
    - Associated conveyors and transfer stations
- Outload circuit:
    - Reclaimer
    - Surge bin
    - Shiploader
    - Associated conveyors and transfer stations.

As the additional infrastructure will support the development of the SP3 berth in South West Creek, it will supersede the proposed development by NWI. It is therefore appropriate for the NWI to be removed as an emissions source from within the PHIC CAM as retaining the superseded NWI would lead to a duplication.

As part of the approval process for this tonnage increase Roy Hill contracted ETA to undertake atmospheric dispersion modelling of both the existing and proposed tonnage scenarios for the Roy Hill Port operations. For this assessment emission estimation for the Roy Hill (and similar) and MRL products was undertaken using source specific emission factors. Emission reductions were applied (in the Base case scenario) for the installation of a BWS at the head of conveyor CVR121 using source derived abatement for the fines products (works completed by Roy Hill but not previously included in the model). For the expansion scenario a BWS is proposed at the head of conveyor CVR105.

Modelling was undertaken using the atmospheric dispersion AERMOD configured in accordance with the work undertaken as part of the PHIC CAM including meteorology, receptors, background concentrations and existing and approved operations in the region.

Modelling was undertaken for two scenarios:

- Base case – 70 Mtpa in isolation of other sources and cumulative
- Expansion scenario – 110 Mtpa (Roy in isolation of other sources and cumulative.

The results of the modelling, for the Roy Hill expansion scenario, at the Taplin St receptor, predict for the:

- Standalone scenario (i.e. Roy Hill operations with increased throughput, and in isolation of other emission sources):
    - There is a predicted decrease of 1 µg/m$^3$ in the maximum predicted ground level concentration at Taplin St.
    - The model is predicting a decrease of 0.3 µg/m$^3$ in the annual average concentration at Taplin St.

    - The modelling also indicates that there will be reductions in the predicted ground level concentrations at other receptors within Port Hedland including those west of Taplin St including the Richardson St and Kingsmill St receptors.
- For the cumulative scenario (i.e. Roy Hill operations with increased throughput, in conjunction with other emission sources):
    - There is no predicted change to the maximum concentration at Taplin St.
    - There is a predicted reduction in the lower percentile concentrations at Taplin St, including the annual average, though this is likely due to changes with the PHIC CAM cumulative sources rather than the Roy Hill emission sources.
    - There is a predicted reduction in the number of excursions of the criteria at the Taplin St receptor, though this likely attributable to changes with the PHIC CAM cumulative sources rather than the Roy Hill emission sources.

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# 7 Acronyms and Glossary

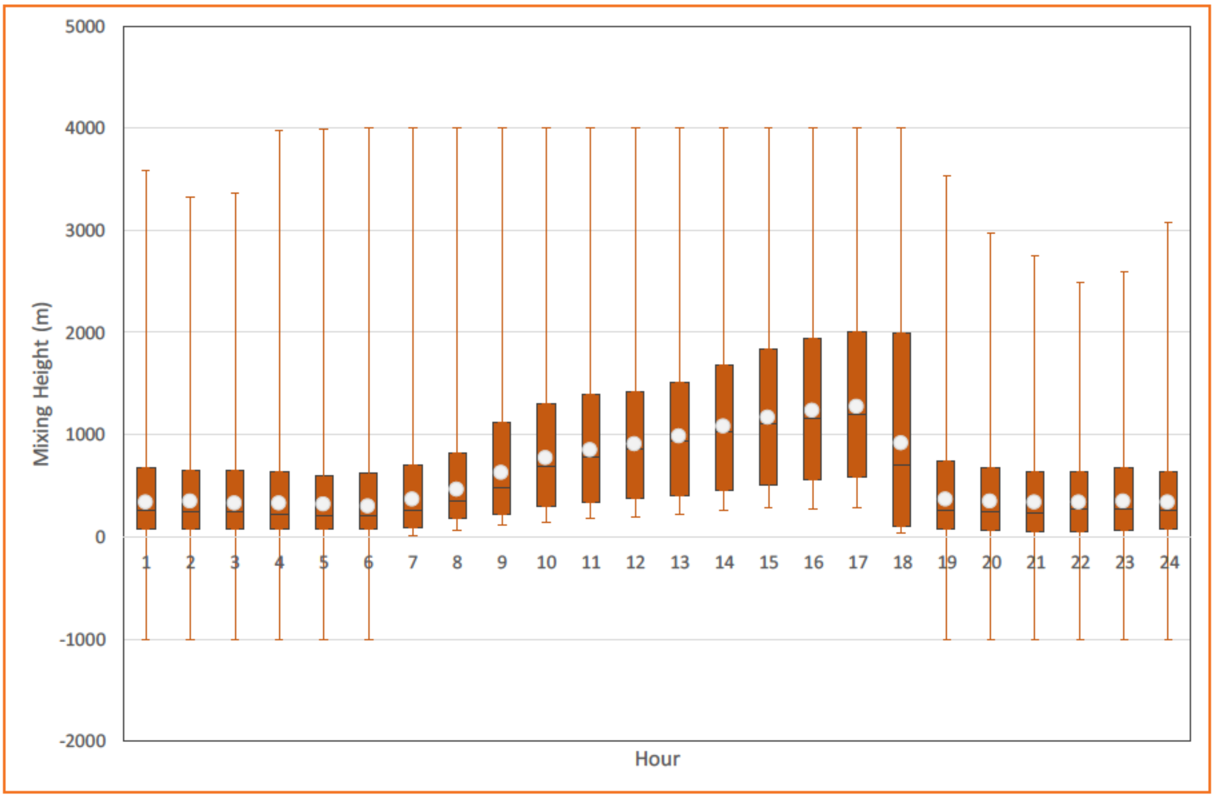
| Acronym | Description |
|---|---|
| AGV | Air guideline value |
| BWS | Belt wash station |
| CAM | Cumulative Air Model |
| CVR | Conveyor |
| DEM | Dust Extinction Moisture |
| DER | Department of Environment Regulation (now DWER) |
| DoE | Department of Environment (now DWER) |
| DSD | Department of State Development |
| DWER | Department of Water and Environmental Regulation |
| EE | Emissions estimation |
| EET | Emissions Estimation Technique |
| EF | Emission factor |
| EPAV | Environmental Protection Authority Victoria, Australia |
| ETA | Environmental Technologies& Analytics Pty Ltd |
| FEL | Front end loader |
| Fortescue | Fortescue Metals Group |
| FY | Financial Year |
| GLC | Ground Level Concentration |
| $g/m^2$ | grams per square metre |
| g/s | grams per second |
| h/yr | Hours per year |
| kg | kilogram |
| kg/ha/hr | kilograms per hectare per hour |
| kg/t | kilogram per tonne |
| kg/yr | kilograms per year |
| km | kilometre |
| m | metre |
| m/s | metres per second |
| mm | millimetre |
| MRL | Mineral Resources Limited |
| Mt | Million tonnes |
| Mtpa | Million tonnes per annum |
| NEPC | National Environment Protection Council |
| NEPM | National Environment Protection Measure |
| NPI | National Pollutant Inventory |
| NSW | New South Wales |
| NWI | North West Infrastructure |
| PHIC | Port Hedland Industries Council |
| PM | Particulate matter, small particles and liquid droplets that can remain suspended in air. |
| $PM_{10}$ | Particulate matter with an aerodynamic diameter of 10 µm or less. |
| $PM_{2.5}$ | Particulate matter with an aerodynamic diameter of 2.5 µm or less. |
| PPA | Pilbara Ports Authority |
| Roy Hill | Roy Hill Holdings Pty Ltd |
| RSF | Rescreened fines |
| t | Tonnes |
| t/h | Tonnes per hour |
| tpa | tonnes per annum |
| tph | tonnes per hour |
| TS | Transfer station |
| TSP | Total suspended particulates |
| $\mu g/m^3$ | micro grams (one millionth of a gram) per cubic metre |
| µm | micrometre |

# 8 Appendices

# Appendix A – PHIC CAM Meteorology

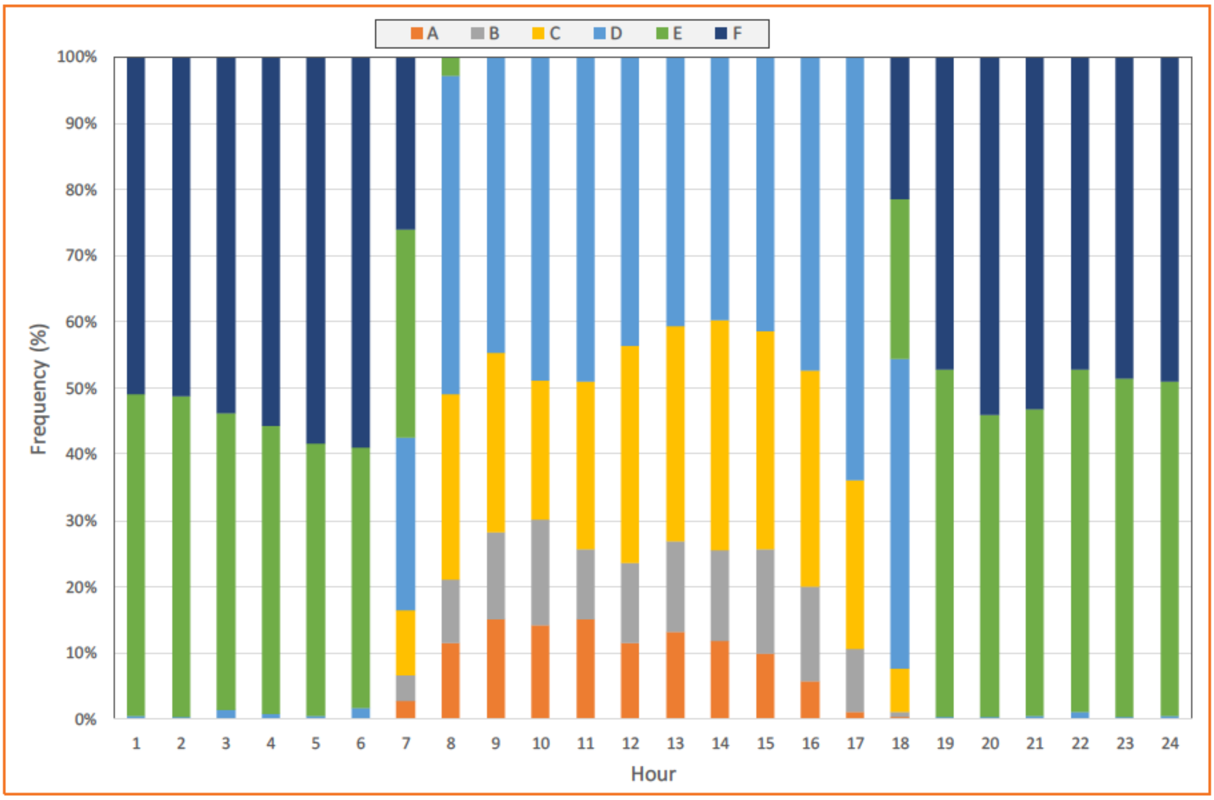
The full details on the meteorological file used in the assessment are contained in the PHIC CAM model comparison report (PEL, 2015). The following sections broadly outline the characteristics of the PHIC CAM meteorological file.

The diurnal statistics of the mixing height are presented in Appendix Figure 1. From this figure it is apparent that there is a gradual increase during the day followed by a marked decline in the average mixing height in the late afternoon. This decrease is due to the transition from convective to mechanical mixing.

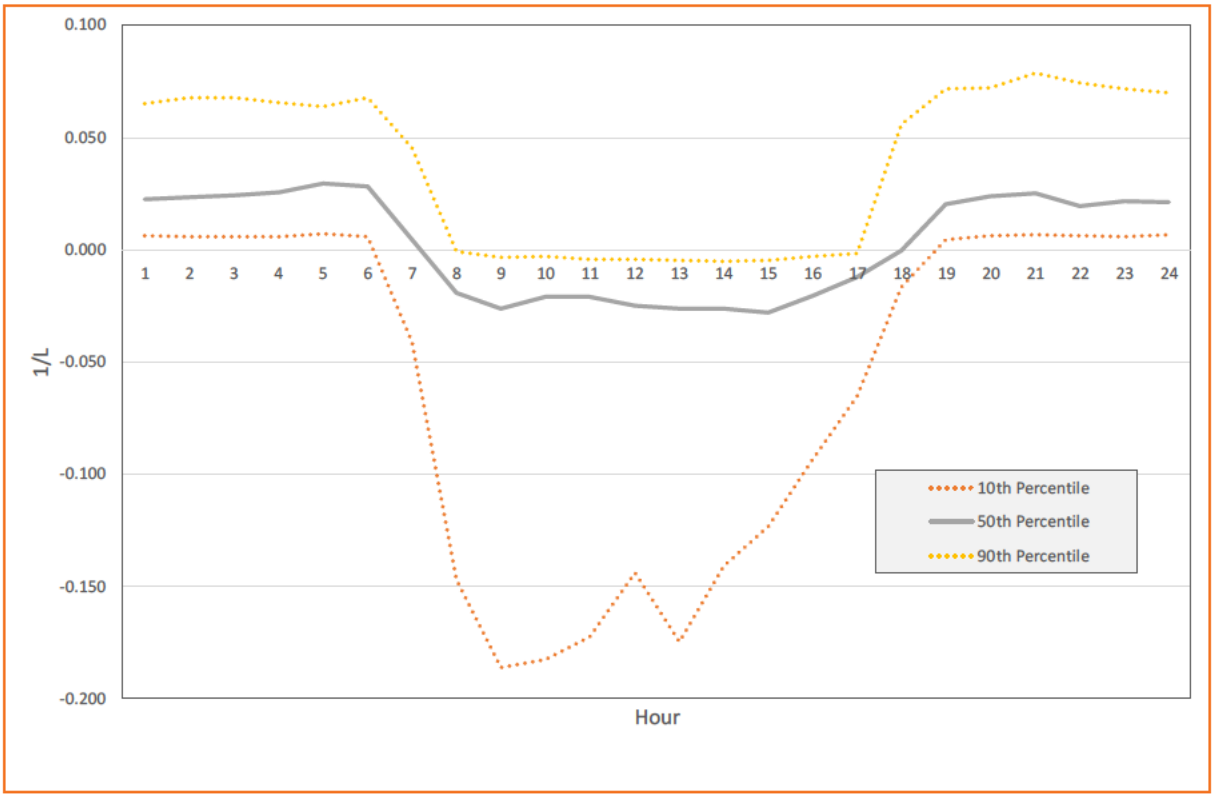



**Appendix Figure 1: AERMET mixing height for the PHIC CAM**

A plot of the atmospheric stability, by hour of the day, is presented in Appendix Figure 2. The profile shows that neutral (D) and unstable (A – C) atmospheric conditions occur during the daytime, with the night dominated by stable conditions (E – F). This is further confirmed in Appendix Figure 3 which shows the statistics, by hour of the day, of the Monin-Obukhov length.




**Appendix Figure 2: Golder plot of stability classes by time of day**




**Appendix Figure 3: Hourly statistics of the Monin-Obukhov length**

# Appendix B – Emission Parameters

**Appendix Table 1: Emission source parameters**

| ID | Easting (m) | Northing (m) | Height (m) | Sigma Y (m) | Sigma Z (m) |
|---|---|---|---|---|---|
| CDU101 | 659950 | 7749710 | 1.75 | 3 | 0.8 |
| CVR104 | 660086 | 7749736 | 1.5 | 3 | 0.7 |
| TS1 | 660117 | 7749746 | 5 | 2 | 2.3 |
| CVR105 | 660190 | 7749550 | 5 | 12 | 2.3 |
| TS2 | 660176 | 7749586 | 5 | 2 | 2.3 |
| CVR111 | 659637 | 7749390 | 1.5 | 140 | 0.7 |
| STK1 | 659605 | 7749375 | 8 | 138 | 3.7 |
| TS3 | 660226 | 7749455 | 5 | 2 | 2.3 |
| CVR113a | 659741 | 7749267 | 8 | 70 | 3.7 |
| CVR113b | 659104 | 7749028 | 8 | 70 | 3.7 |
| STK2 | 659045 | 7749020 | 8 | 138 | 3.7 |
| REC1 | 659370 | 7749215 | 5 | 137 | 2.3 |
| CVR116 | 659815 | 7749370 | 5 | 140 | 2.3 |
| TS4 | 660287 | 7749555 | 5 | 2 | 2.3 |
| CVR121 | 660336 | 7749404 | 10 | 23 | 4.7 |
| LRP | 660429 | 7749206 | 5 | 12 | 2.3 |
| CVR123 | 660356 | 7749388 | 5 | 12 | 2.3 |
| CVR124 | 660294 | 7749544 | 5 | 12 | 2.3 |
| TS13 | 660295 | 7749554 | 5 | 2 | 2.3 |
| TS10 | 660267 | 7749619 | 5 | 2 | 2.3 |
| TS11 | 660316 | 7749486 | 5 | 2 | 2.3 |
| CVR122 | 660259 | 7749661 | 5 | 3 | 2.3 |
| TS5 | 660168 | 7749904 | 5 | 2 | 2.3 |
| CVR161a | 660615 | 7750026 | 1.5 | 35 | 0.7 |
| CVR161b | 661019 | 7750135 | 1.5 | 35 | 0.7 |
| CVR161c | 661503 | 7750276 | 1.5 | 35 | 0.7 |
| CVR161d | 661989 | 7750407 | 1.5 | 35 | 0.7 |
| CVR161e | 662397 | 7750517 | 1.5 | 35 | 0.7 |
| TS6 | 662795 | 7750631 | 10 | 2 | 2.3 |
| CVR162 | 663000 | 7750897 | 15 | 23 | 0.7 |
| TS12 | 663266 | 7751261 | 15 | 2 | 2.3 |
| CVR163 | 663291 | 7751243 | 15 | 2 | 4.7 |
| TS7 | 663321 | 7751219 | 15 | 2 | 2.3 |
| CVR164 | 663528 | 7751492 | 15 | 12 | 0.7 |
| SL1 | 663465 | 7751388 | 20 | 12 | 0.8 |
| STKWE1 | 659863 | 7749355 | 8 | 25 | 3.7 |
| STKWE2 | 659320 | 7749145 | 8 | 25 | 3.7 |
| STKWE3 | 658915 | 7748988 | 8 | 25 | 3.7 |
| STKWE4 | 658965 | 7749093 | 8 | 25 | 3.7 |
| OPWE1 | 660288 | 7749157 | 0.5 | 70 | 0.2 |
| OPWE2 | 660205 | 7749667 | 0.5 | 70 | 0.2 |
| CDU201 | 659810 | 7749760 | 1.75 | 3 | 0.8 |
| CVR499 | 660035 | 7749815 | 1.5 | 3 | 0.7 |
| TS100 | 660065 | 7749825 | 5 | 2 | 2.3 |
| CVR500a | 660137 | 7749633 | 5 | 12 | 2.3 |

| ID | Easting (m) | Northing (m) | Height (m) | Sigma Y (m) | Sigma Z (m) |
|---|---|---|---|---|---|
| CVR500b | 660193 | 7749476 | 5 | 12 | 2.3 |
| TS103 | 660264 | 7749300 | 5 | 2 | 2.3 |
| CVR114a | 659865 | 7749145 | 1.5 | 70 | 3.7 |
| CVR114b | 659177 | 7748885 | 1.5 | 70 | 3.7 |
| STK3 | 659584 | 7749041 | 8 | 138 | 3.7 |
| REC2 | 659712 | 7749165 | 5 | 137 | 2.3 |
| CVR117a | 659325 | 7749021 | 1.5 | 70 | 3.7 |
| CVR117b | 660070 | 7749310 | 1.5 | 70 | 3.7 |
| TS180 | 660440 | 7749450 | 5 | 2 | 2.3 |
| CVR265a | 660385 | 7749605 | 5 | 12 | 2.3 |
| CVR265b | 660325 | 7749765 | 5 | 12 | 2.3 |
| SB1 | 660270 | 7749905 | 5 | 2 | 2.3 |
| TS181 | 660260 | 7749930 | 5 | 2 | 2.3 |
| CVR171A | 660826 | 7750085 | 1.5 | 35 | 0.7 |
| CVR171B | 661290 | 7750215 | 1.5 | 35 | 0.7 |
| CVR171C | 661805 | 7750359 | 1.5 | 35 | 0.7 |
| CVR171D | 662215 | 7750475 | 1.5 | 35 | 0.7 |
| CVR171E | 662589 | 7750570 | 1.5 | 35 | 0.7 |
| TS182 | 662895 | 7750655 | 5 | 2 | 2.3 |
| CVR172 | 663070 | 7750882 | 10 | 12 | 0.7 |
| SL2 | 663245 | 7751060 | 20 | 12 | 0.8 |
| STKWE5 | 659852 | 7749267 | 8 | 25 | 3.7 |
| STKWE6 | 659114 | 7748988 | 8 | 25 | 3.7 |
| STKWE7 | 658963 | 7748846 | 8 | 25 | 3.7 |
| STKWE8 | 659682 | 7749119 | 8 | 25 | 3.7 |
| OPWE3 | 660184 | 7749333 | 0.5 | 70 | 0.2 |

**Appendix Table 2: Emission parameters: vehicle sources**

| ID | Easting (m) | Northing (m) | Height (m) | Sigma Y (m) | Sigma Z (m) |
|---|---|---|---|---|---|
| Veh1 | 658659 | 7748859 | 1.7 | 12.5 | 1.58 |
| Veh2 | 658619 | 7748911 | 1.7 | 12.5 | 1.58 |
| Veh3 | 658601 | 7748981 | 1.7 | 12.5 | 1.58 |
| Veh4 | 658628 | 7749041 | 1.7 | 12.5 | 1.58 |
| Veh5 | 658697 | 7749089 | 1.7 | 12.5 | 1.58 |
| Veh6 | 658795 | 7749147 | 1.7 | 12.5 | 1.58 |
| Veh7 | 658883 | 7749182 | 1.7 | 12.5 | 1.58 |
| Veh8 | 658985 | 7749220 | 1.7 | 12.5 | 1.58 |
| Veh9 | 659095 | 7749264 | 1.7 | 12.5 | 1.58 |
| Veh10 | 659197 | 7749309 | 1.7 | 12.5 | 1.58 |
| Veh11 | 659298 | 7749368 | 1.7 | 12.5 | 1.58 |
| Veh12 | 659413 | 7749413 | 1.7 | 12.5 | 1.58 |
| Veh13 | 659522 | 7749453 | 1.7 | 12.5 | 1.58 |
| Veh14 | 659643 | 7749502 | 1.7 | 12.5 | 1.58 |
| Veh15 | 659746 | 7749537 | 1.7 | 12.5 | 1.58 |
| Veh16 | 659828 | 7749563 | 1.7 | 12.5 | 1.58 |
| Veh17 | 659924 | 7749598 | 1.7 | 12.5 | 1.58 |
| Veh18 | 660013 | 7749620 | 1.7 | 12.5 | 1.58 |
| Veh19 | 660186 | 7749476 | 1.7 | 12.5 | 1.58 |

| ID | Easting (m) | Northing (m) | Height (m) | Sigma Y (m) | Sigma Z (m) |
|---|---|---|---|---|---|
| Veh20 | 658750 | 7748623 | 1.7 | 12.5 | 1.58 |
| Veh21 | 658948 | 7748597 | 1.7 | 12.5 | 1.58 |
| Veh22 | 659159 | 7748627 | 1.7 | 12.5 | 1.58 |
| Veh23 | 659358 | 7748670 | 1.7 | 12.5 | 1.58 |
| Veh24 | 659553 | 7748710 | 1.7 | 12.5 | 1.58 |
| Veh25 | 659751 | 7748749 | 1.7 | 12.5 | 1.58 |
| Veh26 | 659946 | 7748793 | 1.7 | 12.5 | 1.58 |
| Veh27 | 660153 | 7748840 | 1.7 | 12.5 | 1.58 |
| Veh28 | 660346 | 7748882 | 1.7 | 12.5 | 1.58 |
| Veh29 | 660522 | 7748981 | 1.7 | 12.5 | 1.58 |
| Veh30 | 660625 | 7749152 | 1.7 | 12.5 | 1.58 |
| Veh31 | 660663 | 7749356 | 1.7 | 12.5 | 1.58 |
| Veh32 | 660606 | 7749549 | 1.7 | 12.5 | 1.58 |
| Veh33 | 660464 | 7749588 | 1.7 | 12.5 | 1.58 |
| Veh34 | 660382 | 7749455 | 1.7 | 12.5 | 1.58 |
| Veh35 | 660454 | 7749255 | 1.7 | 12.5 | 1.58 |
| Veh36 | 660437 | 7749067 | 1.7 | 12.5 | 1.58 |
| Veh37 | 660347 | 7749261 | 1.7 | 12.5 | 1.58 |
| Veh38 | 658234 | 7748646 | 1.7 | 12.5 | 1.58 |
| Veh39 | 658338 | 7748857 | 1.7 | 12.5 | 1.58 |
| Veh40 | 658494 | 7749042 | 1.7 | 12.5 | 1.58 |
| Veh41 | 658697 | 7749172 | 1.7 | 12.5 | 1.58 |
| Veh42 | 658919 | 7749271 | 1.7 | 12.5 | 1.58 |
| Veh43 | 659136 | 7749369 | 1.7 | 12.5 | 1.58 |
| Veh44 | 659362 | 7749465 | 1.7 | 12.5 | 1.58 |
| Veh45 | 659579 | 7749563 | 1.7 | 12.5 | 1.58 |
| Veh46 | 659796 | 7749661 | 1.7 | 12.5 | 1.58 |
| Veh47 | 659973 | 7749835 | 1.7 | 12.5 | 1.58 |
| Veh48 | 660169 | 7749896 | 1.7 | 12.5 | 1.58 |
| Veh49 | 658393 | 7748637 | 1.7 | 12.5 | 1.58 |
| Veh50 | 658592 | 7748683 | 1.7 | 12.5 | 1.58 |

# Appendix C – Emission Factors

**Appendix Table 3: Estimated source emission factors for Roy Hill products (kg/t)**

| Source | Name | Emission Factors (kg/t) | | Comment |
|---|---|---|---|---|
| | | Lump | Fines | |
| Car dumper | CDU101 | 0.002 | 0.002 | NPI with 99% reduction for enclosure and extraction |
| Conveyor | CVR104 | 0.00021 | 0.00019 | Site specific |
| Transfer station | TS1 | 0.002 | 0.002 | NPI with 70% reduction for enclosure |
| Conveyor | CVR105 | 0.0009 | 0.0008 | Site specific |
| Transfer station | TS2 | 0.002 | 0.002 | NPI with 70% reduction for enclosure |
| Conveyor | CVR111 | 0.00025 | 0.00009 | Site specific |
| Stacker | STK1 | 0.0004 | 0.0001 | Site specific |
| Transfer station | TS3 | 0.002 | 0.002 | NPI with 70% reduction for enclosure |
| Conveyor | CVR113 | 0.00025 | 0.00009 | Site specific |
| Stacker | STK2 | 0.0004 | 0.0001 | Site specific |
| Reclaimer | REC1 | 0.00025 | 0.00016 | Site specific |
| Conveyor | CVR116 | 0.0003 | 0.0004 | Site specific |
| Transfer station | TS4 | 0.00007 | 0.00003 | Site specific |
| Conveyor | CVR121 | 0.0022 | 0.0011 | Site specific |
| Screen & bin facility | LRP | 0.002 | 0.002 | NPI with 90% reduction for enclosure and extraction |
| Conveyor | CVR123 | 0.002 | 0.002 | NPI with 80% reduction BWS |
| Conveyor | CVR124 | 0.002 | 0.002 | NPI with 80% reduction BWS |
| Transfer station | TS13 | 0.00007 | 0.00003 | Site specific |
| Transfer station | TS10 | 0.00007 | 0.00003 | Site specific |
| Transfer station | TS11 | 0.00007 | 0.00003 | Site specific |
| Conveyor | CVR122 | 0.0007 | 0.0009 | Site specific |
| Transfer station | TS5 | 0.00007 | 0.00003 | Site specific |
| Conveyor | CVR161 | 0.0007 | 0.0003 | Site specific |
| Transfer station | TS6 | 0.00007 | 0.00003 | Site specific |
| Conveyor | CVR162 | 0.0002 | 0.0001 | Site specific |
| Transfer station | TS12 | 0.00007 | 0.00003 | Site specific |
| Conveyor | CVR163 | 0.00002 | 0.00001 | Site specific |
| Transfer station | TS7 | 0.00007 | 0.00003 | Site specific |
| Conveyor | CVR164 | 0.002 | 0.002 | NPI with 80% reduction BWS |
| Shiploader | SL1 | 0.0004 | 0.0001 | Site specific |
| Stockpile wind erosion | STKWE1 | N/A | N/A | Modified Shao equation |

| Source | Name | Emission Factors (kg/t) | | Comment |
|---|---|---|---|---|
| | | Lump | Fines | |
| Stockpile wind erosion | STKWE2 | N/A | N/A | Modified Shao equation |
| Stockpile wind erosion | STKWE3 | N/A | N/A | Modified Shao equation |
| Stockpile wind erosion | STKWE4 | N/A | N/A | Modified Shao equation |
| Open area wind erosion | OPWE1 | N/A | N/A | Modified Shao equation |
| Open area wind erosion | OPWE2 | N/A | N/A | Modified Shao equation |

# Appendix D – Emission Rates

**Appendix Table 4: Emission statistics for 70 Mtpa scenario (g/s)**

| ID | Maximum | 99th Percentile | 95th Percentile | 90th Percentile | 70th Percentile | Average |
|---|---|---|---|---|---|---|
| CDU101 | 0.07 | 0.07 | 0.07 | 0.07 | 0.07 | 0.04 |
| CVR104 | 0.70 | 0.70 | 0.70 | 0.70 | 0.63 | 0.44 |
| TS1 | 2.00 | 2.00 | 2.00 | 2.00 | 2.00 | 1.33 |
| CVR105 | 3.00 | 3.00 | 3.00 | 3.00 | 2.67 | 1.86 |
| TS2 | 2.00 | 2.00 | 2.00 | 2.00 | 2.00 | 0.69 |
| CVR111 | 0.83 | 0.83 | 0.83 | 0.30 | 0.30 | 0.16 |
| STK1 | 1.33 | 1.33 | 1.33 | 0.33 | 0.33 | 0.22 |
| TS3 | 2.00 | 2.00 | 2.00 | 2.00 | 2.00 | 0.64 |
| CVR113a | 0.42 | 0.42 | 0.42 | 0.42 | 0.15 | 0.09 |
| CVR113b | 0.42 | 0.42 | 0.42 | 0.42 | 0.15 | 0.09 |
| STK2 | 1.33 | 1.33 | 1.33 | 1.33 | 0.33 | 0.27 |
| REC1 | 0.90 | 0.90 | 0.90 | 0.90 | 0.60 | 0.50 |
| CVR116 | 1.08 | 1.08 | 1.08 | 1.08 | 0.00 | 0.31 |
| TS4 | 0.25 | 0.25 | 0.25 | 0.25 | 0.11 | 0.12 |
| CVR121 | 7.94 | 7.94 | 4.13 | 2.38 | 2.38 | 1.46 |
| LRP | 0.75 | 0.75 | 0.75 | 0.75 | 0.75 | 0.51 |
| CVR123 | 0.30 | 0.30 | 0.30 | 0.30 | 0.00 | 0.09 |
| CVR124 | 0.30 | 0.30 | 0.30 | 0.30 | 0.00 | 0.09 |
| TS13 | 0.45 | 0.45 | 0.45 | 0.45 | 0.00 | 0.13 |
| TS10 | 0.45 | 0.45 | 0.45 | 0.45 | 0.00 | 0.06 |
| TS11 | 0.45 | 0.45 | 0.45 | 0.45 | 0.00 | 0.06 |
| CVR122 | 3.25 | 3.25 | 3.25 | 3.25 | 3.25 | 1.82 |
| TS5 | 0.20 | 0.20 | 0.20 | 0.20 | 0.11 | 0.10 |
| CVR161A | 0.40 | 0.40 | 0.40 | 0.40 | 0.22 | 0.20 |
| CVR161B | 0.40 | 0.40 | 0.40 | 0.40 | 0.22 | 0.20 |
| CVR161C | 0.40 | 0.40 | 0.40 | 0.40 | 0.22 | 0.20 |
| CVR161D | 0.40 | 0.40 | 0.40 | 0.40 | 0.22 | 0.20 |
| CVR161E | 0.40 | 0.40 | 0.40 | 0.40 | 0.22 | 0.20 |
| TS6 | 0.20 | 0.20 | 0.20 | 0.20 | 0.11 | 0.10 |
| CVR162 | 0.57 | 0.57 | 0.57 | 0.57 | 0.36 | 0.30 |
| TS12 | 0.20 | 0.20 | 0.20 | 0.20 | 0.11 | 0.10 |
| CVR163 | 0.06 | 0.06 | 0.06 | 0.06 | 0.04 | 0.03 |
| TS7 | 0.20 | 0.20 | 0.20 | 0.20 | 0.11 | 0.10 |

| ID | Maximum | 99th Percentile | 95th Percentile | 90th Percentile | 70th Percentile | Average |
|---|---|---|---|---|---|---|
| CVR164 | 1.44 | 1.44 | 1.44 | 1.44 | 1.44 | 0.88 |
| SL1 | 1.14 | 1.14 | 1.14 | 1.14 | 0.36 | 0.47 |
| STKWE1 | 12.23 | 1.62 | 0.00 | 0.00 | 0.00 | 0.06 |
| STKWE2 | 6.20 | 0.82 | 0.00 | 0.00 | 0.00 | 0.03 |
| STKWE3 | 6.20 | 0.82 | 0.00 | 0.00 | 0.00 | 0.03 |
| STKWE4 | 6.20 | 0.82 | 0.00 | 0.00 | 0.00 | 0.03 |
| OPWE1 | 18.61 | 3.52 | 0.14 | 0.00 | 0.00 | 0.12 |
| OPWE2 | 23.55 | 4.45 | 0.17 | 0.00 | 0.00 | 0.15 |

**Appendix Table 5: Emission statistics for 110 Mtpa scenario (g/s)**

| ID | Maximum | 99th Percentile | 95th Percentile | 90th Percentile | 70th Percentile | Average |
|---|---|---|---|---|---|---|
| CDU101 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.04 |
| CVR104 | 0.64 | 0.64 | 0.64 | 0.64 | 0.58 | 0.37 |
| TS1 | 1.83 | 1.83 | 1.83 | 1.83 | 1.83 | 1.14 |
| CVR105 | 2.75 | 2.75 | 2.44 | 0.83 | 0.73 | 0.59 |
| TS2 | 1.83 | 1.83 | 1.83 | 1.83 | 1.83 | 0.76 |
| CVR111 | 0.76 | 0.76 | 0.00 | 0.00 | 0.00 | 0.02 |
| STK1 | 1.22 | 1.22 | 1.22 | 1.22 | 0.31 | 0.27 |
| TS3 | 1.83 | 1.83 | 1.83 | 1.83 | 1.83 | 0.76 |
| CVR113a | 0.38 | 0.38 | 0.38 | 0.38 | 0.14 | 0.10 |
| CVR113b | 0.38 | 0.38 | 0.38 | 0.38 | 0.14 | 0.10 |
| STK2 | 1.22 | 1.22 | 1.22 | 1.22 | 0.31 | 0.27 |
| REC1 | 0.94 | 0.94 | 0.94 | 0.94 | 0.60 | 0.37 |
| CVR116 | 1.50 | 1.50 | 1.50 | 1.50 | 1.13 | 0.60 |
| TS4 | 0.26 | 0.26 | 0.26 | 0.26 | 0.11 | 0.09 |
| CVR121 | 8.25 | 8.25 | 2.48 | 2.48 | 0.83 | 1.02 |
| LRP | 0.75 | 0.75 | 0.75 | 0.75 | 0.75 | 0.35 |
| CVR123 | 0.15 | 0.15 | 0.15 | 0.15 | 0.00 | 0.04 |
| CVR124 | 0.15 | 0.15 | 0.15 | 0.15 | 0.00 | 0.04 |
| TS13 | 0.23 | 0.23 | 0.23 | 0.23 | 0.00 | 0.06 |
| TS10 | 0.23 | 0.23 | 0.23 | 0.23 | 0.00 | 0.03 |
| TS11 | 0.23 | 0.23 | 0.23 | 0.23 | 0.00 | 0.03 |
| CVR122 | 3.38 | 3.38 | 3.38 | 3.38 | 3.38 | 1.47 |
| TS5 | 0.26 | 0.26 | 0.26 | 0.26 | 0.11 | 0.08 |
| CVR161A | 0.53 | 0.53 | 0.53 | 0.53 | 0.23 | 0.15 |
| CVR161B | 0.53 | 0.53 | 0.53 | 0.53 | 0.23 | 0.15 |
| CVR161C | 0.53 | 0.53 | 0.53 | 0.53 | 0.23 | 0.15 |

| ID | Maximum | 99th Percentile | 95th Percentile | 90th Percentile | 70th Percentile | Average |
|---|---|---|---|---|---|---|
| CVR161D | 0.53 | 0.53 | 0.53 | 0.53 | 0.23 | 0.15 |
| CVR161E | 0.53 | 0.53 | 0.53 | 0.53 | 0.23 | 0.15 |
| TS6 | 0.26 | 0.26 | 0.26 | 0.26 | 0.11 | 0.08 |
| CVR162 | 0.75 | 0.75 | 0.75 | 0.75 | 0.38 | 0.24 |
| TS12 | 0.26 | 0.26 | 0.26 | 0.26 | 0.11 | 0.08 |
| CVR163 | 0.08 | 0.08 | 0.08 | 0.08 | 0.04 | 0.02 |
| TS7 | 0.26 | 0.26 | 0.26 | 0.26 | 0.11 | 0.08 |
| CVR164 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 0.71 |
| SL1 | 2.81 | 2.81 | 2.81 | 2.81 | 0.38 | 0.57 |
| STKWE1 | 12.23 | 1.62 | 0.00 | 0.00 | 0.00 | 0.06 |
| STKWE2 | 6.20 | 0.82 | 0.00 | 0.00 | 0.00 | 0.03 |
| STKWE3 | 6.20 | 0.82 | 0.00 | 0.00 | 0.00 | 0.03 |
| STKWE4 | 6.20 | 0.82 | 0.00 | 0.00 | 0.00 | 0.03 |
| OPWE1 | 18.61 | 3.52 | 0.14 | 0.00 | 0.00 | 0.12 |
| OPWE2 | 23.55 | 4.45 | 0.17 | 0.00 | 0.00 | 0.15 |
| CDU201 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.02 |
| CVR499 | 0.64 | 0.64 | 0.64 | 0.64 | 0.58 | 0.19 |
| TS100 | 1.83 | 1.83 | 1.83 | 1.83 | 1.83 | 0.57 |
| CVR500a | 1.38 | 1.38 | 0.41 | 0.41 | 0.37 | 0.15 |
| CVR500b | 1.38 | 1.38 | 0.41 | 0.41 | 0.37 | 0.15 |
| TS103 | 1.83 | 1.83 | 1.83 | 1.83 | 0.00 | 0.19 |
| CVR114a | 0.14 | 0.14 | 0.14 | 0.14 | 0.00 | 0.01 |
| CVR114b | 0.14 | 0.14 | 0.14 | 0.14 | 0.00 | 0.01 |
| STK3 | 0.31 | 0.31 | 0.31 | 0.31 | 0.00 | 0.03 |
| REC2 | 0.60 | 0.60 | 0.60 | 0.60 | 0.00 | 0.18 |
| CVR117a | 0.75 | 0.75 | 0.75 | 0.75 | 0.00 | 0.22 |
| CVR117b | 0.75 | 0.75 | 0.75 | 0.75 | 0.00 | 0.22 |
| TS180 | 0.11 | 0.11 | 0.11 | 0.11 | 0.00 | 0.03 |
| CVR265a | 2.06 | 2.06 | 2.06 | 2.06 | 0.00 | 0.61 |
| CVR265b | 2.06 | 2.06 | 2.06 | 2.06 | 0.00 | 0.61 |
| SB1 | 0.75 | 0.75 | 0.75 | 0.75 | 0.00 | 0.22 |
| TS181 | 0.26 | 0.26 | 0.26 | 0.26 | 0.00 | 0.05 |
| CVR171A | 0.53 | 0.53 | 0.53 | 0.53 | 0.00 | 0.10 |
| CVR171B | 0.53 | 0.53 | 0.53 | 0.53 | 0.00 | 0.10 |
| CVR171C | 0.53 | 0.53 | 0.53 | 0.53 | 0.00 | 0.10 |
| CVR171D | 0.53 | 0.53 | 0.53 | 0.53 | 0.00 | 0.10 |
| CVR171E | 0.53 | 0.53 | 0.53 | 0.53 | 0.00 | 0.10 |

| ID | Maximum | 99th Percentile | 95th Percentile | 90th Percentile | 70th Percentile | Average |
|---|---|---|---|---|---|---|
| TS182 | 0.26 | 0.26 | 0.26 | 0.26 | 0.00 | 0.05 |
| CVR172 | 0.75 | 0.75 | 0.75 | 0.75 | 0.00 | 0.15 |
| SL2 | 1.50 | 1.50 | 1.50 | 1.50 | 0.00 | 0.22 |
| STKWE5 | 12.23 | 1.62 | 0.00 | 0.00 | 0.00 | 0.06 |
| STKWE6 | 6.20 | 0.82 | 0.00 | 0.00 | 0.00 | 0.03 |
| STKWE7 | 6.20 | 0.82 | 0.00 | 0.00 | 0.00 | 0.03 |
| STKWE8 | 6.20 | 0.82 | 0.00 | 0.00 | 0.00 | 0.03 |
| OPWE3 | 23.55 | 4.45 | 0.17 | 0.00 | 0.00 | 0.15 |
| MRL-CDU201 | 0.06 | 0.06 | 0.06 | 0.06 | 0.00 | 0.01 |
| MRL-CVR499 | 0.64 | 0.64 | 0.64 | 0.64 | 0.00 | 0.13 |
| MRL-TS100 | 1.83 | 1.83 | 1.83 | 1.83 | 0.00 | 0.38 |
| MRL-CVR500a | 1.38 | 1.38 | 0.41 | 0.41 | 0.00 | 0.10 |
| MRL-CVR500b | 1.38 | 1.38 | 0.41 | 0.41 | 0.00 | 0.10 |
| MRL-TS103 | 1.83 | 1.83 | 1.83 | 1.83 | 0.00 | 0.38 |
| MRL-CVR114a | 0.38 | 0.38 | 0.38 | 0.38 | 0.00 | 0.08 |
| MRL-CVR114b | 0.38 | 0.38 | 0.38 | 0.38 | 0.00 | 0.08 |
| MRL-STK3 | 1.22 | 1.22 | 1.22 | 1.22 | 0.00 | 0.25 |
| MRL-REC2 | 0.94 | 0.94 | 0.94 | 0.94 | 0.00 | 0.16 |
| MRL-CVR117a | 0.56 | 0.56 | 0.56 | 0.56 | 0.00 | 0.09 |
| MRL-CVR117b | 0.56 | 0.56 | 0.56 | 0.56 | 0.00 | 0.09 |
| MRL-TS180 | 0.26 | 0.26 | 0.26 | 0.26 | 0.00 | 0.04 |
| MRL-CVR265a | 4.13 | 4.13 | 4.13 | 4.13 | 0.00 | 0.70 |
| MRL-CVR265b | 4.13 | 4.13 | 4.13 | 4.13 | 0.00 | 0.70 |
| MRL-SB1 | 0.75 | 0.75 | 0.75 | 0.75 | 0.00 | 0.13 |
| MRL-TS181 | 0.26 | 0.26 | 0.26 | 0.26 | 0.00 | 0.04 |
| MRL-CVR171A | 0.53 | 0.53 | 0.53 | 0.53 | 0.00 | 0.09 |
| MRL-CVR171B | 0.53 | 0.53 | 0.53 | 0.53 | 0.00 | 0.09 |
| MRL-CVR171C | 0.53 | 0.53 | 0.53 | 0.53 | 0.00 | 0.09 |
| MRL-CVR171D | 0.53 | 0.53 | 0.53 | 0.53 | 0.00 | 0.09 |
| MRL-CVR171E | 0.53 | 0.53 | 0.53 | 0.53 | 0.00 | 0.09 |
| MRL-TS182 | 0.26 | 0.26 | 0.26 | 0.26 | 0.00 | 0.04 |
| MRL-CVR172 | 0.75 | 0.75 | 0.75 | 0.75 | 0.00 | 0.13 |
| MRL-SL2 | 0.56 | 0.56 | 0.56 | 0.56 | 0.00 | 0.10 |

**Appendix Table 6: Emission statistics for vehicle sources (g/s)**

| ID | Maximum | 99th Percentile | 95th Percentile | 90th Percentile | 70th Percentile | Average |
|---|---|---|---|---|---|---|
| Veh1 | 0.0031 | 0.0031 | 0.0031 | 0.0031 | 0.0031 | 0.0020 |

| ID | Maximum | 99th Percentile | 95th Percentile | 90th Percentile | 70th Percentile | Average |
|---|---|---|---|---|---|---|
| Veh2 | 0.0031 | 0.0031 | 0.0031 | 0.0031 | 0.0031 | 0.0020 |
| Veh3 | 0.0031 | 0.0031 | 0.0031 | 0.0031 | 0.0031 | 0.0020 |
| Veh4 | 0.0031 | 0.0031 | 0.0031 | 0.0031 | 0.0031 | 0.0020 |
| Veh5 | 0.0031 | 0.0031 | 0.0031 | 0.0031 | 0.0031 | 0.0020 |
| Veh6 | 0.0031 | 0.0031 | 0.0031 | 0.0031 | 0.0031 | 0.0020 |
| Veh7 | 0.0031 | 0.0031 | 0.0031 | 0.0031 | 0.0031 | 0.0020 |
| Veh8 | 0.0031 | 0.0031 | 0.0031 | 0.0031 | 0.0031 | 0.0020 |
| Veh9 | 0.0031 | 0.0031 | 0.0031 | 0.0031 | 0.0031 | 0.0020 |
| Veh10 | 0.0031 | 0.0031 | 0.0031 | 0.0031 | 0.0031 | 0.0020 |
| Veh11 | 0.0031 | 0.0031 | 0.0031 | 0.0031 | 0.0031 | 0.0020 |
| Veh12 | 0.0031 | 0.0031 | 0.0031 | 0.0031 | 0.0031 | 0.0020 |
| Veh13 | 0.0031 | 0.0031 | 0.0031 | 0.0031 | 0.0031 | 0.0020 |
| Veh14 | 0.0031 | 0.0031 | 0.0031 | 0.0031 | 0.0031 | 0.0020 |
| Veh15 | 0.0031 | 0.0031 | 0.0031 | 0.0031 | 0.0031 | 0.0020 |
| Veh16 | 0.0031 | 0.0031 | 0.0031 | 0.0031 | 0.0031 | 0.0020 |
| Veh17 | 0.0031 | 0.0031 | 0.0031 | 0.0031 | 0.0031 | 0.0020 |
| Veh18 | 0.0031 | 0.0031 | 0.0031 | 0.0031 | 0.0031 | 0.0020 |
| Veh19 | 0.0031 | 0.0031 | 0.0031 | 0.0031 | 0.0031 | 0.0020 |
| Veh20 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0000 |
| Veh21 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0000 |
| Veh22 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0000 |
| Veh23 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0000 |
| Veh24 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0000 |
| Veh25 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0000 |
| Veh26 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0000 |
| Veh27 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0000 |
| Veh28 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0000 |
| Veh29 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0000 |
| Veh30 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0000 |
| Veh31 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0000 |
| Veh32 | 0.0031 | 0.0031 | 0.0031 | 0.0031 | 0.0031 | 0.0020 |
| Veh33 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0000 |
| Veh34 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0000 |
| Veh35 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0000 |
| Veh36 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0000 |
| Veh37 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0000 |
| Veh38 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0000 |

| ID | Maximum | 99th Percentile | 95th Percentile | 90th Percentile | 70th Percentile | Average |
|---|---|---|---|---|---|---|
| Veh39 | 0.0031 | 0.0031 | 0.0031 | 0.0031 | 0.0031 | 0.0020 |
| Veh40 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0000 |
| Veh41 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0000 |
| Veh42 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0000 |
| Veh43 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0000 |
| Veh44 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0000 |
| Veh45 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0000 |
| Veh46 | 0.0031 | 0.0031 | 0.0031 | 0.0031 | 0.0031 | 0.0020 |
| Veh47 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0000 |
| Veh48 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0000 |
| Veh49 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0000 |
| Veh50 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0000 |

# Appendix E – Model Results

**Appendix Table 7: Predicted 24-hour ground level concentrations of $PM_{10}$ for Roy Hill (70 Mtpa) without background (µg/m³)**

| Source | Harbour | Richardson St | BMX | Kingsmill St | Hospital | Taplin St | St Cecilia's | Holiday Inn | Shop | All Seasons | Council | Neptune Pl | Primary School | South Hedland | Wedgefield |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Maximum | 11 | 12 | 9 | 9 | 10 | 9 | 8 | 9 | 6 | 8 | 7 | 6 | 4 | 8 | 27 |
| 99th percentile | 9 | 7 | 8 | 7 | 7 | 6 | 5 | 6 | 4 | 5 | 4 | 3 | 3 | 5 | 10 |
| 95th percentile | 6 | 4 | 4 | 4 | 4 | 4 | 3 | 4 | 3 | 3 | 3 | 2 | 2 | 3 | 5 |
| 90th percentile | 5 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 4 |
| 75th percentile | 3 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 2 |
| Average | 2.0 | 1.5 | 1.4 | 1.2 | 1.1 | 0.9 | 0.9 | 0.8 | 0.8 | 0.8 | 0.7 | 0.6 | 0.5 | 0.5 | 1.5 |

**Appendix Table 8: Predicted 24-hour ground level concentrations of $PM_{10}$ for Roy Hill (70 Mtpa) and NWI (50 Mtpa) without background (µg/m³)**

| Source | Harbour | Richardson St | BMX | Kingsmill St | Hospital | Taplin St | St Cecilia's | Holiday Inn | Shop | All Seasons | Council | Neptune Pl | Primary School | South Hedland | Wedgefield |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Maximum | 18 | 18 | 15 | 14 | 15 | 12 | 11 | 11 | 9 | 10 | 9 | 7 | 6 | 11 | 27 |
| 99th percentile | 16 | 11 | 12 | 12 | 12 | 9 | 7 | 9 | 6 | 8 | 7 | 6 | 4 | 6 | 13 |
| 95th percentile | 9 | 7 | 7 | 7 | 6 | 5 | 4 | 5 | 4 | 5 | 4 | 3 | 3 | 4 | 7 |
| 90th percentile | 7 | 5 | 5 | 5 | 4 | 4 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 5 |
| 75th percentile | 4 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 3 |
| Average | 3.0 | 2.3 | 2.1 | 1.9 | 1.7 | 1.5 | 1.4 | 1.3 | 1.3 | 1.2 | 1.1 | 0.9 | 0.8 | 1.0 | 2.3 |

**Appendix Table 9: Predicted 24-hour ground level concentrations of $PM_{10}$ for Roy Hill (70 Mtpa) and NWI (50 Mtpa) with PHIC CAM, including background (µg/m³)**

| Source | Harbour | Richardson St | BMX | Kingsmill St | Hospital | Taplin St | St Cecilia's | Holiday Inn | Shop | All Seasons | Council | Neptune Pl | Primary School | South Hedland | Wedgefield |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Maximum | 227 | 219 | 219 | 219 | 215 | 200 | 198 | 196 | 197 | 196 | 195 | 195 | 193 | 189 | 195 |
| 99th percentile | 152 | 131 | 111 | 101 | 96 | 81 | 74 | 70 | 68 | 67 | 66 | 63 | 61 | 62 | 102 |
| 95th percentile | 110 | 96 | 86 | 88 | 79 | 61 | 59 | 57 | 56 | 55 | 52 | 45 | 43 | 46 | 76 |
| 90th percentile | 100 | 83 | 78 | 76 | 69 | 54 | 51 | 47 | 48 | 45 | 44 | 40 | 38 | 38 | 67 |
| 75th percentile | 83 | 69 | 65 | 63 | 59 | 45 | 43 | 41 | 40 | 39 | 37 | 35 | 33 | 30 | 50 |
| Average | 67.7 | 57.5 | 54.3 | 50.9 | 46.8 | 36.0 | 34.7 | 32.3 | 31.9 | 31 | 30 | 27.6 | 26.5 | 25.7 | 39.1 |

**Appendix Table 10: Predicted 24-hour ground level concentrations of $PM_{10}$ for Roy Hill (110 Mtpa) (µg/m³)**

| Source | Harbour | Richardson St | BMX | Kingsmill St | Hospital | Taplin St | St Cecilia's | Holiday Inn | Shop | All Seasons | Council | Neptune Pl | Primary School | South Hedland | Wedgefield |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Maximum | 19 | 17 | 11 | 12 | 11 | 11 | 11 | 12 | 9 | 11 | 10 | 8 | 5 | 11 | 31 |
| 99th percentile | 11 | 9 | 8 | 8 | 9 | 7 | 7 | 8 | 6 | 7 | 6 | 5 | 4 | 6 | 16 |
| 95th percentile | 8 | 6 | 5 | 5 | 5 | 4 | 3 | 4 | 3 | 3 | 3 | 3 | 2 | 4 | 7 |
| 90th percentile | 6 | 4 | 4 | 4 | 4 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 5 |
| 75th percentile | 3 | 3 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 |
| Average | 2.5 | 2.0 | 1.7 | 1.5 | 1.4 | 1.2 | 1.2 | 1.1 | 1.1 | 1.0 | 0.9 | 0.8 | 0.7 | 0.7 | 2.1 |

**Appendix Table 11: Predicted 24-hour ground level concentrations of $PM_{10}$ for Roy Hill (110 Mtpa) with PHIC CAM, including background (µg/m³)**

| Source | Harbour | Richardson St | BMX | Kingsmill St | Hospital | Taplin St | St Cecilia's | Holiday Inn | Shop | All Seasons | Council | Neptune Pl | Primary School | South Hedland | Wedgefield |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Maximum | 217 | 212 | 223 | 223 | 218 | 200 | 198 | 195 | 195 | 194 | 194 | 193 | 191 | 187 | 193 |
| 99th percentile | 133 | 137 | 101 | 96 | 88 | 72 | 67 | 65 | 64 | 64 | 64 | 61 | 59 | 61 | 101 |
| 95th percentile | 104 | 89 | 81 | 78 | 72 | 57 | 55 | 52 | 52 | 51 | 49 | 43 | 42 | 46 | 72 |
| 90th percentile | 88 | 77 | 72 | 68 | 62 | 51 | 49 | 46 | 47 | 45 | 44 | 40 | 38 | 38 | 63 |
| 75th percentile | 72 | 61 | 57 | 55 | 52 | 43 | 41 | 39 | 40 | 38 | 37 | 34 | 33 | 29 | 48 |
| Average | 59.9 | 52.3 | 48.4 | 45.3 | 42.7 | 34.1 | 33.0 | 31.2 | 31.3 | 30.2 | 29.3 | 27.2 | 26.1 | 25.2 | 37.4 |

# Appendix F – Model input file

## AERMOD

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**
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**
** AERMOD Input Produced by:
** AERMOD View Ver. 10.2.1
** Lakes Environmental Software Inc.
** Date: 10/05/2023
** File: C:\AERMOD\1368 RoyHill_Expansion\Run4_10May23\RH_RunA\RHIO_all.ADI
**
****************************************
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**
****************************************
** AERMOD Control Pathway
****************************************
**
**
CO STARTING
   TITLEONE Run6a AERMET - RHIO
   TITLETWO 1368, RoyHill, Run4, 110Mtpa, 5 May 2023
   MODELOPT CONC DRYDPLT WETDPLT ALPHA
   AVERTIME 1 24 ANNUAL
   POLLUTID PM_10
   RUNORNOT RUN
   LOW_WIND 0.20
   ERRORFIL RHIO_all.err
CO FINISHED
**
****************************************
** AERMOD Source Pathway
****************************************
**
**
SO STARTING
** Source Location **
** Source ID - Type - X Coord. - Y Coord. **
   LOCATION CDU101      VOLUME     659950.000  7749710.000        5.560
   LOCATION CVR104      VOLUME     660085.800  7749736.114        6.320
   LOCATION TS1         VOLUME     660117.076  7749746.105        8.680
   LOCATION CVR105      VOLUME     660189.626  7749549.734        6.100
   LOCATION TS2         VOLUME     660175.970  7749586.375        5.450
   LOCATION CVR111      VOLUME     659637.000  7749390.000        7.800
   LOCATION STK1        VOLUME     659605.000  7749375.000        6.830
   LOCATION TS3         VOLUME     660226.191  7749455.328        5.280
   LOCATION CVR113A     VOLUME     659740.885  7749266.771        2.900
   LOCATION CVR113B     VOLUME     659104.314  7749027.800       11.000
   LOCATION STK2        VOLUME     659045.000  7749020.000        9.330
   LOCATION REC1        VOLUME     659370.000  7749215.000        4.830
   LOCATION CVR116      VOLUME     659815.000  7749370.000        7.220
   LOCATION TS4         VOLUME     660287.040  7749554.819        5.570
   LOCATION CVR121      VOLUME     660335.564  7749404.424        5.850
```

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   LOCATION LRP            VOLUME     660429.000  7749206.000         6.700
   LOCATION CVR123         VOLUME     660355.574  7749388.337         6.660
   LOCATION CVR124         VOLUME     660294.367  7749544.494         5.810
   LOCATION TS13           VOLUME     660295.151  7749553.911         5.840
   LOCATION TS10           VOLUME     660266.902  7749619.041         6.670
   LOCATION TS11           VOLUME     660315.554  7749485.641         5.130
   LOCATION CVR122         VOLUME     660259.368  7749660.861         6.650
   LOCATION TS5            VOLUME     660168.153  7749904.340         6.360
   LOCATION CVR161A        VOLUME     660614.507  7750026.201         5.490
   LOCATION CVR161B        VOLUME     661019.000  7750135.000         8.970
   LOCATION CVR161C        VOLUME     661502.785  7750276.368         1.400
   LOCATION CVR161D        VOLUME     661988.799  7750406.618         6.370
   LOCATION CVR161E        VOLUME     662397.292  7750516.847         6.560
   LOCATION TS6            VOLUME     662794.527  7750631.402         8.410
   LOCATION CVR162         VOLUME     663000.292  7750896.972         8.200
   LOCATION TS12           VOLUME     663265.963  7751261.434        11.480
   LOCATION CVR163         VOLUME     663291.074  7751242.601         4.050
   LOCATION TS7            VOLUME     663320.706  7751218.692         0.300
   LOCATION CVR164         VOLUME     663527.970  7751491.899         0.000
   LOCATION SL1            VOLUME     663465.000  7751388.000         0.000
   LOCATION STKWE1         VOLUME     659863.000  7749355.000         9.090
   LOCATION STKWE2         VOLUME     659320.000  7749145.000         5.830
   LOCATION STKWE3         VOLUME     658915.000  7748988.000         4.830
   LOCATION STKWE4         VOLUME     658964.769  7749092.541         5.550
   LOCATION OPWE1          VOLUME     660287.756  7749157.280         5.410
   LOCATION OPWE2          VOLUME     660204.694  7749667.113         5.180
** Source Parameters **
   SRCPARAM CDU101               1.0     1.750     3.000     0.814
   SRCPARAM CVR104               1.0     1.500     3.000     0.698
   SRCPARAM TS1                  1.0     5.000     2.326     2.326
   SRCPARAM CVR105               1.0     5.000    12.000     2.326
   SRCPARAM TS2                  1.0     5.000     2.326     2.326
   SRCPARAM CVR111               1.0     1.500   139.535     0.698
   SRCPARAM STK1                 1.0     8.000   137.907     3.721
   SRCPARAM TS3                  1.0     5.000     2.326     2.326
   SRCPARAM CVR113A              1.0     1.500    69.767     3.721
   SRCPARAM CVR113B              1.0     1.500    69.767     3.721
   SRCPARAM STK2                 1.0     8.000   138.000     3.721
   SRCPARAM REC1                 1.0     5.000   137.209     2.326
   SRCPARAM CVR116               1.0     1.500   139.535     2.326
   SRCPARAM TS4                  1.0     5.000     2.326     2.326
   SRCPARAM CVR121               1.0    10.000    23.256     4.651
   SRCPARAM LRP                  1.0     5.000    11.628     2.326
   SRCPARAM CVR123               1.0     5.000    11.628     2.326
   SRCPARAM CVR124               1.0     5.000    11.628     2.326
   SRCPARAM TS13                 1.0     5.000     2.326     2.326
   SRCPARAM TS10                 1.0     5.000     2.326     2.326
   SRCPARAM TS11                 1.0     5.000     2.326     2.326
   SRCPARAM CVR122               1.0     5.000     3.000     2.326
   SRCPARAM TS5                  1.0     5.000     2.326     2.326
   SRCPARAM CVR161A              1.0     1.500    34.884     0.698
   SRCPARAM CVR161B              1.0     1.500    34.884     0.698
   SRCPARAM CVR161C              1.0     1.500    34.884     0.698
   SRCPARAM CVR161D              1.0     1.500    34.884     0.698
   SRCPARAM CVR161E              1.0     1.500    34.884     0.698
   SRCPARAM TS6                  1.0    10.000     2.326     2.326
   SRCPARAM CVR162               1.0    15.000    23.256     0.698
   SRCPARAM TS12                 1.0    15.000     2.326     2.326
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SRCPARAM CVR163              1.0    15.000     2.326     4.651
SRCPARAM TS7                 1.0    15.000     2.326     2.326
SRCPARAM CVR164              1.0    15.000    12.000     0.698
SRCPARAM SL1                 1.0    20.000    12.000     0.791
SRCPARAM STKWE1              1.0     8.000    25.000     3.721
SRCPARAM STKWE2              1.0     8.000    25.000     3.721
SRCPARAM STKWE3              1.0     8.000    25.000     3.721
SRCPARAM STKWE4              1.0     8.000    25.000     3.721
SRCPARAM OPWE1               1.0     0.500    70.000     0.233
SRCPARAM OPWE2               1.0     0.500    70.000     0.233
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PARTDIAM TS1 1 4 7 9
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PARTDIAM CVR113A 1 4 7 9
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PARTDIAM STK2 1 4 7 9
PARTDIAM REC1 1 4 7 9
PARTDIAM CVR116 1 4 7 9
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PARTDIAM CVR163 1 4 7 9
PARTDIAM TS7 1 4 7 9
PARTDIAM CVR164 1 4 7 9
PARTDIAM SL1 1 4 7 9
PARTDIAM STKWE1 1 4 7 9
PARTDIAM STKWE2 1 4 7 9
PARTDIAM STKWE3 1 4 7 9
PARTDIAM STKWE4 1 4 7 9
PARTDIAM OPWE1 1 4 7 9
PARTDIAM OPWE2 1 4 7 9
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MASSFRAX CVR104 0.31 0.26 0.23 0.2
MASSFRAX TS1 0.31 0.26 0.23 0.2
MASSFRAX CVR105 0.31 0.26 0.23 0.2
MASSFRAX TS2 0.31 0.26 0.23 0.2
MASSFRAX CVR111 0.31 0.26 0.23 0.2
MASSFRAX STK1 0.31 0.26 0.23 0.2
```

```
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MASSFRAX CVR113B 0.31 0.26 0.23 0.2
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MASSFRAX REC1 0.31 0.26 0.23 0.2
MASSFRAX CVR116 0.31 0.26 0.23 0.2
MASSFRAX TS4 0.31 0.26 0.23 0.2
MASSFRAX CVR121 0.31 0.26 0.23 0.2
MASSFRAX LRP 0.31 0.26 0.23 0.2
MASSFRAX CVR123 0.31 0.26 0.23 0.2
MASSFRAX CVR124 0.31 0.26 0.23 0.2
MASSFRAX TS13 0.31 0.26 0.23 0.2
MASSFRAX TS10 0.31 0.26 0.23 0.2
MASSFRAX TS11 0.31 0.26 0.23 0.2
MASSFRAX CVR122 0.31 0.26 0.23 0.2
MASSFRAX TS5 0.31 0.26 0.23 0.2
MASSFRAX CVR161A 0.31 0.26 0.23 0.2
MASSFRAX CVR161B 0.31 0.26 0.23 0.2
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PARTDENS TS3 1 1 1 1
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PARTDENS STK2 1 1 1 1
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PARTDENS CVR161A 1 1 1 1
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   PARTDENS TS12 1 1 1 1
   PARTDENS CVR163 1 1 1 1
   PARTDENS TS7 1 1 1 1
   PARTDENS CVR164 1 1 1 1
   PARTDENS SL1 1 1 1 1
   PARTDENS STKWE1 1 1 1 1
   PARTDENS STKWE2 1 1 1 1
   PARTDENS STKWE3 1 1 1 1
   PARTDENS STKWE4 1 1 1 1
   PARTDENS OPWE1 1 1 1 1
   PARTDENS OPWE2 1 1 1 1
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   HOUREMIS 1368_ROYHILL_RUNA_EMISSIONS_VER4_10MAY2023.TXT CVR105 TS2 CVR111
   HOUREMIS 1368_ROYHILL_RUNA_EMISSIONS_VER4_10MAY2023.TXT STK1 TS3 CVR113A
   HOUREMIS 1368_ROYHILL_RUNA_EMISSIONS_VER4_10MAY2023.TXT CVR113B STK2 REC1
   HOUREMIS 1368_ROYHILL_RUNA_EMISSIONS_VER4_10MAY2023.TXT CVR116 TS4 CVR121
   HOUREMIS 1368_ROYHILL_RUNA_EMISSIONS_VER4_10MAY2023.TXT LRP CVR123 CVR124
   HOUREMIS 1368_ROYHILL_RUNA_EMISSIONS_VER4_10MAY2023.TXT TS13 TS10 TS11
   HOUREMIS 1368_ROYHILL_RUNA_EMISSIONS_VER4_10MAY2023.TXT CVR122 TS5 CVR161A
   HOUREMIS 1368_ROYHILL_RUNA_EMISSIONS_VER4_10MAY2023.TXT CVR161B CVR161C CVR161D
   HOUREMIS 1368_ROYHILL_RUNA_EMISSIONS_VER4_10MAY2023.TXT CVR161E TS6 CVR162
   HOUREMIS 1368_ROYHILL_RUNA_EMISSIONS_VER4_10MAY2023.TXT TS12 CVR163 TS7
   HOUREMIS 1368_ROYHILL_RUNA_EMISSIONS_VER4_10MAY2023.TXT CVR164 SL1 STKWE1
   HOUREMIS 1368_ROYHILL_RUNA_EMISSIONS_VER4_10MAY2023.TXT STKWE2 STKWE3 STKWE4
   HOUREMIS 1368_ROYHILL_RUNA_EMISSIONS_VER4_10MAY2023.TXT OPWE1 OPWE2
   SRCGROUP ALL
SO FINISHED
**
****************************************
** AERMOD Receptor Pathway
****************************************
**
**
RE STARTING
   INCLUDED RHIO_all.rou
RE FINISHED
**
****************************************
** AERMOD Meteorology Pathway
****************************************
**
**
ME STARTING
   SURFFILE 6866_Run6a_6Feb2015.SFC
   PROFFILE 6866_Run6a_6Feb2015.PFL
   SURFDATA 0 2013
   UAIRDATA 54321 2013
   SITEDATA 1 2013
   PROFBASE 9.0 METERS
ME FINISHED
**
****************************************
```

```
** AERMOD Output Pathway
****************************************
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OU STARTING
   RECTABLE ALLAVE 1ST
   RECTABLE 1 1ST
   RECTABLE 24 1ST
   POSTFILE 1 ALL PLOT RHIO_ALL.AD\01_GALL.POS 31
   POSTFILE 24 ALL PLOT RHIO_ALL.AD\24_GALL.POS 32
   POSTFILE ANNUAL ALL PLOT RHIO_ALL.AD\AN_GALL.POS 33
** Auto-Generated Plotfiles
   PLOTFILE 1 ALL 1ST RHIO_ALL.AD\01H1GALL.PLT 34
   PLOTFILE 24 ALL 1ST RHIO_ALL.AD\24H1GALL.PLT 35
   PLOTFILE ANNUAL ALL RHIO_ALL.AD\AN00GALL.PLT 36
   SUMMFILE RHIO_all.sum
OU FINISHED
**
****************************************
** Project Parameters
****************************************
** PROJCTN  CoordinateSystemUTM
** DESCPTN  UTM: Universal Transverse Mercator
** DATUM    World Geodetic System 1984
** DTMRGN   Global Definition
** UNITS    m
** ZONE     -50
** ZONEINX  0
**
```

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