Mulga Rock Uranium Project - Public Environmental Review - December 2015

Appendix E - Air Quality and Atmospheric Gases

E1

Vimy Resources Limited

Mulga Rock Uranium Project
Dispersion Modelling

October 2015

Executive summary

Introduction

Vimy Resources Limited (VMY)[1] is the proponent for the Mulga Rock Uranium Project (MRUP). The project involves mining four poly-metallic deposits located approximately 240 km north-east of Kalgoorlie-Boulder. In the shire of Menzies The MRUP area covers approximately 102,000 hectares and will produce up to 1360 tonnes of uranium oxide concentrate per year over the life of the mine, which is expected to be 16 years.

The MRUP involves shallow open pit mining of four poly-metallic deposits containing commercial grades of contained uranium hosted in carbonaceous material. A central mill will be used to process the material.

GHD Pty Ltd (GHD) was commissioned by VMY to quantify current dust and power generation impacts and develop a predictive model in early 2015. A greenhouse gas assessment was also undertaken at this time. GHD was then engaged in September 2015 to modify the modelling with updated data. This document comprises the updated modelling.

Emissions estimate

The main airborne emissions are expected to be dust from pits, tailings storage facilities and wheel generated dust from vehicles. Accepted emissions estimation techniques have been used to estimate the dust emission rates for use in dispersion modelling. Emissions of products of combustion from the diesel fired power station has also been included in the air assessment.

The three closest existing or historical settlements are located 90 to 110 km from the site. The proposed accommodation camp will be located on the site, approximately 10 km from the processing plant.

Existing environment

The area has a natural background dust concentration that is contributed to by sources such as bush fires or wind erosion. There is limited publically available air quality data. Dust has, however, been measured at the proposed MRUP site (high volume air sampling and dust deposition). Background levels of other pollutants are unlikely to be of any significance.

Air dispersion modelling

Due to the size of the model domain and availability of surface observations, air dispersion modelling has been completed using the US EPA approved CALPUFF dispersion model.

VMY provided surface meteorological observations for three sites to inform CALMET (the 3D meteorological model pre-processor to CALPUFF) in combination with upper air data synthesized using The Air Pollution Model (TAPM). Model development was for the year 1 June 2012 through 31 May 2013.

CALPUFF was then used to simulate the dispersion characteristics and concentrations of pollutants generated by the proposed activities.

Four scenario years were selected from the 16 planned operational years, and one from the five closure (rehabilitation) years. The selected years were chosen as they were considered to have the worst case emissions in different locations (determined from estimated throughput and active areas).

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[1] Formerly Energy and Minerals Australia Limited

Dust assessment - Predicted concentrations and deposition

- During mining, predicted concentrations at MRUP Accommodation range between 22% and 52% of the various assessment criteria for the four scenarios. During mining, predicted dust concentrations at MRUP site boundaries range between 5% and 42% of the guidelines for the scenarios.
- When considering the three population receptors surrounding MRUP, as they are a significant distance from the MRUP, the predicted concentrations during mining range from 0.1% to 0.7% of any of the criteria.
- Predicted concentrations at receptors during the closure scenario are lower than those predicted during mining years.
- Predicted dust deposition is highest at MRUP accommodation, though well below the monthly deposition criteria (approximately 2%). Deposition at other sites is predicted to be much lower.

Dust assessment - Cumulative impacts

- As there are limited anthropogenic dust sources in the area, the majority of dust in the area will be through dust emission processes that naturally occur in the environment. Namely, wind erosion from open areas and bushfire smoke.
- Dust emissions from the MRUP project, regional background sources, or both have the potential to dominate in the neighbourhood of the mine site (a scale of kilometres from the site); however further afield, where the receptors are located (tens of kilometres), background regional and their own local neighbourhood sources will dominate.
- Based on the predicted concentrations at MRUP Accommodation the cumulative ambient dust concentration may on occasion exceed guideline values, but this cannot be quantified without hourly or daily measurements being taken at the MRUP site.
- Cumulative dust deposition is unlikely to be significantly affected at receptors, as the predicted dust deposition values are 3 to 7 orders of magnitude smaller than current measured dust deposition values. This is due to the large separation distances between the sources and the receptor.
- As the closest major dust source to MRUP is Tropicana (110 km from MRUP), cumulative impacts from the two sources are likely to be insignificant.

Power plant emissions

- The predicted concentrations at all receptors are below the assessment criteria for all assessed pollutants.
- PM_{10} and for NO_2 concentrations at the power station site are assessed against health criterion, as they exceed 1-hour average assessment criteria:
  - NO_2 concentrations are below occupational exposure standards; however diesel particulate matter is predicted at 290% of exposure standards.
  - The following is noted:
    - Diesel fuel has been modelled for worst case emissions; however the fuel source is most likely going to be gas. Particulate emissions from a gas source are significantly lower than diesel (approximately 0.003% of diesel[2]). As such, use of

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[2] National Pollutant Inventory 2008. NPI *Emissions Estimation Technique Manual (EET) for Combustion Engines*.

gas as a fuel source would bring predicted emissions to below assessment criteria.

  - Should diesel fuel be chosen at the power station, diesel particulate filters can be used. Filters generally provided 80-90% reduction in emissions, which would bring emissions to below the assessment criteria.

Greenhouse gases

Total greenhouse gas emissions for the sixteen operational years are estimated as:

- Total diesel fleet emissions: 543,136 tonnes CO_2-e (15% of total)
- Total electricity emissions 2,609,980 tonnes CO_2-e (73% of total)
- Total production of uranium oxide and other precious metal concentrates emissions 443,520 tonnes CO_2-e (12% of total)

There are also comparatively small contributions anticipated from oil and gas use of oils, greases and lubricants in workshops, on-site waste management, overall land use change, air transport of personnel, site deliveries and waste removal.

Greenhouse gas emissions will be reduced by considering the following:

- Fuel type at power station (gas versus diesel)
- Investigation of slurry pumping versus truck transfer of post-beneficiation ore to the processing plant
- Investigation of carbon off-sets

Future monitoring

As sensitive receptors outside of the tenement are a significant distance from site, there is no need to undertake offsite dust monitoring at this stage.

It would be beneficial to maintain a monitoring station at the Mining Camp (sensitive receptor though the tenement boundary) to monitor dust concentrations.

Stack testing will be needed upon commissioning of the power station to ensure emissions are within specified parameters. It would be beneficial to also undertake quarterly, biannual or annual stack testing.

Limitations

This report is subject to, and must be read in conjunction with, the limitations set out in Section 1.5 and the assumptions and qualifications contained throughout the report.

Glossary of acronyms and terms

AIOH	Australian Institute of Occupational Hygiene
Air NEPM	*National Environment Protection (Ambient Air Quality) Measure*
Air Toxics NEPM	*National Environment Protection (Air Toxics) Measure*
Ambient Air SEP	draft *State Environmental (Ambient Air) Policy 2009*
AWS	automatic weather station
BoM	Bureau of Meteorology
CALMET	3D meteorological model pre-processor to CALPUFF
CALPUFF	Model that simulates dispersion of air pollutants
CO	carbon monoxide
DPM	diesel particulate matter
EP Act	Environmental Protection Act 1986
EPA	Environmental Protection Authority
EPP	Environmental Protection Policy
FIFO	Fly in, fly out
GHD	GHD Pty Ltd
GL	Gigalitres
Kwinana EPP	*Environmental Protection (Kwinana) (Atmospheric Wastes) Policy 1999*
MRUP	Mulga Rock Uranium Project
Mtpa	Million tonnes per annum
MW	megawatts
NEPM	National Environment Protection Measure
NO_2	nitrogen dioxide
NOHSC	National Occupational Health and Safety Commission
NO_x	oxides of nitrogen
NSW DEC	NSW Department of Environment and Conservation
PM_1	particulate matter of less than 1 micron in aerodynamic diameter
$PM_{2.5}$	particulate matter of less than 2.5 microns in aerodynamic diameter
PM_{10}	particulate matter of less than 10 microns in aerodynamic diameter
PAHs	polycyclic aromatic hydrocarbons
SEPP-AQM	Victorian *State Environment Protection Policy (Air Quality Management)*
SO_2	sulphur dioxide
STEL	short term exposure level
TAPM	The Air Pollution Model
TSP	total suspended particulates
TWA	time weighted average
µm	micrometre
$\mu g/m^3$	micrograms per cubed meter
Vic EPA	Victorian EPA
VMY	Vimy Resources Limited (formerly Energy and Minerals Australia Limited)
VOC	volatile organic compounds

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Appendices

1. Introduction

1.1 Purpose of this report

Vimy Resources Limited (VMY)[3] is the proponent for the Mulga Rock Uranium Project (MRUP). The project involves mining four poly-metallic deposits located approximately 240 km north-east of Kalgoorlie-Boulder. In the shire of Menzies The MRUP area covers approximately 102,000 hectares and will produce up to 1360 tonnes of uranium oxide concentrate per year over the life of the mine, which is expected to be 16 years.

As part of the Public Environmental Review (PER) process assessed by the Environmental Protection Authority (EPA) under Part IV of the *Environmental Protection Act 1986* (EP Act), key environmental factors have been flagged for investigation. One of these is airborne emissions and their dispersion and deposition to the surrounding area.

1.2 Background

The MRUP involves shallow open pit mining of four poly-metallic deposits containing commercial grades of contained uranium hosted in carbonaceous material. A central mill will be used to process the material.

Up to 4.5 Mtpa will be mined to produce up to 1360 tonnes of uranium oxide concentrate per year over the lifetime of the project, which is expected to be 16 years. Other metal oxides will be extracted during the process and sold separately.

The main airborne emission is expected to be dust, which will be predominantly from pits, tailings storage facilities and wheel generated dust from vehicles; the processing area is expected to have a sufficient moisture content to prevent significant emissions from this location.

Other than the MRUP mining village, there are no population centres within 100 km of the proposed site.

1.3 Scope

GHD Pty Ltd (GHD) was commissioned by VMY to quantify current dust and power generation impacts and develop a predictive model in early 2015. A greenhouse gas assessment was also undertaken at this time. GHD was then engaged in September 2015 to modify the modelling with updated data, and an additional scenario. This document comprises the updated modelling.

The scope of works is as follow:

- **Task 1: Emissions inventory (dust only)**
  - Interpret planned operational details (as provided by VMY) to determine the mechanically driven PM_{10} and total suspended particulate (TSP) dust emission rates for the various sources at the site.
  - Use available meteorological data to develop a wind erosion emission rate for fugitive dust emissions that will vary for each hour of a representative modelling year.
- **Task 2: Model development**

  Development of a dispersion and deposition model through:

  - Development of meteorological input files

[3] Formerly Energy and Minerals Australia Limited

- Consideration of terrain
- Consideration of background dust
- Inclusion of discrete receptors
- Input of appropriate values into the models for other input parameters as required

- **Task 3: Scenario modelling**

  Estimate emissions for each year by programming PM_{10} and TSP source emissions into the dispersion model with the specified emission rates, locations and areas for the given mine site configurations for the following discrete scenarios:

  - Scenario 1: Operational and wind erosion emissions from open pit mining during the third year of operations
  - Scenario 2: Operational and wind erosion emissions from open pit mining during the tenth year of operations
  - Scenario 3: Operational and wind erosion emissions from open pit mining during the eleventh year of operations
  - Scenario 4: Operational and wind erosion emissions from open pit mining during the fourteenth year of operations
  - Scenario 5: wind erosion emissions from the first year of rehabilitation after closure

  These discrete scenarios represent the highest production years for the various deposit areas and are expected to produce the highest emission rates. Emissions from these scenarios will be used to calculate cumulative worst case deposition from the life of mine.

- **Task 4: Reporting**

  Provide a comprehensive report detailing methodology and results of emissions development and dispersion modelling.

Power station and greenhouse gas investigations involved:

- Task 1: Emissions inventory of emissions from power generation (CO, TSP, PM_{10}, SO_2 and NOx (assessed as NO_2).
- Task 2: Model development (using existing met file)
- Task 3: Modelling of power station emissions
- Task 4: Greenhouse gas estimation and assessment
- Task 4: Reporting

1.4 Approach

The approach adopted by GHD for the assessment of emissions to air from the Project is summarised in the following points. Each point is described in detail in the subsequent sections of the report.

- Outline of the Project, including layout, equipment and process flows (Section 2).
- Identification of emission sources and mitigation measures for the operational phase of the Project, including from mine operations, power station and greenhouse gases (Section 3).
- Identification of the appropriate air quality criteria and guidelines applicable to this air assessment (Section 3.3).
- Investigation of the existing environment, in terms of topography and land use, meteorology, background air quality and sensitive receptors (Section 5).

- Meteorological modelling, in order to synthesize site representative meteorology for use in dispersion modelling (Section 6).
- Development of dispersion model for determining operational impacts (Section 7).
- Atmospheric dispersion modelling for the assessment of predicted air quality impacts (dust and other pollutants) during operation of the Project (Section 8 and Section 9).
- Assessment of greenhouse gas emissions for the operation of the Project (Section 10).
- Conclusions and recommendations drawn from the above assessment (Section 11).

1.5 Limitations

This report has been prepared by GHD for Vimy Resources Limited and may only be used and relied on by Vimy Resources Limited for the purpose agreed between GHD and Vimy Resources Limited as set out in this report.

GHD otherwise disclaims responsibility to any person other than Vimy Resources Limited arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report. GHD disclaims liability arising from any of the assumptions being incorrect.

GHD has prepared this report on the basis of information provided by Vimy Resources Limited and others who provided information to GHD (including Government authorities), which GHD has not independently verified or checked beyond the agreed scope of work. GHD does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information.

2. Project description

2.1 Project proposal

Details of the project proposal were obtained from the *Environmental Scoping Document* and literature provided by Vimy Resources[4].

The MRUP area is located in the Shire of Menzies, on the western flank of the Great Victoria Dessert, comprising of a series of large, generally parallel sand dunes, with inter-dunal swales and broad flat plains. The MRUP site consists of approximately 102,000 ha on granted mining tenure (primarily M39/1080 and M39/1081) within unallocated crown land.

The only land access to the area is currently via 4WD, with the closest residential town, Laverton, lying approximately 200 km to the north-west. There are a small number of regional residential communities surrounding the site; including:

- Pinjin Station homestead (approximately 100 km to the west)
- Coonana Aboriginal community (approximately 130 km to the south-south-west)
- Kanandah Station homestead (approximately 150 km to the south-east)
- Tropicana Gold mine (approximately 110 km to the north-east)

All are greater than 100 km from the proposed MRUP site.

Figure 2-1 shows the proposed MRUP site and the closest receptors. As shown, an accommodation camp is proposed as part of the MRUP.

2.1.1 Mine operations

Up to 4.5 Mtpa will be mined to produce up to 1360 tonnes of uranium oxide concentrate per year over the lifetime of the project, which is expected to be up to 16 years. Other metal oxides will be extracted during the process and sold separately. These concentrates will not be classified as radioactive.

The MRUP involves shallow open pit mining of four poly-metallic deposits in two distinct mining centres. The deposits are shown in Figure 2-2 and named:

- Mulga Rock East, comprising Princess and Ambassador deposits
- Mulga Rock West, comprising Shogun and Emperor deposits

The deposits contain commercial grades of contained uranium hosted in carbonaceous material and will be mined, backfilled and capped progressively in order to reduce the active footprint of the mine.

Each pit will be mined using traditional open cut techniques. At this stage, blasting is not anticipated to be required. Ore will be crushed and beneficiated within the operational pit and sent via a slurry pipeline or truck to a central processing plant. Uranium oxide concentrate will be trucked in sealed containers to a suitable port, approved to receive and ship Class 7 materials, for export. At this stage, the port is expected to be Port Adelaide.

Tailings will be placed in a surface tailing area for the first few years. After this point, tailings will be directed to completed mine voids in order to commence backfilling. Low grade rock will also initially be stockpiled on two surface stockpiles. Once mine voids have been backfilled partially with tailings, the majority of the low grade rock will be used as capping material whilst backfilling depleted mine voids. Revegetation will occur once mine voids are refilled.

[4] Vimy Resources Pty Ltd, 2013. *Mulga Rock Uranium Project Environmental Scoping Document.*

It is expected that ore will be processed continuously, however a stockpile area adjacent to the processing plant has been included in the design to allow for cessation of processing for a nominal period of one year, should this be required.

The Project will require the following:

- Clearing of vegetation
- Borefield abstraction
- Mine dewatering and reinjection
- Creation of overburden (un-mineralised) landforms
- Construction of site processing facilities, waste management systems and accommodation and administration facilities, including
  - Processing plant
  - Ore stockpile area
  - Above ground tailings storage facility
  - Storage/evaporation facilities
  - Mine administration and workshop facilities
  - Fuel and chemical storage
  - Power and water supply and water reinjection (see details below)
  - Accommodation village for fly in, fly out (FIFO) workers
  - Airstrip
  - Laydown areas
  - Waste water and solid waste treatment facilities
  - Road infrastructure
  - Communications
  - Dedicated site access road for supply of consumables, and deployment of product to port

Upon completion of the project, the site will be decommissioned and rehabilitated following an approved Mine Closure Plan.

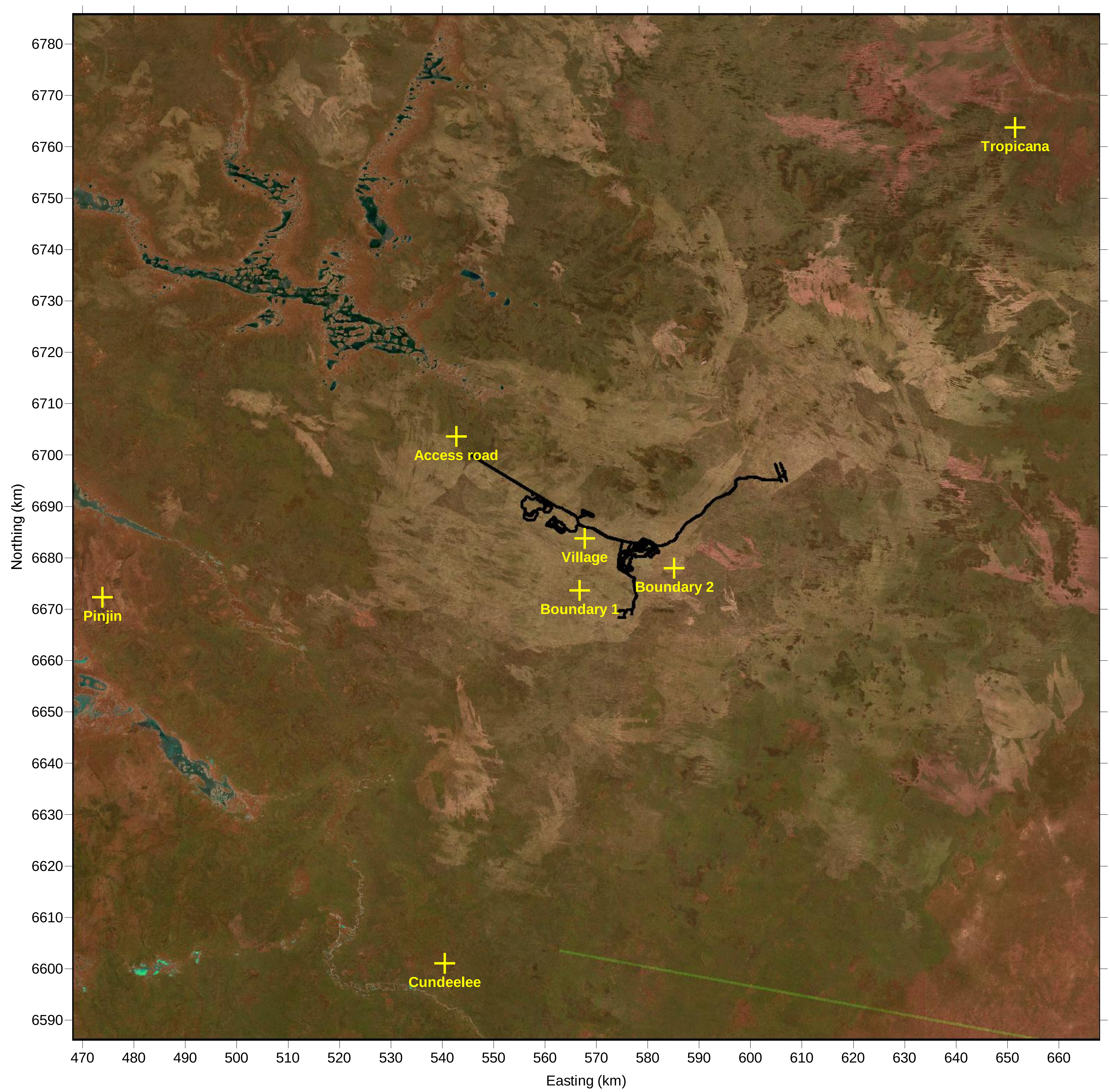
2.1.2 Water supply and reinjection

Water for the mining process will be from a dedicated borefield, located to the north-east of the main mining area. Operational demand is anticipated to be up to 3 GL/annum. A reinjection field will be used for disposal of surplus pit dewatering water. It is expected that up to 1.5 GL/annum will be reinjected, where water quality permits. An alternative disposal method is through constructed evaporation ponds.

2.1.3 Power supply

A new power station will be required to provide power for MRUP. The power station will be diesel powered with up to 20 megawatt capacity. It will consist of 20, one megawatt (MW) generators (Cummins KTA50). These are fired by diesel and have a custom waste heat recovery circuit delivering a 6-7% increase in diesel efficiency.

It is also possible that a standalone 1 MW generator may be constructed at the extraction bore field.



LEGEND

- Proposed mine layout
- Sensitive receptors

SCALE

0 6 12 18 24
Kilometres (at A3)

MAP PROJECTION:
Transverse Mercator

HORIZONTAL DATUM:
Geocentric Datum of Australia (GDA)

GRID:
Map Grid of Australia 1994, Zone 51

DATA SOURCE:
LGATE_MGA51_20150220

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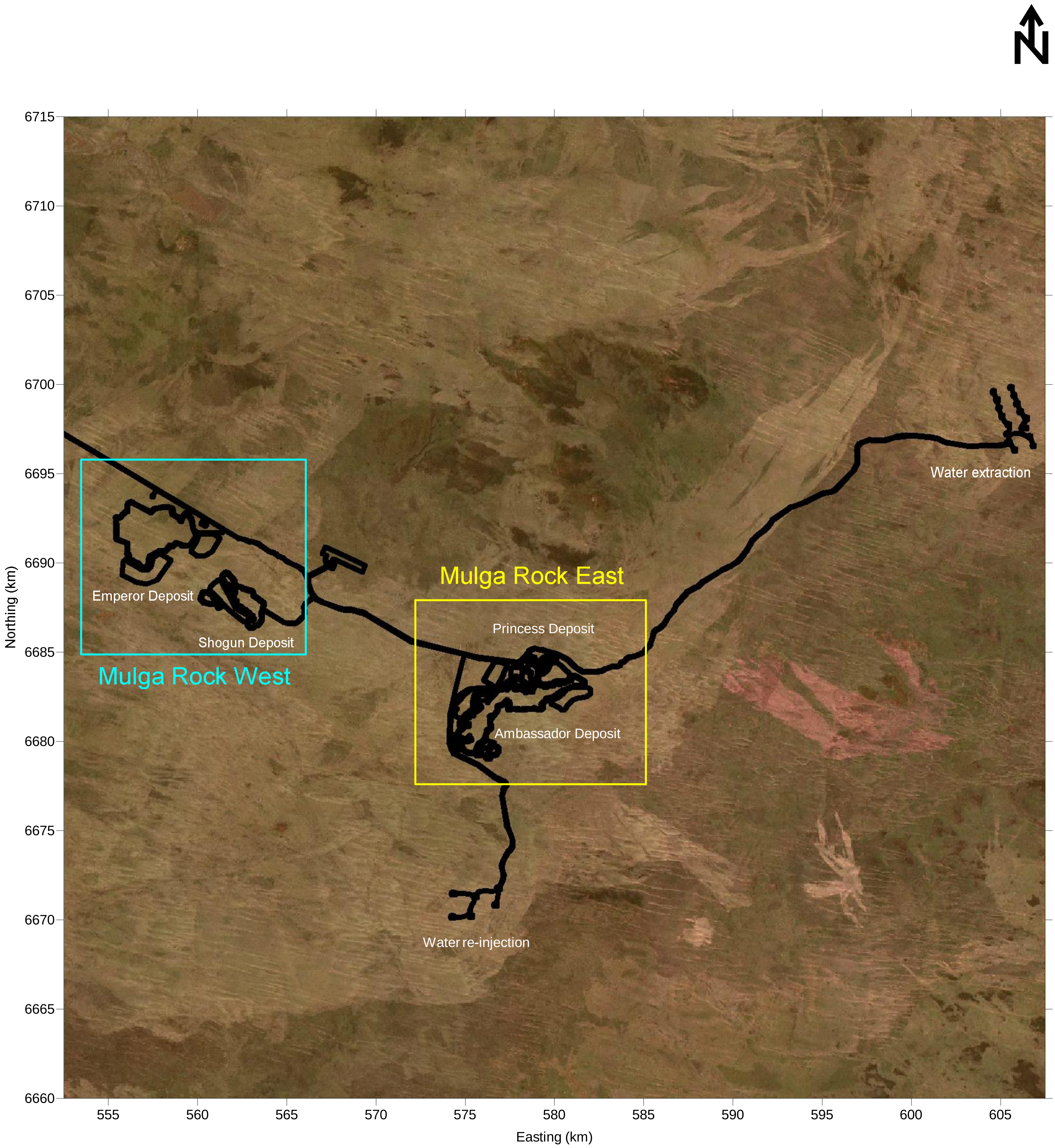
Mulga Rock Uranium Project Dispersion Modelling

FIGURE 2-1

Proposed MRUP site and receptor locations

CREATED	CHECKED	APPROVED	DATE	FILE LOCATION	DRAWING NO.	REVISION
LC	JF	JF	17.10.15	G:/61/32680/Technical/Surfer/Figure 01	Figure 2-1.srf	1



LEGEND

Proposed mine layout

SCALE

0 4 8 12 16
Kilometres (at A3)

MAP PROJECTION:
Transverse Mercator

HORIZONTAL DATUM:
Geocentric Datump of Australia (GDA)

GRID:
Map Grid of Australia 1994, Zone 51

DATA SOURCE:
LGATE_MGA51_20150220

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Mulga Rock Uranium Project Dispersion Modelling

FIGURE 2-2

MRUP ore deposit locations

CREATED	CHECKED	APPROVED	DATE	FILE LOCATION	DRAWING NO.	REVISION
LC	JF	JF	17.10.15	G:/61/32680/Technical/Surfer/Figure 01	Figure 2-2.srf	0

2.2 Emission sources

2.2.1 Mine operational dust emission sources

The following processes are expected to produce significant dust emissions.

Mechanical emission sources:

- Loading ore and waste rock
- Hauling ore and waste rock
- Light vehicle traffic (including buses)
- Grading of haul roads
- Waste rock dumping and dozing
- Ore dumping and conveying (transfer points) within the processing plant[5]

Wind erosion dust sources:

- Active pit area (worst case, when the pit depth is minimal)
- Waste rock dump
- Roads (haul and light vehicle roads)
- Tailings dam (surface storage only)[6]
- Ore stockpile[5]

Undeveloped and rehabilitated capped pits (five years post capping and seeding) are taken as background dust sources and will therefore not be included in the modelling process.

2.2.2 Power station pollution sources

The main source of other pollutants is the power station. The principle emissions of criteria pollutants from diesel fired power stations are products of combustion including:

- Oxides of nitrogen (NO_x)
- Sulphur dioxide (SO_2)
- Particulate matter less than 10 microns in aerodynamic diameter (PM_{10})
- Volatile organic compounds (VOCs)

2.2.3 Greenhouse gases

Greenhouse gases are produced from a number of sources throughout the mine site and power station. These are:

- Emissions from transporting materials (diesel use in vehicles)
- Emissions from power generation (diesel use in generators)
- Emissions from use of carbonates for production of uranium oxide and other precious metal concentrates
- Emissions from use of oils and lubricants in vehicle and equipment maintenance

[5] Potential stockpile in the event that the processing plant is not operational for a period

[6] Whilst tailings storage dams are expected to be maintained in a wet condition, it is likely that some areas will dry to an extent where wind erosion may occur. However, as tailings within pits are likely to be significantly lower than local ground surface, negligible emission are expected from these sources. As such, tailings dam emissions will be modelled for the surface tailings dam only.

It is expected that oil and lubricant use will be negligible when compared to diesel use for transport and power generation. As such, it is not included in the greenhouse calculations within this report.

3. Emissions inventory

3.1 Mine operation dust sources

The predominant mine operation dust sources include mechanical sources (trucking, conveying, dozing and grading) and wind erosion sources (cleared areas and stockpiles). The following sections detail the methods used to calculate emission rates for various sources. The calculated emission rates for each modelled scenario are summarised in Section 8.1 of this report.

3.1.1 Wind erosion emissions

Shao *et. al.*[7] describes the process by which dust lift off occurs for three grain sizes:

- Large particles (>1000 µm) remain stationary or move along the ground (creep) as they are too aerodynamically heavy.
- Sand particles (typically between 60 and 1000 µm) are easily lifted from the surface into saltation motion as they have small threshold velocities. This leads to sand drift.
- Dust particles (typically <60 µm) are not lifted directly from the surface (under normal conditions) due to large threshold velocities which are present due to large inter-particle cohesive forces. However, when saltation occurs (by sand particles), dust particles are ejected from the surface due to sand grain impacts. This is termed saltation bombardment. In the atmosphere, turbulence and buoyancy keep the dust particles suspended for a period of time (determined by a number of factors) until deposition occurs, often many kilometres from the original source.

These movements are illustrated in Figure 3-1.

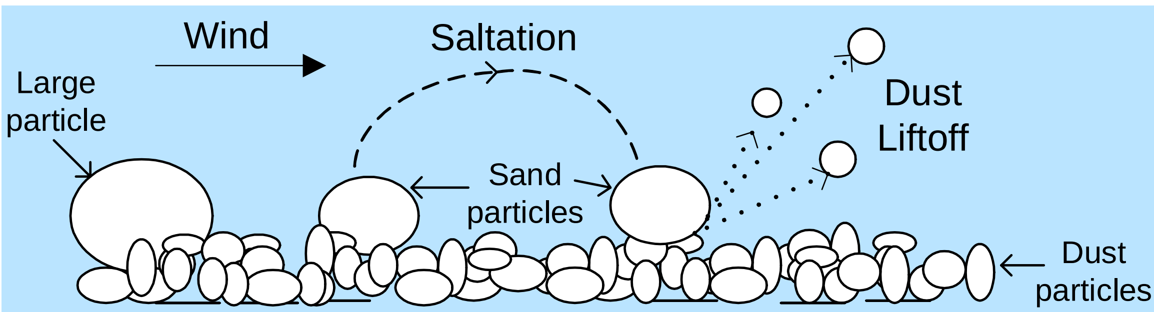

Figure 3-1 Dust lift off resulting from saltation of sand particles

An SKM study[8] calculated stream wise dust flux (Q(d)) for a particle size as following Equation 3-1.

Equation 3-1

$$\tilde{Q}(d) = \left(\frac{c_s \rho}{g}\right) \times u_*^3 \left[1 - \left(\frac{u_{*t}(d)}{u_*}\right)^2\right] \quad (u_* \geq u_{*t})$$

$$= 0 \quad (u_* < u_{*t})$$

7 Shao, Raupach and Leys,(1996) *A model for predicting Aeolian sand drift and dust entrainment on scales from Paddock to Region*. Australian Journal fo Soil Research, 34, pp. 309-342.

8 SKM (Sinclair Knight Merz), 2004. *Kwinana residue area dust emission modelling: Final 12/11/04.*

Where u_{*t} is the threshold friction velocity, u_* is the frictional velocity, c_s is a coefficient of order 1, ρ is the air density and g is gravity.

In the SKM study, U was assumed to be directly proportional to u_* and the first term was simplified as constant of proportionality, which was determine when calibrating the model.

However, Shao *et. al.* indicates that Equation 3-1 is for estimating stream wise sand flux (i.e. d = d_s). Shao *et. al.* goes on to postulate that dust flux, $F(d_d, d_s)$, can be calculated using Equation 3-2.

Equation 3-2

$$\tilde{F}(d_d, d_s) = \frac{2}{3}\left(\frac{\rho_P}{\rho}\right)\left[\frac{\beta\gamma g}{\{u_{*t}(d_d)\}^2}\right]\tilde{Q}(d_s)$$

Where ρ_P and ρ are the density of the particle and air, β is a constant bombardment parameter and γ is a dimensionless constant empirically derived as 2.5.

By substituting the stream wise sand flux (Equation 3-1) into the dust flux (Equation 3-2), GHD has derived Equation 3-3.

Equation 3-3

$$F(d_d, d_s) = B \times u_* \left(\frac{u_*^2}{u_{*t}^2} - 1\right) \qquad (u_* \geq u_{*t})$$

$$= 0 \qquad (u_* < u_{*t})$$

Where:

- F is the average hourly dust flux (PM_{10} or TSP) per active area for a given area. It has units of $g/s/m^2$.
- B is a dimensioned constant of proportionality that incorporates particle and air densities, a bombardment constant, source particle size distribution, gravity, ground cover, a degree of management effort and other empirical constants.
- u_* is the average hourly surface friction velocity for the active area
- $u_{*,t}$ is the average hourly threshold friction velocity for dust lift-off.

GHD has adopted the above methodology for a number of similar studies[9].

Calculation of u_*

u_* values are provided as output from the CALMET meteorological model (see Section 6 for more information on CALMET model development).

Calculation of u_{*t}

Equation 3-4 below may be used to determine u_{*t}. This is an adapted form of the u_*, equation presented in Shao *et. al*.

Equation 3-4

$$u_{*t} = \frac{u_{*,t,dry}}{H(\omega)}$$

[9] GHD, 2009. *Kwinana Residue Dust Emissions Study Report for Alcoa of Australia*
GHD. 2013 *Pinjarra Residue Dust Emissions Study Report for Alcoa of Australia*
GHD, 2014 *Project Shaheen Air Quality Assessment Report for Mubadala & DUBAL*

Where $u_{*,t,dry}$ is the average threshold friction velocity for the drying area when the drying area is dry and H(ω) is a measure of soil wetness where 0 is a wet soil and 1 is a dry soil. The following $u_{*,t,dry}$ values were adopted for this study:

- $u_{*,t,dry}$ = 0.3 for tailings dam (majority of area is wet)
- $u_{*,t,dry}$ = 0.232 for other areas

It is noted that Shao *et. al.* includes a ground cover, or management function within the denominator of Equation 3-4. As GHD has no means of calculating an hourly varying management of cover factor, GHD has assumed it is a constant which is effectively incorporated into the calibration factor B of Equation 3-3. Incorporation of a valid management function, based on a continuous measure of management effort could be a significant future improvement to the emissions model.

Calibration of B

In the absence of measured hourly dust concentration data for the typical site conditions, B values were adjusted to give the overall hourly emission rates in line with the National Pollutant Inventory (NPI) default emission values of 0.4 and 0.2 kg/ha/hr for TSP and PM_{10}, respectively. The B values used for this assessment were:

- $B_{TSP} = 2.75x10^{-4}$
- $B_{PM10} = 1.38\ x10^{-4}$

3.1.2 Mechanical emissions

Mechanical emission factors (EF) are calculated using a combination of process rates, ore properties and emission factors from the NPI estimation manual for mining[10]. Table 3-1 shows NPI equations used within this study.

3.1.3 Control factors

Emission factors were multiplied by various ratios, depending on controls employed to reduce dust emission from various dust sources. Control factors are from the NPI manual for mining[10]. The following control factors were utilised in this study for various activities.

- Hauling – 75% for level 2 watering (>2 litres/m^2/hr)
- Wind erosion from stockpiles – 50% for water sprays (standard irrigation to maintain moisture content in soil)
- Unloading trucks – 70% for water sprays
- Rehabilitation (vegetation) – 30% for primary rehabilitation, 40% for vegetation established but not self-sustaining, 60% for secondary rehabilitation and, 90% for revegetation

10 National Pollutant Inventory, 2012. *National Pollutant Inventory Emission Estimation Technique Manual for Mining, 3.1*.

Table 3-1 Emission estimate NPI emission factor equations

Equation ID	Equation	Constants	Dust sources
Equation 3-5 Excavators/ shovels/ front end loaders	$EF(kg/t) = k \times 0.0016 \times \frac{\left(\frac{U_{(m/s)}}{2.2}\right)^{1.3}}{\left(\frac{M_{(\%)}}{2}\right)^{1.4}}$ Where: U is mean wind speed, M is % moisture	$k_{TSP} = 0.74$, $k_{PM10} = 0.35$ U = (3.5 m/s) M = 5% for low grade rock, 20 % for ore	Ore loading Low grade rock loading
Equation 3-6 Wheel generated dust	$EF(kg/VKT) = \frac{0.4536}{1.6093} \times k \times \left(\frac{S_{(\%)}}{12}\right)^{a} \times \left(\frac{W_{(t)}}{3}\right)^{b}$ Where: s is % silt content, $W_{(t)}$ is vehicle mass, and k, a and b are empirical constants.	(TSP / PM_{10}) a: 0.7 / 0.9 b: 0.45 / 0.45 k: 4.9 / 1.5 S = 6% (road surface) W(t) = 384 for HV, 5 for LV (inc. buses).	Hauling ore Hauling low grade rock Miscellaneous vehicle travel
Equation 3-7 Dumping	$EF_{TSP}(kg/t) = 0.012$ $EF_{PM10}(kg/t) = 0.0043$		Dumping ore Dumping low grade rock
Equation 3-8 Dozing	$EF(kg/h) = a \times \frac{s^{b}{}_{(\%)}}{M^{1.4}{}_{(\%)}}$ Where: s is % silt content, M is % moisture content	(TSP / PM_{10}) a: 2.6 / 0.34 b: 1.2 / 1.5 c: 1.3 / 1.4 s = 6% and M = 5% (low grade rock)	Low grade rock dozing
Equation 3-9 Grading	$EF(kg/VKT) = 0.0034 \times S^{a}$ Where: S is mean grader speed	(TSP / PM_{10}) a: 2.5 / 2.0 S = 10 km/hr	Grading roads
Equation 3-10 Conveying	$EF_{TSP}(kg/t) = 0.005$ $EF_{PM10}(kg/t) = 0.002$	For high moisture content ores	Processing plant conveyor 1 Processing plant conveyor 2

3.2 Power station pollutants

The principle emissions of criteria pollutants from the diesel gensets would be products of combustion including oxides of nitrogen (NO_X), sulphur dioxide (SO_2), particulate matter less than 10 and 2.5 microns in aerodynamic diameter (PM_{10} and $PM_{2.5}$) and volatile organic compounds (VOCs).

3.2.1 Emissions estimation

Emissions from diesel gensets were estimated using emission factors from the NPI emissions estimation manual for combustion engines.[11]

Emissions were estimated using the formula:

Equation 3-11
$$E_i = \frac{(FC \times EF_i \times 1{,}000)}{(365 \times 24 \times 60 \times 60)}$$

Where: E_i = Emission rate of pollutant *i* (g/s)
FC = Fuel consumption of each diesel genset (m^3/yr)
EF_i = Emission factor for pollutant *i* (for a stationary diesel engine greater than 450 kW) (kg/m^3)

Table 3-2 outlines the estimated emissions of criteria pollutants from each 1 MW diesel genset based on annual fuel consumption of 2891 m^3.[12] Table 3-3 outlines the estimated emissions of total and constituent VOCs.

Table 3-2 NPI estimated emissions for criteria pollutants, 1 MW genset

Pollutant	EFi (kg/m^3)[13]	Ei (g/s)
Oxides of nitrogen [14]	52.6	2.86
Carbon monoxide	14.0	1.28
Particulates as PM_{10}	1.64	0.15
Sulphur dioxide [15]	16.6	0.002

Table 3-3 NPI estimated emissions of VOCs, 1MW genset

Pollutant	EFi (kg/m^3)[16]	Ei (g/s)	% total VOCs
Total VOCs	1.32	0.121	-
Acetaldehyde	0.000414	0.00004	0.03%
Benzene	0.128	0.00117	0.97%
Formaldehyde	0.0013	0.00012	0.10%
Toluene	0.00462	0.00042	0.35%
Xylene	0.00322	0.00030	0.24%
Other non speciated VOCs	-	0.11895	98.31%

11 National Pollutant Inventory 2008. NPI *Emissions Estimation Technique Manual (EET) for Combustion Engines*.
12 Annual fuel consumption based on 330 L/hr use for each genset.
13 From Table 15 (page 33) *EET for Combustion Engines*
14 Diesel gensets assumed to be controlled diesel engines
15 Calculated based on the percentage of sulphur in diesel, regulated at 50 ppm (0.005%)
16 From Table 15 and Table 16 (page 33) *EET for Combustion Engines*

3.2.2 Start up and upset conditions

The diesel gensets to be installed at the power station will operate based on the required load, with gensets starting up and shutting down automatically. Like all diesel engines, there is excess fuel on startup and the emissions may be slightly higher than during operation. However, the gensets have guaranteed emission limits which are met during all ranges of operation, including start up. As emissions at start up comply with the manufacturer guaranteed limits, start-up conditions have not been further assessed.

Operation of the diesel gensets will be monitored continuously and any performance degradation will be identified using on board sensors. Upset operations are not expected to account for significant periods and hence have not been assessed.

3.2.3 Mitigation measures

Diesel gensets installed for the power station will automatically start up and shut down based on the required load, conserving fuel and reducing emissions.

Emissions from the diesel gensets are minimised by ensuring all the gensets are well maintained and operated using ultra low sulphur (50 ppm) diesel.

3.3 Greenhouse gases

Under National Greenhouse and Energy Reporting (NGER) legislation (s 1.18 *National Greenhouse and Energy Reporting (Measurement) Determination 2008* (NGER (Measurement) Determination)) the person with operational control of a facility is responsible for reporting the facilities' annual emissions.

The following are the most significant emissions sources on site.

- Vehicle movement (combustion of diesel)
- Energy production from the power station (combustion of diesel) for operation of minesite and borefield
- Use of carbonates for production of uranium oxide and other precious metal concentrates

3.3.1 Vehicle movement

Emissions from transport of products can be estimated using Equation 3-12:

Equation 3-12

$$E_{ij} = \frac{Q \times EF_j \times EC_i}{1000}$$

where:

E_j is the emission of in CO_2-e tonnes

Q is the quantity of material being burned in kL for transport purposes

EF_j is the emission factor per tonne of material used measured in kg CO_2-e/GJ. The emission factor for diesel is 69.9 (combined emissions of CO_2, NH_4 and N_2O).

ECj is the energy content factor in GJ/kL for diesel. The energy factor for diesel is 38.6.

3.3.2 Energy production (diesel generators)

Emissions from the burning of diesel for energy production can be estimated Equation 3-13:

Equation 3-13

$$E_{ij} = \frac{Q \times EF_j \times EC_i}{1000}$$

where:

E_j is the emission of in CO_2-e tonnes

Q is the quantity of material being burned in kL

EF_j is the emission factor per tonne of material used measured in kg CO_2-e/GJ. The *emission factor for diesel is 69.5 (combined emissions of CO_2, NH_4 and N_2O).*

ECj is the energy content factor in GJ/kL for diesel. The energy factor for diesel is 38.6.

3.3.3 Use of carbonates for production of product

Emissions from the production of uranium oxide and other precious metal concentrates can be calculated following Equation 3-14.

Equation 3-14

$$E_{ij} = Q_i \times EF_j \times F_{cal}$$

where:

E_j is the emission of in CO_2-e tonnes

Q_i is the quantity of raw carbonate material (i) consumed in the production of product in tonnes

EF_j is the emission factor for raw carbonate (i) measured in tonnes of emissions of carbon dioxide per tonne of carbonate. The factor for calcium carbonate is 0.396.

F_{cal} is the fraction of raw carbonate consumed in the industrial process per year

4. Assessment criteria

Air quality impacts are assessed by comparing monitoring results or model predictions with appropriate criteria. The criteria referred to in this assessment include:

- National Environment Protection Measures (NEPM)
- Victorian Environmental Protection Authority (Vic EPA) Design Criteria
- WA Environmental Protection Authority (EPA) Guidance Statements

4.1 National Environment Protection Measures

4.1.1 Air NEPM

The *National Environment Protection (Ambient Air Quality) Measure* (Air NEPM) was developed to provide benchmark standards for ambient air quality to ensure all Australians have protection from the potential health effects of air pollution. Air NEPM standards have been developed for carbon monoxide (CO), NO_2, photochemical oxidants (as ozone (O_3)), SO_2, lead and PM_{10}.[17] Air NEPM standards are provided in Table 4-1.

Table 4-1 *National Environment Protection (Ambient Air Quality) Measure standards*

Pollutant	Averaging period	Maximum concentration[18]
Carbon monoxide	8-hours	11,254 µg/m^3
Nitrogen dioxide	1-hour	247 µg/m^3
	Annual	62 µg/m^3
Photochemical oxidants (as ozone)	1-hour	214 µg/m^3
	4-hour	172 µg/m^3
Sulphur dioxide	1-hour	572 µg/m^3
	24-hours	229 µg/m^3
	Annual	57 µg/m^3
Lead	Annual	0.5 µg/m^3
Particulates as PM_{10}	24-hours	50 µg/m^3
Particulates as $PM_{2.5}$	24-hours	25 µg/m^3
	Annual	8 µg/m^3

In July 2014, National Environment Protection Council (NEPC) released an *Impact Statement for Draft Variation to the National Environment Protection (Ambient Air Quality) Measure*. This impact statement outlines in some detail the proposed variation to the AAQ NEPM. These included the introduction of an annual standard of 20 µg/m^3 for PM_{10}.

4.1.2 Air Toxics NEPM

The *National Environment Protection (Air Toxics) Measure* (Air Toxics NEPM)provides a framework for monitoring, assessing and reporting on ambient levels of five air toxics; benzene, formaldehyde, toluene, xylenes and polycyclic aromatic hydrocarbons (PAHs), in order to facilitate the collection of information for the future development of air quality standards for these pollutants (NEPC 2004). Air Toxics NEPM standards are provided in Table 4-2.

[17] NEPC, 1998. *National Environment Protection Measure for Ambient Air Quality*. Canberra, June 1998

[18] Concentrations of gaseous pollutants have been converted from the Air NEPM standard expressed as ppm at 0ºC and 1 atmosphere

Table 4-2 *National Environment Protection (Air Toxics) Measure* standards

Pollutant	Averaging period	Maximum concentration[19]
Benzene	Annual	10.5 µg/m^3
Toluene	24-hours	4114 µg/m^3
	Annual	411 µg/m^3
Xylenes (as total of ortho, meta and para isomers)	24-hours	1183 µg/m^3
	Annual	946 µg/m^3
Formaldehyde	24-hours	53.6 µg/m^3
Benzo(a)pyrene (as a marker for PAHs)	Annual	0.3 ng/m^3

The draft *State Environmental (Ambient Air) Policy 2009* (Ambient Air SEP) gives effect to the NEPM standards and goals by establishing such standards as environmental quality criteria. The Ambient Air SEP states *"Environmental quality criteria should act as a trigger for investigation and management action when they are not met"*[20].

Environmental quality criteria are applied across the whole State except where an Environmental Protection Policy (EPP) exists, within the boundary of an industrial premise, within industrial buffer areas, within the boundary of a road or where there are no sensitive receptors[20].

Consistent with the application of environmental quality criteria, Air NEPM standards have not been applied within the Project disturbance area. However, as sensitive receptors are present with this area, such as the Accommodation Camps, Air NEPM standards have been applied at the location of such sensitive receptors. Assessment of compliance with NEPM standards has been made at the maximum predicted value.

4.2 Victorian Environmental Protection Authority Design Criteria

The Victorian Environment Protection Authority (Vic EPA) Design Criteria established under the Victorian *State Environment Protection Policy (Air Quality Management)* (SEPP-AQM) were used during this assessment where NEPM standards were not available.

Similar to Air NEPM, SEPP-AQM design criteria have not been applied within the Project disturbance area but have been applied at sensitive receptors located within this area. SEPP-AQM design criteria are taken at the 99.9 percentile concentration using an averaging time of one hour or less, which corresponds to the 9th highest hourly concentration when using one year of meteorological data[21]. The relevant SEPP-AQM design criteria are provided in Table 4-3.

[19] Concentrations of gaseous pollutants have been converted from the Air Toxis NEPM standard expressed as ppm at 0ºC and 1 atmosphere

[20] Government of WA, 2009. *State Environmental (Ambient Air) Policy 2009 - Draft Policy for Public and Stakeholder Comment*. Perth, June 2009

[21] Vic EPA, 2001. *State Environment Protection Policy (Air Quality Management)*, Victorian Government Gazette, December 2001.

Table 4-3 Victorian *State Environment Protection Policy (Air Quality Management)* design criteria

Pollutant	Averaging period	99.9 %ile concentration [22]
Hexane	3-minutes	5900 µg/m^3
Toluene	3-minutes	650 µg/m^3
Xylenes	3-minutes	350 µg/m^3
Phenol	3-minutes	36 µg/m^3
Formaldehyde	3-minutes	40 µg/m^3
Acetaldehyde	3-minutes	76 µg/m^3
Acetone	3-minutes	40,000 µg/m^3
Particulate matter as PM_{10}	1-hour	80 µg/m^3

4.3 WA Environmental Protection Authority

4.3.1 Total suspended particulates (TSP)

There are no specific statewide criteria for TSP. Historically, EPA have applied the standard and limits for TSP from the *Environmental Protection (Kwinana) (Atmospheric Wastes) Policy 1999* (Kwinana EPP). The Kwinana EPP defines limits (concentrations of atmospheric waste that shall not be exceeded) and standards (concentrations of atmospheric waste that should desirably not be exceeded) for TSP. The Kwinana EPP is divided into three defined areas namely:

- Area A - Core industrial area
- Area B - Buffer area
- Area C - Rural residential area beyond the buffer area

The standard and limits for TSP in each of the buffer zones is presented in Table 4-4.

Table 4-4 Kwinana EPP standards and limits for TSP

Area	TSP standard (µg/m^3)	TSP limit (µg/m^3)	Averaging period
Policy area	-	1,000	15-minutes
A	150	260	24-hours
B	90	260	24-hours
C	90	150	24-hours

4.3.2 Dust deposition

There are no specific statewide criteria for dust deposition. EPA have applied the NSW Department of Environment and Conservation (NSW DEC) dust deposition standard provided in the *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW*.[23] NSW DEC impact assessment goals for dust deposition such that nuisance dust impacts could be avoided are:

- Maximum increase in deposited dust of 2 g/m^2/month
- Maximum total deposited dust level of 4 g/m^2/month

4.4 Air pollutants assessed

Assessment criteria for the Project are summarised in Table 4-5, for each component of the Project.

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[22] Gas volumes expressed at 25ºC and 1 atmosphere

[23] NSW DEC (NSW Department of Environment and Conservation), 2005. *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales.* Sydney, August 2005

Table 4-5 Assessment criteria

Pollutant	Averaging period	Max. / 99.9th %ile	Criterion
Mine operations			
Total suspended particles	24-hours	Maximum	90 µg/m^3
Particulates as PM_{10}	24-hours	Maximum	50 µg/m^3
	1-hour	99.9 %ile	80 µg/m^3
	Annual[24]	Maximum	20 µg/m^3
Dust deposition	Annual	Maximum	2.0 g/m^2/month
Power station (other pollutants)			
Carbon monoxide	8-hours	Maximum	11,254 µg/m^3
Nitrogen dioxide	1-hour	Maximum	247 µg/m^3
	Annual	Maximum	62 µg/m^3
Sulphur dioxide	1-hour	Maximum	572 µg/m^3
	24-hours	Maximum	229 µg/m^3
	Annual	Maximum	57 µg/m^3
Xylenes	3-minutes	99.9 %ile	350 µg/m^3
Formaldehyde	3-minutes	99.9 %ile	40 µg/m^3
Acetaldehyde	3-minutes	99.9 %ile	76 µg/m^3
Benzene	Annual	Maximum	10.5 µg/m^3
Toluene	3-minutes	99.9 %ile	650 µg/m^3
	24-hours	Maximum	4114 µg/m^3
	Annual	Maximum	411 µg/m^3

4.5 Occupational exposure

Table 4-6 lists occupational air quality criteria as referred from WorkSafe Australia's exposure standards[25]. A time weighted average (TWA) concentration is the standard criterion, measured for and eight hour working day and five day working week. A short term exposure level (STEL) standard is a 15-minute average which is not to be exceeded.

Diesel particulate matter (DPM) refers to the fraction of diesel exhaust consisting of very small particles (typically 15-30 nanometres in diameter) which rapidly agglomerate together to form larger particles typically <1 µm in aerodynamic size PM_1[26].

Occupational guidelines for DPM have not been provided by NOHSC. Australian Institute of Occupational Hygienists (AIOH) released a Position Paper outlining their recommendation for an occupational DPM 8-hour exposure standard of 100 µg/m^3 measured as elemental carbon (equivalent to 130 µg/m^3 measured as total carbon)[26].

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[24] Proposed addition to the Air NEPM

[25] NOHSC, 1995. *Exposure Standards for Atmospheric Contaminants in the Occupational Environment*. Canberra, May 1995.

[26] AIOH, 2007. *Diesel Particulate and Occupational Health Issues – AIOH Position Paper*. Melbourne, May 2007

Table 4-6 Occupational air quality criteria

Pollutant	TWA (8-hour), µg/m^3	TWA (12-hr)[27], µg/m^3	STEL (15-minute), µ/m^3
Carbon monoxide	34,000	17,000	--
Nitrogen dioxide	5600	2800	9400
Sulphur dioxide	5200	2600	13,000
Diesel particulate matter	130	65	--
Acetaldehyde	36,000	18,000	91,000
Benzene	3200	1600	--
Formaldehyde	1200	600	2500
Toluene	191,000	95,500	574,000
Xylenes	350,000	175,000	655,000

Occupational air quality criteria were only assessed against where Air NEPM of SEPP-AQM criteria were exceeded at the power station site.

[27] 12-hour TWA calculated using Brief and Scala Model outlined in Appendix B of Safe Work Australia, 2013. Guidance on the interpretation of work exposure standards for airborne contaminants. April 2013.

5. Existing environment

5.1 Topography and land use

The site is located in the Great Victoria Desert bioregion, which is characterised by dunefields, playa lakes and lunettes. The predominant vegetation in the area is marble gum, mulga and yarldarlba over spinifex grassland[28].

The Great Victoria Desert is little developed, with the majority of the area consisting of unallocated crown land, conservation reserves and Aboriginal land. There are no major population centres in the area. Mineral exploration is also evident in the area[28].

The closest major population centre to the MRUP site is Kalgoorlie, approximately 200 km to the south-west.

5.2 Meteorology

The site is located in an arid area, with limited and variable rainfall in any given year. For example, over the past 117 years, Leonora[29] has on average received 240 mm of rainfall annually. Each year has an average of 30 days that contribute to the rainfall totals[30].

Daytime temperatures typically reach 30 to 40 ºC during the summer and 18 to 30 ºC degrees in the winter. Temperatures are as low as 5 to 15 ºC during the winter months and 15 to 22 ºC during the summer months[30].

Leonora typically receives wind from the west in the morning. Afternoons are typically dominated by light to moderate wind from the east and south-east and light, moderate or strong winds from the west and north-west[30].

5.3 Existing air quality

There is limited publically available air quality data for the area. Dust has, however, been measured at the proposed MRUP site as follows:

- High volume air sampler (HVAS):
  - 56 samples taken since May 2012
  - Sample periods range from 1 to 37 days, but are usually one to four weeks long
- Dust deposition gauge
  - 9 samples each at up to ten sites taken since July 2013
  - Sample periods range from 29 to 86 days (one to three months)

Figure 5-1 shows the HVAS sample results, with the number of sampling days listed at the top of each column. Figure 5-2 shows the dust deposition results.

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28 Department of Environment, 2008. Great Victoria Desert bioregion. Supporting report to Rangelands 2008 – Taking the Pulse. Department of Environment, Government of Australia. Available online http://www.environment.gov.au/land/publications/acris-rangelands-2008-taking-pulse accessed 19/02/15.

29 Leonora is the closest Bureau of Meteorology (BoM) Automatic Weather Station (AWS) to the proposed site.

30 Statistical data for Leonora AWS retrieved from publically available data on the BoM website http://www.bom.gov.au/climate/averages/tables/cw_012046_All.shtml on 19/02/2015.

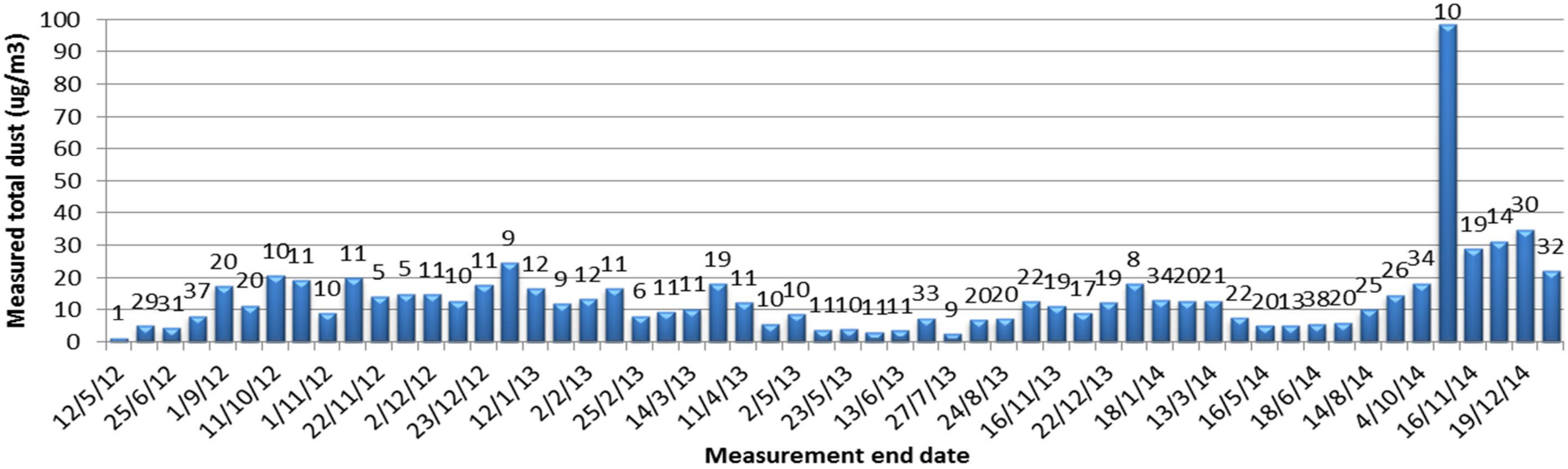

Figure 5-1 Measured HVAS dust concentration

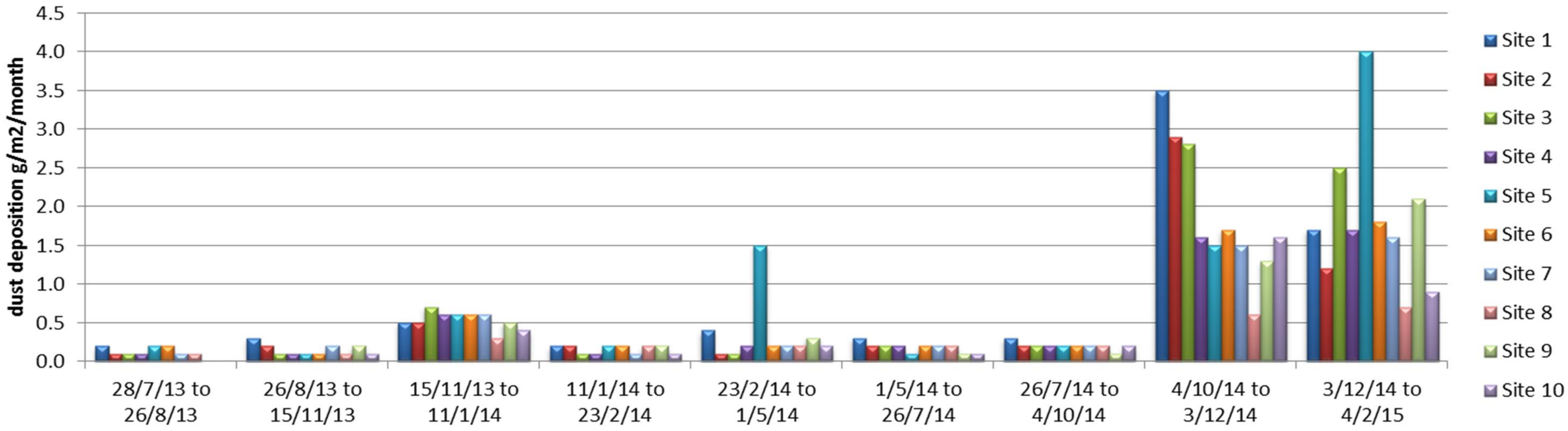

Figure 5-2 Measured dust deposition

Although the sample periods are highly variable, making any statistical analysis unsuitable, the general variation of measured concentrations is expected. The higher measured concentrations are observed during the typical dust season for the area (October through April).

It is of interest to note that a bushfire was the cause of the elevated HVAS measurement (98 µg/m^3 averaged over a 10 day sampling period). This illustrates that natural events can and do have a significant impact on local air quality from time to time.

As there are limited anthropogenic sources of pollutants in the area (Tropicana Gold Mine approximately 110 km to the north-east and Pinjin and Cundeelee settlements approximately 105 km to the west and 90 km to the south-west, respectively), background levels are unlikely to be of any significance.

5.4 Existing emissions

The area has a natural background dust concentration that is contributed to by sources such as bush fires or wind erosion. There are limited other sources in the area. As detailed in Section 5.3, the closest known sites in the area that may also produce dust or other pollutant emissions are the Tropicana Gold Mine, Pinjin and Cundeelee.

5.5 Sensitive receptors

The following receptor locations have been included in this investigation. Three are for existing or historical settlements in the area within a 200 km gird centred on the Project, whilst the remainder are associated with the proposed MRUP development.

It should be made clear that the Cundeelee settlement is an abandoned settlement, but is included as it is the only settlement in the southern direction.

Table 5-1 Receptor locations

Name	Detail	Easting, m	Northing, m	Distance from MRUP processing plant (km)
Tropicana Gold Mine	Active mine	651,500	6763,700	110
Pinjin	Existing pastoral station	473,900	6672,300	105
Cundeelee	Abandoned indigenous settlement	540,500	6601,000	90
Tenement boundary 1	MRUP boundary	566,740	6673,620	15
Tenement boundary 2	MRUP boundary	585,170	6677,920	9
Access Road	PNC and TPG access road	542,745	6703,620	40
Mining Village	Conceptual village location	567,730	6683,770	10

6. Meteorological modelling

6.1 Meteorological model choice

CALMET (v 5.8) is the 3D meteorological model pre-processor to the CALPUFF dispersion model (discussed in Section 7). CALMET includes a diagnostic wind field generator, with algorithms to generate slope flows, kinematic terrain effects (wind channelling), terrain blocking effects (stagnation), and also divergence minimisation (mass consistency) over spatially varying land uses and types. The latter can vary from industrial areas to barren land and even water bodies and ice.

CALMET also includes separate micrometeorological models to characterise both the overland and over water atmospheric boundary layers. The sub-models each formulate the evolution of spatially varying temperature profiles and the heights of the different mixed layers both over water and overland and the thermal internal boundary layer interface between them through a process of upwind spatial averaging. They also generate parameters that characterise the atmospheric stability within and above these layers.

This meteorological, micro-meteorological and land use information is passed to the CALPUFF dispersion model so that the manner in which emission plumes are transported and dispersed in the atmosphere can be determined.

6.2 Meteorological configuration

6.2.1 CALMET settings

CALMET settings were as per the CALPUFF guidance document[31] for "hybrid mode" using a combination of gridded meteorological data supplemented by surface data (three meteorological stations located at the MRUP site), except for the following:

- Kinematic effects were computed (IKINE = 1)

  The nature of the terrain means that hills and valleys create flow divergence and convergence as the wind moves around the natural obstacles. A better representation of the vertical velocity was required to maintain mass consistency and to more accurately represent the situations of "plume strike".

- The O'Brien procedure for vertical velocity adjustment was applied (IOBR = 1)

  With kinematic effects included, the O'Brien procedure was applied so that domain mass consistency could be maintained at the top of the domain.

The TERRAD variable was set to a value of 10 km based on an inspection of the terrain elevations in the vicinity of MRUP.

Terrain and land use data was derived from 90 m resolution topography obtained from the AUSLIG data set. Aerial imagery was applied to confirm land use characteristics as part of the verification process; no modifications were required. Figure 6-1 shows a summary of the terrain in the model domain. This model domain was used for all scenario models as variations in topography due to temporary structures are unlikely to have a significant impact on dispersion model results.

Table 6-1 provides a summary of key parameters used in the CALMET model

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31 Atmospheric Studies Group, 2011. *Generic Guidance and Optimum Model Setting for the CALPUFF Modelling System for Inclusion into the 'Approved Methods for Modelling and Assessments of Air Pollutants in NSW, Australia'*. Prepared for NSW Office of Environment and Heritage, Sydney Australia.

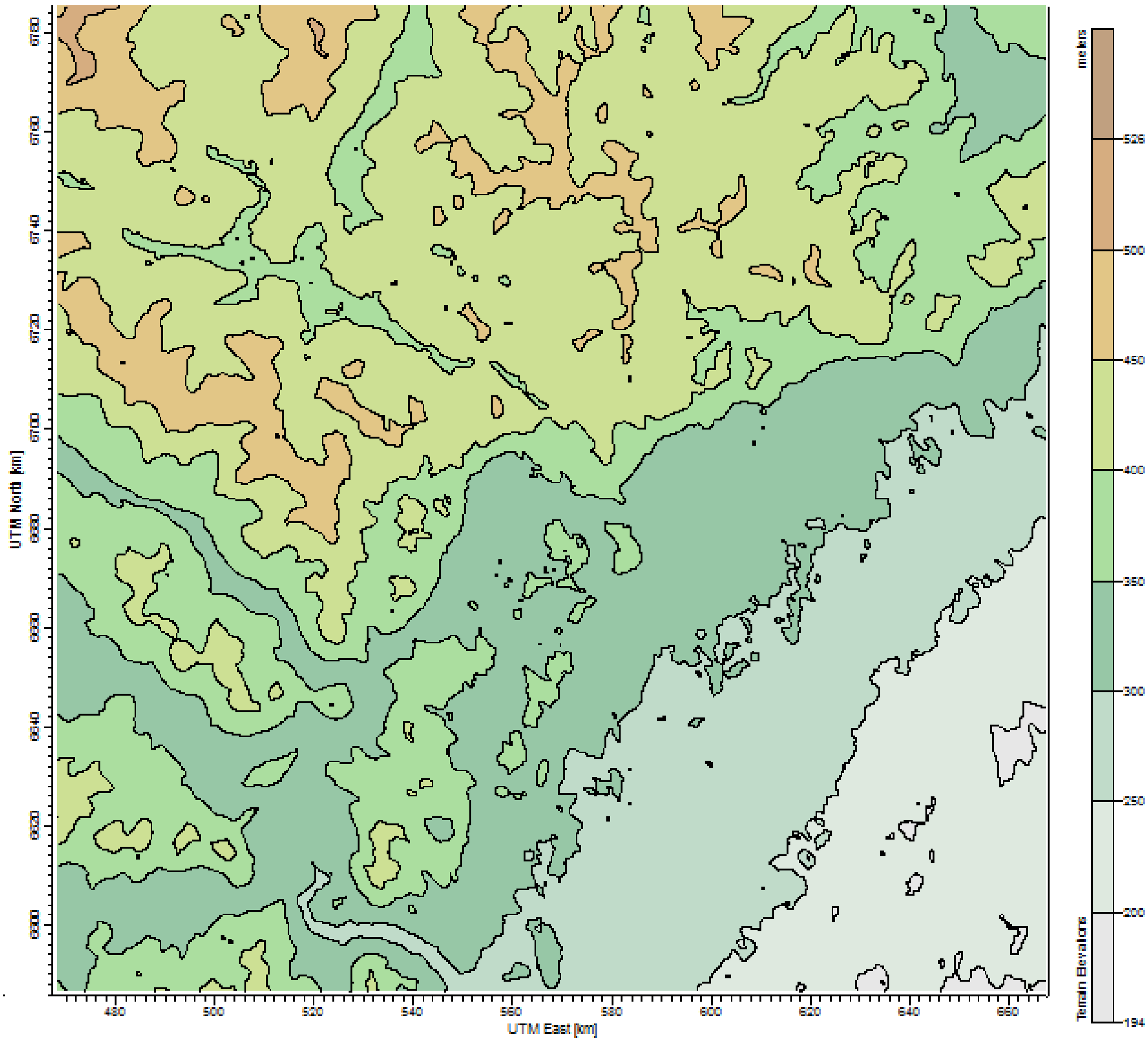


Figure 6-1 Terrain from model domain

Table 6-1 CALMET model configurations

Domain origin	UTM 51 coordinates 468 km east and 6586 km north
CALMET grid resolution	1 km
No. CALMET grids	Easting = 200; Northing = 200
No. vertical levels	11
Vertical levels (m)	0, 20, 40, 61, 80, 100, 120, 180, 420, 700, 1500, 2500
CALMET setting for hybrid mode	TERRAD = 10 km Kinematic effects O'Brien corrections

Other inputs into CALMET include:

- Surface data
- Upper data (synthesised using the The Air Pollution Model (TAPM).

6.2.2 Surface data

Three dedicated meteorological stations located in the proposed MRUP site have been measuring key parameters from 2009 to present. The three sites are:

- Airstrip (574.715 km E, 6684.600 km N, MGA94 zone 51)
- Emperor (557.391 km E, 6691.424 km N, MGA94 zone 51)
- Shogun (563.569 km E, 6687.909 km N, MGA94 zone 51)

Figure 6-2 shows the monitoring site locations.

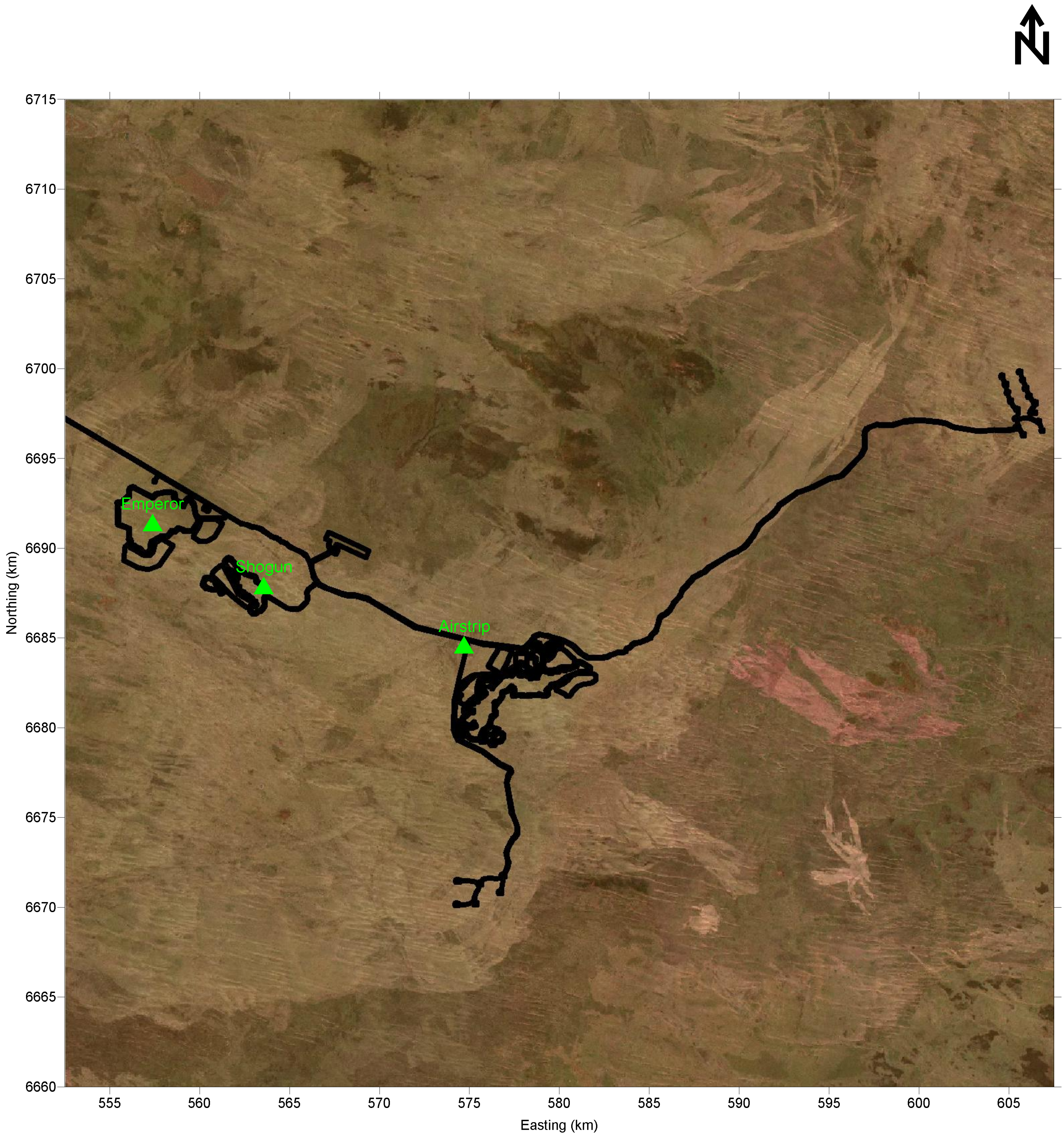
A review of measurements for the three sites included comparison against BoM Laverton AWS measured data to confirm and validate measurements at the MRUP site. The review also allowed for selection of an appropriate year long period to use in modelling. This year was chosen by choosing meteorological conditions that are most similar to typical meteorological patterns in the area. June 2012 through May 2013 was chosen as the most appropriate time period.

The following hourly measured parameters were adopted for input into the CALMET model.

- Wind speed
- Wind direction
- Ambient temperature
- Relative humidity
- Pressure
- Precipitation

In addition to this, ceilometer data from Laverton AWS was included in the data input to provide ceiling height and cloud cover (in tenths).

A summary of measured data is provided in Appendix A, as well as some basic statistical data which aided in choice of the modelling year.



LEGEND

Proposed mine layout

Meteorological monitoring site

SCALE

0 2 4 6

Kilometres (at A3)

MAP PROJECTION:
Transverse Mercator

HORIZONTAL DATUM:
Geocentric Datump of Australia (GDA)

GRID:
Map Grid of Australia 1994, Zone 51

DATA SOURCE:
LGATE_MGA51_20150220

CLIENTS | PEOPLE | PERFORMANCE

Vimy Resources Limited
Mulga Rock Uranium Project Dispersion Modelling

FIGURE 6-2

Meteorological monitoring sites

CREATED	CHECKED	APPROVED	DATE	FILE LOCATION	DRAWING NO.	REVISION
LC	JF	JF	17.10.15	G:/61/32680/Technical/Surfer/Figure 01	Figure 6-2.srf	0

6.2.3 Upper data

The 3D prognostic model The Air Pollution Model (TAPM) was used to synthesise upper data in the absence of suitable upper observations.

TAPM was configured using a nested model domain approach designed to capture:

- Broad scale synoptic flows
- Regional and broader scale sea and land breezes
- Regional and broader wind channelling around geographical features
- Influences of land use

The nested grids were then configured with surface characteristics such as terrain elevation, surface roughness, vegetation type, soil type, monthly varying (initial) deep soil moisture content and sea-surface temperature for open water bodies. The synoptic analysis for June was used with the model settings, shown in Table 6-2 for each of the project areas (coastal and inland).

Table 6-2 TAPM model configurations

Model description	MRUP project site
Three nested grids	10,000 m, 3000 m, and 1500 m resolution 81 x 81 grid points
Vertical levels	11 vertical levels, ranging up to 8000 m
Grids centred at	568000 m E and 6686000 m N, Map Grid of Australia, Zone 51
Vegetation, terrain and land use	Datasets provided with the model Where required, adjustments made, with cross-reference to aerial imagery, in the immediate area of the mine site.
Deep soil volumetric moisture content for land areas and air-sea temperature differences	Default
Surface vegetation and precipitation processes	Included (snow processes and non-hydrostatic process excluded)

Upper data from TAPM was then converted using CALTAPM to form data input files for use in the CALMET model.

7. Dispersion model development

7.1 Model selection

7.1.1 CALPUFF dispersion and deposition model

Due to the scale of the model domain, air dispersion modelling of MRUP emissions has been carried out using the US EPA approved CALPUFF dispersion model (version 5.8.4). CALPUFF is an advanced Lagrangian, non steady state air dispersion model. The model has been approved by the US EPA, *40 CFR Part 51 Guideline on Air Quality Models*[32], as the preferred model for assessing long range transport of pollutants and on a case by case basis for certain near field applications involving complex meteorological conditions.

The CALPUFF dispersion model utilises the three dimensional wind fields from CALMET to simulate the dispersion of air pollutants to predict ground level concentrations across a Cartesian gridded domain. CALPUFF contains parameterisations for complex terrain effects, overwater transport, coastal interaction effects, variability in land use (the latter two being of paramount importance in this assessment) and their associated meteorological effects, building downwash, wet and dry removal, and simple chemical transformation. CALPUFF employs the 3D meteorological fields generated from the CALMET model by simulating the effects of time and space varying meteorological conditions on pollutant transport, transformation and removal. CALPUFF contains algorithms that can remove near source effects such as building downwash, transitional plume rise, partial plume penetration, sub grid scale terrain interactions, as well as the long range effects of removal, transformation, vertical wind shear, overwater transport and coastal interactions.

Emission sources can be characterised as arbitrarily varying point, area, volume and lines or any combination of those sources within the modelling domain.

CALPUFF was used to simulate the dispersion characteristics and concentrations of pollutants generated by the proposed activities.

Key features of CALPUFF used to simulate dispersion in this assessment are:

- Emissions for each scenario (as detailed in Section 8.2 and 9.1. These emissions were characterised as either volume or area sources, with initial release geometries representative of each activity.
- The 1000 m resolution 3D winds and temperatures, the spatially varying micrometeorological fields used to characterise atmospheric turbulence and the geophysical data from CALMET were used to characterise transport and dispersion of the emissions to air.
- Dispersion option micro meteorology
- Averaging time of 1 hour
- Wind speed profile ISC rural
- Calm condition is defined as wind speeds less than 0.5 m/s
- Terrain heights at sources determined from geophysical data
- Discrete receptor heights of 1.5 metres
- Computational grid size was 200 x 200 km

[32] US EPA, 2005. *40 CFR Part 51 Guideline on Air Quality Models*

- Chemical transformation for pollutants was not modelled.
- Dust deposition was calculated for receptor locations using the dry and wet flux settings. Total dust was separated into three size fractions to accommodate this calculation (see Section 8.2.1).
- The plume element modelling method selected was ‘puff’
- The model was configured to predict concentrations over the sampling grid for the year 1 June 2012 through 31 May 2013, with the meteorology described in Section 6.
- The model run period was for 8760 hours (1 year)
- The CALPOST run period was also for 8760 (1 year) hours with output options only calculated for concentration with various averaging times to align with assessment criteria. A peak to mean ratio of 1.82 was used to convert 1 hour results to 3 minute results when assessing against VOCs.

The following section details the model configuration for each emission source.

8. Dust dispersion modelling results

8.1 Scenario development

Four scenario years were selected from the 16 planned operational years and one after closure. The selected years were chosen as they were considered to have the worst case emissions in different locations (determined from estimated throughput, and active areas). The five scenarios are:

- Scenario 1, Year 3

  The highest production year during the onset of mining, with a surface tailings dam still in production

- Scenario 2, Year 10

  The highest predicted production year for the life of mine

- Scenario 3, Year 11

  High mining rate, also with two active pits

- Scenario 4, Year 14

  Elevated mining rate, two active pits and production of an ore stockpile for processing in later years

- Scenario 5, closure (first year)

  The first year after mine closure, with the largest surface areas with partial rehabilitation.

The prevalence of modelling years later in the mining cycle is due to the higher mining rates in the later years of the Project, as well as the elevated number of active mining pits and increased number of areas where wind erosion may occur (overburden landforms, partially rehabilitated capped pits).

The closure scenario was included in order to quantify the dust impacts of the site upon conclusion of mining, but whilst the rehabilitation process (revegetation) is not fully complete. It is anticipated that rehabilitation will not be complete until full vegetation establishment (closure plus five years). The first closure year was chosen as it has the highest surface area of landforms that have incomplete rehabilitation.

Table 8-1 shows the predicted throughput for the 16 modelled operational years, as well as landforms that are in use or undergoing rehabilitation. The table provides the five selected scenario years in blue. The pit locations for each scenario are provided in Figure 8-1, as are other key landforms.

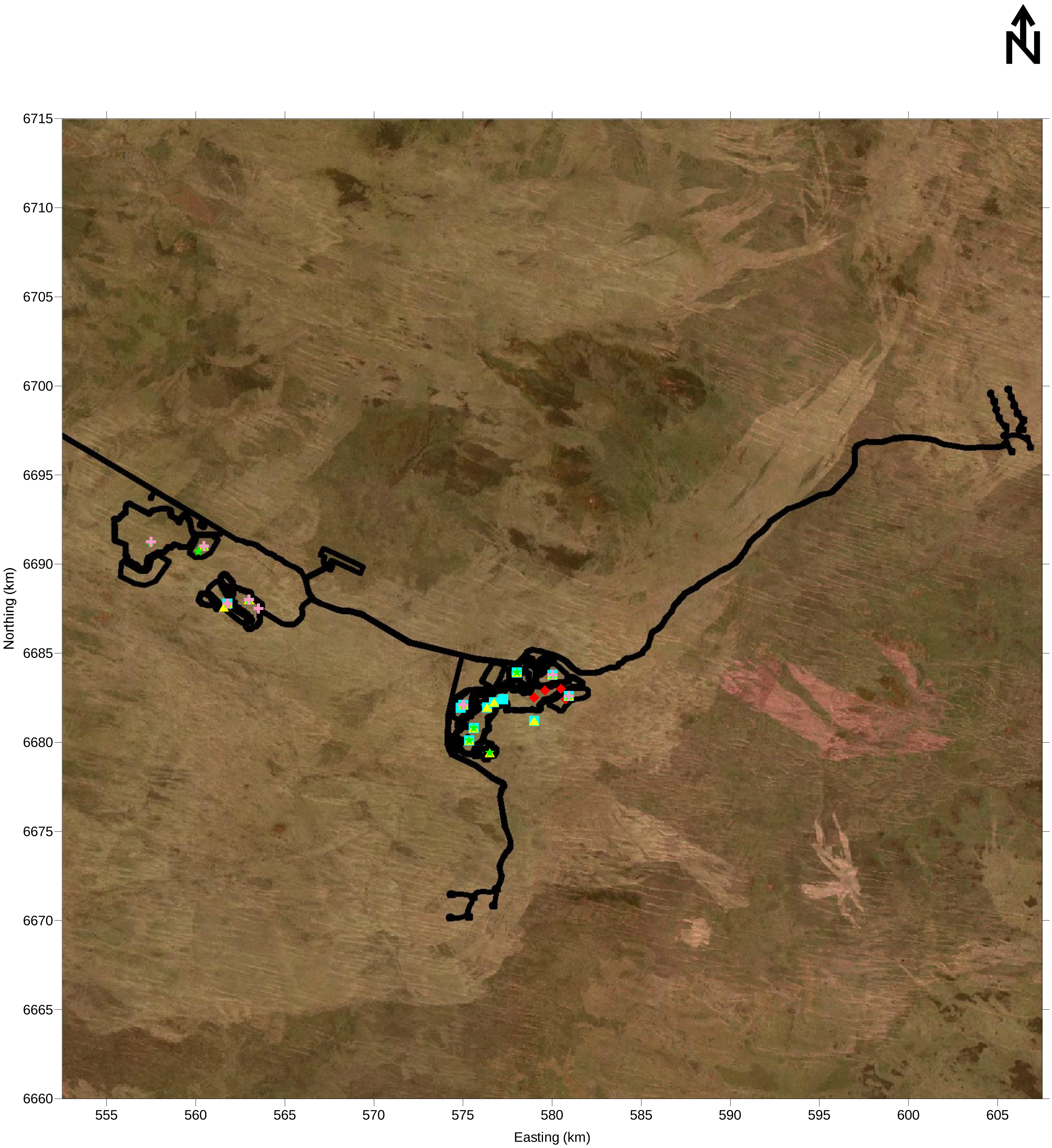
Table 8-1 Predicted throughput for life of mine

Year	Total throughput (Mtpa	Active Pit		Overburden Landforms		Surface tailings		Ore stockpile		Rehab in progress[33]	
		Total area (ha)	No# of pits	Total area (ha)	No# of sites	Total area (ha)	No# of sites	Total area (ha)	No# of sites	Total area (ha)	No# of sites
Mining year 1	2.08	15	1	7	1	41	1	-	-	0	0
Mining year 2	2.27	15	1	19	2	41	1	-	-	60	1
Mining year 3	2.38	15	1	19	2	40	1	-	-	120	2
Mining year 4	2.33	20	1	19	2	-	-	-	-	180	3
Mining year 5	2.78	15	1	27	3	-	-	-	-	240	4
Mining year 6	2.1	15	1	39	4	-	-	-	-	320	5
Mining year 7	1.95	15	1	70	5	-	-	-	-	320	5
Mining year 8	2.99	20	1	70	5	-	-	-	-	330	5
Mining year 9	3.93	20	1	70	5	-	-	-	-	350	5
Mining year 10	4.68	20	1	70	5	-	-	-	-	360	5
Mining year 11	3.39	27	2	70	5	-	-	-	-	390	5
Mining year 12	2.28	25	2	70	5	-	-	-	-	430	7
Mining year 13	3.36	20	1	70	5	-	-	-	-	450	7
Mining year 14	3.57[34]	25	2	70	5	-	-	20	1	450	7
Mining year 15	2.04[35]	15	1	70	5	-	-	25	1	450	8
Mining year 16	Process stockpiled	-	-	70	5	-	-	25	1	420	8
Rehab year 1	-	-	-	-	-	-	-	-	-	450	12
Rehab year 2	-	-	-	-	-	-	-	-	-	430	11
Rehab year 3	-	-	-	-	-	-	-	-	-	380	10
Rehab year 4	-	-	-	-	-	-	-	-	-	270	8
Rehab year 5	-	-	-	-	-	-	-	-	-	210	7

33 Capped pits or landforms in first five years of rehabilitation- after five year, emissions assumed to return to background.

34 Plus 2.2 Mtpa to be stockpiled for processing in year 15

35 Plus 3.7 Mtpa to be stockpiled for processing in year 16



LEGEND

- Proposed mine layout
- Scenario 1 source locations
- Scenario 2 source locations
- Scenario 3 source locations
- Scenario 4 source locations
- Scenario 5 source locations

SCALE

0 2 4 6 8

Kilometres (at A3)

MAP PROJECTION:
Transverse Mercator

HORIZONTAL DATUM:
Geocentric Datum of Australia (GDA)

GRID:
Map Grid of Australia 1994, Zone 51

DATA SOURCE:
LGATE_MGA51_20150220

GHD CLIENTS | PEOPLE | PERFORMANCE

Vimy Resources Limited
Mulga Rock Uranium Project Dispersion Modelling

FIGURE 8-1

Scenario source locations

CREATED	CHECKED	APPROVED	DATE	FILE LOCATION	DRAWING NO.	REVISION
LC	JF	JF	17.10.15	G:/61/32680/Technical/Surfer/Figure 01	Figure 8-1.srf	0

8.2 Scenario emission rates

Table 8-2 through Table 8-4 show the source details for the dust scenarios volume and area sources, whilst Table 8-5 through Table 8-9 provide the predicted emission rates for each scenario. Appendix B provides more detailed summaries of the modelled emissions estimates.

As shown in the tables, Scenario 1 contains a surface tailings dam dust source. It is assumed tailings emissions are relatively small for other scenarios as for the other scenarios the tailings is backfilled within pit voids. Scenario 4 contains an ore stockpile, which is to be maintained for processing in a later mining year.

It is assumed that hauling will be to the side of the active pit, with slurry pumping from this point to the processing plant.

8.2.1 Dust deposition

Dust deposition was determined by separating dust emission rates for each source into three fraction sizes. The emission rates for each fraction size were calculated through multiplication by a mass percentage ratio. The following ratios were employed for various sources:

Table 8-2 Size fraction ratios for deposition modelling

Source types	TSP size fraction	PM_{10} size fraction	$PM_{2.5}$ size fraction
Mechanical emissions (ore handling)[36]	5%	30%	65%
Mechanical emissions (low grade rock or hauling processes)[37]	15%	34%	49%
Wine erosion emissions (all sources)[38]	50%	43%	8%

36 Derived from grain size data for ore, as provided by Vimy.
37 Values from USEPA's AP42, Appendix B.2 Generalized Particle Size Distributions. Available online http://www.epa.gov/ttn/chief/ap42/appendix/appb-2.pdf
38 Values from USEPA's AP42 background document for revisions to fine fraction ratios for AP 42 fugitive dust emissions.

Table 8-3 Modelled source configuration for MRUP – Volume sources

Source	Scenario	Centroid x coordinate, km	Centroid y coordinate, km	Effective height, m	Base elevation, m	Initial sigma y, m	Initial sigma z, m
Loading ore	1	579.000	6682.500	2.0	370	1.0	1.0
	2	575.350	6680.100	2.0	372	1.0	1.0
	3	580.031	6683.781	2.0	387	1.0	1.0
	4	563.000	6688.000	2.0	337	1.0	1.0
Loading overburden	1	579.000	6682.500	2.0	370	1.0	1.0
	2	575.350	6680.100	2.0	372	1.0	1.0
	3	580.031	6683.781	2.0	387	1.0	1.0
	4	563.000	6688.000	2.0	337	1.0	1.0
Dumping overburden	1	580.941	6682.591	2.0	338	1.0	1.0
	2	575.030	6682.101	2.0	360	1.0	1.0
	3	561.778	6687.771	2.0	359	1.0	1.0
	4	560.460	6671.005	2.0	333	1.0	1.0
Dumping ore	1-4	578.030	6683.910	2.0	321	1.0	1.0
Conveyor 1	1-4	578.030	6683.910	2.0	321	10.0	1.0
Conveyor 2	1-4	578.030	6683.910	4.0	321	10.0	1.0

Table 8-4 Modelled source configuration for MRUP – Area sources

Source	Scenario	Corner x coordinates, km	Corner y coordinates, km	Effective height, m	Base elevation, m	Initial sigma z, m
Constant area sources						
Hauling overburden	1-4	553.394, 556.836, 581.431, 577.953	6689.89, 6696.719, 6684.195, 6677.383	2.0	356	1.0
Hauling ore	1-4	553.394, 556.836, 581.431, 577.953	6689.89, 6696.719, 6684.195, 6677.383	2.0	356	1.0
Grading	1-4	553.394, 556.836, 581.431, 577.953	6689.89, 6696.719, 6684.195, 6677.383	1.0	356	1.0
Misc. travel	1-4	554.307, 606.563, 606.563, 554.307	6669.974, 6669.974, 6699.221, 6699.221	1.0	358	1.0
Dozing at overburden landform	1	580.757, 580.757, 581.125, 581.125	6682.407, 6682.775, 6682.775, 6682.407	4.0	355	1.0
	2	574.867, 574.867, 575.193, 575.193	6681.938, 6682.264, 6682.264, 6681.938	4.0	360	1.0
	3	561.589, 561.589, 561.967, 561.967	6687.582, 6687.96, 6687.96, 6687.582	4.0	341	1.0
	4	560.155, 560.155, 560.765, 560.765	6690.700, 6691.310, 6691.310, 6690.700	4.0	333	1.0
Variable area sources (wind erosion)[39]						
Active pit	1	578.788, 578.788, 579.212, 579.212	6682.288, 6682.712, 6682.712, 6682.288	0.5	370	0.5
	2	575.106, 575.106, 575.594, 575.594	6679.856, 6680.344, 6680.344, 6679.856	0.5	372	0.5
	3A	576.288, 576.288, 576.712, 576.712	6679.188, 6679.612, 6679.612, 6679.188	0.5	385	0.5
	3B	562.811, 562.811, 563.189, 563.189	6687.811, 6688.189, 6688.189, 6687.811	0.5	338	0.5
	4A	562.827, 562.827, 563.173, 563.173	6687.827, 6688.173, 6688.173, 6687.827	0.5	338	0.5
	4B	557.288, 557.288, 557.712, 557.712	6691.038, 6691.462, 6691.462, 6691.038	0.5	339	0.5
Overburden -Pri	1-5[40]	580.757, 580.757, 581.125, 581.125	6682.407, 6682.775, 6682.775, 6682.407	0.5	338	0.5
Overburden – Am1	1-5[40]	580.757, 580.757, 581.125, 581.125	6682.407, 6682.775, 6682.775, 6682.407	0.5	339	0.5
Overburden – Am2	2-5[40]	574.867, 574.867, 575.193, 575.193	6681.938, 6682.264, 6682.264, 6681.938	0.5	338	0.5
Overburden - Sho	2-5[40]	561.589, 561.589, 561.967, 561.967	6687.582, 6687.960, 6687.960, 6687.582	0.5	338	0.5
Overburden - Emp	2-5[40]	560.155, 560.155, 560.765, 560.765	6690.700, 6691.310, 6691.310, 6690.700	0.5	339	0.5
Light vehicle roads (areas 1, 2 and 3)	1-4	574.156, 577.783, 577.804, 574.177	6680.455, 6680.455, 6669.990, 6669.990	0.5	398	0.5
	1-4	581.128, 579.805, 596.406, 597.750	6682.031, 6683.845, 6695.887, 6694.116	0.5	336	0.5
	1-4	596.876, 596.897, 606.566, 606.566	6693.433, 6699.300, 6699.300, 6693.433	0.5	310	0.5

[39] Rise velocities for each source assigned as 0 m/s, and hourly variable temperature taken as hourly variable ambient temperature.
[40] Overburden landform rehabilitation included in Scenario 5

Source	Scenario	Corner x coordinates, km	Corner y coordinates, km	Effective height, m	Base elevation, m	Initial sigma z, m
Haul roads	1-4	553.394, 556.836, 581.431, 577.953	6689.89, 6696.719, 6684.195, 6677.383	0.5	356	0.5
Plant stockpile	4	563.276, 563.276, 563.764, 563.764	6687.256, 6687.744, 6687.744, 6687.256	0.5	338	0.5
Tails dam (surface)	1	576.245, 576.245, 576.935, 576.935	6683.185, 6683.875, 6683.875, 6683.185	0.5	354	0.5
Capped pit, 1 year rehab	1	579.388, 579.388, 579.812, 579.812	6682.688, 6683.112, 6683.112, 6682.688	0.5	364	0.5
	2	575.356, 575.356, 575.844, 575.844	6680.556, 6681.044, 6681.044, 6680.556	0.5	370	0.5
	3	575.138, 575.138, 575.562, 575.562	6679.888, 6680.312, 6680.312, 6679.888	0.5	372	0.5
	4	557.327, 557.327, 557.673, 557.673	6691.077, 6691.423, 6691.423, 6691.077	0.5	338	0.5
	5	563.276, 563.276, 563.764, 563.764	6687.256, 6687.744, 6687.744, 6687.256	0.5	338	0.5
Capped pit, 2 year rehab	1	578.756, 578.756, 579.244, 579.244	6680.956, 6681.444, 6681.444, 6680.956	0.5	356	0.5
	2	578.756, 578.756, 579.244, 579.244	6680.956, 6681.444, 6681.444, 6680.956	0.5	381	0.5
	3	575.388, 575.388, 575.812, 575.812	6680.588, 6681.012, 6681.012, 6680.588	0.5	370	0.5
	4A	557.327, 557.327, 557.673, 557.673	6691.077, 6691.423, 6691.423, 6691.077	0.5	339	0.5
	4B	562.827, 562.827, 563.173, 563.173	6687.827, 6688.173, 6688.173, 6687.827	0.5	338	0.5
	5	557.327, 557.327, 557.673, 557.673	6691.077, 6691.423, 6691.423, 6691.077	0.5	339	0.5
Capped pit, 3 year rehab	2	576.106, 576.106, 576.594, 576.594	6681.706, 6682.194, 6682.194, 6681.706	0.5	367	0.5
	3	578.788, 578.788, 579.212, 579.212	6680.988, 6681.412, 6681.412, 6680.988	0.5	381	0.5
	4A	562.827, 562.827, 563.173, 563.173	6687.827, 6688.173, 6688.173, 6687.827	0.5	338	0.5
	4B	576.327, 576.327, 576.673, 576.673	6679.227, 6679.573, 6679.573, 6679.227	0.5	387	0.5
	5A	557.077, 557.077, 557.923, 557.923	6690.827, 6691.673, 6691.673, 6690.827	0.5	339	0.5
	5B	562.614, 562.614, 563.386, 563.386	6687.614, 6688.386, 6688.386, 6687.614	0.5	338	0.5
Capped pit, 4 year rehab	2	576.506, 576.506, 576.994, 576.994	6682.006, 6682.494, 6682.494, 6682.006	0.5	365	0.5
	3	576.138, 576.138, 576.562, 576.562	6681.738, 6682.162, 6682.162, 6681.738	0.5	367	0.5
	4	575.177, 575.177, 575.523, 575.523	6679.927, 6680.273, 6680.273, 6679.927	0.5	372	0.5
	5	557.114, 557.114, 557.886, 557.886	6690.864, 6691.636, 6691.636, 6690.864	0.5	339	0.5
Capped pit, 5 year rehab	2	577.006, 577.006, 577.494, 577.494	6682.156, 6682.644, 6682.644, 6682.156	0.5	366	0.5
	3	576.538, 576.538, 576.962, 576.962	6682.038, 6682.462, 6682.462, 6682.038	0.5	368	0.5
	4	575.427, 575.427, 575.773, 575.773	6680.627, 6680.973, 6680.973, 6680.627	0.5	370	0.5
	5A	557.077, 557.077, 557.923, 557.923	6690.827, 6691.673, 6691.673, 6690.827	0.5	339	0.5
	5B	562.511, 562.511, 563.489, 563.489	6687.511, 6688.489, 6688.489, 6687.511	0.5	338	0.5

Table 8-5 Scenario 1, Year 3 emission rates

Description of source	Total area, ha	Average annual emissions, no control TSP g/s	Average annual emissions, no control PM10 g/s	Control factor TSP & PM10	Average annual emissions, with control TSP g/s	TSP g/s/ha	PM10 g/s	PM10 g/s/ha
Mechanical sources								
Loading ore	- -	0.01	0.003	1	0.01	- -	0.003	- -
Loading overburden	- -	0.3	0.1	1	0.3	- -	0.1	- -
Hauling overburden[41]	2.0	40	9	0.3	10	5	2	1.1
Hauling ore[41]	2.0	2	0	0.3	0	0.2	0.1	0.05
Roads - grading haul roads[41]	2.0	6	2	0.3	1	0.7	0.5	0.2
Roads - misc vehicle traffic[41]	38.5	0.1	0.02	0.3	0.03	0.001	0.004	0.0001
Overburden dumping	- -	6	2	1	6	- -	2	- -
PP - dumping	- -	0.7	0.2	1	0.7	- -	0.2	- -
PP - conveyor to crusher	- -	0.00	0.002	1	0.00	- -	0.002	- -
PP - conveyor to ball mill	- -	0.6	0.2	1	0.6	- -	0.2	- -
Dozing – overburden	- -	2	0.3	1	2	- -	0.3	- -
Wind erosion sources								
Wind Erosion - Pit A	15.0	2	0.9	1	1.7	0.1	0.9	0.06
Wind Erosion - overburden, Princess	7.2	0.8	0.4	0.75	0.6	0.09	0.3	0.04
Wind Erosion - overburden, Ambassador 1	11.4	1.2	0.6	0.75	0.9	0.08	0.5	0.04
Wind Erosion - overburden, Ambassador 2	8.9	0.9	0.5	0.75	0.7	0.08	0.3	0.04
Wind Erosion - overburden, Shogun	11.9	1.2	0.6	0.75	0.9	0.08	0.5	0.04
Wind Erosion - overburden, Emperor	31.1	3.0	1.5	0.75	2.3	0.07	1.1	0.04
Wind Erosion - LV roads[41]	162.7	15	8	0.37	6	0.03	3	0.02
Wind Erosion - Haul roads[41]	38.5	3	2	0.37	1	0.03	0.6	0.02
Wind Erosion - Tailings dam (surface)	39.8	5	2	0.55	2	0.06	1	0.03
Wind Erosion - capped pit 1 year rehab	60.0	7	3	0.7	5	0.08	2	0.04
Wind Erosion - capped pit 2 year rehab	60.0	7	3	0.6	4	0.07	2	0.03

[41] Emission rate was modelled as a generalised area source containing the road network. Emission rates were scaled accordingly to ensure that total emissions were equal to predicted emissions for the exposed surface areas.

Table 8-6 Scenario 2, Year 10 emission rates

Description of source	Total area, ha	Average annual emissions, no control		Control factor	Average annual emissions, with control			
		TSP	PM_{10}	TSP & PM_{10}	TSP		PM_{10}	
		g/s	g/s		g/s	g/s/ha	g/s	g/s/ha
Mechanical sources								
Loading ore	- -	0.01	0.006	1	0.01	- -	0.006	- -
Loading overburden	- -	0.6	0.3	1	0.6	- -	0.3	- -
Hauling overburden[41]	2.0	79	17	0.3	20	10	4	2.1
Hauling ore[41]	2.0	4	1	0.3	1	0.5	0.2	0.10
Roads - grading haul roads[41]	2.0	6	2	0.3	1	0.7	0.5	0.2
Roads - misc vehicle traffic[41]	38.5	0.1	0.02	0.3	0.03	0.001	0.004	0.0001
Overburden dumping	- -	12	4	1	12	- -	4	- -
PP - dumping	- -	1.3	0.5	1	1.3	- -	0.5	- -
PP - conveyor to crusher	- -	0.01	0.004	1	0.01	- -	0.004	- -
PP - conveyor to ball mill	- -	1.1	0.4	1	1.1	- -	0.4	- -
Dozing – overburden	- -	2	0.3	1	2	- -	0.3	- -
Wind erosion sources								
Wind Erosion - Pit A	20.0	2	1.1	1	2.3	0.1	1.1	0.06
Wind Erosion - overburden, Princess	7.2	0.8	0.4	0.75	0.6	0.09	0.3	0.04
Wind Erosion - overburden, Ambassador 1	11.4	1.2	0.6	0.75	0.9	0.08	0.5	0.04
Wind Erosion - overburden, Ambassador 2	8.9	0.9	0.5	0.75	0.7	0.08	0.3	0.04
Wind Erosion - overburden, Shogun	11.9	1.2	0.6	0.75	0.9	0.08	0.5	0.04
Wind Erosion - overburden, Emperor	31.1	3.0	1.5	0.75	2.3	0.07	1.1	0.04
Wind Erosion - LV roads[41]	162.7	15	8	0.37	6	0.03	3	0.02
Wind Erosion - Haul roads[41]	38.5	3	2	0.37	1	0.03	0.6	0.02
Wind Erosion - capped pit 1 year rehab	90.0	10	5	0.7	7	0.08	4	0.04
Wind Erosion - capped pit 2 year rehab	80.0	9	5	0.6	5	0.07	3	0.03
Wind Erosion - capped pit 3 year rehab	70.0	8	4	0.4	3	0.05	2	0.02
Wind Erosion - capped pit 4 year rehab	60.0	7	3	0.1	1	0.01	0	0.01
Wind Erosion - capped pit 5 year rehab	60.0	7	3	0.1	1	0.01	0	0.01

Table 8-7 Scenario 3, Year 11 emission rates

Description of source	Total area, ha	Average annual emissions, no control		Control factor	Average annual emissions, with control			
		TSP	PM_{10}	TSP & PM_{10}	TSP		PM_{10}	
		g/s	g/s		g/s	g/s/ha	g/s	g/s/ha
Mechanical sources								
Loading ore	- -	0.01	0.004	1	0.01	- -	0.004	- -
Loading overburden	- -	0.4	0.2	1	0.4	- -	0.2	- -
Hauling overburden[41]	1.3	54	12	0.3	14	10	3	2.2
Hauling Ore[41]	2.0	3	1	0.3	1	0.3	0.1	0.07
Roads - grading haul roads[41]	2.0	6	2	0.3	1	0.7	0.5	0.2
Roads - misc vehicle traffic[41]	38.5	0.1	0.02	0.3	0.03	0.001	0.004	0.0001
Overburden dumping	- -	9	3	1	9	- -	3	- -
PP - Dumping	- -	0.9	0.3	1	0.9	- -	0.3	- -
PP - Conveyor to crusher	- -	0.01	0.003	1	0.01	- -	0.003	- -
PP - Conveyor to ball mill	- -	0.8	0.3	1	0.8	- -	0.3	- -
Dozing - overburden	- -	2	0.3	1	2	- -	0.3	- -
Loading ore	- -	0.01	0.004	1	0.01	- -	0.004	- -
Wind erosion sources								
Wind Erosion - Pit A	15.0	2	0.9	1	1.7	0.1	0.9	0.06
Wind Erosion - Pit B	12.0	1	0.7	1	1.4	0.1	0.7	0.06
Wind Erosion - overburden, Princess	7.2	0.8	0.4	0.75	0.6	0.09	0.3	0.04
Wind Erosion - overburden, Ambassador 1	11.4	1.2	0.6	0.75	0.9	0.08	0.5	0.04
Wind Erosion - overburden, Ambassador 2	8.9	0.9	0.5	0.75	0.7	0.08	0.3	0.04
Wind Erosion - overburden, Shogun	11.9	1.2	0.6	0.75	0.9	0.08	0.5	0.04
Wind Erosion - overburden, Emperor	31.1	3.0	1.5	0.75	2.3	0.07	1.1	0.04
Wind Erosion - LV roads[41]	162.7	15	8	0.37	6	0.03	3	0.02
Wind Erosion - Haul roads[41]	38.5	3	2	0.37	1	0.03	0.6	0.02
Wind Erosion - capped pit 1 year rehab	90.0	10	5	0.7	7	0.08	4	0.04
Wind Erosion - capped pit 2 year rehab	90.0	10	5	0.6	6	0.07	3	0.03
Wind Erosion - capped pit 3 year rehab	80.0	9	5	0.4	4	0.05	2	0.02
Wind Erosion - capped pit 4 year rehab	70.0	8	4	0.1	1	0.01	0	0.01
Wind Erosion - capped pit 5 year rehab	60.0	7	3	0.1	1	0.01	0	0.01

Table 8-8 Scenario 4, Year 14 emission rates

Description of source	Total area, ha	Average annual emissions, no control		Control factor	Average annual emissions, with control			
		TSP	PM_{10}	TSP & PM_{10}	TSP		PM_{10}	
		g/s	g/s		g/s	g/s/ha	g/s	g/s/ha
Mechanical sources								
Loading ore	- -	0.01	0.005	1	0.01	- -	0.005	- -
Loading overburden	- -	0.5	0.2	1	0.5	- -	0.2	- -
Hauling overburden[41]	3.0	62	13	0.3	16	5	3	1.1
Hauling Ore[41]	2.0	3	1	0.3	1	0.3	0.1	0.07
Roads - grading haul roads[41]	2.0	6	2	0.3	1	0.7	0.5	0.2
Roads - misc vehicle traffic[41]	38.5	0.1	0.02	0.3	0.03	0.001	0.004	0.0001
Overburden dumping	- -	9	3	1	9	- -	3	- -
PP - Dumping	- -	1.0	0.4	1	1.0	- -	0.4	- -
PP - Conveyor to crusher	- -	0.01	0.003	1	0.01	- -	0.003	- -
PP - Conveyor to ball mill	- -	0.8	0.3	1	0.8	- -	0.3	- -
Dozing - overburden	- -	2	0.3	1	2	- -	0.3	- -
Wind erosion sources								
Wind Erosion - Pit A	10.0	1	0.6	1	0.1	0.6	0.06	0.1
Wind Erosion - Pit B	15.0	2	0.9	1	0.1	0.9	0.06	0.1
Wind Erosion - overburden, Princess	7.2	0.8	0.4	0.75	0.09	0.3	0.04	0.09
Wind Erosion - overburden, Ambassador 1	11.4	1.2	0.6	0.75	0.08	0.5	0.04	0.08
Wind Erosion - overburden, Ambassador 2	8.9	0.9	0.5	0.75	0.08	0.3	0.04	0.08
Wind Erosion - overburden, Shogun	11.9	1.2	0.6	0.75	0.08	0.5	0.04	0.08
Wind Erosion - overburden, Emperor	31.1	3.0	1.5	0.75	0.07	1.1	0.04	0.07
Wind Erosion - LV roads[41]	162.7	15	8	0.37	0.03	3	0.02	0.03
Wind Erosion - Haul roads[41]	38.5	3	2	0.37	0.03	0.6	0.02	0.03
Wind Erosion - PP Stockpile	20.0	2	1	0.55	0.06	1	0.03	0.06
Wind Erosion - capped pit 1 year rehab	90.0	10	5	0.7	0.08	4	0.04	0.08
Wind Erosion - capped pit 2 year rehab (A)	60.0	7	3	0.6	0.07	2	0.03	0.07
Wind Erosion - capped pit 2 year rehab (B)	40.0	5	2	0.6	0.07	1	0.03	0.07
Wind Erosion - capped pit 3 year rehab (A)	20.0	2	1	0.4	0.05	0	0.02	0.05

Description of source	Total area, ha	Average annual emissions, no control		Control factor	Average annual emissions, with control			
		TSP	PM_{10}	TSP & PM_{10}	TSP		PM_{10}	
		g/s	g/s		g/s	g/s/ha	g/s	g/s/ha
Wind Erosion - capped pit 3 year rehab (B)	60.0	7	3	0.4	0.05	1	0.02	0.05
Wind Erosion - capped pit 4 year rehab	90.0	10	5	0.1	0.01	1	0.01	0.01
Wind Erosion - capped pit 5 year rehab	90.0	10	5	0.1	0.01	1	0.01	0.01

Table 8-9 Scenario 5, closure – 1 year, emission rates

Description of source	Total area, ha	Average annual emissions, no control		Control factor	Average annual emissions, with control			
		TSP	PM_{10}	TSP & PM_{10}	TSP		PM_{10}	
		g/s	g/s		g/s	g/s/ha	g/s	g/s/ha
Wind erosion sources								
Wind Erosion - overburden, Princess	7.2	0.8	0.4	0.70	0.6	0.08	0.3	0.04
Wind Erosion - overburden, Ambassador 1	11.4	1.2	0.6	0.70	0.9	0.08	0.4	0.04
Wind Erosion - overburden, Ambassador 2	8.9	0.9	0.5	0.70	0.7	0.07	0.3	0.04
Wind Erosion - overburden, Shogun	11.9	1.2	0.6	0.70	0.8	0.07	0.4	0.04
Wind Erosion - overburden, Emperor	31.1	3.0	1.5	0.70	2.1	0.07	1.1	0.03
Wind Erosion - capped pit 1 year rehab	20.0	2	1	0.7	2	0.08	1	0.04
Wind Erosion - capped pit 2 year rehab	60.0	7	3	0.6	4	0.07	2	0.03
Wind Erosion - capped pit 3 year rehab (A)	60.0	7	3	0.4	3	0.05	1	0.02
Wind Erosion - capped pit 3 year rehab (B)	50.0	6	3	0.4	2	0.05	1	0.02
Wind Erosion - capped pit 4 year rehab	50.0	6	3	0.1	1	0.01	0	0.01
Wind Erosion - capped pit 5 year rehab (A)	60.0	7	3	0.1	1	0.01	0	0.01
Wind Erosion - capped pit 5 year rehab (B)	80.0	9	5	0.1	1	0.01	0	0.01

8.3 Scenario modelling results

The following sections provide modelling results for the four scenarios. Contour plots included for each scenario are (in order):

- 99.9th percentile 1-hour PM_{10}
- Maximum 24-hour PM_{10}
- Annual average PM_{10}
- 99.9th percentile 1-hour TSP
- Maximum 24-hour TSP

8.3.1 Scenario 1, Year 3 modelling results

Table 8-10 shows predicted PM_{10} and TSP concentrations at receptors, while Table 8-11 shows predicted deposition.

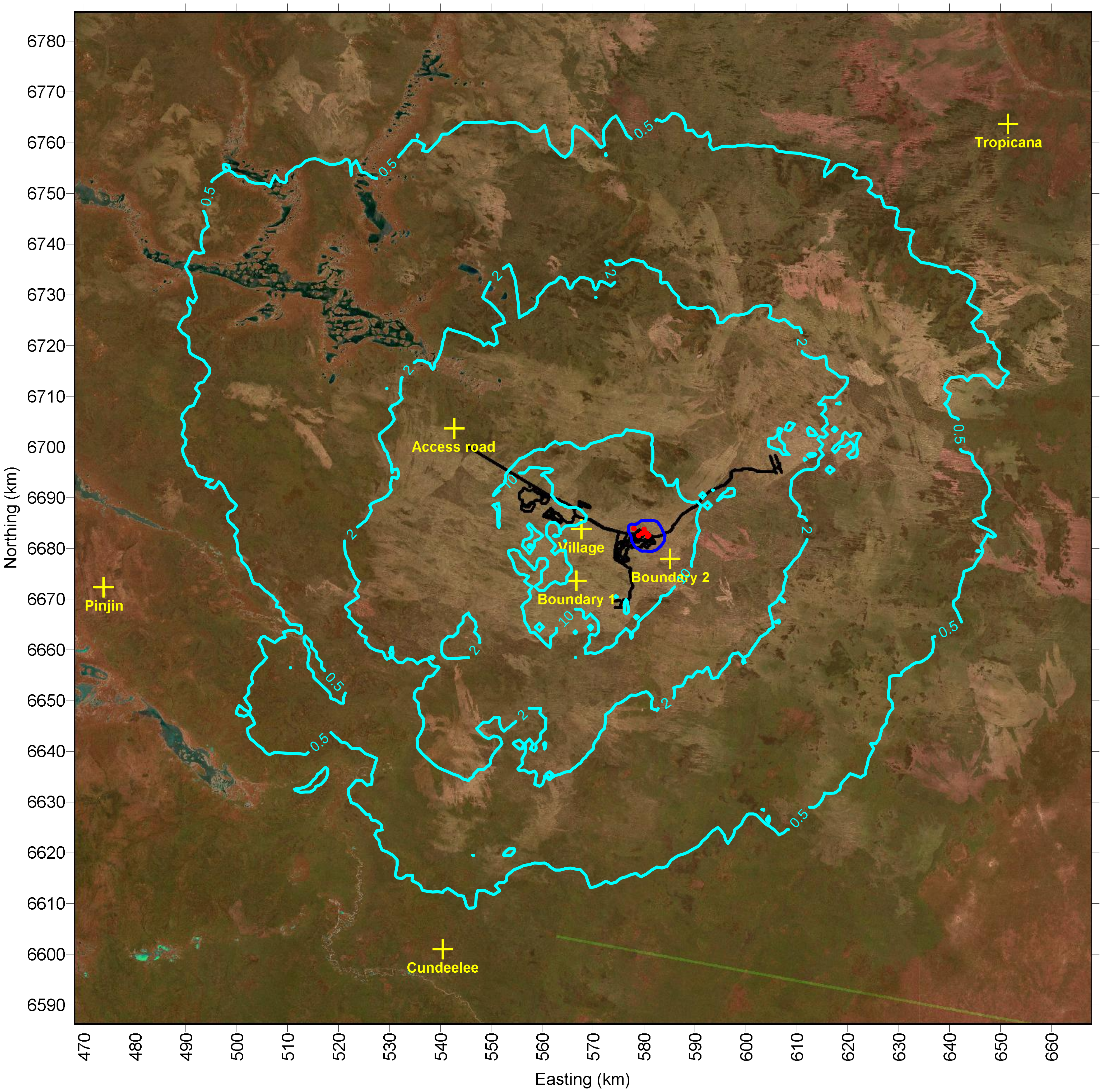
Figure 8-2 through Figure 8-6 show contour plots from the Scenario 1 model for year 3 of the modelling. Appendix D provides these figures focusing on the development area of the MRUP site.

Table 8-10 Scenario 1, Year 3 predicted concentrations at receptors

Receptor	PM_{10}, µg/m^3			TSP, µg/m^3	
Averaging period	Annual	24-hour	1-hour	24-hour	1-hour
Rank	Max	Max	99.9 %ile	Max	99.9 %ile
Guideline	20	50	80	90	- -
1: Tropicana Gold Mine	0.001	0.02	0.06	0.07	0.23
2: Pinjin	0.005	0.03	0.10	0.12	0.41
3: Cundeelee	0.005	0.07	0.32	0.27	1.10
4: Tenement boundary	0.806	5.05	17.40	17.40	59.93
5: PNC X TPG access road	0.120	0.83	3.88	3.20	14.40
6: Mining village	1.316	5.39	17.95	18.04	52.01
7: Tenement boundary 2	0.726	11.93	24.70	38.25	78.57

Table 8-11 Scenario 1, Year 3 predicted dust deposition at receptors

Receptor	Dry deposition			Wet deposition			Total deposition		
Units	$g/m^2/s$	$g/m^2/mth$	$g/m^2/yr$	$g/m^2/s$	$g/m^2/mth$	$g/m^2/yr$	$g/m^2/s$	$g/m^2/mth$	$g/m^2/yr$
Guideline	- -	- -	- -	- -	- -	- -	- -	2	- -
1: Tropicana Gold Mine	8.4×10^{-13}	2.2×10^{-6}	2.6×10^{-5}	4.7×10^{-12}	1.3×10^{-5}	1.5×10^{-4}	5.6×10^{-12}	1.5×10^{-5}	1.8×10^{-4}
2: Pinjin	2.2×10^{-12}	5.8×10^{-6}	6.8×10^{-5}	9.5×10^{-11}	2.5×10^{-5}	3.0×10^{-4}	1.2×10^{-11}	3.1×10^{-5}	3.7×10^{-4}
3: Cundeelee	2.0×10^{-12}	5.2×10^{-6}	6.2×10^{-5}	4.1×10^{-12}	1.1×10^{-5}	1.3×10^{-4}	6.1×10^{-12}	1.6×10^{-5}	1.9×10^{-4}
4: Tenement boundary	1.0×10^{-8}	2.7×10^{-2}	3.2×10^{-1}	1.6×10^{-10}	4.4×10^{-4}	5.2×10^{-3}	1.0×10^{-8}	2.8×10^{-2}	3.3×10^{-1}
5: PNC X TPG access road	5.7×10^{-11}	1.5×10^{-4}	1.8×10^{-3}	8.9×10^{-11}	2.2×10^{-4}	2.6×10^{-3}	1.4×10^{-10}	3.7×10^{-4}	4.4×10^{-3}
6: Mining village	1.1×10^{-10}	2.9×10^{-2}	3.4×10^{-1}	5.5×10^{-10}	1.5×10^{-3}	1.7×10^{-2}	1.1×10^{-8}	3.1×10^{-2}	3.6×10^{-1}
7: Tenement boundary 2	6.0×10^{-10}	1.6×10^{-3}	1.9×10^{-2}	1.4×10^{-10}	3.7×10^{-4}	4.4×10^{-3}	7.4×10^{-10}	2.0×10^{-3}	2.3×10^{-2}



Guideline values:
Victorian SEPP-AQM 1-hour 99.9 percentile PM10 design criteria of 80 ug/m3

LEGEND

- Proposed mine layout
- Pit and processing plant source locations
- Sensitive receptors
- Predicted 1-hr 99.9 percentile PM10 concentrations
- Victorian SEPP-AQM criteria (80 ug/m3)

SCALE

0 10 20 30

Kilometres (at A3)

MAP PROJECTION:
Transverse Mercator

HORIZONTAL DATUM:
Geocentric Datump of Australia (GDA)

GRID:
Map Grid of Australia 1994, Zone 51

DATA SOURCE:
LGATE_MGA51_20150220

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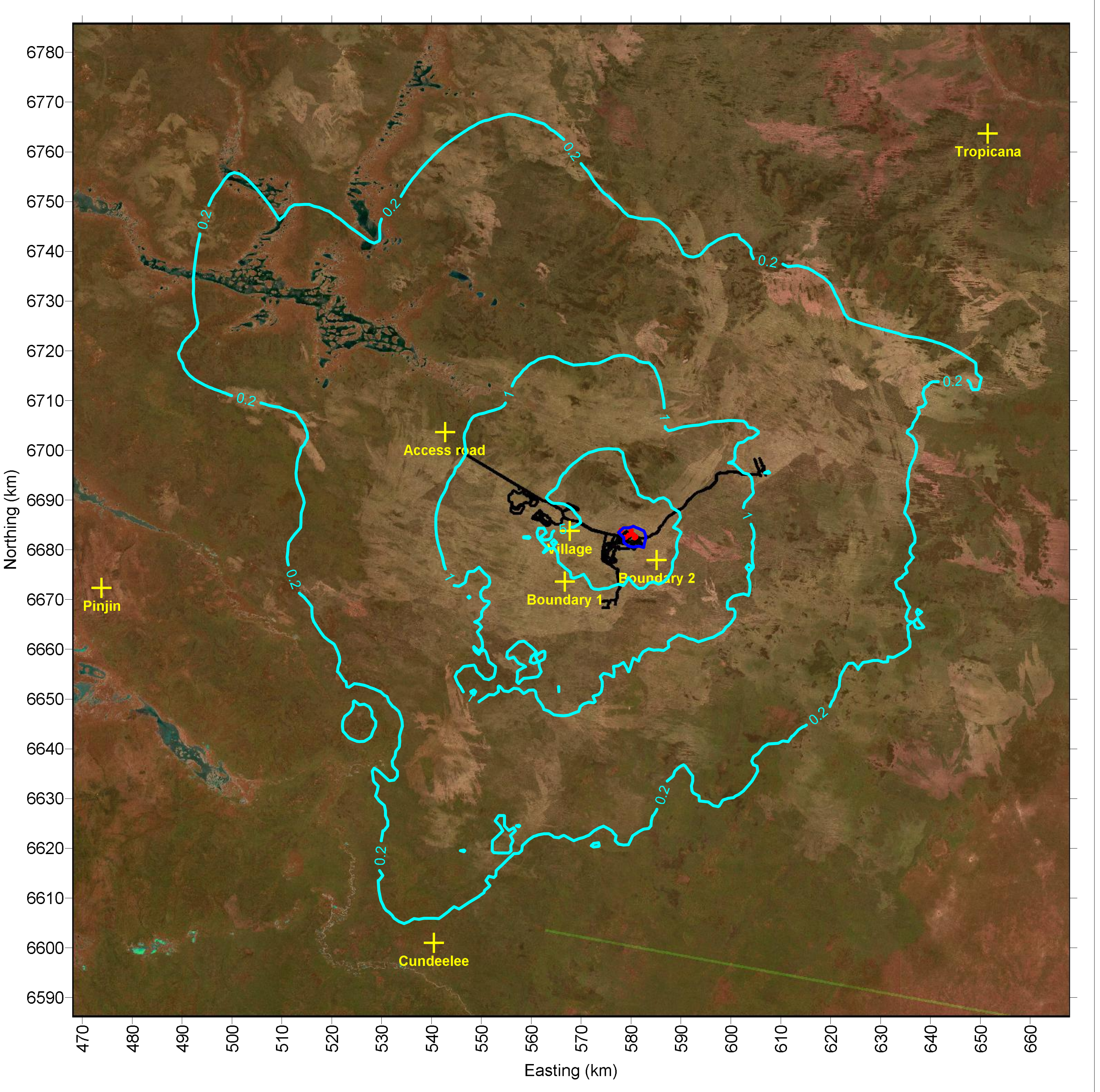
FIGURE 8-2

Scenario 1, Year 3
Predicted PM10 99.9 percentile 1-hour concentrations

CREATED	CHECKED	APPROVED	DATE	FILE LOCATION	DRAWING NO.	REVISION
LC	JF	JF	17.10.15	G:/61/32680/Technical/Surfer/Figure 01	Figure 8-2.srf	1



Guideline values:
Air NEPM 24-hour maximum PM10 concentration of 50 ug/m3

LEGEND

- Proposed mine layout
- Pit and processing plant source locations
- Sensitive receptors
- Predicted 24-hr max PM10 concentrations
- Air NEPM criteria (50 ug/m3)

SCALE

0 10 20 30

Kilometres (at A3)

MAP PROJECTION:
Transverse Mercator

HORIZONTAL DATUM:
Geocentric Datum of Australia (GDA)

GRID:
Map Grid of Australia 1994, Zone 51

DATA SOURCE:
LGATE_MGA51_20150220

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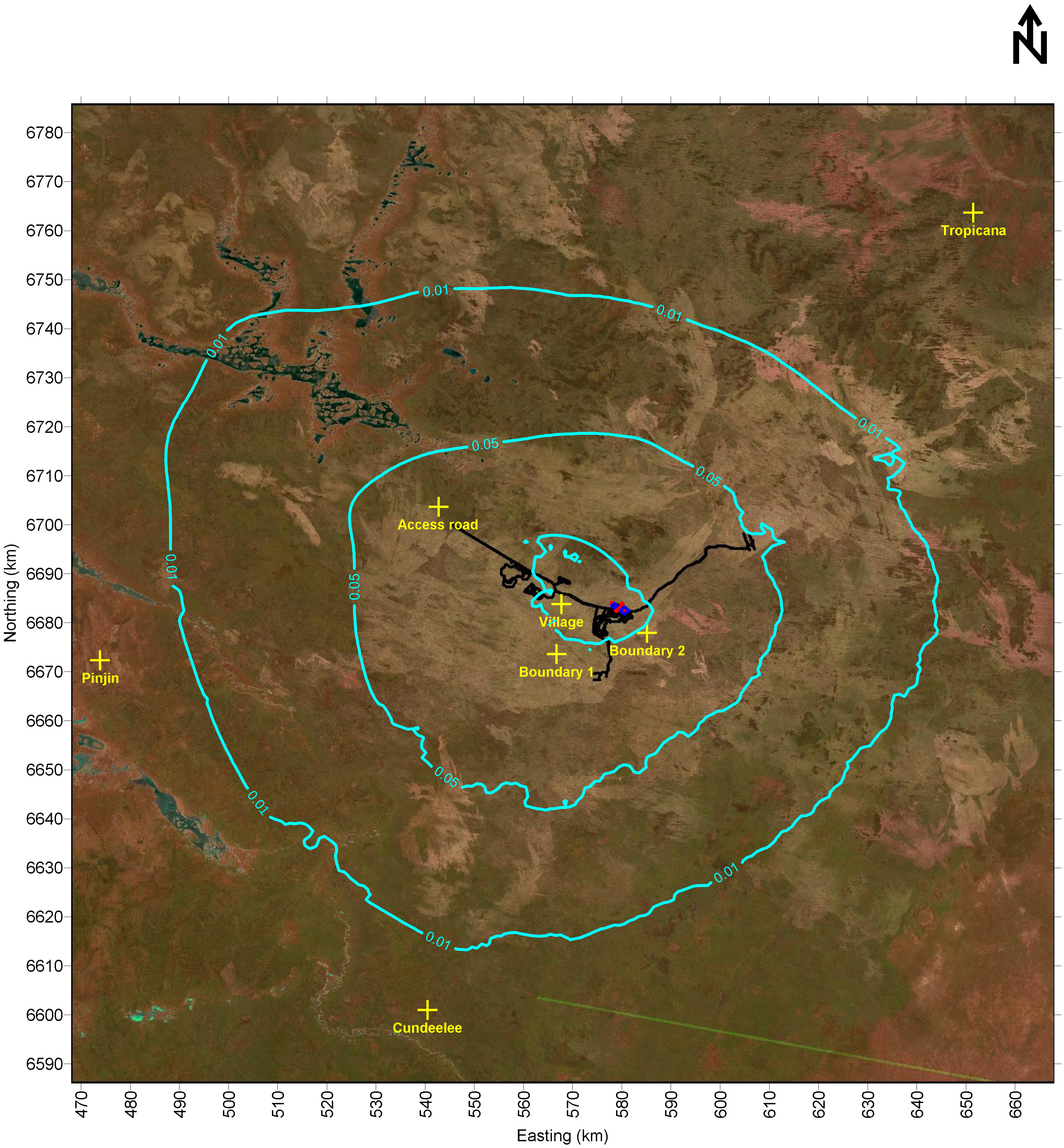
FIGURE 8-3

Scenario 1, Year 3
Predicted 24-hour maximum PM10 concentrations

CREATED	CHECKED	APPROVED	DATE	FILE LOCATION	DRAWING NO.	REVISION
LC	JF	JF	17.10.15	G:/61/32680/Technical/Surfer/Figure 01	Figure 8-3.srf	1



Guideline values:
Proposed variation to the Air NEPM for an annual PM10 concentration of 20 ug/m3

LEGEND

- Proposed mine layout
- Pit and processing plant source locations
- Sensitive receptors
- Predicted annual PM10 concentrations
- Proposed variation to Air NEPM (20 ug/m3)

SCALE

0 10 20 30

Kilometres (at A3)

MAP PROJECTION:
Transverse Mercator

HORIZONTAL DATUM:
Geocentric Datump of Australia (GDA)

GRID:
Map Grid of Australia 1994, Zone 51

DATA SOURCE:
LGATE_MGA51_20150220

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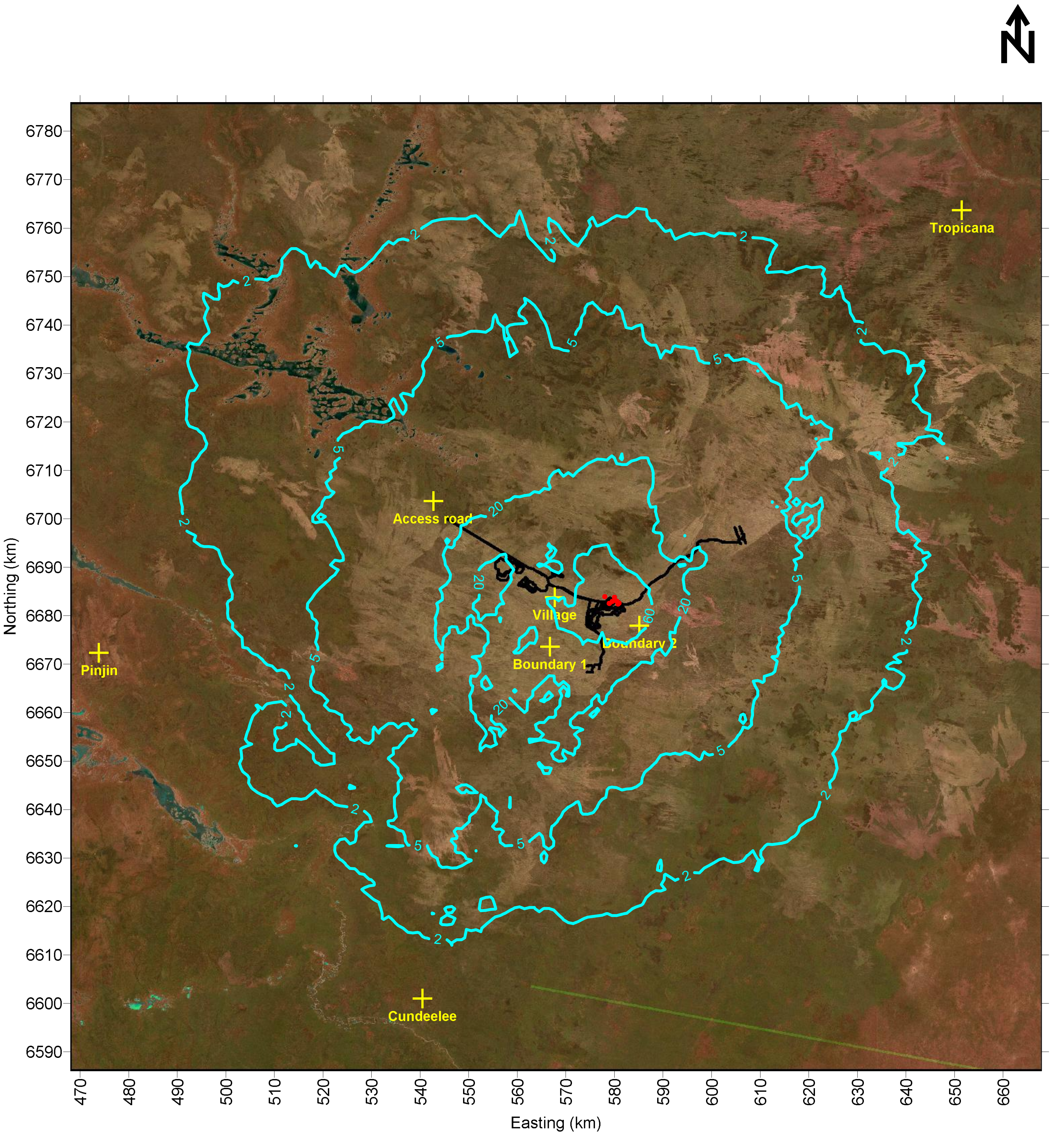
FIGURE 8-4

Scenario 1, Year 3
Predicted annual PM10 concentrations

CREATED	CHECKED	APPROVED	DATE	FILE LOCATION	DRAWING NO.	REVISION
LC	JF	JF	17.10.15	G:/61/32680/Technical/Surfer/Figure 01	Figure 8-4.srf	1



Guideline values:
Nil

LEGEND

- Proposed mine layout
- Pit and processing plant source locations
- Sensitive receptors
- Predicted 1-hr 99.9 percentile TSP concentrations

SCALE

0 10 20 30

Kilometres (at A3)

MAP PROJECTION:
Transverse Mercator

HORIZONTAL DATUM:
Geocentric Datump of Australia (GDA)

GRID:
Map Grid of Australia 1994, Zone 51

DATA SOURCE:
LGATE_MGA51_20150220

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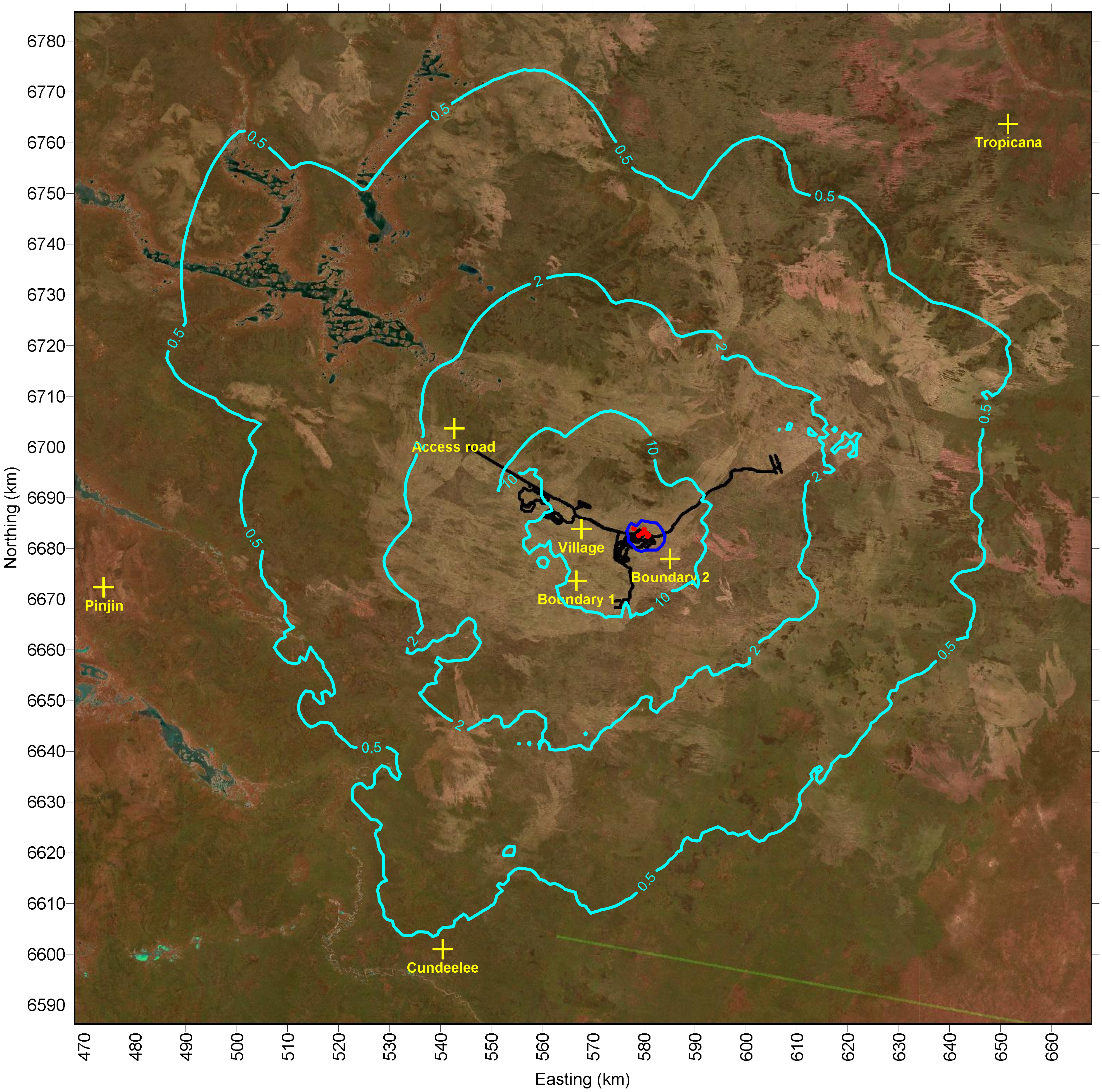
FIGURE 8-5

Scenario 1, Year 3
Predicted 1-hour 99.9 percentile TSP concentrations

CREATED	CHECKED	APPROVED	DATE	FILE LOCATION	DRAWING NO.	REVISION
LC	JF	JF	17.10.15	G:/61/32680/Technical/Surfer/Figure 01	Figure 8-5.srf	1



Guideline values:
Kwinana EPP 24-hour maximum TSP of 90 ug/m3

LEGEND

- Proposed mine layout
- Pit and processing plant source locations
- Sensitive receptors
- Predicted 24-hr max TSP concentrations
- Kwinana EPP criteria (90 ug/m3)

SCALE

0 10 20 30
Kilometres (at A3)

MAP PROJECTION:
Transverse Mercator

HORIZONTAL DATUM:
Geocentric Datump of Australia (GDA)

GRID:
Map Grid of Australia 1994, Zone 51

DATA SOURCE:
LGATE_MGA51_20150220

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FIGURE 8-6

Scenario 1, Year 3
Predicted 24-hour maximum TSP concentrations

CREATED	CHECKED	APPROVED	DATE	FILE LOCATION	DRAWING NO.	REVISION
LC	JF	JF	17.10.15	G:/61/32680/Technical/Surfer/Figure 01	Figure 8-6.srf	1

8.3.2 Scenario 2, Year 10 modelling results

Table 8-12 shows predicted PM_{10} and TSP concentrations at receptors, whilst Table 8-13 shows predicted deposition.

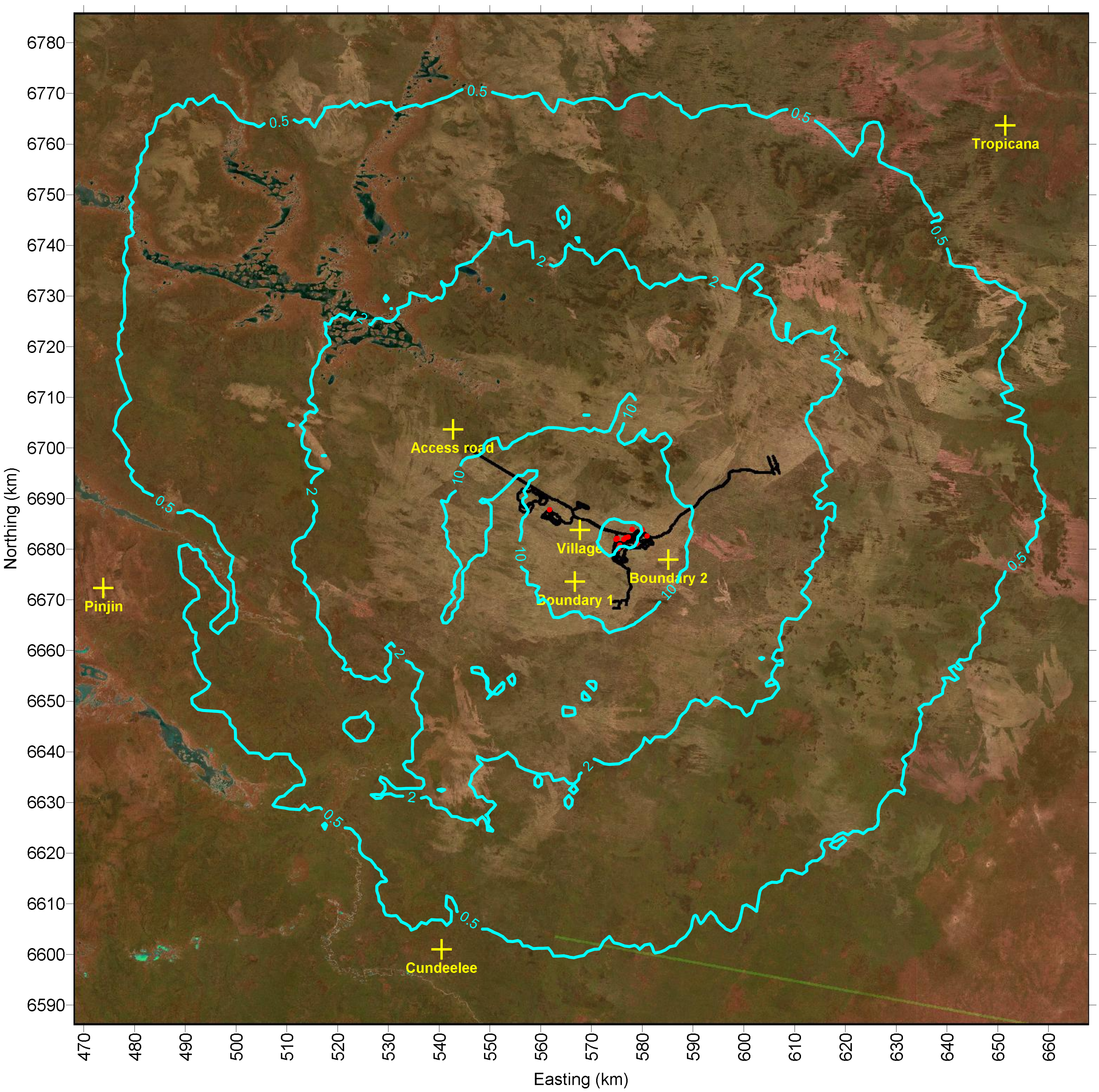
Figure 8-7 through Figure 8-11 show contour plots from the Scenario 2 model for Year 10 of the modelling. Appendix D provides these figures focusing on the development area of the MRUP site.

Table 8-12 Scenario 2, Year 10 predicted concentrations at receptors

Receptor	PM_{10}, µg/m³			TSP, µg/m³	
Averaging period	Annual	24-hour	1-hour	24-hour	1-hour
Rank	Max	Max	99.9th %ile	Max	99.9 %ile
Guideline	20	50	80	90	- -
1: Tropicana Gold Mine	0.002	0.03	0.11	0.11	0.41
2: Pinjin	0.009	0.01	0.21	0.20	0.76
3: Cundeelee	0.009	0.14	0.57	0.50	2.09
4: Tenement boundary	1.539	9.21	25.84	29.89	84.39
5: PNC X TPG access road	0.964	1.69	6.22	6.11	23.35
6: Mining village	3.161	13.64	30.13	42.73	94.87
7: Tenement boundary 2	0.727	8.19	19.42	25.81	60.02

Table 8-13 Scenario 2, Year 10 predicted dust deposition at receptors

Receptor	Dry deposition			Wet deposition			Total deposition		
Units	$g/m^2/s$	$g/m^2/mth$	$g/m^2/yr$	$g/m^2/s$	$g/m^2/mth$	$g/m^2/yr$	$g/m^2/s$	$g/m^2/mth$	$g/m^2/yr$
Guideline	- -	- -	- -	- -	- -	- -	- -	2	- -
1: Tropicana Gold Mine	5.4×10^{-13}	1.4×10^{-6}	1.7×10^{-5}	6.3×10^{-12}	1.7×10^{-5}	2.0×10^{-4}	6.8×10^{-12}	1.8×10^{-5}	2.1×10^{-4}
2: Pinjin	3.2×10^{-12}	8.6×10^{-6}	1.0×10^{-4}	1.5×10^{-11}	3.9×10^{-5}	4.6×10^{-4}	1.8×10^{-11}	4.7×10^{-5}	5.6×10^{-4}
3: Cundeelee	2.5×10^{-12}	6.7×10^{-6}	7.9×10^{-5}	5.3×10^{-12}	1.4×10^{-5}	1.7×10^{-4}	7.8×10^{-12}	2.1×10^{-5}	2.5×10^{-4}
4: Tenement boundary	1.3×10^{-8}	3.5×10^{-2}	4.2×10^{-1}	2.0×10^{-10}	5.5×10^{-4}	6.4×10^{-3}	1.3×10^{-08}	3.6×10^{-2}	4.2×10^{-1}
5: PNC X TPG access road	8.8×10^{-11}	2.4×10^{-4}	2.8×10^{-3}	1.4×10^{-10}	3.7×10^{-4}	4.4×10^{-3}	2.3×10^{-10}	6.1×10^{-4}	7.1×10^{-3}
6: Mining village	7.7×10^{-9}	2.1×10^{-2}	2.4×10^{-1}	5.3×10^{-10}	1.4×10^{-3}	1.7×10^{-2}	8.2×10^{-09}	2.2×10^{-2}	2.6×10^{-1}
7: Tenement boundary 2	5.4×10^{-10}	1.4×10^{-3}	1.7×10^{-2}	1.3×10^{-10}	3.4×10^{-4}	4.0×10^{-3}	6.6×10^{-10}	1.8×10^{-3}	2.1×10^{-2}



Guideline values:
Victorian SEPP-AQM 1-hour 99.9 percentile PM10 design criteria of 80 ug/m3

LEGEND

- Proposed mine layout
- Pit and processing plant source locations
- Sensitive receptors
- Predicted 1-hr 99.9 percentile PM10 concentrations
- Victorian SEPP-AQM criteria (80 ug/m3)

SCALE

0 10 20 30
Kilometres (at A3)

MAP PROJECTION:
Transverse Mercator

HORIZONTAL DATUM:
Geocentric Datum of Australia (GDA)

GRID:
Map Grid of Australia 1994, Zone 51

DATA SOURCE:
LGATE_MGA51_20150220

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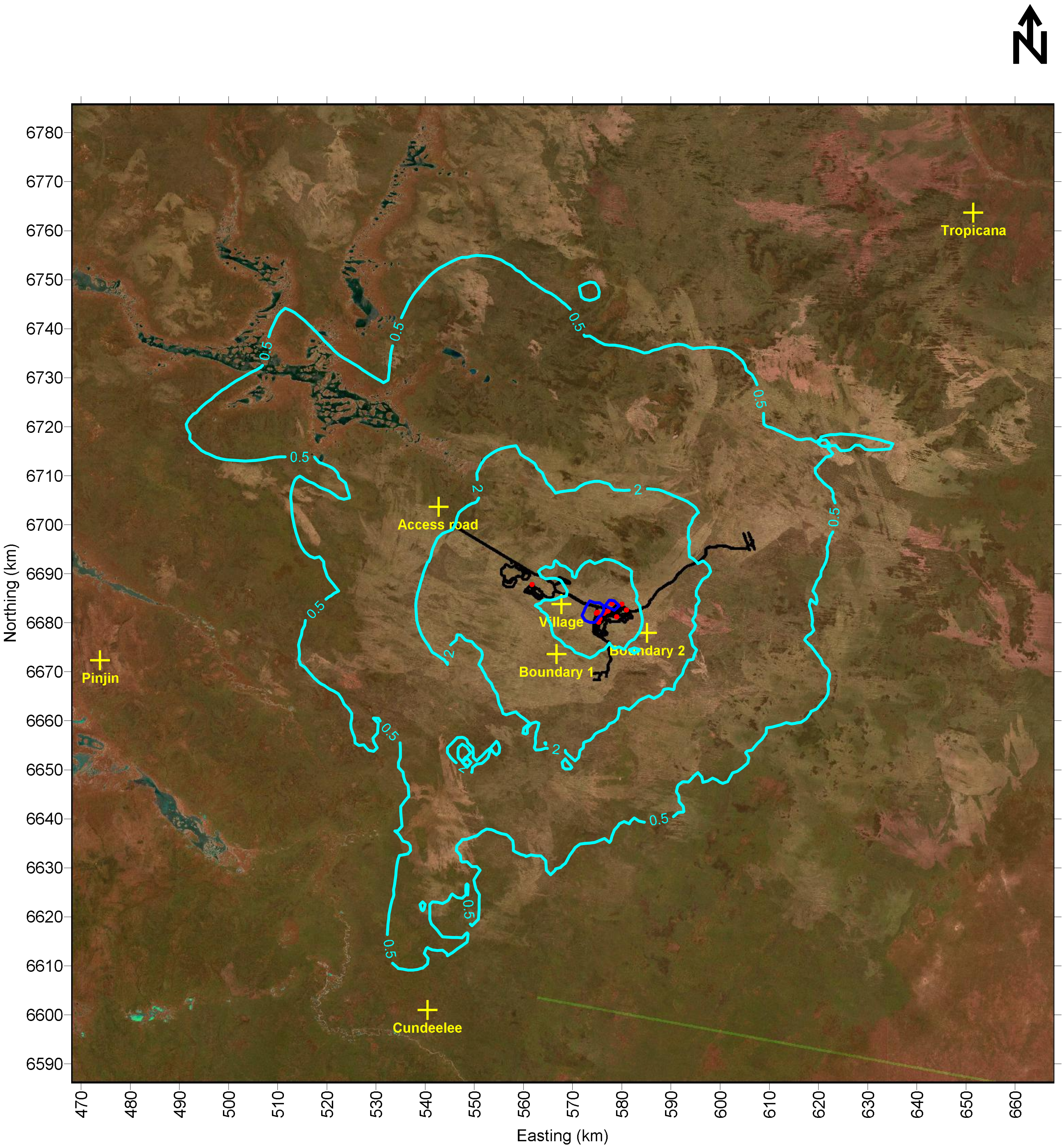
FIGURE 8-7

Scenario 2, Year 10
Predicted 1-hour 99.9 percentile PM10 concentrations

CREATED	CHECKED	APPROVED	DATE	FILE LOCATION	DRAWING NO.	REVISION
LC	JF	JF	17.10.15	G:/61/32680/Technical/Surfer/Figure 01	Figure 8-7.srf	1



Guideline values:
Air NEPM 24-hour maximum PM10 concentration of 50 ug/m3

LEGEND

- Proposed mine layout
- Pit and processing plant source locations
- Sensitive receptors
- Predicted 24-hr max PM10 concentrations
- Air NEPM criteria (50 ug/m3)

SCALE

0 10 20 30

Kilometres (at A3)

MAP PROJECTION:
Transverse Mercator

HORIZONTAL DATUM:
Geocentric Datum of Australia (GDA)

GRID:
Map Grid of Australia 1994, Zone 51

DATA SOURCE:
LGATE_MGA51_20150220

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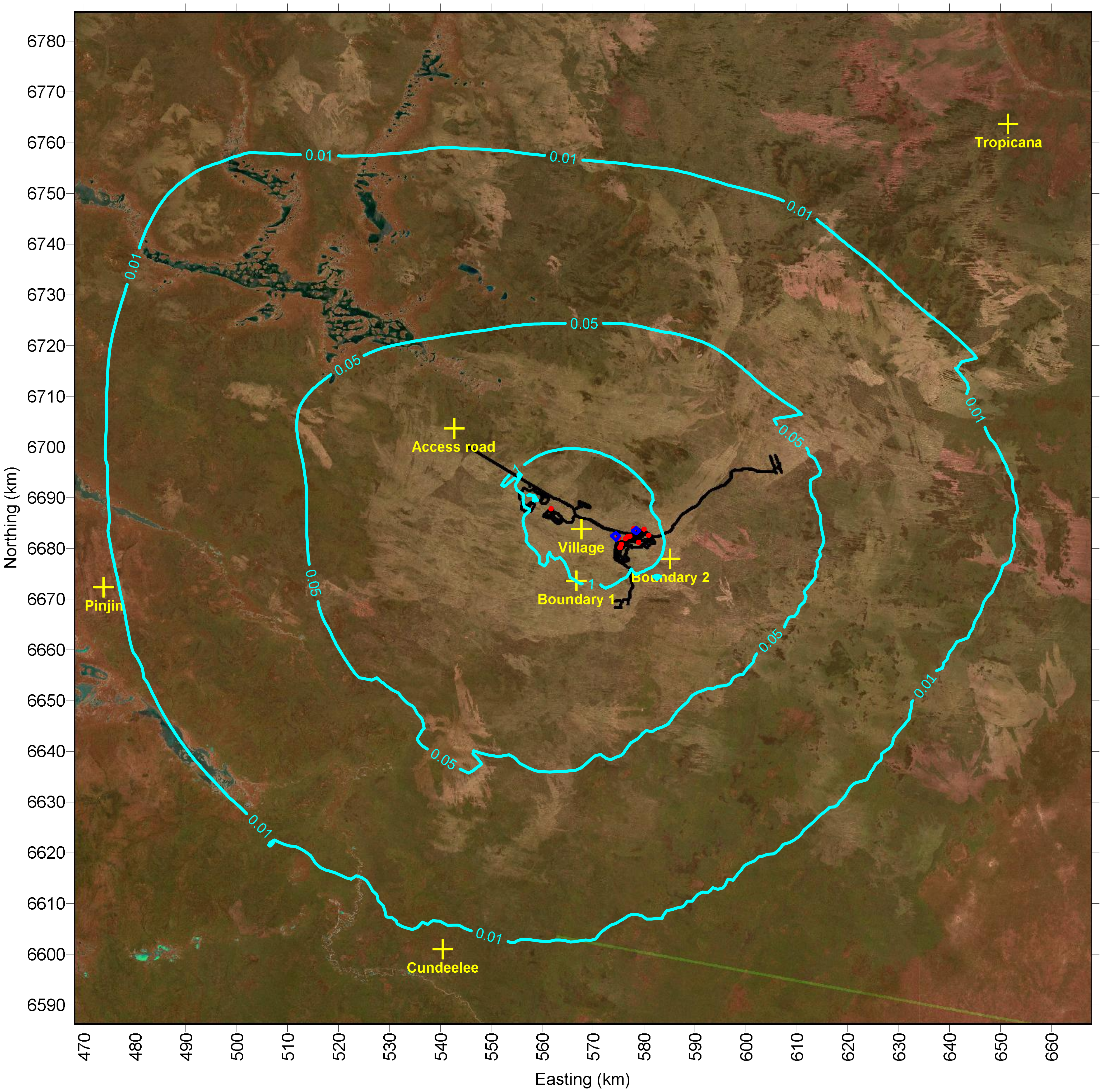
FIGURE 8-8

Scenario 2, Year 10
Predicted 24-hour maximum PM10 concentrations

CREATED	CHECKED	APPROVED	DATE	FILE LOCATION	DRAWING NO.	REVISION
LC	JF	JF	17.10.15	G:/61/32680/Technical/Surfer/Figure 01	Figure 8-8.srf	1



Guideline values:
Proposed variation to the Air NEPM for an annual maximum PM10 concentration of 20 ug/m3

LEGEND

- Proposed mine layout
- Pit and processing plant source locations
- Sensitive receptors
- Predicted annual max PM10 concentrations
- Proposed variation to Air NEPM criteria (20 ug/m3)

SCALE

0 10 20 30
Kilometres (at A3)

MAP PROJECTION:
Transverse Mercator

HORIZONTAL DATUM:
Geocentric Datump of Australia (GDA)

GRID:
Map Grid of Australia 1994, Zone 51

DATA SOURCE:
LGATE_MGA51_20150220

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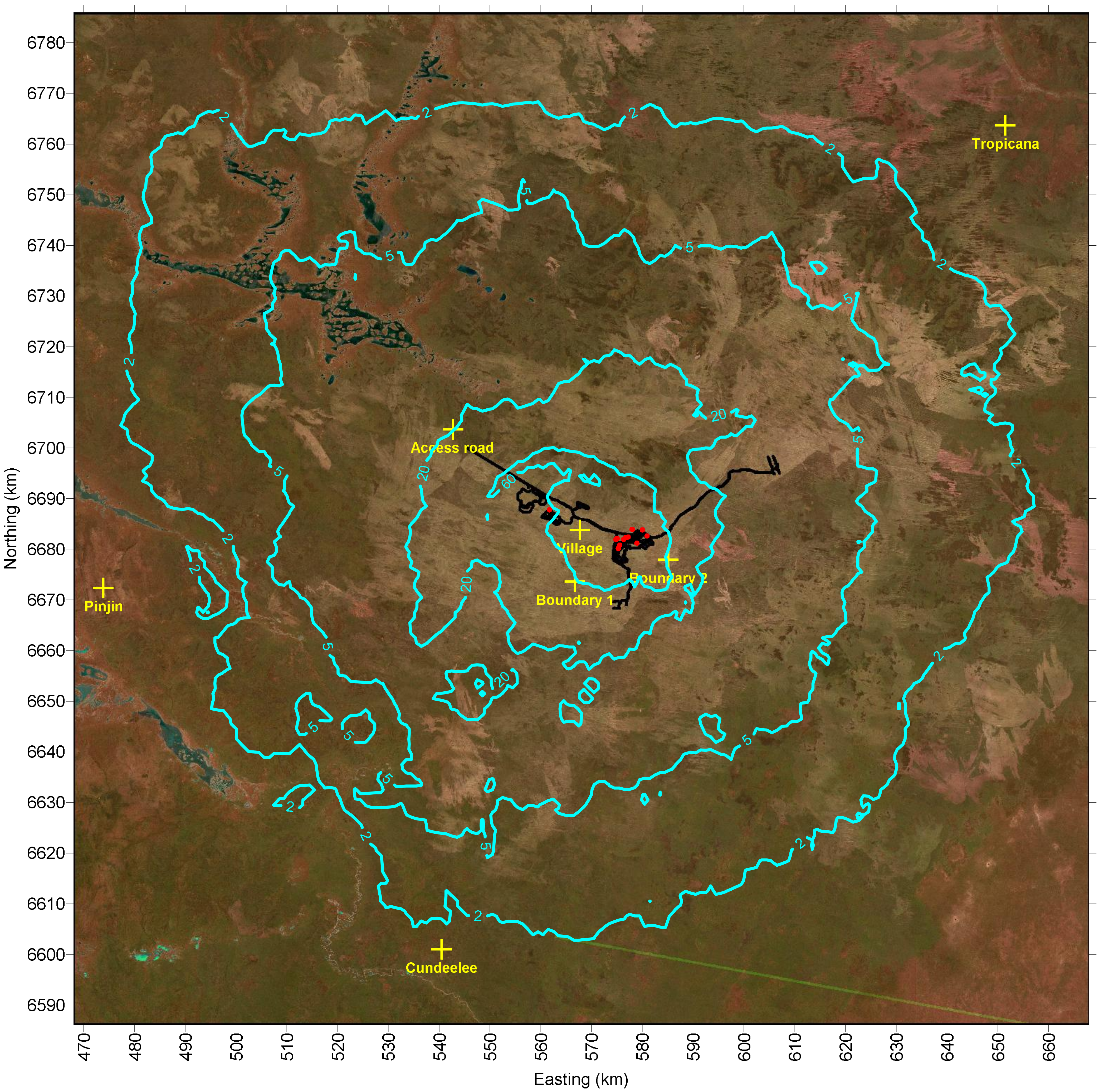
FIGURE 8-9

Scenario 2, Year 10
Predicted annual maximum PM10 concentrations

CREATED	CHECKED	APPROVED	DATE	FILE LOCATION	DRAWING NO.	REVISION
LC	JF	JF	17.10.15	G:/61/32680/Technical/Surfer/Figure 01	Figure 8-9.srf	1



Guideline values:
Nil

LEGEND

- Proposed mine layout
- Pit and processing plant source locations
- Sensitive receptors
- Predicted 1-hr 99.9 percentile TSP concentrations

SCALE

0 10 20 30

Kilometres (at A3)

MAP PROJECTION:
Transverse Mercator

HORIZONTAL DATUM:
Geocentric Datum of Australia (GDA)

GRID:
Map Grid of Australia 1994, Zone 51

DATA SOURCE:
LGATE_MGA50_20150220

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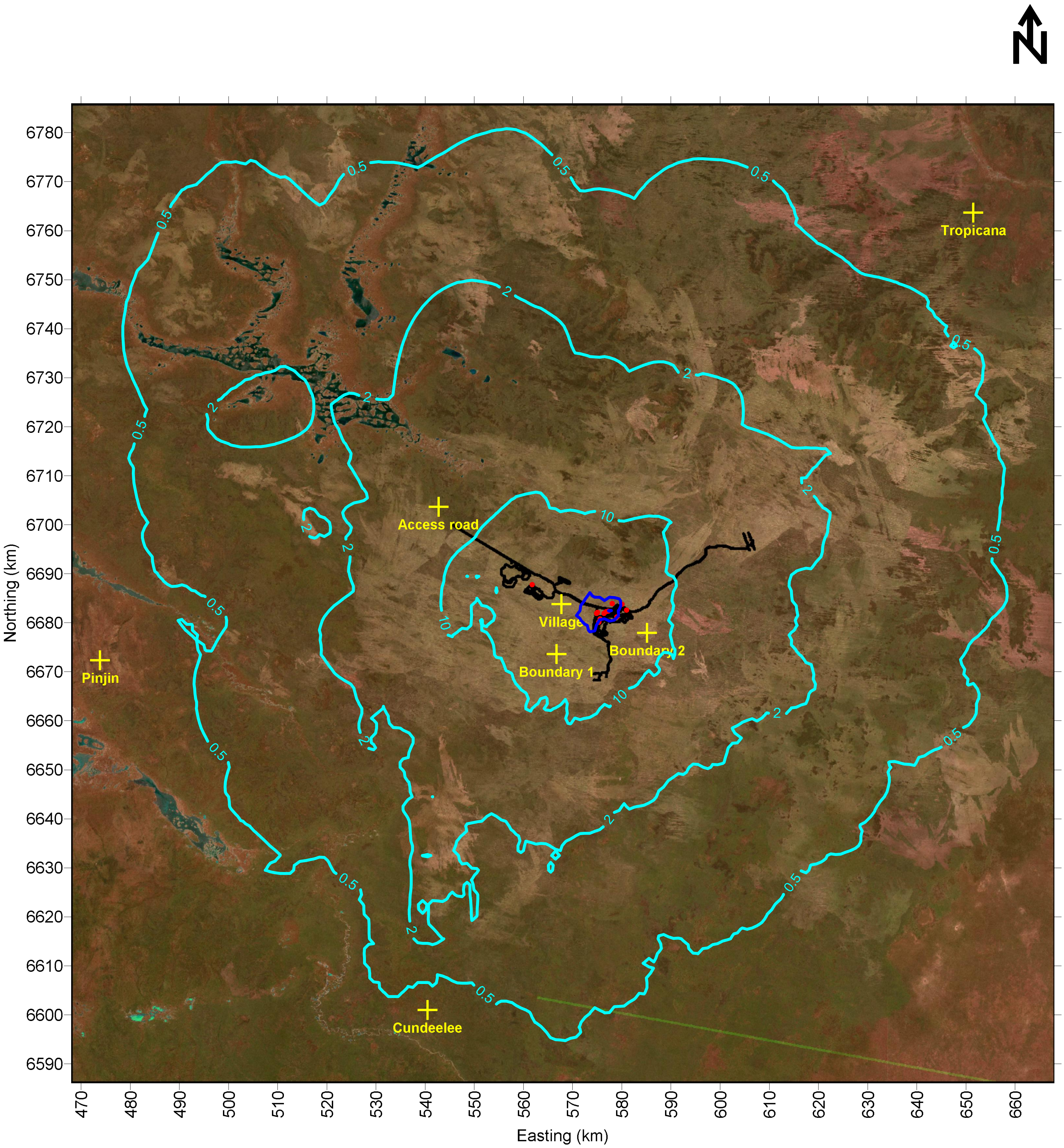
FIGURE 8-10

Scenario 2, Year 10
Predicted 1-hour 99.9 percentile TSP conncentrations

CREATED	CHECKED	APPROVED	DATE	FILE LOCATION	DRAWING NO.	REVISION
LC	JF	JF	17.10.15	G:/61/32680/Technical/Surfer/Figure 01	Figure 8-10.srf	1



Guideline values:
Kwinana EPP 24-hour maximum TSP of 90 ug/m3

LEGEND

- Proposed mine layout
- Pit and processing plant source locations
- Sensitive receptors
- Predicted 24-hr max TSP concentrations
- Kwinana EPP criteria (90 ug/m3)

SCALE

0 10 20 30

Kilometres (at A3)

MAP PROJECTION: Transverse Mercator

HORIZONTAL DATUM: Geocentric Datum of Australia (GDA)

GRID: Map Grid of Australia 1994, Zone 51

DATA SOURCE: LGATE_MGA51_20150220

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FIGURE 8-11

Scenario 2, Year 10
Predicted 24-hour maximum TSP concentrations

CREATED	CHECKED	APPROVED	DATE	FILE LOCATION	DRAWING NO.	REVISION
LC	JF	JF	28.10.15	G:/61/32680/Technical/Surfer/Figure 01	Figure 8-11.srf	1

8.3.3 Scenario 3, Year 11 modelling results

Table 8-14 shows predicted PM_{10} and TSP concentrations at receptors, whilst Table 8-15 details predicted deposition at receptors.

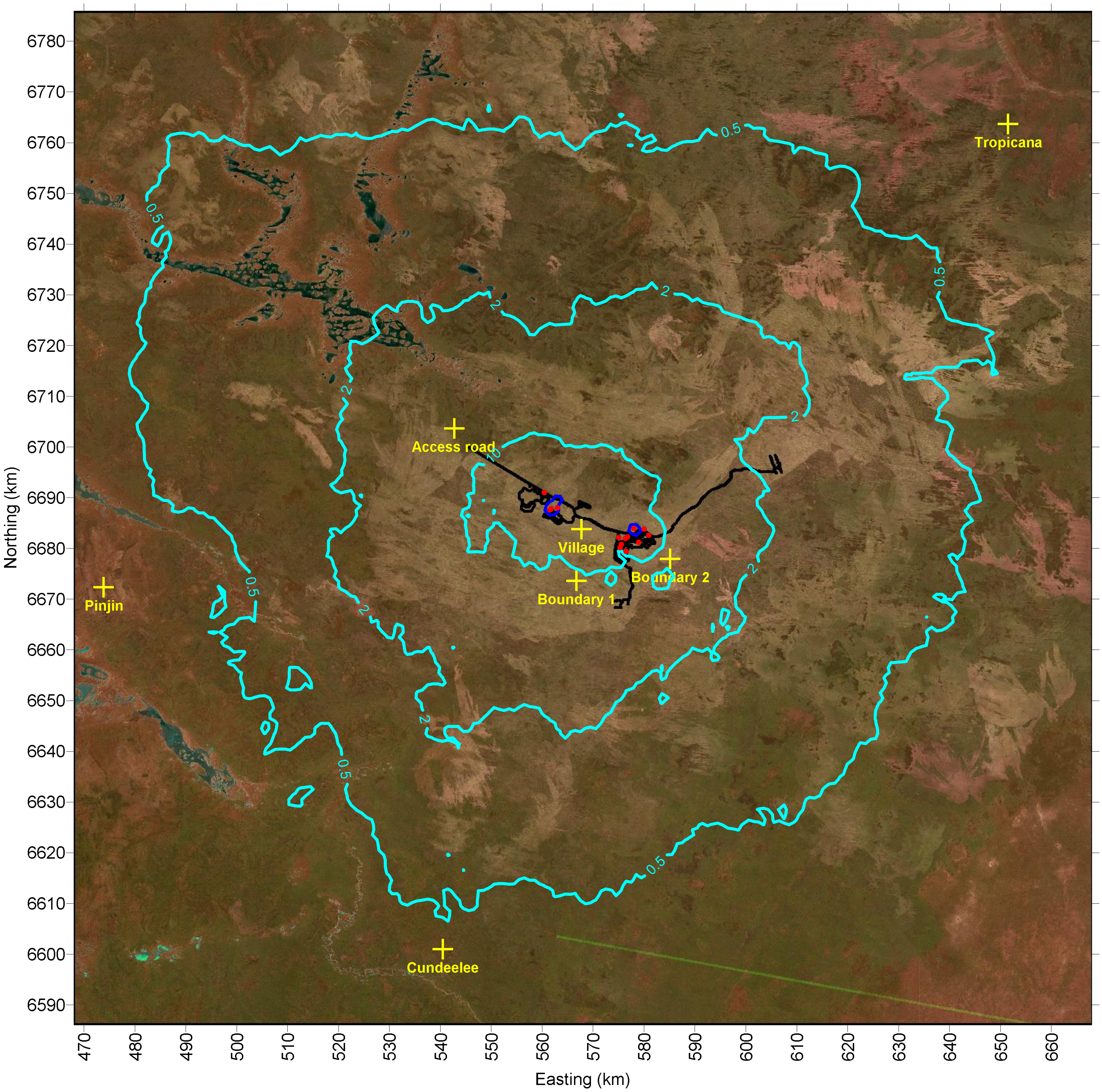
Figure 8-12 through Figure 8-16 show contour plots from the Scenario 3 model for Year 11 of the modelling. Appendix D provides these figures focusing on the development area of the MRUP site.

Table 8-14 Scenario 3, Year 11 predicted concentrations at receptors

Receptor	$PM_{10,}$ µg/m^3			TSP, µg/m^3	
Averaging period	Annual	24-hour	1-hour	24-hour	1-hour
Rank	Max	Max	99.9 %ile	Max	99.9 %ile
Guideline	20	50	80	90	- -
1: Tropicana Gold Mine	0.001	0.03	0.09	0.07	0.21
2: Pinjin	0.007	0.05	0.16	0.12	0.40
3: Cundeelee	0.006	0.09	0.39	0.23	1.01
4: Tenement boundary	0.883	5.65	16.91	13.76	44.82
5: PNC X TPG access road	0.175	1.38	6.47	3.68	17.07
6: Mining village	1.839	10.48	24.47	27.50	66.84
7: Tenement boundary 2	0.314	3.13	7.34	7.61	18.03

Table 8-15 Scenario 3, Year 11 predicted dust deposition at receptors

Receptor	Dry deposition			Wet deposition			Total deposition		
Units	$g/m^2/s$	$g/m^2/mth$	$g/m^2/yr$	$g/m^2/s$	$g/m^2/mth$	$g/m^2/yr$	$g/m^2/s$	$g/m^2/mth$	$g/m^2/yr$
Guideline	- -	- -	- -	- -	- -	- -	- -	2	- -
1: Tropicana Gold Mine	5.5×10^{-13}	1.5×10^{-6}	1.7×10^{-5}	4.9×10^{-12}	1.3×10^{-5}	1.5×10^{-4}	5.5×10^{-12}	1.5×10^{-5}	1.7×10^{-4}
2: Pinjin	2.9×10^{-12}	7.8×10^{-6}	9.2×10^{-5}	1.1×10^{-11}	2.8×10^{-5}	3.3×10^{-4}	1.4×10^{-11}	3.6×10^{-5}	4.3×10^{-4}
3: Cundeelee	2.5×10^{-12}	6.6×10^{-6}	7.8×10^{-5}	4.2×10^{-12}	1.1×10^{-5}	1.3×10^{-4}	6.7×10^{-12}	1.8×10^{-5}	2.1×10^{-4}
4: Tenement boundary	1.3×10^{-8}	3.4×10^{-2}	4.0×10^{-1}	1.7×10^{-10}	4.5×10^{-4}	5.3×10^{-3}	1.3×10^{-08}	3.4×10^{-2}	4.1×10^{-1}
5: PNC X TPG access road	7.8×10^{-11}	2.1×10^{-4}	2.5×10^{-3}	9.6×10^{-11}	2.6×10^{-4}	3.0×10^{-3}	1.7×10^{-10}	4.6×10^{-4}	5.5×10^{-3}
6: Mining village	1.4×10^{-8}	3.8×10^{-2}	4.5×10^{-1}	5.7×10^{-10}	1.5×10^{-3}	1.8×10^{-2}	1.5×10^{-8}	4.0×10^{-2}	4.7×10^{-1}
7: Tenement boundary 2	5.7×10^{-10}	1.5×10^{-3}	1.8×10^{-2}	1.3×10^{-10}	3.4×10^{-4}	4.0×10^{-3}	7.0×10^{-10}	1.9×10^{-3}	2.2×10^{-2}



Guideline values:
Victorian SEPP-AQM 1-hour 99.9 percentile PM10 design criteria of 80 ug/m3

LEGEND

- Proposed mine layout
- Pit and processing plant source locations
- Sensitive receptors
- Predicted 1-hr 99.9 percentile PM10 concentrations
- Victorian SEPP-AQM criteria (80 ug/m3)

SCALE

0 10 20 30
Kilometres (at A3)

MAP PROJECTION:
Transverse Mercator

HORIZONTAL DATUM:
Geocentric Datump of Australia (GDA)

GRID:
Map Grid of Australia 1994, Zone 51

DATA SOURCE:
LGATE_MGA51_20150220

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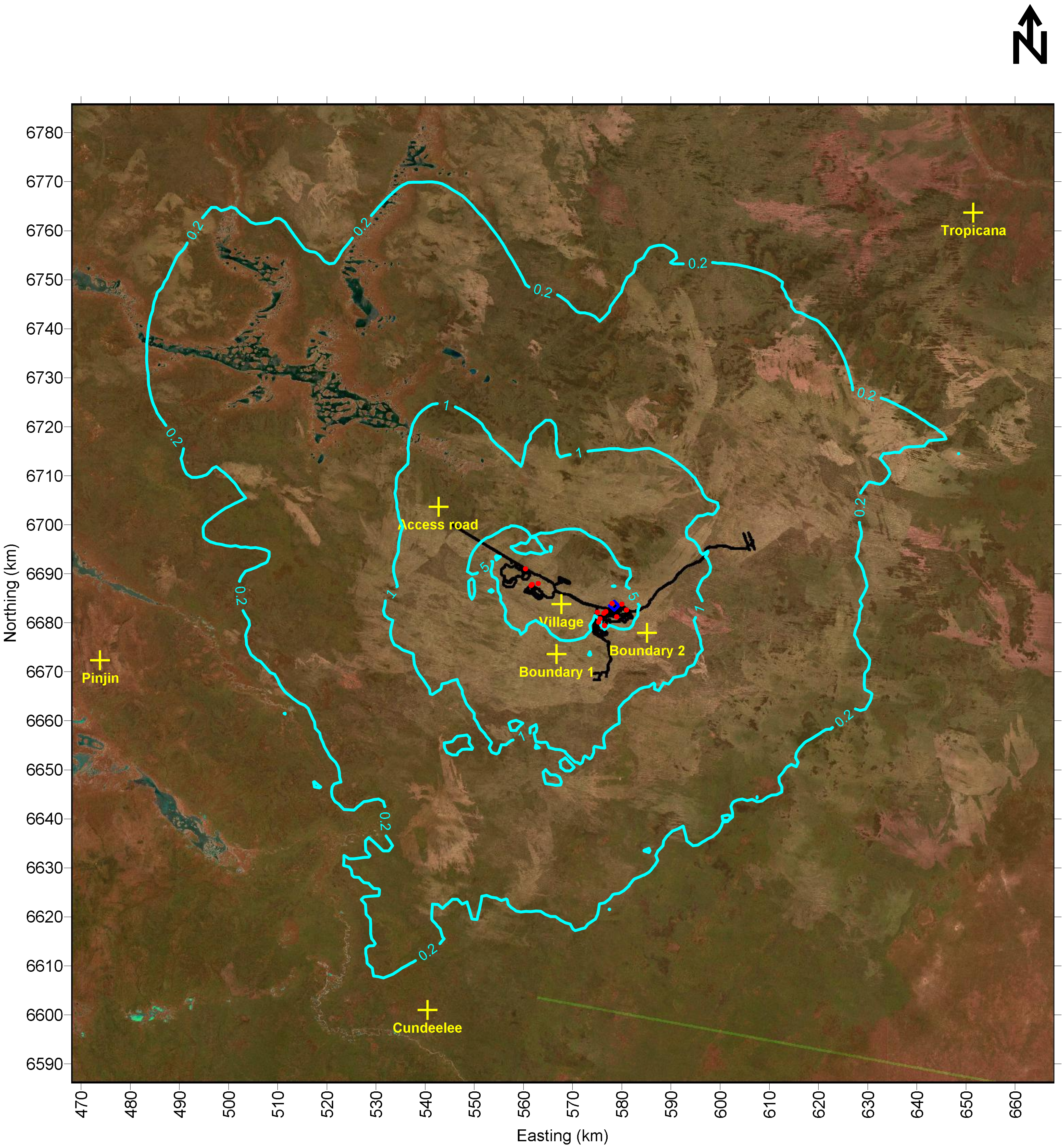
FIGURE 8-12

Scenario 3, Year 11
Predicted 1-hour 99.9 percentile PM10 concentrations

CREATED	CHECKED	APPROVED	DATE	FILE LOCATION	DRAWING NO.	REVISION
LC	JF	JF	17.10.15	G:/61/32680/Technical/Surfer/Figure 01	Figure 8-12.srf	1



Guideline values:
Air NEPM 24-hour maximum PM10 concentration of 50 ug/m3

LEGEND

- Proposed mine layout
- Pit and processing plant source locations
- Sensitive receptors
- Predicted 24-hr max PM10 concentrations
- Air NEPM criteria (50 ug/m3)

SCALE

0 10 20 30
Kilometres (at A3)

MAP PROJECTION:
Transverse Mercator

HORIZONTAL DATUM:
Geocentric Datum of Australia (GDA)

GRID:
Map Grid of Australia 1994, Zone 51

DATA SOURCE:
LGATE_MGA51_20150220

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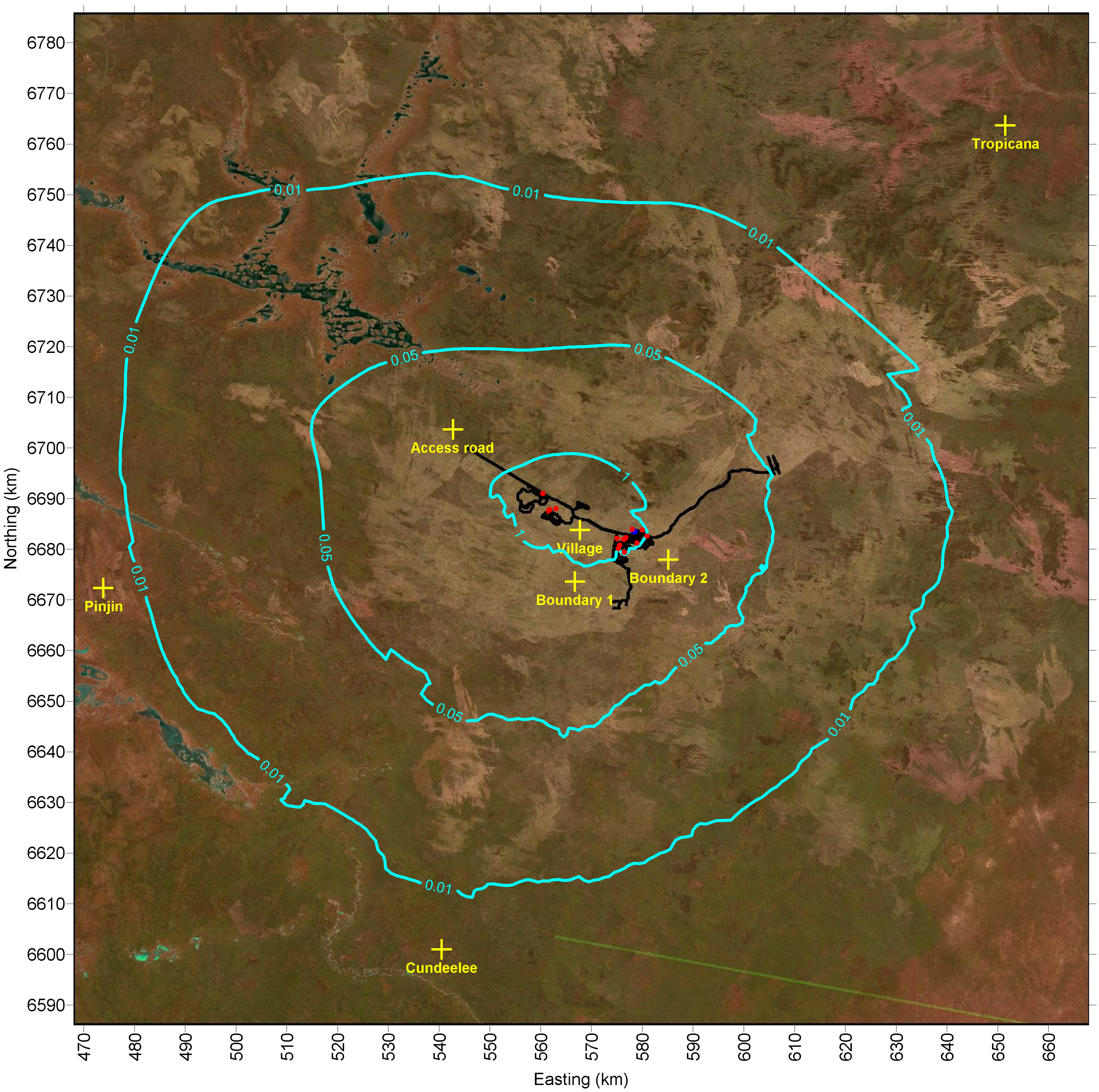
FIGURE 8-13

Scenario 3, Year 11
Predicted 24-hour maximum PM10 concentrations

CREATED	CHECKED	APPROVED	DATE	FILE LOCATION	DRAWING NO.	REVISION
LC	JF	JF	17.10.15	G:/61/32680/Technical/Surfer/Figure 01	Figure 8-13.srf	1



Guideline values:
Proposed variation to the Air NEPM for an annual maximum PM10 concentration of 20 ug/m3

LEGEND

- Proposed mine layout
- Pit and processing plant source locations
- Sensitive receptors
- Predicted annual PM10 concentrations
- Proposed variation to Air NEPM criteria (20 ug/m3)

SCALE

0 10 20 30

Kilometres (at A3)

MAP PROJECTION:
Transverse Mercator

HORIZONTAL DATUM:
Geocentric Datump of Australia (GDA)

GRID:
Map Grid of Australia 1994, Zone 51

DATA SOURCE:
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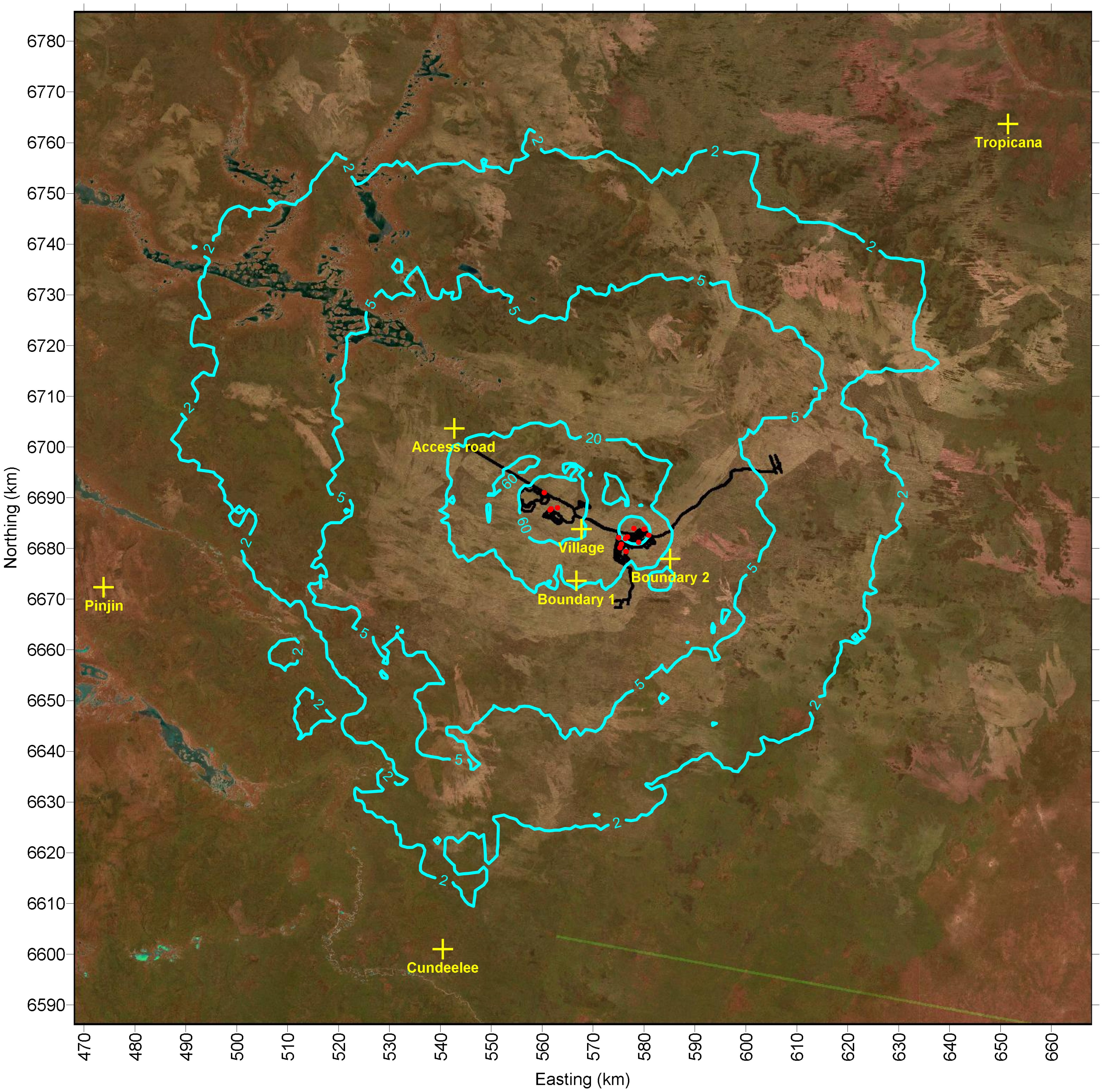
FIGURE 8-14

Scenario 3, Year 11
Predicted annual PM10 concentrations

CREATED	CHECKED	APPROVED	DATE	FILE LOCATION	DRAWING NO.	REVISION
LC	JF	JF	17.10.15	G:/61/32680/Technical/Surfer/Figure 01	Figure 8-14.srf	1



Guideline values:
Nil

LEGEND

- Proposed mine layout
- Pit and processing plant source locations
- Sensitive receptors
- Predicted 1-hr 99.9 percentile TSP concentrations

SCALE

0 10 20 30
Kilometres (at A3)

MAP PROJECTION:
Transverse Mercator

HORIZONTAL DATUM:
Geocentric Datum of Australia (GDA)

GRID:
Map Grid of Australia 1994, Zone 51

DATA SOURCE:
LGATE_MGA51_20150220

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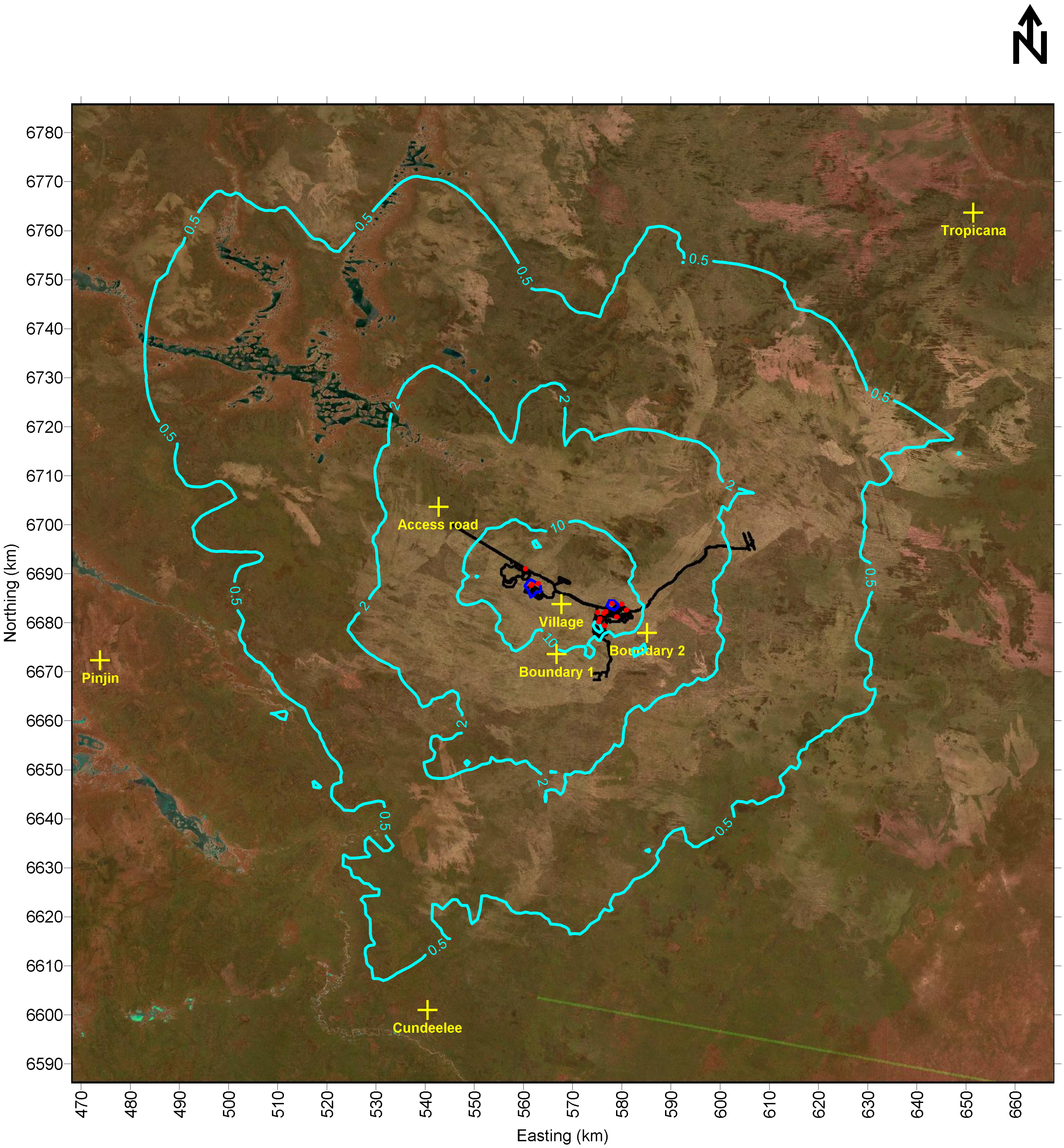
FIGURE 8-15

Scenario 3, Year 7
Predicted 1-hour 99.9 percentile TSP concentrations

CREATED	CHECKED	APPROVED	DATE	FILE LOCATION	DRAWING NO.	REVISION
LC	JF	JF	17.10.15	G:/61/32680/Technical/Surfer/Figure 01	Figure 8-15.srf	1



Guideline values:
Kwinana EPP 24-hour maximum TSP of 90 ug/m3

LEGEND

- Proposed mine layout
- Pit and processing plant source locations
- Sensitive receptors
- Predicted 24-hr max TSP concentrations
- Kwinana EPP criteria (90 ug/m3)

SCALE

0 10 20 30

Kilometres (at A3)

MAP PROJECTION:
Transverse Mercator

HORIZONTAL DATUM:
Geocentric Datum of Australia (GDA)

GRID:
Map Grid of Australia 1994, Zone 51

DATA SOURCE:
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FIGURE 8-16

Scenario 3, Year 11
Predicted 24-hour maximum TSP contours

CREATED	CHECKED	APPROVED	DATE	FILE LOCATION	DRAWING NO.	REVISION
LC	JF	JF	17.10.15	G:/61/32680/Technical/Surfer/Figure 01	Figure 8-16.srf	1

8.3.4 Scenario 4, Year 14 modelling results

Table 8-16 shows predicted PM_{10} and TSP concentrations at receptors whilst Table 8-15 provides predicted deposition at receptors.

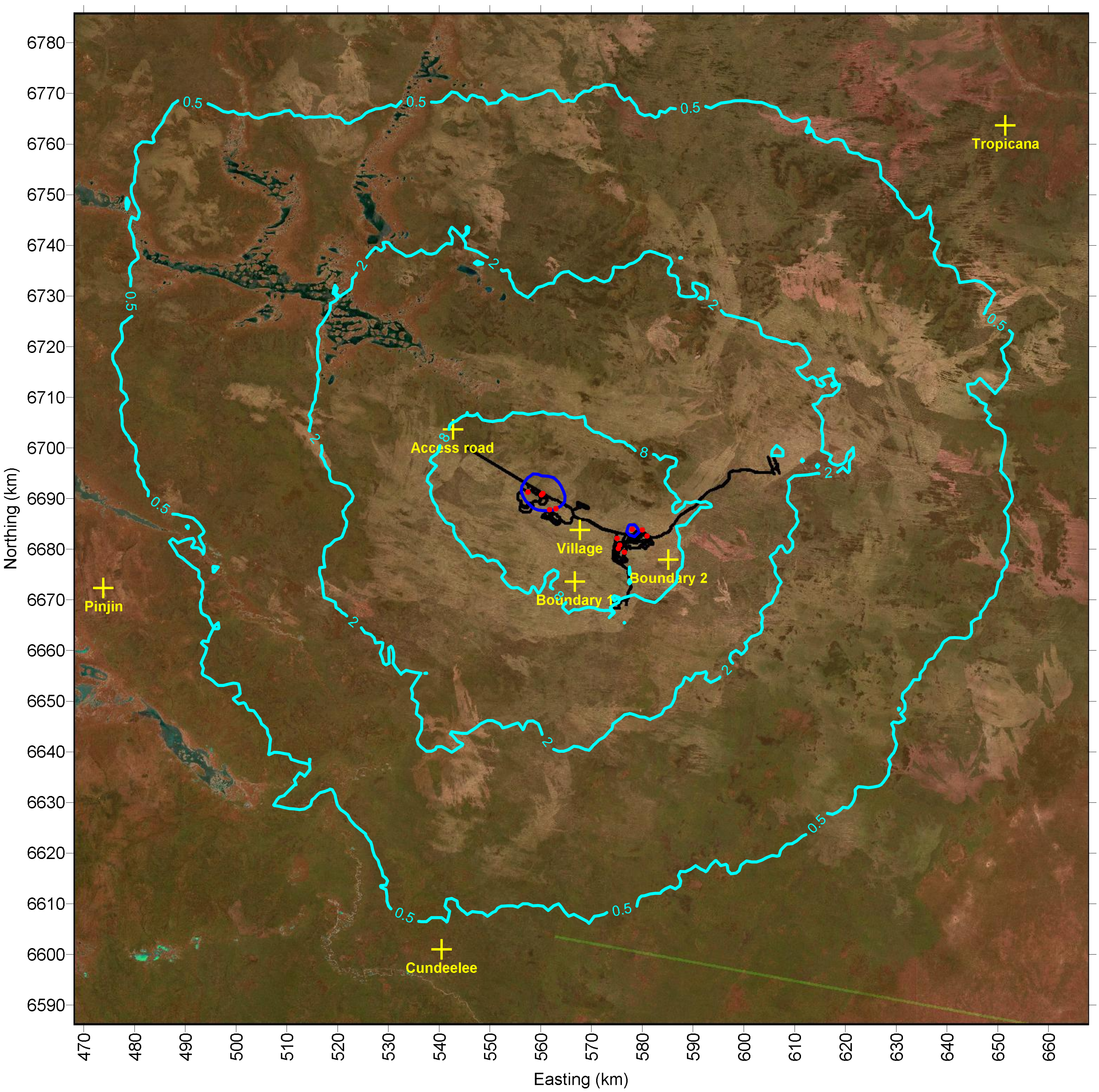
Figure 8-17 through Figure 8-21 show contour plots from the Scenario 4 model for Year 14 of the modelling. Appendix D provides these figures focusing on the development area of the MRUP site.

Table 8-16 Scenario 4, Year 14 predicted concentrations at receptors

Receptor	$PM_{10,}$ µg/m^3			TSP, µg/m^3	
Averaging period	Annual	24-hour	1-hour	24-hour	1-hour
Rank	Max	Max	99.9 %ile	Max	99.9 %ile
Guideline	20	50	80	90	- -
1: Tropicana Gold Mine	0.002	0.04	0.11	0.14	0.41
2: Pinjin	0.009	0.06	0.19	0.23	0.72
3: Cundeelee	0.007	0.13	0.47	0.47	1.63
4: Tenement boundary	0.945	5.93	17.92	22.18	63.71
5: PNC X TPG access road	0.272	2.05	9.17	7.46	33.09
6: Mining village	2.007	12.83	29.14	46.44	98.74
7: Tenement boundary 2	0.362	3.90	11.96	13.45	38.75

Table 8-17 Scenario 4, Year 14 predicted dust deposition at receptors

Receptor	Dry deposition			Wet deposition			Total deposition		
Units	$g/m^3/s$	$g/m^3/mth$	$g/m^3/yr$	$g/m^3/s$	$g/m^3/mth$	$g/m^3/yr$	$g/m^3/s$	$g/m^3/mth$	g/m3/yr
Guideline	- -	- -	- -	- -	- -	- -	- -	2	- -
1: Tropicana Gold Mine	6.9×10^{-13}	1.9×10^{-6}	2.2×10^{-5}	7.7×10^{-12}	2.1×10^{-5}	2.4×10^{-4}	8.4×10^{-12}	2.3×10^{-5}	2.7×10^{-4}
2: Pinjin	4.0×10^{-12}	1.1×10^{-5}	1.3×10^{-4}	1.8×10^{-11}	4.8×10^{-5}	5.7×10^{-4}	2.2×10^{-11}	5.9×10^{-5}	6.9×10^{-4}
3: Cundeelee	2.9×10^{-12}	7.6×10^{-6}	9.0×10^{-5}	6.2×10^{-12}	1.7×10^{-5}	1.9×10^{-4}	9.0×10^{-12}	2.4×10^{-5}	2.8×10^{-4}
4: Tenement boundary	1.4×10^{-8}	3.8×10^{-2}	4.4×10^{-1}	2.1×10^{-10}	5.7×10^{-4}	6.7×10^{-3}	1.4×10^{-8}	3.8×10^{-2}	4.5×10^{-1}
5: PNC X TPG access road	1.4×10^{-10}	3.8×10^{-4}	4.4×10^{-3}	1.9×10^{-10}	5.2×10^{-4}	6.1×10^{-3}	3.4×10^{-10}	9.0×10^{-4}	1.1×10^{-2}
6: Mining village	1.6×10^{-8}	4.3×10^{-2}	5.1×10^{-1}	6.8×10^{-10}	1.8×10^{-3}	2.1×10^{-2}	1.7×10^{-8}	4.5×10^{-2}	5.3×10^{-1}
7: Tenement boundary 2	5.3×10^{-10}	1.4×10^{-3}	1.7×10^{-2}	1.2×10^{-10}	3.1×10^{-4}	3.7×10^{-3}	6.4×10^{-10}	1.7×10^{-3}	2.0×10^{-2}



Guideline values:
Victorian SEPP-AQM 1-hour 99.9 percentile PM10 design criteria of 80 ug/m3

LEGEND

- Proposed mine layout
- Pit and processing plant source locations
- Sensitive receptors
- Predicted 1-hr 99.9 percentile PM10 concentrations
- Victorian SEPP-AQM criteria (80 ug/m3)

SCALE

0 10 20 30
Kilometres (at A3)

MAP PROJECTION: Transverse Mercator
HORIZONTAL DATUM: Geocentric Datum of Australia (GDA)
GRID: Map Grid of Australia 1994, Zone 51
DATA SOURCE: LGATE_MGA51_20150220

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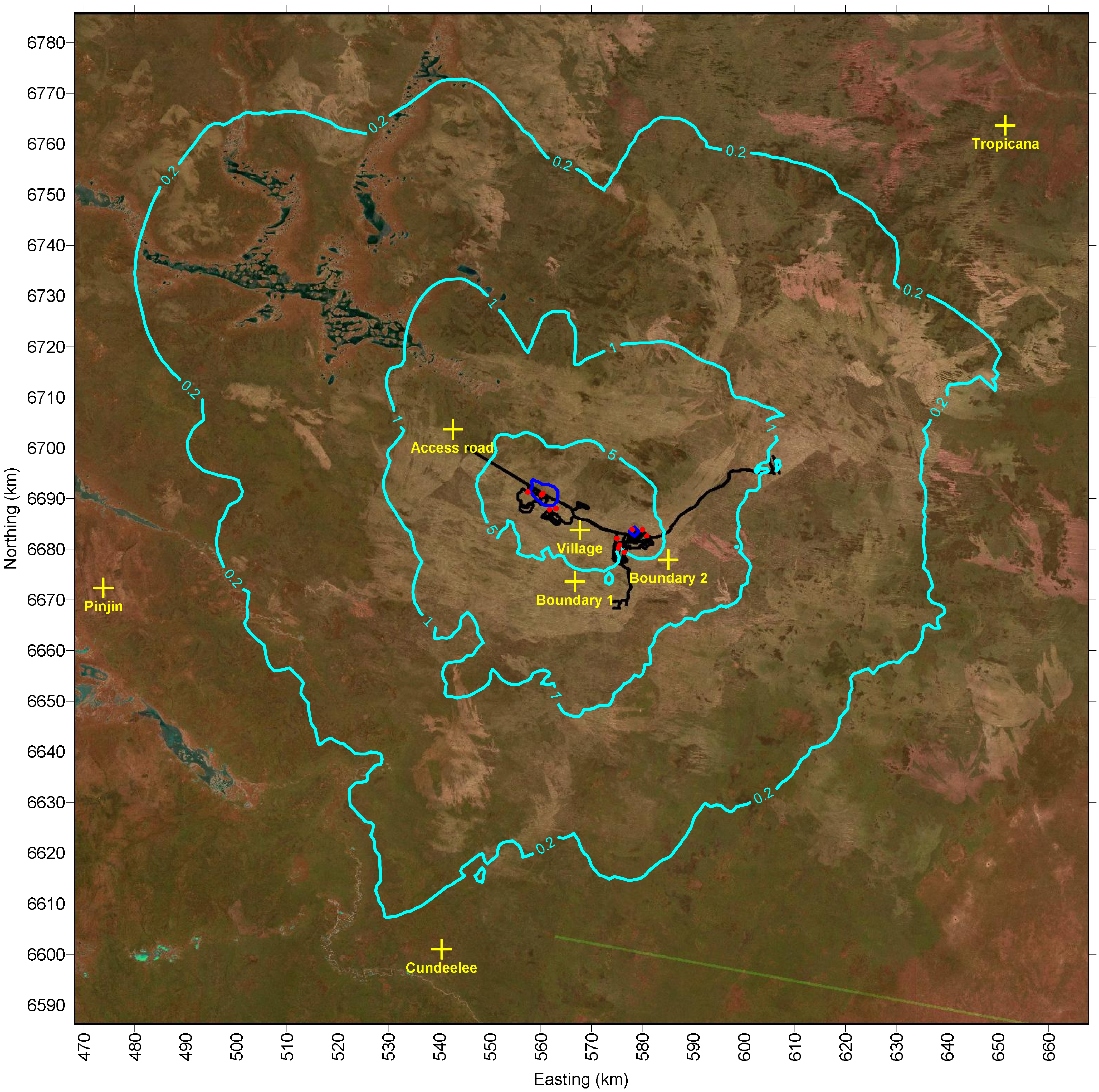
FIGURE 8-17

Scenario 4, Year 14
Predicted 1-hour 99.9 percentile PM10 concentrations

CREATED	CHECKED	APPROVED	DATE	FILE LOCATION	DRAWING NO.	REVISION
LC	JF	JF	17.10.15	G:/61/32680/Technical/Surfer/Figure 01	Figure 8-17.srf	1



Guideline values:
Air NEPM 24-hour maximum PM10 concentration of 50 ug/m3

LEGEND

- Proposed mine layout
- Pit and processing plant source locations
- Sensitive receptors
- Predicted 24-hr max PM10 concentrations
- Air NEPM criteria (50 ug/m3)

SCALE

0 10 20 30

Kilometres (at A3)

MAP PROJECTION:
Transverse Mercator

HORIZONTAL DATUM:
Geocentric Datump of Australia (GDA)

GRID:
Map Grid of Australia 1994, Zone 51

DATA SOURCE:
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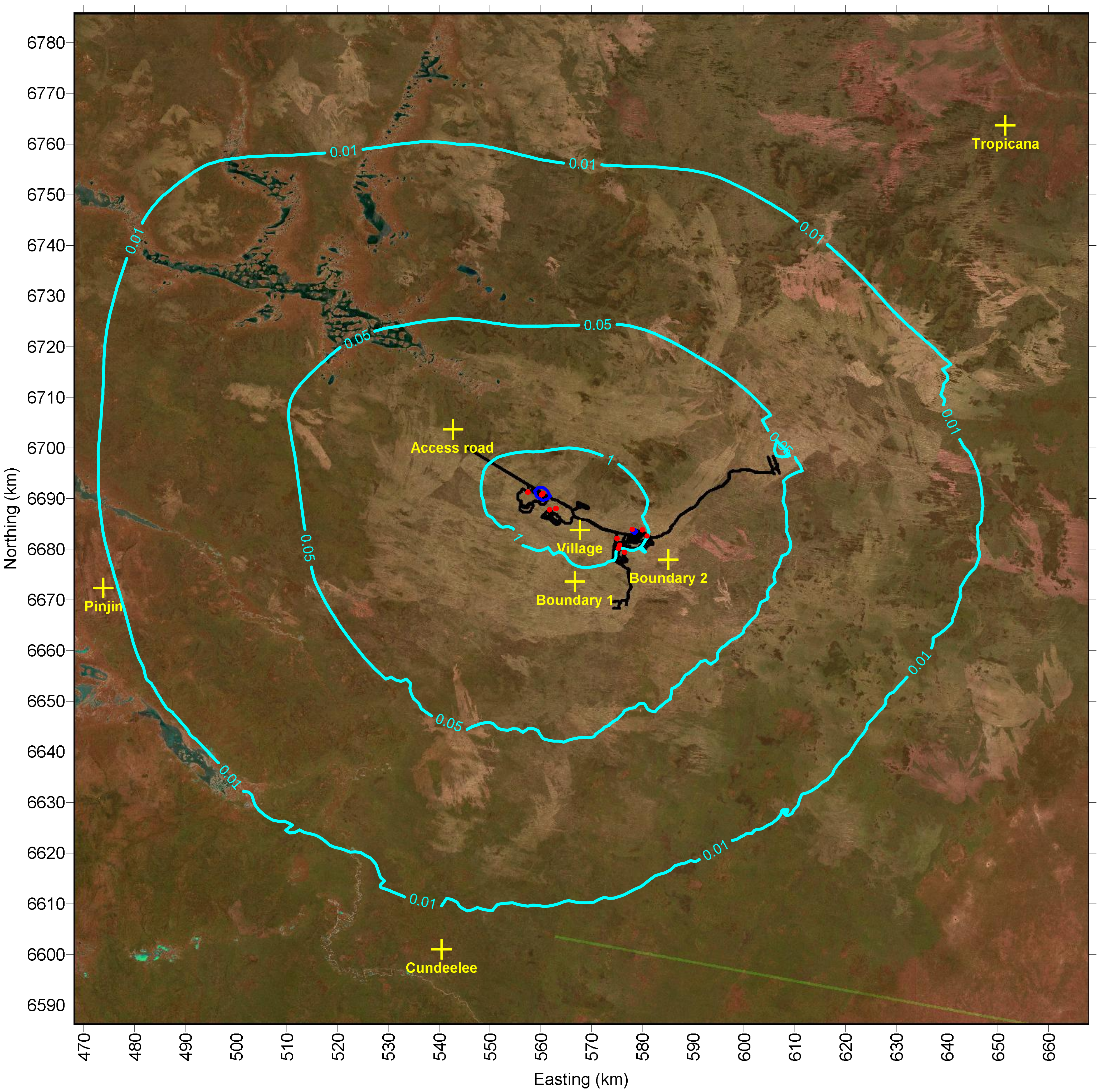
FIGURE 8-18

Scenario 4, Year 14
Predicted 24-hour maximum PM10 concentrations

CREATED	CHECKED	APPROVED	DATE	FILE LOCATION	DRAWING NO.	REVISION
LC	JF	JF	17.10.15	G:/61/32680/Technical/Surfer/Figure 01	Figure 8-18.srf	1



Guideline values:
Proposed variation to the Air NEPM for an annual maximum PM10 concentration of 20 ug/m3

LEGEND

- Proposed mine layout
- Pit and processing plant source locations
- Sensitive receptors
- Predicted annual PM10 concentrations
- Proposed variation to Air NEPM criteria (20 ug/m3)

SCALE

0 10 20 30
Kilometres (at A3)

MAP PROJECTION: Transverse Mercator

HORIZONTAL DATUM: Geocentric Datump of Australia (GDA)

GRID: Map Grid of Australia 1994, Zone 51

DATA SOURCE: LGATE_MGA51_20150220

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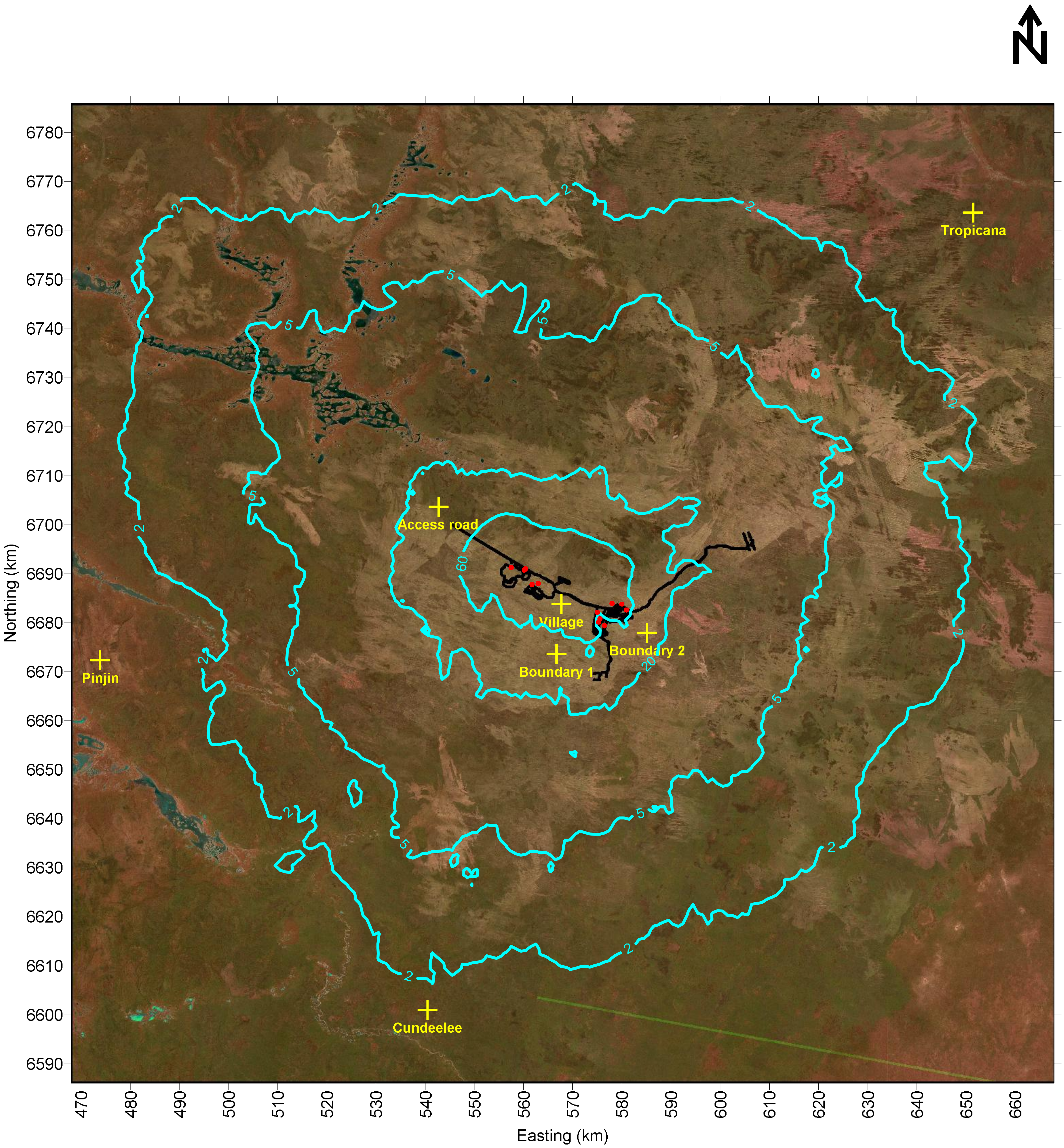
FIGURE 8-19

Scenario 4, Year 14
Predicted annual PM10 concentrations

CREATED	CHECKED	APPROVED	DATE	FILE LOCATION	DRAWING NO.	REVISION
LC	JF	JF	17.10.15	G:/61/32680/Technical/Surfer/Figure 01	Figure 8-19.srf	1



Guideline values:
Nil

LEGEND

- Proposed mine layout
- Pit and processing plant source locations
- Sensitive receptors
- Predicted 1-hr 99.9 percentile TSP concentrations

SCALE

0 10 20 30
Kilometres (at A3)

MAP PROJECTION:
Transverse Mercator

HORIZONTAL DATUM:
Geocentric Datump of Australia (GDA)

GRID:
Map Grid of Australia 1994, Zone 51

DATA SOURCE:
LGATE_MGA51_20150220

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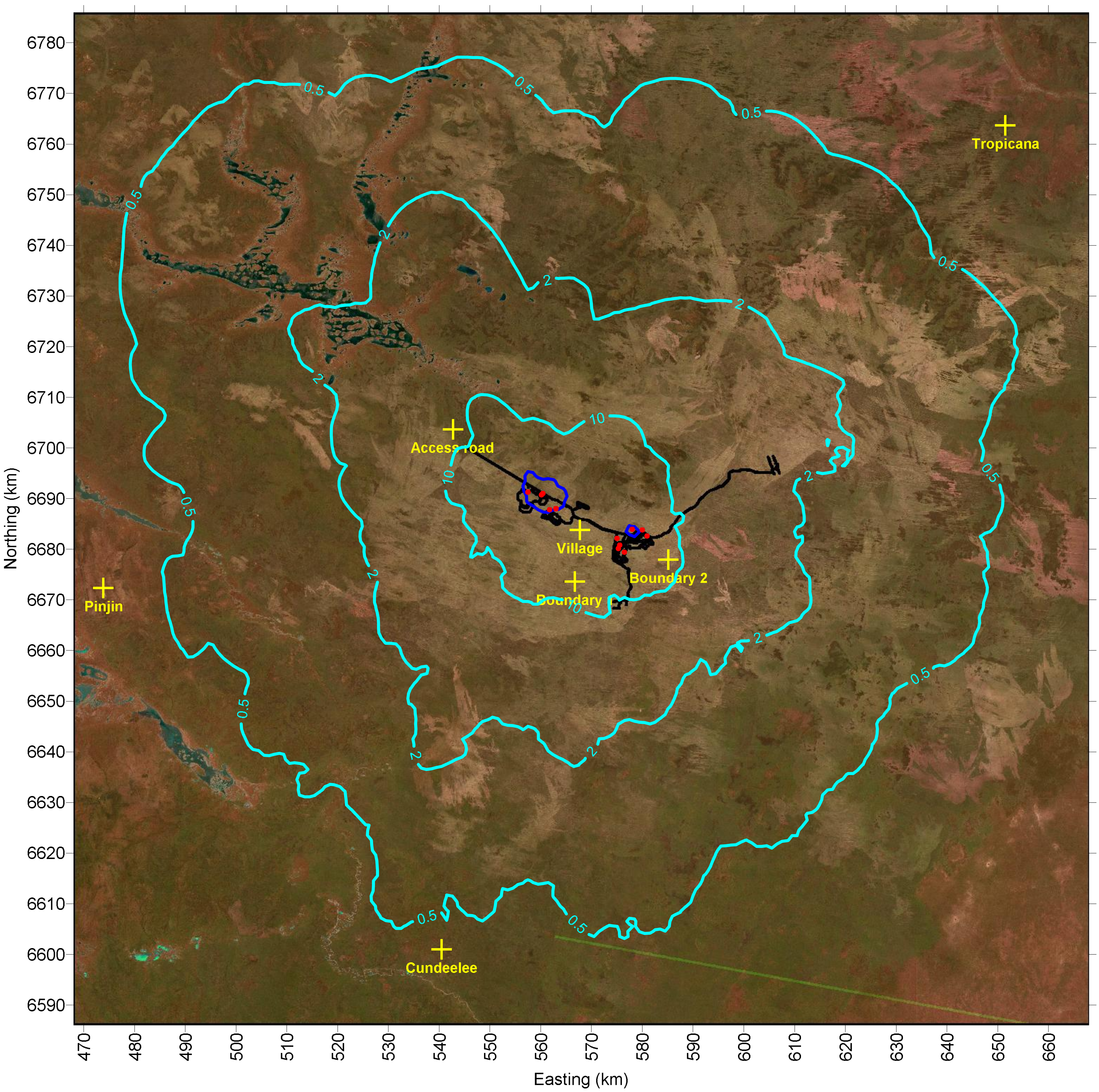
FIGURE 8-20

Scenario 4, Year 14
Predicted 1-hour 99.9 percentile TSP concentrations

CREATED	CHECKED	APPROVED	DATE	FILE LOCATION	DRAWING NO.	REVISION
LC	JF	JF	17.10.15	G:/61/32680/Technical/Surfer/Figure 01	Figure 8-20.srf	1



Guideline values:
Kwinana EPP 24-hour maximum TSP of 90 ug/m3

LEGEND

- Proposed mine layout
- Pit and processing plant source locations
- Sensitive receptors
- 24-hr max TSP contours
- Kwinana EPP criteria (90 ug/m3)

SCALE

0 10 20 30

Kilometres (at A3)

MAP PROJECTION:
Transverse Mercator

HORIZONTAL DATUM:
Geocentric Datum of Australia (GDA)

GRID:
Map Grid of Australia 1994, Zone 51

DATA SOURCE:
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FIGURE 8-21

Scenario 4, Year 14
Predicted 24-hour maximum TSP concentrations

CREATED	CHECKED	APPROVED	DATE	FILE LOCATION	DRAWING NO.	REVISION
LC	JF	JF	17.10.15	G:/61/32680/Technical/Surfer/Figure 01	Figure 8-21.srf	1

8.3.5 Scenario 5, closure (first year) year modelling results

Table 8-18 shows predicted PM_{10} and TSP concentrations at receptors whilst Table 8-19 provides predicted deposition at receptors.

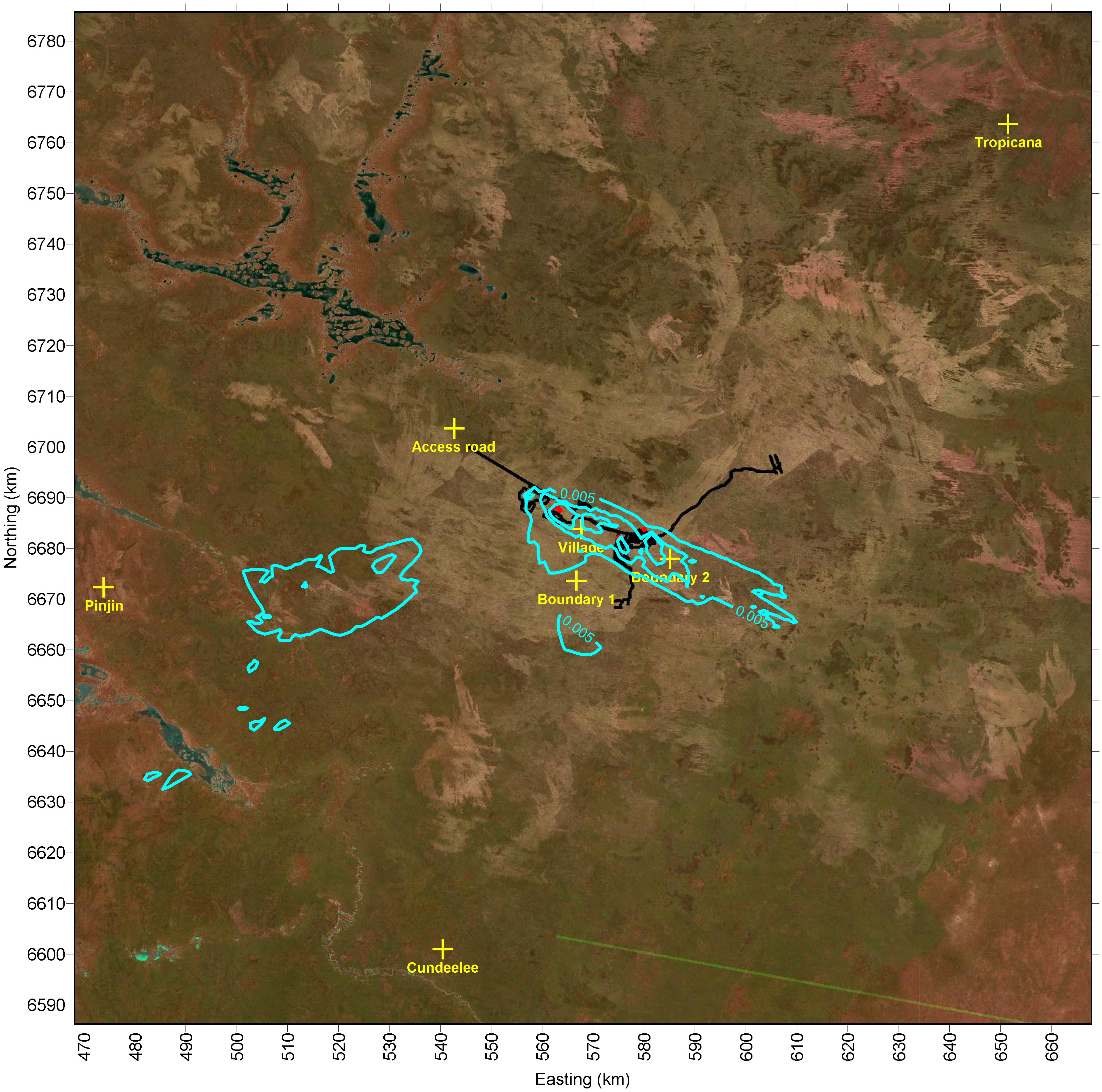
Figure 8-22 through Figure 8-26 show contour plots from the Scenario 5 model for closure (first year) of the modelling. Appendix D provides these figures focusing on the development area of the MRUP site.

Table 8-18 Scenario 5, closure (first year) predicted concentrations at receptors

Receptor	$PM_{10,}$ µg/m^3			TSP, µg/m^3	
Averaging period	Annual	24-hour	1-hour	24-hour	1-hour
Rank	Max	Max	99.9 %ile	Max	99.9 %ile
Guideline	20	50	80	90	- -
1: Tropicana Gold Mine	1.8×10^{-12}	5.8×10^{-10}	3.6×10^{-11}	1.2×10^{-9}	7.1×10^{-11}
2: Pinjin	1.4×10^{-11}	2.8×10^{-9}	6.5×10^{-9}	5.7×10^{-9}	1.3×10^{-8}
3: Cundeelee	2.6×10^{-11}	6.3×10^{-9}	2.4×10^{-10}	1.3×10^{-8}	4.7×10^{-10}
4: Tenement boundary	2.0×10^{-10}	6.9×10^{-8}	3.2×10^{-8}	1.4×10^{-7}	6.4×10^{-8}
5: PNC X TPG access road	1.5×10^{-11}	4.6×10^{-9}	2.1×10^{-9}	9.2×10^{-9}	4.2×10^{-9}
6: Mining village	3.4×10^{-10}	9.3×10^{-8}	4.4×10^{-8}	1.9×10^{-7}	8.8×10^{-8}
7: Tenement boundary 2	2.5×10^{-10}	4.7×10^{-8}	6.5×10^{-8}	9.4×10^{-8}	1.3×10^{-7}

Table 8-19 Scenario 5, closure (first year) predicted dust deposition at receptors

Receptor	Dry deposition			Wet deposition			Total deposition		
Units	$g/m^3/s$	$g/m^3/mth$	$g/m^3/yr$	$g/m^3/s$	$g/m^3/mth$	$g/m^3/yr$	$g/m^3/s$	$g/m^3/mth$	g/m3/yr
Guideline	- -	- -	- -	- -	- -	- -	- -	2	- -
1: Tropicana Gold Mine	Below model calculation parameters								
2: Pinjin									
3: Cundeelee									
4: Tenement boundary									
5: PNC X TPG access road									
6: Mining village									
7: Tenement boundary 2									



Guideline values:
Victorian SEPP-AQM 1-hour 99.9 percentile PM10 design criteria of 80 ug/m3

LEGEND

- Proposed mine layout
- Pit and processing plant source locations
- Sensitive receptors
- Predicted 1-hr 99.9 percentile PM10 concentrations

SCALE

0 10 20 30

Kilometres (at A3)

MAP PROJECTION:
Transverse Mercator

HORIZONTAL DATUM:
Geocentric Datump of Australia (GDA)

GRID:
Map Grid of Australia 1994, Zone 51

DATA SOURCE:
LGATE_MGA51_20150220

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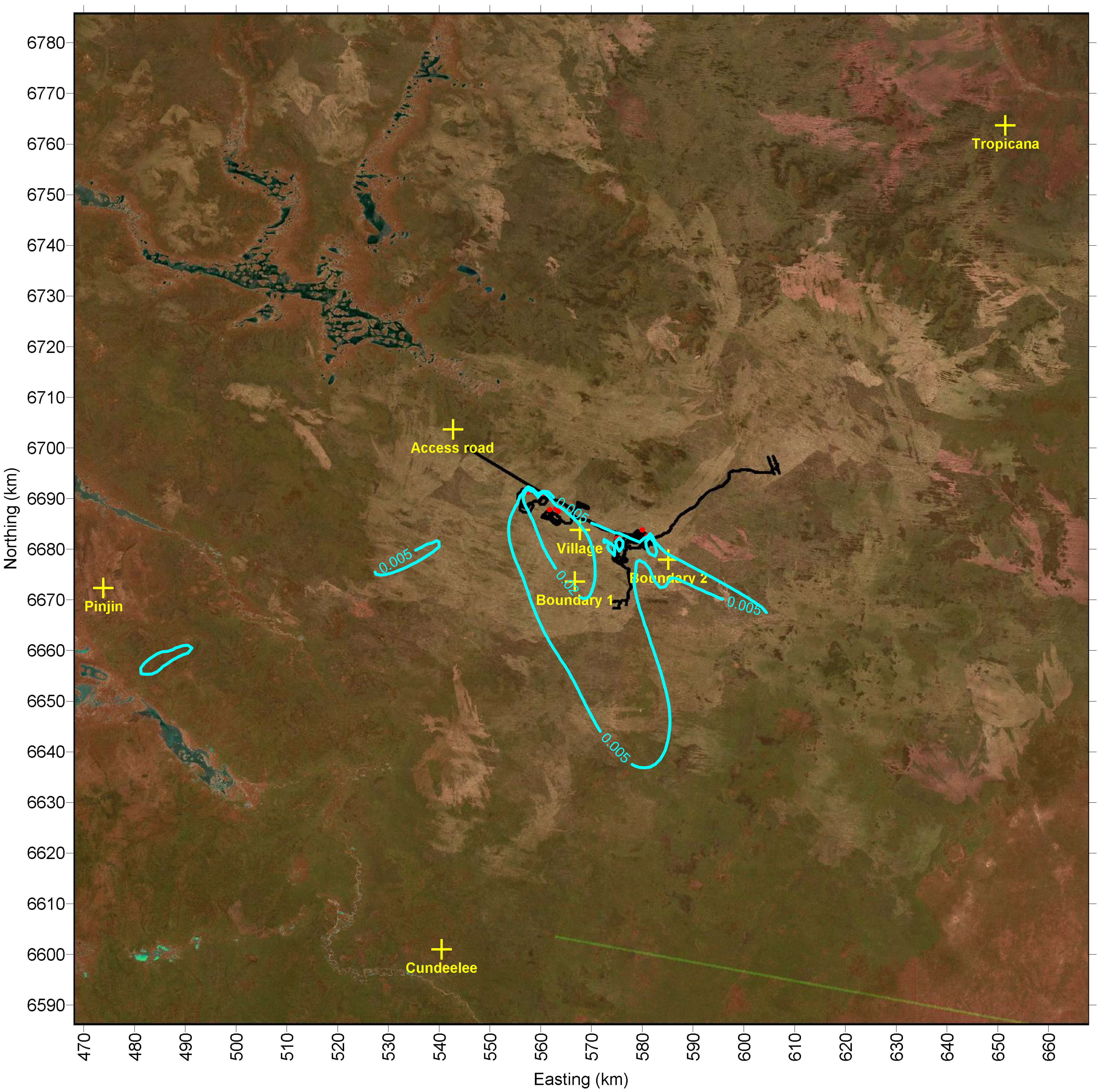
FIGURE 8-22

Scenario 5, closure - 1 year
Predicted 1-hour 99.9 percentile PM10 concentrations

CREATED	CHECKED	APPROVED	DATE	FILE LOCATION	DRAWING NO.	REVISION
LC	JF	JF	17.10.15	G:/61/32680/Technical/Surfer/Figure 01	Figure 8-17.srf	1



Guideline values:
Air NEPM 24-hour maximum PM10 concentration of 50 ug/m3

LEGEND

- Proposed mine layout
- Pit and processing plant source locations
- Sensitive receptors
- Predicted 24-hr max PM10 concentrations

SCALE

0 10 20 30

Kilometres (at A3)

MAP PROJECTION:
Transverse Mercator

HORIZONTAL DATUM:
Geocentric Datum of Australia (GDA)

GRID:
Map Grid of Australia 1994, Zone 51

DATA SOURCE:
LGATE_MGA51_20150220

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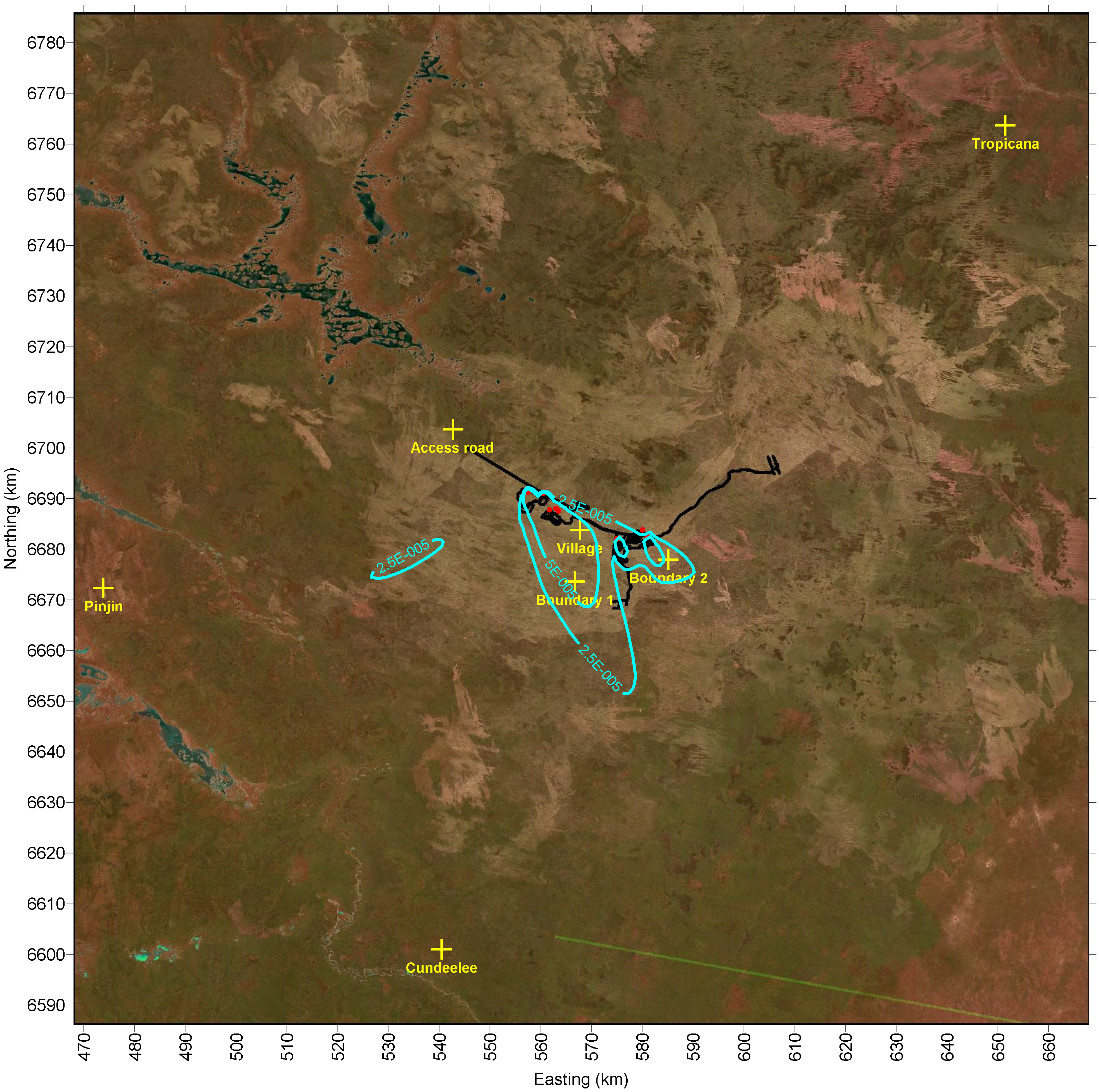
FIGURE 8-23

Scenario 5, closure - 1 year
Predicted 24-hour maximum PM10 concentrations

CREATED	CHECKED	APPROVED	DATE	FILE LOCATION	DRAWING NO.	REVISION
LC	JF	JF	17.10.15	G:/61/32680/Technical/Surfer/Figure 01	Figure 8-18.srf	1



Guideline values:
Proposed variation to the Air NEPM for an annual maximum PM10 concentration of 20 ug/m3

LEGEND

- Proposed mine layout
- Pit and processing plant source locations
- Sensitive receptors
- Predicted annual PM10 concentrations

SCALE

0 10 20 30

Kilometres (at A3)

MAP PROJECTION:
Transverse Mercator

HORIZONTAL DATUM:
Geocentric Datump of Australia (GDA)

GRID:
Map Grid of Australia 1994, Zone 51

DATA SOURCE:
LGATE_MGA51_20150220

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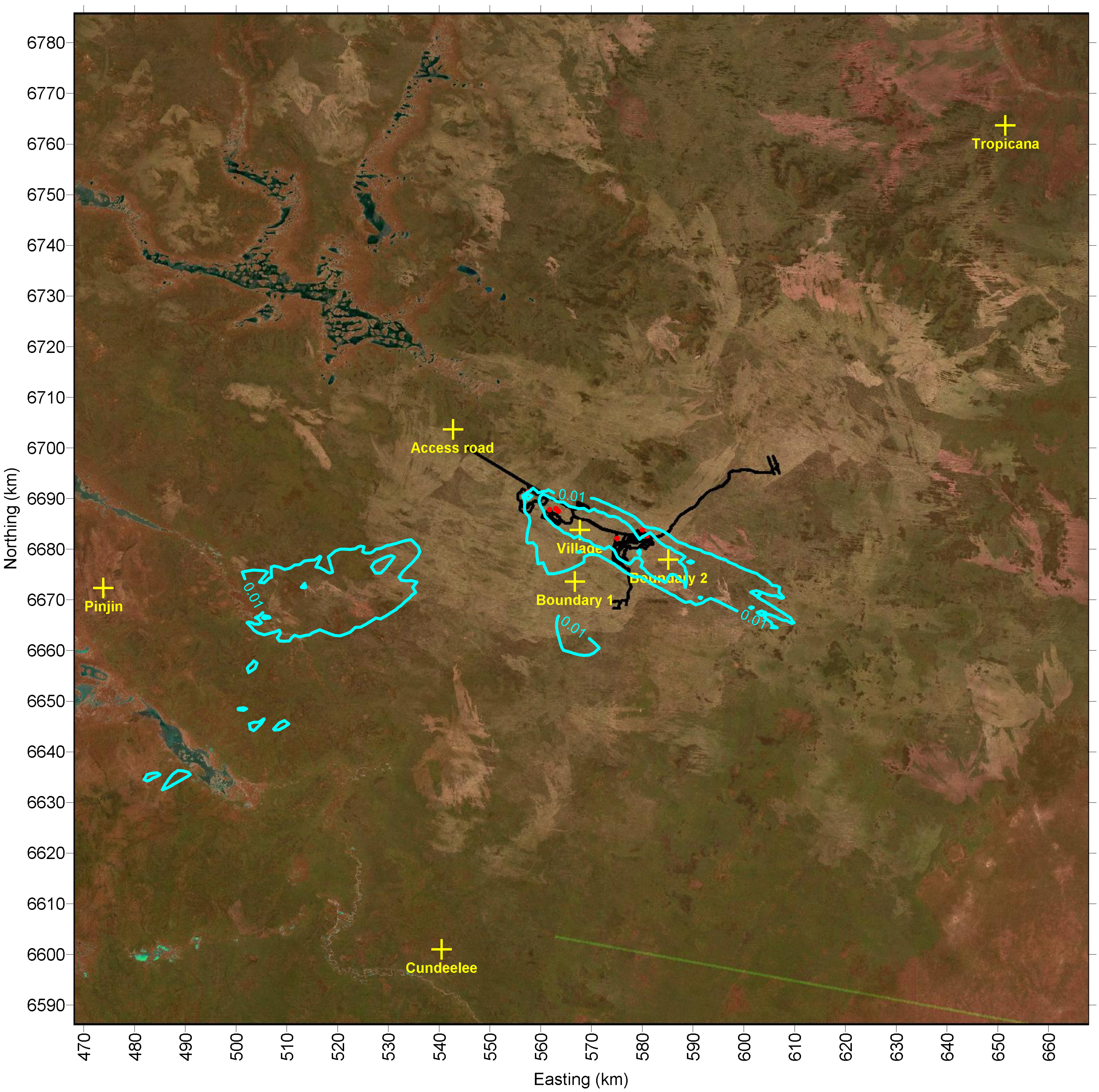
FIGURE 8-24

Scenario 5, closure - 1 year
Predicted annual PM10 concentrations

CREATED	CHECKED	APPROVED	DATE	FILE LOCATION	DRAWING NO.	REVISION
LC	JF	JF	17.10.15	G:/61/32680/Technical/Surfer/Figure 01	Figure 8-19.srf	1



Guideline values:
Nil

LEGEND

- Proposed mine layout
- Pit and processing plant source locations
- Sensitive receptors
- Predicted 1-hr 99.9 percentile TSP concentrations

SCALE

0 10 20 30

Kilometres (at A3)

MAP PROJECTION:
Transverse Mercator

HORIZONTAL DATUM:
Geocentric Datump of Australia (GDA)

GRID:
Map Grid of Australia 1994, Zone 51

DATA SOURCE:
LGATE_MGA51_20150220

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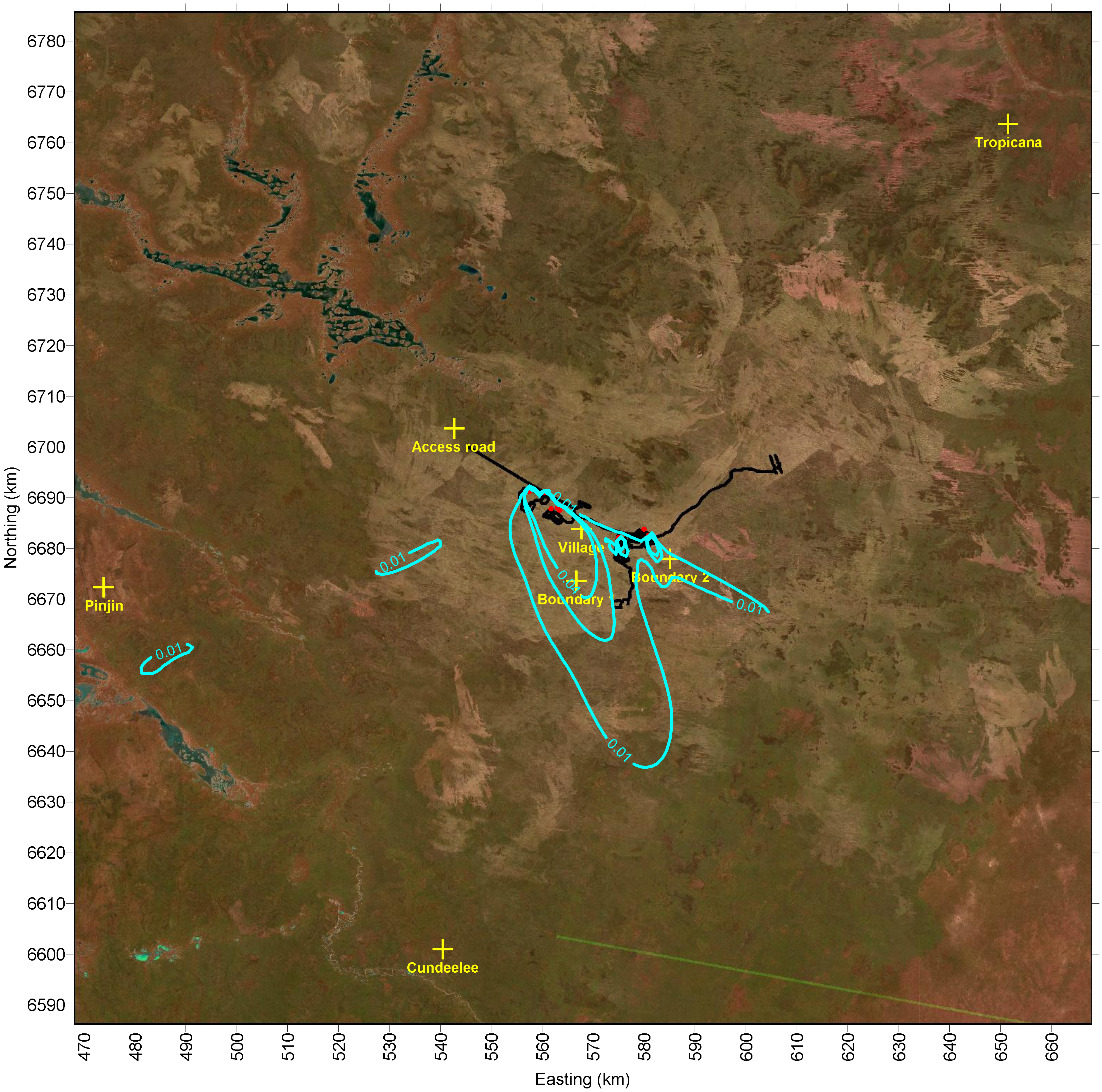
Mulga Rock Uranium Project Dispersion Modelling

FIGURE 8-25

Scenario 5, closure - 1 year
Predicted 1-hour 99.9 percentile TSP concentrations

CREATED	CHECKED	APPROVED	DATE	FILE LOCATION	DRAWING NO.	REVISION
LC	JF	JF	17.10.15	G:/61/32680/Technical/Surfer/Figure 01	Figure 8-20.srf	1



Guideline values:
Kwinana EPP 24-hour maximum TSP of 90 ug/m3

LEGEND

- Proposed mine layout
- Pit and processing plant source locations
- Sensitive receptors
- 24-hr max TSP contours
- Kwinana EPP criteria (90 ug/m3)

SCALE

0 10 20 30

Kilometres (at A3)

MAP PROJECTION:
Transverse Mercator

HORIZONTAL DATUM:
Geocentric Datump of Australia (GDA)

GRID:
Map Grid of Australia 1994, Zone 51

DATA SOURCE:
LGATE_MGA51_20150220

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Vimy Resources Limited
Mulga Rock Uranium Project Dispersion Modelling

FIGURE 8-26

Scenario 5, closure - 1 year
Predicted 24-hour maximum TSP concentrations

CREATED	CHECKED	APPROVED	DATE	FILE LOCATION	DRAWING NO.	REVISION
LC	JF	JF	17.10.15	G:/61/32680/Technical/Surfer/Figure 01	Figure 8-21.srf	1

8.4 Total deposition over the life of the mine

Table 8-20 shows the predicted total deposition over the life of the mine. This is estimated as follows:

- Years 1 through 5 annual deposition values are estimated using Scenario 1, Year 3 deposition values.
- Years 5 through 10 annual deposition values are estimated using Scenario 2, Year 10 deposition values.
- Years 11 through 13 annual deposition values are estimated using Scenario 3, Year 11 deposition values.
- Years 14 through 16 annual deposition values are estimated using Scenario 4, Year 14 deposition values.
- Closure year deposition values are estimated using Scenario 5, closure – 1 year

Table 8-20 Total deposition over the life of the mine

Receptor	Dry deposition	Wet deposition	Total deposition
Averaging period	$g/m^2/16$ years		
1: Tropicana Gold Mine	3.3×10^{-4}	2.9×10^{-3}	3.3×10^{-3}
2: Pinjin	1.5×10^{-3}	6.5×10^{-3}	8.0×10^{-3}
3: Cundeelee	1.2×10^{-3}	2.5×10^{-3}	3.7×10^{-3}
4: Tenement boundary	6.2×10^{0}	9.4×10^{-2}	6.3×10^{0}
5: PNC X TPG access road	4.4×10^{-2}	6.2×10^{-2}	1.1×10^{-1}
6: Mining village	5.8×10^{0}	2.9×10^{-1}	6.1×10^{0}
7: Tenement boundary 2	2.8×10^{-1}	6.5×10^{-2}	3.5×10^{-1}

8.5 Discussion of results

8.5.1 Predicted dust concentrations (MRUP project)

Predicted impacts are anticipated to be the highest during Scenario 2 (the highest mining throughput and therefore the greatest dust emissions). However, predicted impacts at receptors are all lower than assessment criteria.

The highest predicted concentration impacts from the MRUP project are predicted at the closest receptor (MRUP Accommodation). Predicted concentrations at MRUP Accommodation during mining years range between 22% and 52% percent of the various assessment criteria for the four scenarios.

Predicted concentrations at MRUP site boundaries during mining years range between 5% and 42% of the guidelines for the scenarios.

When considering the three population receptors surrounding MRUP, as they are a significant distance from the MRUP, the predicted concentrations during mining years range from 0. 1% to 0.7% percent of any of the criteria.

Predicted concentrations at receptors during the closure scenario are lower than those predicted during mining years.

8.5.2 Predicted dust deposition

Predicted dust deposition is highest at MRUP accommodation, though well below the monthly deposition criteria (approximately 2%). Deposition at other sites is predicted to be much lower.

The reason for the low emissions is due to the distance from sources. Large particles will be deposited closer to the sources than any of the receptor locations. Smaller particles will remain airborne further from the emission sources, but are less prone to deposition.

8.5.3 Consideration of cumulative impacts from regional background dust

As there are limited anthropogenic dust sources in the area, the majority of dust in the area will be through dust emission processes that naturally occur in the environment. Namely, wind erosion from open areas and bushfire smoke.

As illustrated in Section 5.3, the impact of a nearby bushfire on air quality can be very significant.

Dust emissions from the MRUP project, regional background sources, or both have the potential to dominate in the neighbourhood of the minesite (a scale of kilometres from the site); however further afield, where the receptors are located (tens of kilometres), background regional and their own local neighbourhood sources will dominate.

Ambient dust concentrations

In regards to regional dust impacts during typical conditions, there is insufficient information to estimate the variable dust concentrations that may be observed in the area. The highest predicted incremental increase in concentration at MRUP Accommodation from mining activities is approximately 14 µg/m^3 (PM_{10}, 24-hr avg).

However, times of elevated dust emissions from MRUP will likely correlate with elevated regional dust due to wind erosion in the surrounding environment. Based on the predicted concentrations at MRUP Accommodation the cumulative concentration may on occasion exceed guideline values, but this cannot be quantified without hourly or daily measurements being taken at the MRUP site, though MRUP contribution will likely have only contributed up to25% of the overall dust.

Dust deposition

Dust deposition monitoring undertaken at the MRUP site ranges from 0.1 to 0.3 g/m^2/month for 6 of 9 sample periods. Three sample periods has consistently elevated measurements, ranging from 0.3 to 4.0 g/m^2/month. These measured deposition values are 3 to 7 orders of magnitude greater than the predicted mine dust deposition at receptor locations. The predicted deposition is significantly lower due to the separation distances between the sources and the receptor.

8.5.4 Consideration of cumulative impacts from other sources

The plots show that the range of any measurable dust impact (taken as 10% of the assessment criterion) is approximately 30 km. That is, any location outside of a radius of 30 km from the mine site is unlikely to distinguish MRUP dust contributions from other regional sources. As the closest major dust source to MRUP is Tropicana (110 km from MRUP), cumulative impacts from the two sources are likely to be insignificant.

9. Power generation dispersion modelling results

9.1 Emission rates

Worst case emissions were estimated for the site by assuming that the 20 1 MW diesel gensets at the processing plant and the single 1 MW diesel genset at the bore field are operating at maximum capacity for the modelling year.

Table 9-1 provides the predicted emission rates for each pollutant for each location. Table 9-2 provides the model source configuration. Each source was modelled with building downwash (5 m height, and 10 m width). Stack height, radius, exit velocity and temperature are based on specs for KT50 series engine, as final specs not finalised at present.[42]

Table 9-1 Emission rates

Pollutant	Genset emission rate (g/s)
CO	1.3
NOx (controlled)[43]	2.9
PM_{10}	0.15
SO_2	0.002
VOC	0.12

[42] Specs sourced from http://www.cumminspower.com.br/pdf/dflc/60/kta50.pdf
[43] Emission controls utilised (e.g. fuel additives, water/fuel emulsions, injection timing retard and rate control, combustion chamber modifications, exhaust gas recirculation, catalysts).

Table 9-2 Modelled source configuration for MRUP

Source	Centroid x coordinate, km	Centroid y coordinate, km	Stack height (m)	Stack radius (m)	Exit velocity (m/s)	Temp. (K)
PS01	578.330	6683.350	6	0.229	24	733
PS02	578.334	6683.350	6	0.229	24	733
PS03	578.338	6683.350	6	0.229	24	733
PS04	578.342	6683.350	6	0.229	24	733
PS05	578.346	6683.350	6	0.229	24	733
PS06	578.350	6683.350	6	0.229	24	733
PS07	578.354	6683.350	6	0.229	24	733
PS08	578.358	6683.350	6	0.229	24	733
PS09	578.362	6683.350	6	0.229	24	733
PS10	578.366	6683.350	6	0.229	24	733
PS11	578.370	6683.350	6	0.229	24	733
PS12	578.374	6683.350	6	0.229	24	733
PS13	578.378	6683.350	6	0.229	24	733
PS14	578.382	6683.350	6	0.229	24	733
PS15	578.386	6683.350	6	0.229	24	733
PS16	578.390	6683.350	6	0.229	24	733
PS17	578.394	6683.350	6	0.229	24	733
PS18	578.398	6683.350	6	0.229	24	733
PS19	578.402	6683.350	6	0.229	24	733
PS20	578.406	6683.350	6	0.229	24	733
Bore01	601.441	6696.602	6	0.229	24	733

9.2 Modelling results

Table 9-3 and Table 9-4 show predicted concentrations at receptors for each species, with predicted exceedances in orange.

The predicted concentrations at each source (processing plant power station and bore field) have been included to the results to review air quality at the source locations. If any contaminant has predicted exceedances of the assessment criteria, they are then assessed against occupational health criterion.

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Table 9-3 Predicted concentrations at receptors, µg/m³

Receptor	CO	NO_2[44]		PM_{10}			SO_2		
Averaging period	8-hour	1-hour	Annual	1-hour	24-hour	Annual	1-hour	24-hour	Annual
Rank	Max	Max	- -	99.9 %ile	Max	- -	Max	Max	- -
Guideline	11,254	247	62	80	50	20	572	229	57
1: Tropicana Gold Mine	0.2	0.4	0.002	0.04	0.010	0.0005	0.014	0.0013	0.000070
2: Pinjin	0.5	0.6	0.012	0.11	0.03	0.003	0.022	0.0038	0.00041
3: Cundeelee	1.2	1.3	0.013	0.3	0.05	0.003	0.046	0.0067	0.00046
4: Tenement boundary	10	14	0.12	3	0.4	0.03	0.48	0.051	0.0042
5: PNC X TPG access road	4	3	0.07	0.6	0.2	0.02	0.11	0.027	0.0023
6: Mining village	7	16	0.1	2	0.3	0.03	0.54	0.04	0.0045
7: Tenement boundary 2	11	14	0.1	3	0.4	0.02	0.49	0.06	0.0030
8: Plant power station	3,647	**2,171**	**126**	**480**	**168**	**33**	75	22	4.3
9. Bore field	12	37	0.1	3	0.5	0.04	1.3	0.07	0.0050

[44] Taken as 20% of NOx results

Table 9-4 Predicted concentrations at receptors (VOC components), µg/m³

Receptor	Acetaldehyde	Benzene	Formaldehyde	Toluene			Xylene
Averaging period	3-min	3-min	3-min	3-min	24-hour	annual	3-min
Rank	99.9%ile	99.9%ile	99.9%ile	99.9%ile	max	- -	99.9%ile
Guideline	76	10.5	40	650	4114	411	350
1: Tropicana Gold Mine	6.2×10^{-2}	7.9×10^{-3}	4.2×10^{-4}	1.9×10^{-5}	6.0×10^{-4}	6.2×10^{-5}	2.2×10^{-4}
2: Pinjin	1.7×10^{-1}	2.3×10^{-2}	2.5×10^{-3}	5.0×10^{-5}	1.6×10^{-3}	1.7×10^{-4}	5.8×10^{-4}
3: Cundeelee	3.9×10^{-1}	4.0×10^{-2}	2.8×10^{-3}	1.2×10^{-4}	3.8×10^{-3}	3.9×10^{-4}	1.4×10^{-3}
4: Tenement boundary	3.9×10^{0}	3.1×10^{-1}	2.5×10^{-2}	1.2×10^{-3}	3.7×10^{-2}	3.9×10^{-3}	1.3×10^{-2}
5: PNC X TPG access road	9.3×10^{-1}	1.6×10^{-1}	1.4×10^{-2}	2.8×10^{-4}	9.1×10^{-3}	9.3×10^{-4}	3.3×10^{-3}
6: Mining village	2.3×10^{0}	2.6×10^{-1}	2.7×10^{-2}	7.0×10^{-4}	2.2×10^{-2}	2.3×10^{-3}	8.1×10^{-3}
7: Tenement boundary 2	3.8×10^{0}	3.4×10^{-1}	1.8×10^{-2}	1.1×10^{-3}	3.7×10^{-2}	3.8×10^{-3}	1.3×10^{-2}
8: Plant power station	7.0×10^{2}	1.3×10^{2}	2.6×10^{1}	2.1×10^{-1}	6.8×10^{0}	7.0×10^{-1}	2.4×10^{0}
9. Bore field	4.7×10^{0}	5.2×10^{-1}	3.0×10^{-2}	1.4×10^{-3}	4.6×10^{-2}	4.7×10^{-3}	1.7×10^{-2}

9.1 Discussion of results

9.1.1 Predicted concentrations (MRUP project)

The predicted concentrations at all receptors are below the assessment criteria for all assessed pollutants. Predicted ground level concentrations at the bore field power generation site are also below these assessment criteria.

However, ground level concentrations at the processing plant are predicted to exceed air quality criteria for PM_{10} and for NO_2 1-hour averages. Whilst ambient air quality criteria are not applied at the processing plant, site personnel may be working in this location. As such, these two pollutants are also assessed against occupational health and safety standards (Table 9-5).

Table 9-5 Occupational health and safety review

Receptor	NO_2 µg/m^3[45]	Diesel particulate matter µg/m^3[46]
Averaging period	12-hour	12-hour
Rank	Max	Max
Guideline	2,800	65
7. Processing plant	730	**189**

As shown, NO_2 predicted concentrations are below exposure standards; however diesel particulate matter is predicted at 290% of exposure standards.

The following is noted:

- Diesel fuel has been modelled for worst case emissions; however the fuel source is most likely going to be gas. Particulate emissions from a gas source are significantly lower than diesel (approximately 0.003% of diesel[47]). As such, use of gas as a fuel source would bring predicted emissions to below assessment criteria.
- Should diesel fuel be chosen at the power station, diesel particulate filters can be used. Filters generally provided 80-90% reduction in emissions, which would bring emissions to below the assessment criteria.

9.1.2 Consideration of cumulative impacts and background concentrations

As there are limited anthropogenic sources of pollutants other than dust in the area (Tropicana mine site being the closest major source, and this is located more than 110 km away), background levels are unlikely to be of any significance.

Dust emissions from power generation were modelled separately from dust emissions from the remainder of the mine. The following is noted when considering cumulative dust impacts:

Predicted dust concentrations due to power generation are only elevated directly at the power station (dust generation point), and this would have occurred during low dispersion events. As such, cumulative impacts at the power station are significant. However, predicted concentrations at the mining village are small, so there is negligible cumulative impact.

When considering occupational health for workers at the power station, it is noted that the predominant source of diesel particulate matter is the power station, so there is a negligible

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45 Taken as 20% of NOx results

46 Taken as 100% PM_{10} µg/m^3

47 National Pollutant Inventory 2008. NPI *Emissions Estimation Technique Manual (EET) for Combustion Engines*.

increase in the diesel particulate matter concentration assessed in Table 9-5. Occupational health guidelines for respirable dust are significantly higher than any cumulative dust concentration resulting from the modelled scenarios.[48]

[48] Guidelines for respirable dust vary depending upon the type of dust, but they are generally greater than 1000 µg/m^3.

10. Greenhouse gas assessment

10.1 MRUP greenhouse footprint

10.1.1 Operational emissions

The total greenhouse footprint is expected to vary by a small amount over the course of the project. Emissions for the worst case scenario year were estimated. This year includes:

- Vehicle transport of ore to the edge of pit
- Power station running at full capacity
- Production of uranium oxide and other precious metal concentrates

This worst case year was used to produce an overall greenhouse emission footprint for the 10-year period. In reality, total carbon emissions are likely to be less than the estimates in this assessment, as this assessment focuses on the worst case emissions.

As outlined in Section 2.2.3 of this report, vehicle movement and electricity generation are expected to be the greatest sources of greenhouse gas. Table 10-1 details the greenhouse gas generation processes that are encompassed in these two categories.

Other processes considered comparatively small and excluded from the study are:

- Use of oils, greases and lubricants in workshops
- Onsite waste management
- Overall land use change[49]

The following processes are considered to be under the operational control of contractors, also relatively small. As such, they are not included within this assessment[50].

- Air transport of personnel to site
- Delivery of goods to site and removal of wastes

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49 Progressive revegetation clearing for the duration of the MRUP project is offset by progressive revegetation and mine closure activities. As such, the process is considered to be carbon neutral.

50 A similar study (KAC, 2009, *Tropicana Gold Project Greenhouse Gas Assessment* for Tropicana Joint Venture), for a mine site in the area shows that aircraft and goods delivery have a combined contribution of 2.6% to the overall estimates; this is comparatively small when considering that scenario years used in this assessment are the worst case emission years.

Table 10-1 Greenhouse gas sources

Process	Emission source	Included in vehicle movement calculation	Included in electricity generation calculation
Ore extraction and delivery to processing plant	Excavators and front end loaders	Yes	
	Use of power plant electricity (bene plant)		Yes
	Loading of ore and low grade rock	Yes	
	Transport of materials to processing plant	Yes	
Ore processing	Use of power plant electricity (processing plant)		Yes
Stockpiles	Front end loaders	Yes	
General transport	Bus and light vehicle movement around site	Yes	
	Water carts	Yes	
	Grading haul roads	Yes	
Water extraction and injection	Use of power plant electricity (extraction and reinjection bores)		Yes
Personnel	Use of site electricity (accommodation camp, workshops and admin areas)		Yes

10.1.2 Construction emissions

Construction GHG emissions are also dominated by diesel consumption from power generation and vehicular movement.

10.2 Calculation of GHG emissions from vehicle movement

Using the equation outlined in Section 3.3.1, the emissions from product transport (diesel use) was calculated using the available data from MRUP for each Scenario (Table 10-2).

Table 10-2 Transport calculations

Factor	Unit	Operational year	Total construction phase (18 months)
Total fuel used	kL	12,200	6,100
Energy content factor for diesel	GJ/kL	38.6	38.6
Emissions factor	kg CO2-e/GJ	69.9	69.9
Emissions	CO_2-e tonnes	32,917	16,459

Total fuel use for the fleet was provided by Vimy Resources.

Appendix C provides these calculations.

10.3 Calculation of GHG emissions from power generation

Using the equation outlined in Section 3.3.2, the emissions from power generation (diesel use) were calculated using the available data from MRUP (Table 10-3).

These values assume that 100% of all diesel fuel is consumed and that all ten diesel gensets are in continuous operation for the entire year.

Table 10-3 Power plant greenhouse gas emissions

Factor	Unit	Any given operational year	Construction phase
Fuel amount (annual amount)[51]	kL	60,707	1,584
Energy content factor for diesel	GJ/kL	38.6	38.6
Emissions factor (diesel)	kg CO_2-e/GJ	69.5	69.5
Emissions	CO_2-e tonnes	162,858	4,249

Appendix C provides these calculations.

10.1 Calculation of GHG emissions from production of product

Using the equation outlined in Section 3.3.3, emissions from use of carbonates for production of uranium oxide and other precious metal concentrates were calculated using the available data from MRUP (Table 10-4).

These values assume that 100% of carbonate is consumed.

Table 10-4 Product production greenhouse gas emissions

Factor	Unit	Any given operational year
Calcium carbonate consumed (annual amount)	Tonnes carbonate	70,000
Emissions factor ($CaCO_3$)	Tonnes CO_2-e/tonnes carbonate	0.396
Fraction material consumed	%	100
Emissions	CO_2-e tonnes	27,720

Appendix C provides these calculations.

10.2 Total greenhouse gas emissions

Total greenhouse gas emissions for the life of mine (construction and operation) are estimated from:

- Sixteen operational year emissions
- Construction emission

Table 10-5 shows the total emissions.

[51] Based on 330 L/hour diesel use for each 1MW unit.

Table 10-5 Summary of total emissions

Source	Total Emissions (tonnes CO_2-e)	Percentage of total
Total diesel fleet	543,136	15%
Total electricity	2,609,980	73%
Total production of product[52]	443,520	12%
All emissions	**3,596,635**	**100%**

10.3 Greenhouse gas emissions - Management

Greenhouse gas emissions will be reduced by consideration of the following:

- Fuel type at power station (gas versus diesel)
- Investigation of slurry pumping versus truck transfer of post-beneficiation ore to the processing plant
- Investigation of carbon off-sets

[52] Uranium oxide and other precious metal concentrates

11. Conclusions

11.1 Dust assessment

11.1.1 Predicted concentrations and deposition

- During mining, predicted concentrations at MRUP Accommodation range between 22% and 52% of the various assessment criteria for the four scenarios.
- During mining, predicted dust concentrations at MRUP site boundaries range between 5% and 42% of the guidelines for the scenarios.
- When considering the three population receptors surrounding MRUP, as they are a significant distance from the MRUP, the predicted concentrations during mining range from 0.1% to 0.7% of any of the criteria.
- Predicted concentrations at receptors during the closure scenario are lower than those predicted during mining years.
- Predicted dust deposition is highest at MRUP accommodation, though well below the monthly deposition criteria (approximately 2%). Deposition at other sites is predicted to be much lower.

11.1.2 Cumulative impacts

- As there are limited anthropogenic dust sources in the area, the majority of dust in the area will be through dust emission processes that naturally occur in the environment. Namely, wind erosion from open areas and bushfire smoke.
- Dust emissions from the MRUP project, regional background sources, or both have the potential to dominate in the neighbourhood of the minesite (a scale of kilometres from the site); however further afield, where the receptors are located (tens of kilometres), background regional and their own local neighbourhood sources will dominate.
- Based on the predicted concentrations at MRUP Accommodation the cumulative ambient dust concentration may on occasion exceed guideline values, but this cannot be quantified without hourly or daily measurements being taken at the MRUP site.
- Cumulative dust deposition is unlikely to be significantly affected at receptors, as the predicted dust deposition values are 3 to 7 orders of magnitude smaller than current measured dust deposition values. This is due to the large separation distances between the sources and the receptor.
- As the closest major dust source to MRUP is Tropicana (110 km from MRUP), cumulative impacts from the two sources are likely to be insignificant.

11.2 Power plant emissions

11.2.1 Predicted concentrations

- The predicted concentrations at all receptors are below the assessment criteria for all assessed pollutants.
- PM_{10} and for NO_2 concentrations at the power station site are assessed against health criterion, as they exceed 1-hour average assessment criteria:
  - NO_2 concentrations are below occupational exposure standards; however diesel particulate matter is predicted at 290% of exposure standards.

– The following is noted:

  - Diesel fuel has been modelled for worst case emissions; however the fuel source is most likely going to be gas. Particulate emissions from a gas source are significantly lower than diesel (approximately 0.003% of diesel[53]). As such, use of gas as a fuel source would bring predicted emissions to below assessment criteria.
  - Should diesel fuel be chosen at the power station, diesel particulate filters can be used. Filters generally provided 80-90% reduction in emissions, which would bring emissions to below the assessment criteria.

11.2.2 Cumulative impacts

- As there are limited anthropogenic sources of pollutants other than dust in the area, background levels are unlikely to be of any significance.

11.3 Greenhouse gas

Total greenhouse gas emissions for the sixteen operational years are estimated as:

- Total diesel fleet emissions: 543,136 tonnes CO_2-e (15% of total)
- Total electricity emissions 2,609,980 tonnes CO_2-e (73% of total)
- Total production of uranium oxide and other precious metal concentrates emissions 443,520 tonnes CO_2-e (12% of total)

There are also comparatively small contributions anticipated from oil and gas use of oils, greases and lubricants in workshops, on-site waste management, overall land use change, air transport of personnel, site deliveries and waste removal.

Greenhouse gas emissions will be reduced by considering the following:

- Fuel type at power station (gas versus diesel)
- Investigation of slurry pumping versus truck transfer of post-beneficiation ore to the processing plant
- Investigation of carbon off-sets

11.4 Future monitoring

11.4.1 Dust

As sensitive receptors outside of the tenement are a significant distance from site, there is no need to undertake offsite dust monitoring at this stage.

It would be beneficial to maintain a monitoring station at the Mining Camp (sensitive receptor within the tenement boundary). The monitoring station should contain a continuous monitor in compliance with Australian Standards (such as a EBAM or TEOM) to record PM_{10}.

It is understood that at least one existing meteorological monitor will be maintained; though it may be worthwhile relocating one mast to the dust monitoring site to assist in interpretation of results.

Monitoring results should be assessed against relevant criteria. It is likely that the cumulative background (regional) and mine dust contributions will occasional cause elevated dust concentrations. The assessment of results should include a review of the meteorological

[53] National Pollutant Inventory 2008. NPI *Emissions Estimation Technique Manual (EET) for Combustion Engines*.

conditions during the day, as well as any local or regional activities that may have resulted in elevated concentrations.

11.4.2 Power station

Stack testing will be needed upon commissioning of the power station to ensure emissions are within specified parameters. It would be beneficial to also undertake quarterly, biannual or annual stack testing.

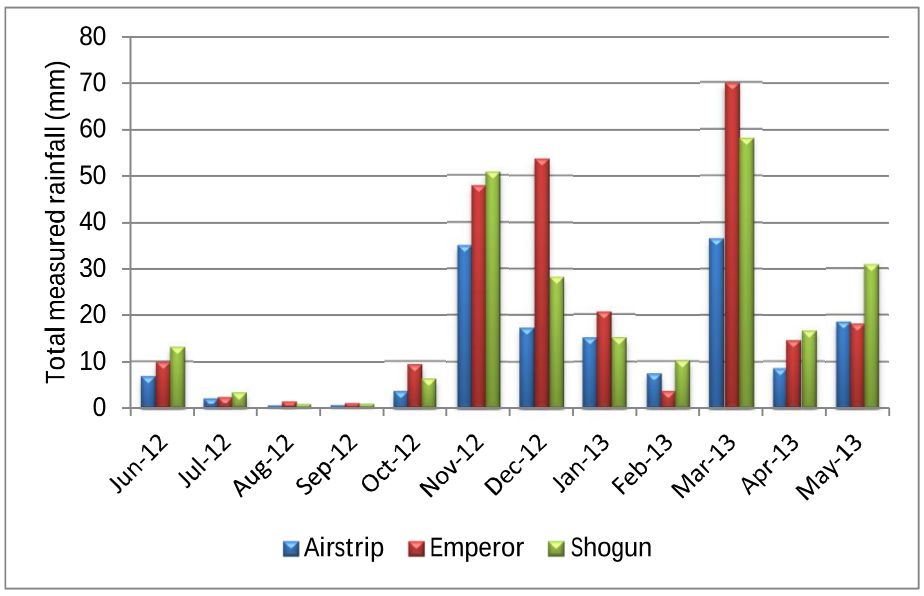
Appendices

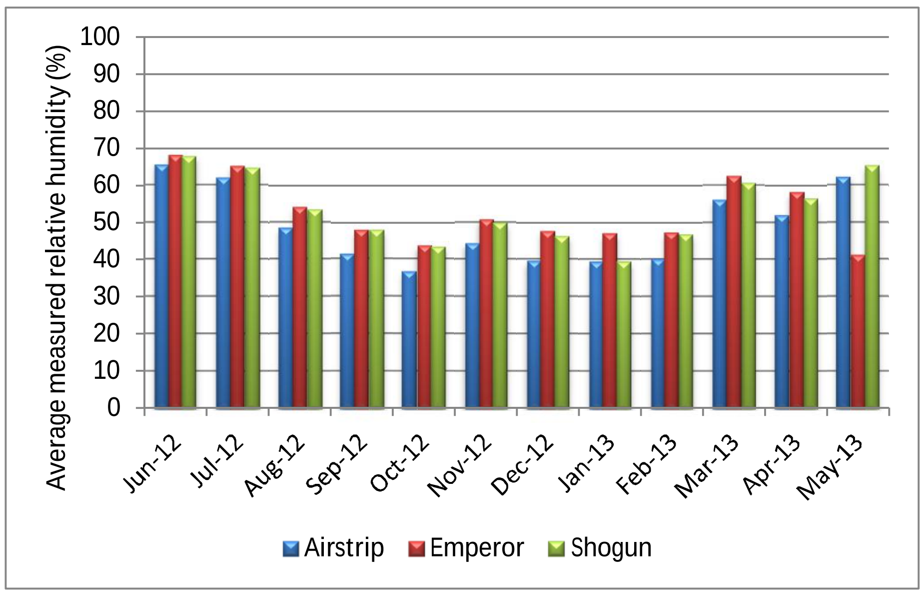
Appendix A – Measured meteorological data summaries

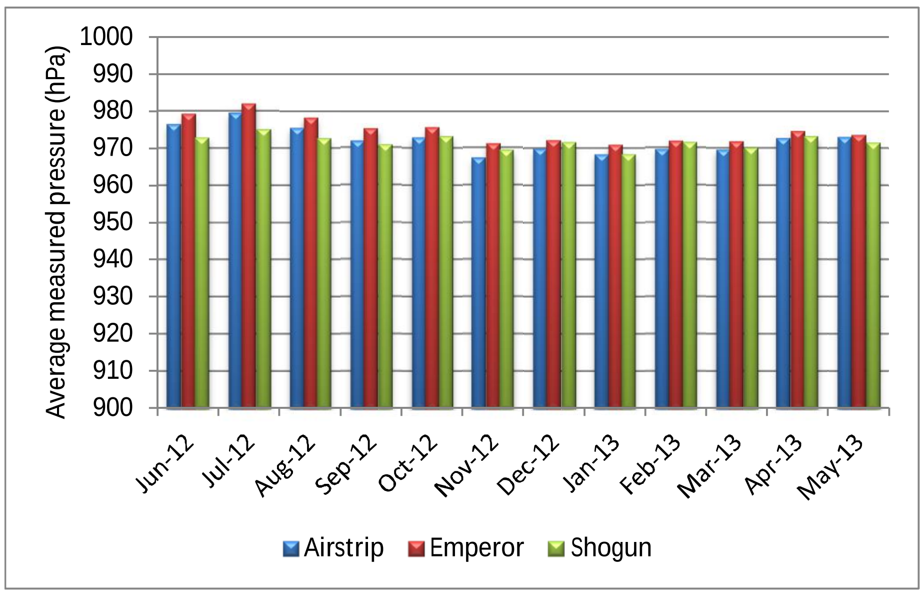
Summary of modelling year June 2012 through May 2013

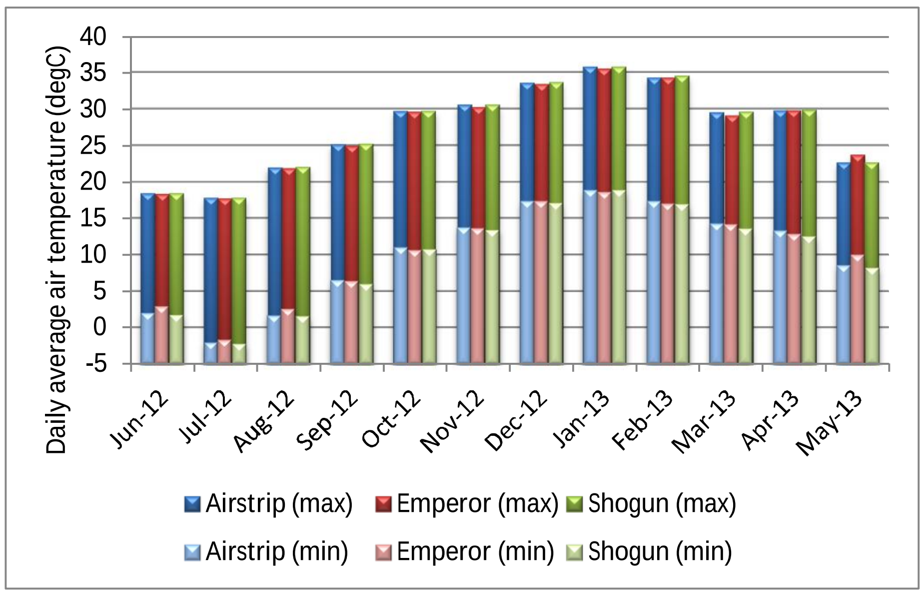
Summaries of monitoring years 2010 through 2014

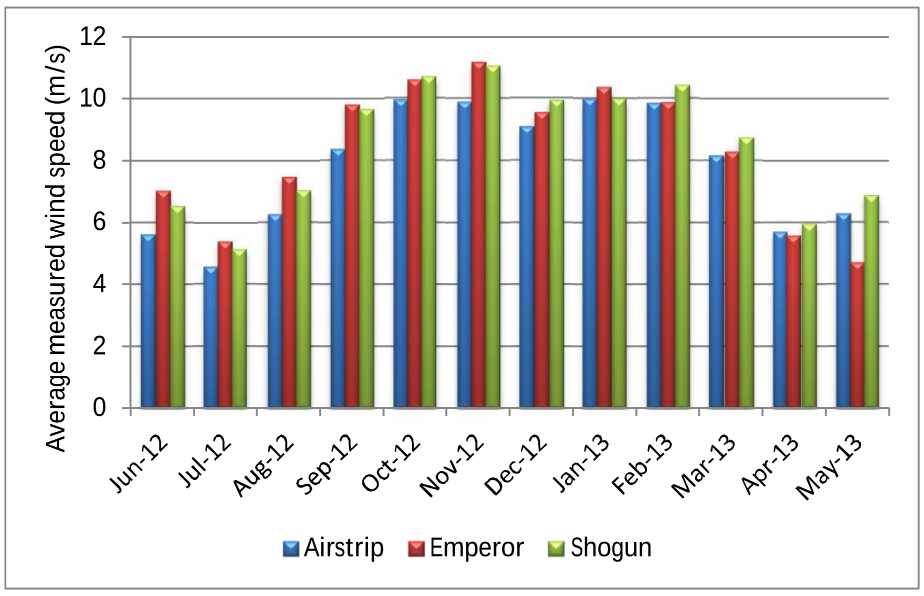
Summary of measured data, June 2012 to May 2013



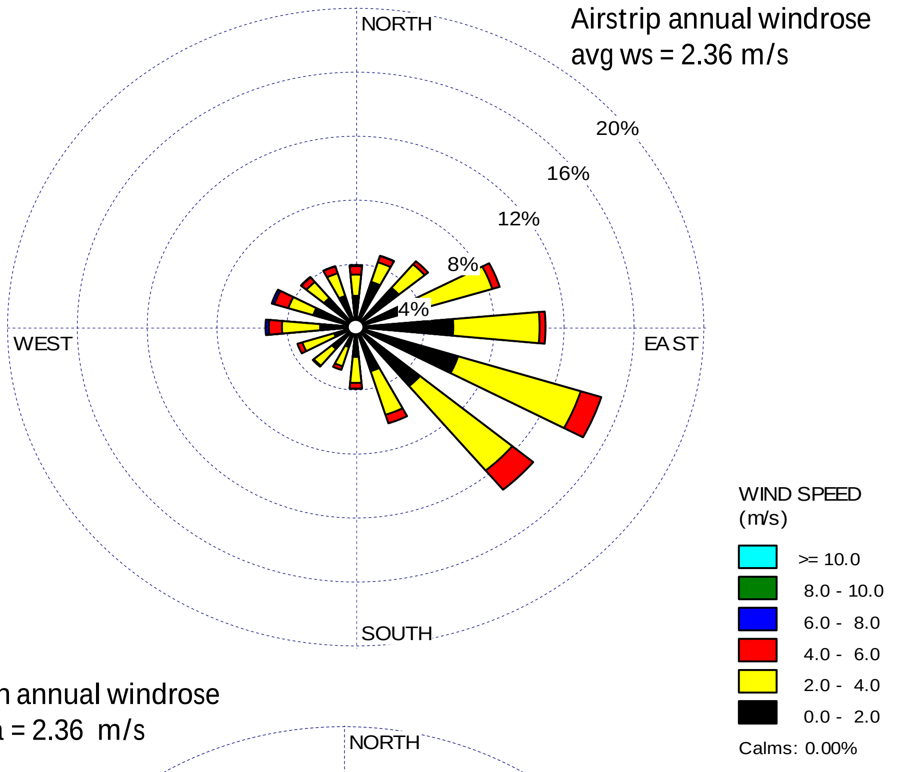




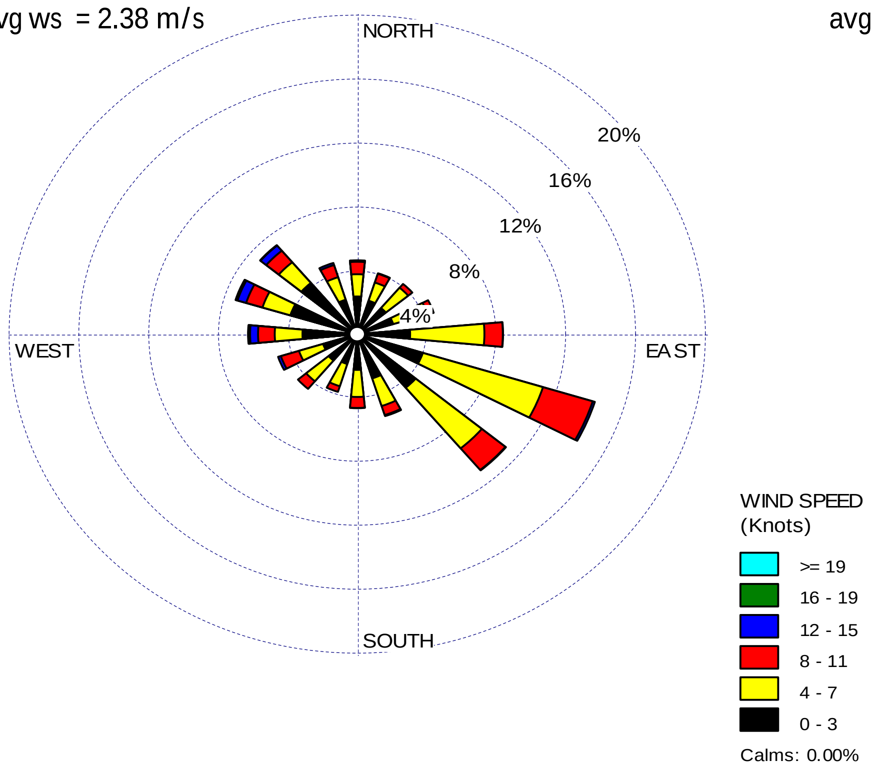




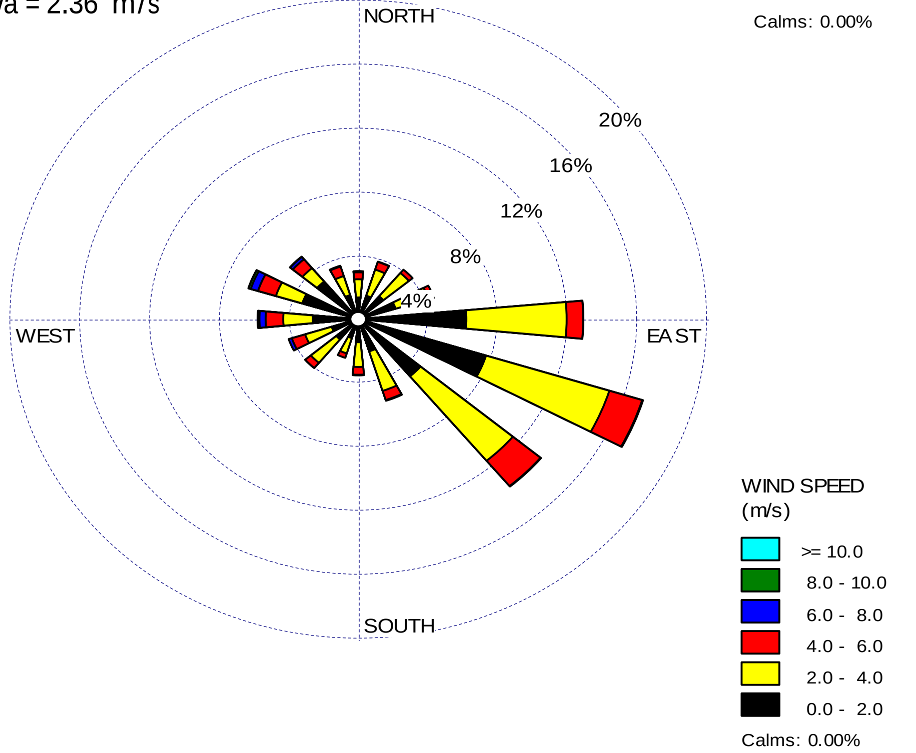
Airstrip annual windrose
avg ws = 2.36 m/s



Emperor annual windrose
avg ws = 2.38 m/s

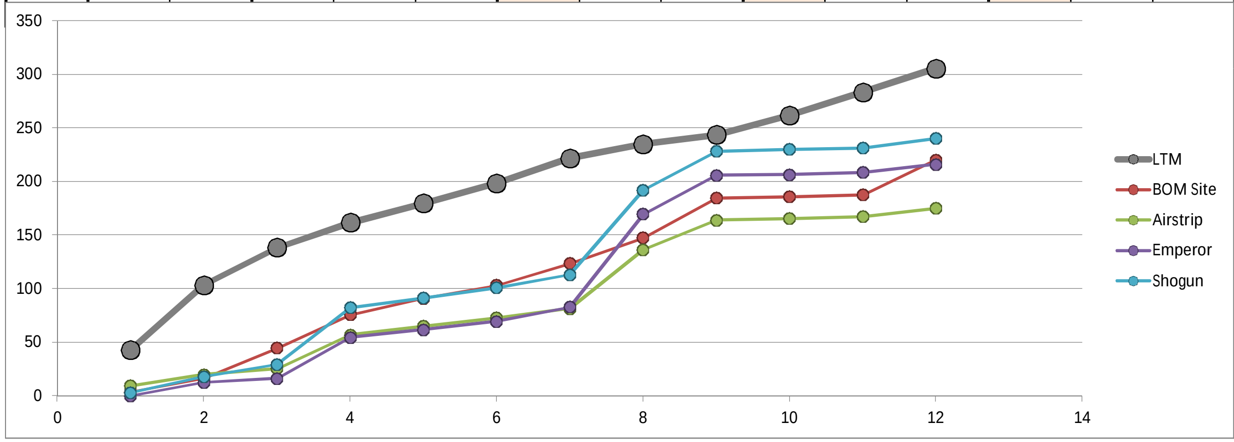


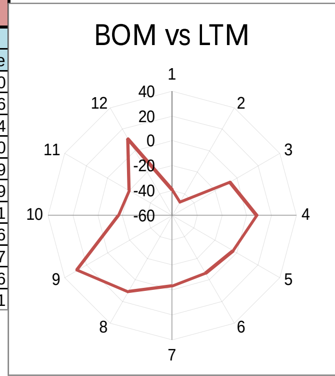
Shogun annual windrose
avg wa = 2.36 m/s

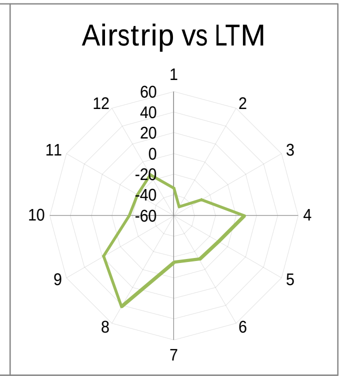


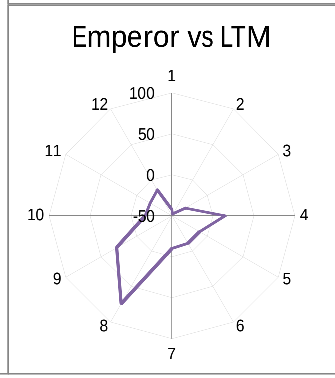
Review of monitoring data
Rainfall summary
Assessment Year 2010

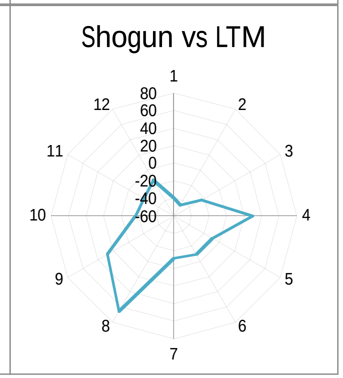
						Missing 11 days of data			Missing 6 days of data			Missing 6 days of data		
Month	LTM		BOM measured			Measured Airstrip			Measured Emperor			Measured Shogun		
	Discrete	Cumulative	Discrete	Cumulative	Difference	Discrete	Cumulative	Difference	Discrete	Cumulative	Difference	Discrete	Cumulative	Difference
1	43	43	4	4	-39	9.3	9	-34	0	0	-43	3	3	-40
2	61	104	13	16	-48	10.3	20	-50	12.6	13	-48	15	18	-46
3	35	138	28	45	-7	5.9	26	-29	3.6	16	-31	11.2	29	-24
4	23	162	31	76	8	31.3	57	8	38.2	54	15	53	82	30
5	18	180	15	91	-3	8	65	-10	7.3	62	-11	9.1	91	-9
6	19	198	12	103	-6	7.8	73	-11	7.8	70	-11	9.6	101	-9
7	23	222	20	123	-3	8.8	81	-15	13.2	83	-10	12	113	-11
8	13	235	24	147	11	55.1	137	42	86.8	170	74	79.2	192	66
9	9	244	37	185	28	27.4	164	19	36.4	206	28	36.2	228	27
10	18	262	1	186	-17	1.5	165	-17	0.6	207	-18	1.8	230	-16
11	22	283	2	187	-20	1.9	167	-20	2	209	-20	1	231	-21







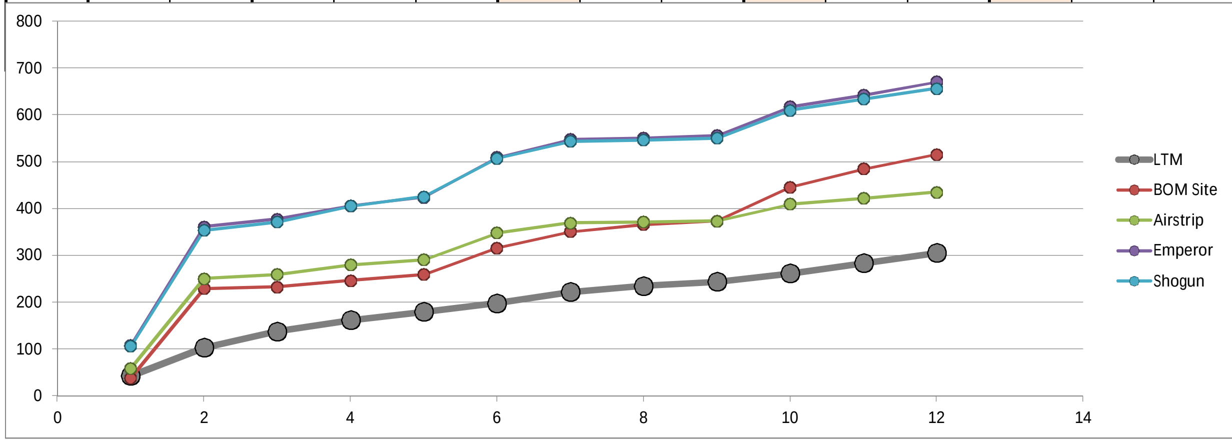


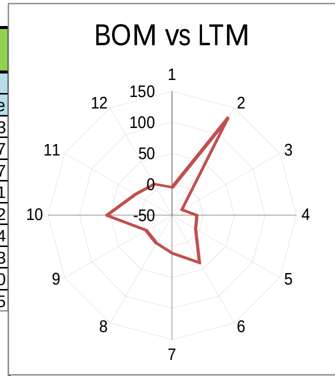


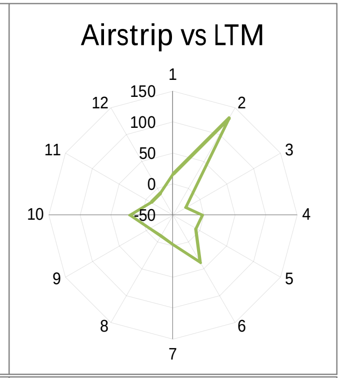
Review of monitoring data
Rainfall summary

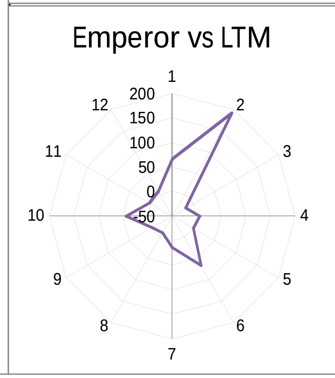
Assessment Year 2011

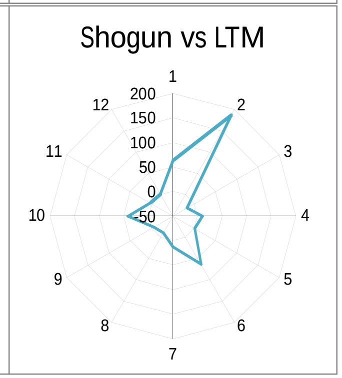
						Sufficient data available			Sufficient data available			Sufficient data available		
Month	LTM		BOM measured			Measured Airstrip			Measured Emperor			Measured Shogun		
	Discrete	Cumulative	Discrete	Cumulative	Difference	Discrete	Cumulative	Difference	Discrete	Cumulative	Difference	Discrete	Cumulative	Difference
1	43	43	38	38	-5	58.7	59	16	108.2	108	65	105.8	106	63
2	61	104	191	229	130	191.3	250	131	252.4	361	192	247.4	353	187
3	35	138	3	232	-32	9.3	259	-26	17	378	-18	18.2	371	-17
4	23	162	14	246	-10	20.3	280	-3	28.8	406	6	33.8	405	11
5	18	180	13	259	-5	11.2	291	-7	17.4	424	-1	19.8	425	2
6	19	198	57	316	38	57.2	348	39	85.2	509	67	82.2	507	64
7	23	222	35	351	11	21	369	-2	38.4	547	15	36.2	543	13
8	13	235	15	366	2	1.9	371	-11	3	550	-10	3	546	-10
9	9	244	7	373	-2	2.1	373	-7	5.6	556	-3	4	550	-5







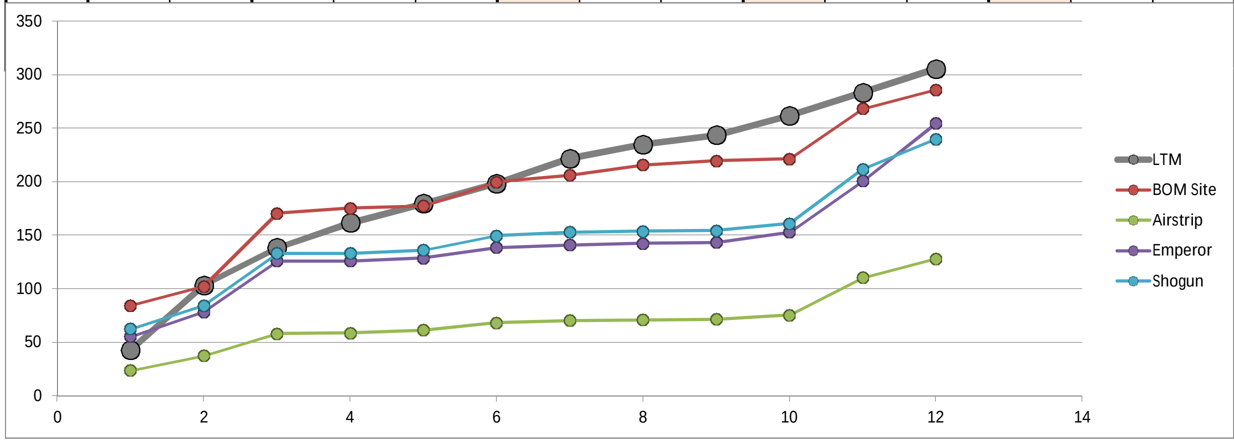


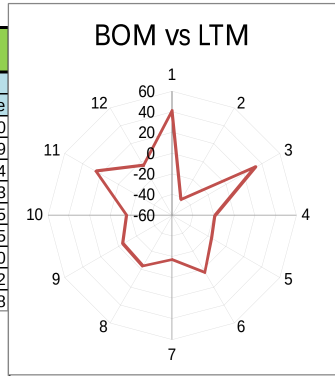


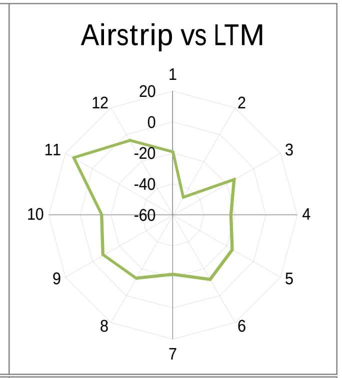
Review of monitoring data
Rainfall summary

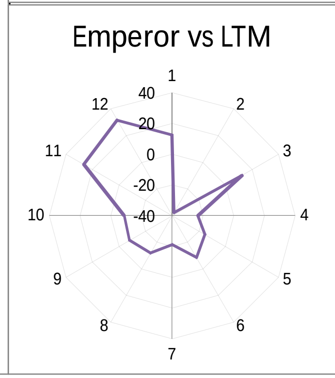
Assessment Year 2012

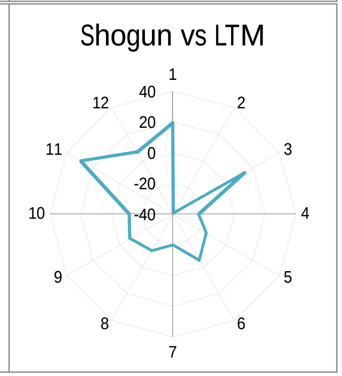
Month	LTM		BOM measured			Measured Airstrip			Measured Emperor			Measured Shogun		
						Sufficient data available			Sufficient data available			Sufficient data available		
	Discrete	Cumulative	Discrete	Cumulative	Difference	Discrete	Cumulative	Difference	Discrete	Cumulative	Difference	Discrete	Cumulative	Difference
1	43	43	84	84	41	23.6	24	-19	55.4	55	12	62.6	63	20
2	61	104	18	102	-42	13.7	37	-47	23	78	-38	21.6	84	-39
3	35	138	68	171	33	20.7	58	-14	47.4	126	12	48.8	133	14
4	23	162	5	175	-19	0.7	59	-23	0.2	126	-23	0.2	133	-23
5	18	180	2	178	-16	2.6	61	-16	2.6	129	-16	3	136	-15
6	19	198	22	200	4	6.9	68	-12	10	139	-9	13.2	149	-5
7	23	222	6	206	-17	2.1	70	-21	2.4	141	-21	3.4	153	-20
8	13	235	10	216	-4	0.6	71	-13	1.4	142	-12	0.8	154	-12
9	9	244	4	219	-5	0.6	72	-8	1	143	-8	0.8	154	-8







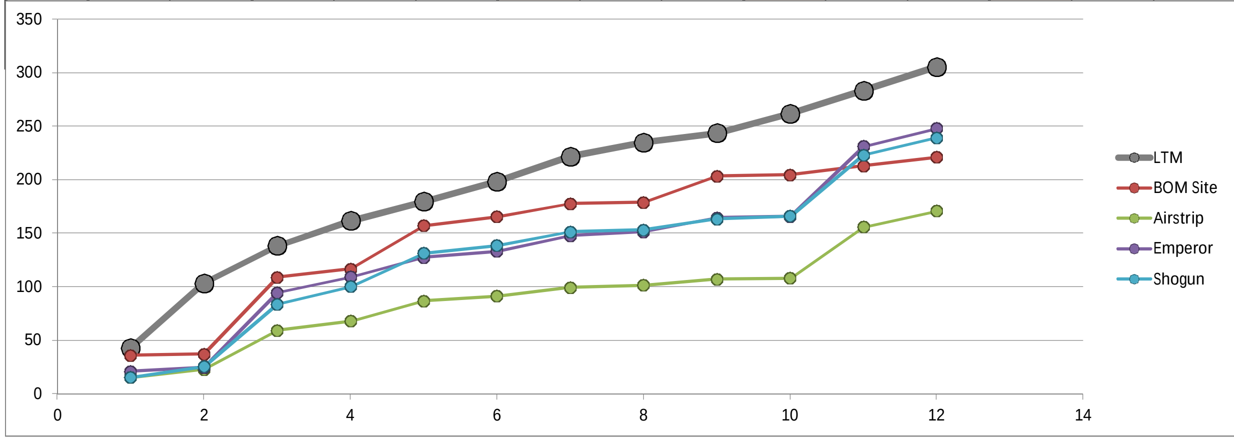


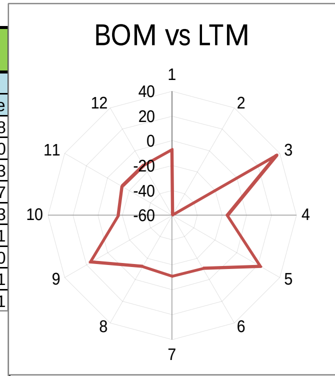


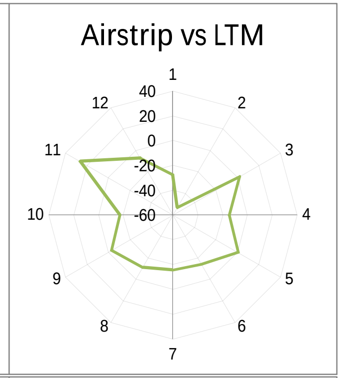
Review of monitoring data
Rainfall summary

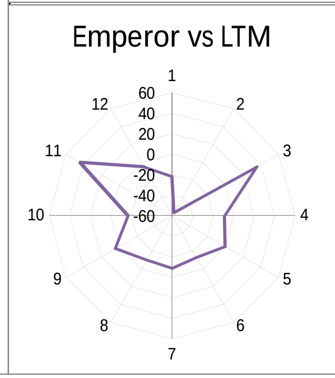
Assessment Year 2013

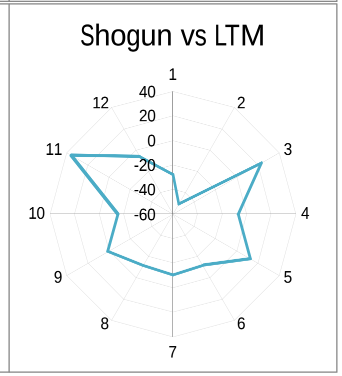
						Sufficient data available			Missing 10 days			Sufficient data available		
Month	LTM		BOM measured			Measured Airstrip			Measured Emperor			Measured Shogun		
	Discrete	Cumulative	Discrete	Cumulative	Difference	Discrete	Cumulative	Difference	Discrete	Cumulative	Difference	Discrete	Cumulative	Difference
1	43	43	36	36	-7	15.2	15	-28	20.8	21	-22	15.2	15	-28
2	61	104	1	37	-59	7.5	23	-53	3.8	25	-57	10.2	25	-50
3	35	138	72	109	37	36.6	59	2	70	95	35	58.2	84	23
4	23	162	8	117	-16	8.6	68	-15	14.6	109	-9	16.6	100	-7
5	18	180	41	157	22	18.7	87	1	18.2	127	0	31	131	13
6	19	198	8	165	-10	4.5	91	-14	5.8	133	-13	7.2	138	-11
7	23	222	12	178	-11	8.1	99	-15	14.7	148	-9	13	151	-10
8	13	235	1	179	-12	2.1	101	-11	3.4	151	-10	1.8	153	-11
9	9	244	25	204	16	5.8	107	-3	13.2	165	4	10	163	1





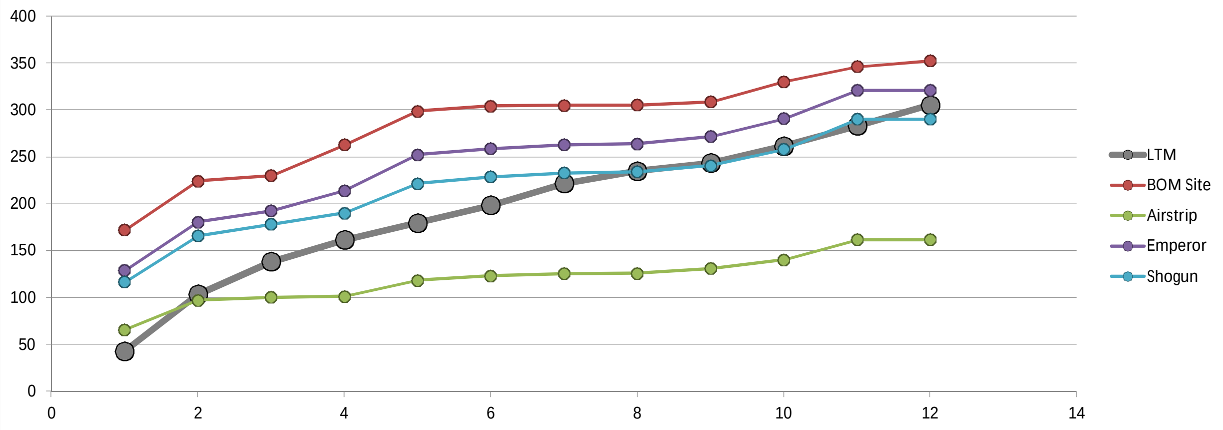


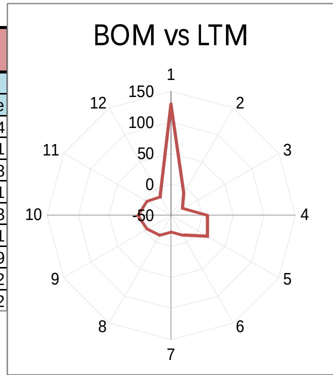


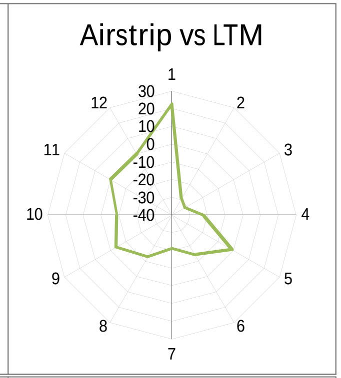


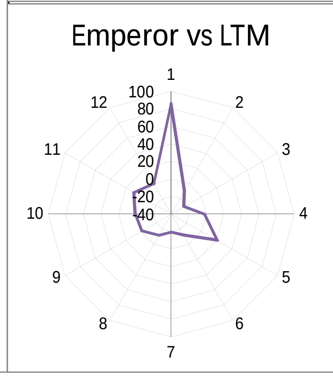
Review of monitoring data
Rainfall summary
Assessment Year 2014

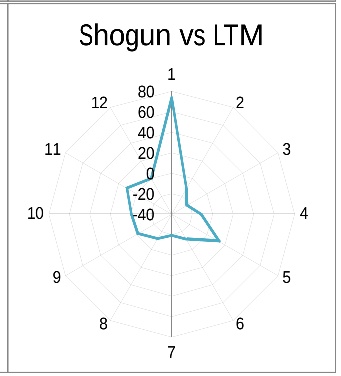
						Sufficient data available			Sufficient data available			Missing 10 days		
Month	LTM		BOM measured			Measured Airstrip			Measured Emperor			Measured Shogun		
	Discrete	Cumulative	Discrete	Cumulative	Difference	Discrete	Cumulative	Difference	Discrete	Cumulative	Difference	Discrete	Cumulative	Difference
1	43	43	172	172	129	65.7	66	23	128.8	129	86	116.6	117	74
2	61	104	52	224	-8	31.3	97	-29	51.8	181	-9	49.2	166	-11
3	35	138	6	230	-29	3.3	100	-32	11.8	192	-23	12.2	178	-23
4	23	162	33	263	9	0.9	101	-22	21.4	214	-2	12	190	-11
5	18	180	36	299	18	17.2	118	-1	38.4	252	20	31.6	222	13
6	19	198	5	304	-13	4.6	123	-14	6.6	259	-12	7.2	229	-11
7	23	222	1	305	-23	2.5	126	-21	4	263	-19	4	233	-19
8	13	235	0	305	-13	0.4	126	-13	1.2	264	-12	1.2	234	-12
9	9	244	4	309	-5	5.1	131	-4	7.6	272	-1	6.8	241	-2











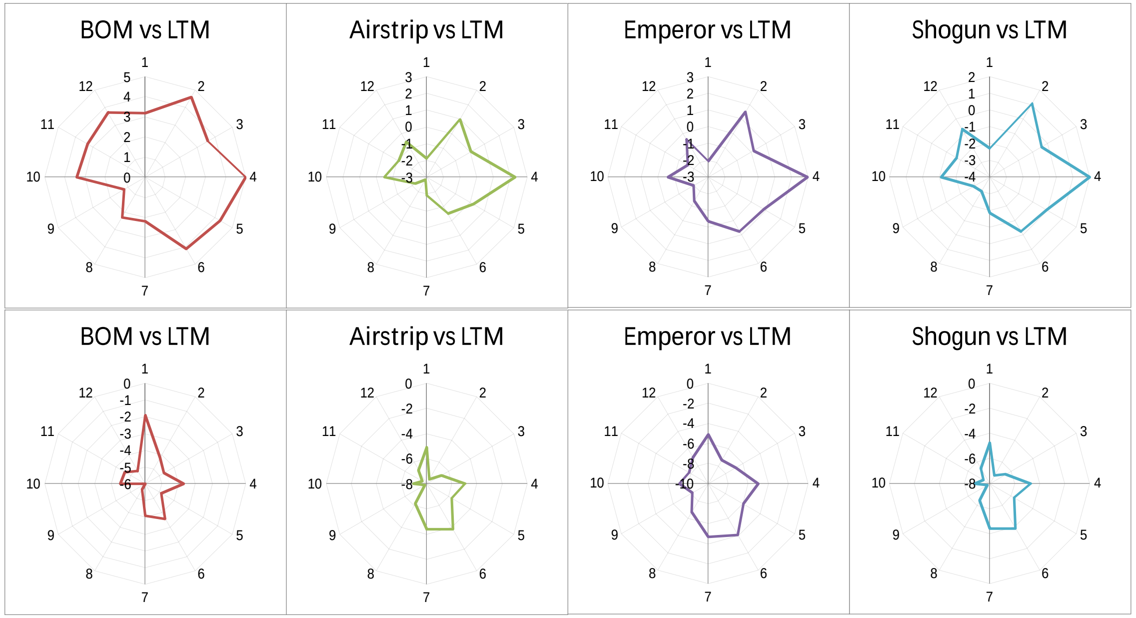
Review of monitoring data
Temperature Summary
Assessment Year 2010

Daily minimum

Month	LTM	BOM measured		Measured Airstrip		Measured Emperor		Measured Shogun	
				Sufficient data availabl (use 2010 Jan and Feb		Sufficient data available (use 2010 Jan and Feb)		Sufficient data available	
	Discrete	Discrete	Difference	Discrete	Difference	Discrete	Difference	Discrete	Difference
1	20	23	3	18	-2	18	-2	17	-2
2	19	23	5	20	1	20	1	20	1
3	16	19	4	16	0	16	0	15	0
4	12	17	5	14	2	15	3	14	2
5	6	11	4	7	0	7	1	6	0
6	4	8	4	4	0	5	1	4	0
7	3	5	2	1	-2	3	0	1	-2
8	4	6	2	1	-3	3	-1	1	-3
9	8	9	1	6	-2	6	-2	5	-3
10	11	14	3	10	0	10	-1	9	-1
11	14	18	3	13	-1	13	-2	12	-2
12	17	20	4	16	-1	16	0	16	-1

Daily maximum

Month	LTM	BOM measured		Measured Airstrip		Measured Emperor		Measured Shogun	
				Sufficient data availabl (use 2010 Jan and Feb		Sufficient data available (use 2010 Jan and Feb)		Sufficient data available	
	Discrete	Discrete	Difference	Discrete	Difference	Discrete	Difference	Discrete	Difference
1	41	39	-2	36	-5	36	-5	36	-5
2	43	39	-4	35	-8	35	-7	35	-7
3	38	33	-5	31	-7	31	-7	32	-7
4	33	29	-4	28	-5	28	-5	28	-5
5	28	23	-5	22	-6	22	-6	22	-6
6	22	18	-4	18	-4	18	-4	18	-4
7	22	18	-4	18	-4	17	-5	18	-4
8	26	20	-6	20	-6	19	-7	19	-6
9	28	22	-6	20	-8	20	-8	20	-8
10	33	28	-5	26	-7	25	-7	26	-7
11	38	33	-5	30	-8	30	-8	30	-7
12	40	35	-5	33	-7	33	-7	33	-7



Review of monitoring data
Temperature Summary

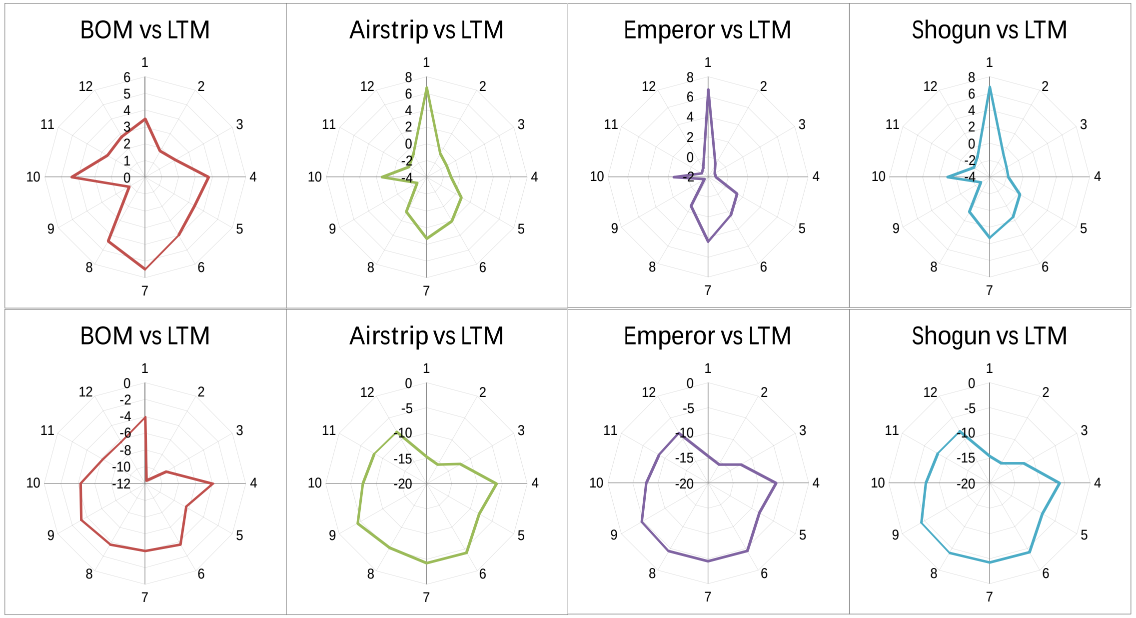
Assessment Year 2011

Daily minimum

				Sufficient data available (use 2010 Jan and Feb)		Sufficient data available (use 2010 Jan and Feb)		Sufficient data available	
Month	LTM	BOM measured		Measured Airstrip		Measured Emperor		Measured Shogun	
	Discrete	Discrete	Difference	Discrete	Difference	Discrete	Difference	Discrete	Difference
1	20	23	4	26	7	26	7	26	7
2	19	20	2	18	-1	18	0	18	-1
3	16	18	2	14	-1	14	-1	14	-2
4	12	16	4	11	-1	11	-1	10	-2
5	6	10	3	7	1	8	1	7	0
6	4	8	4	6	2	7	2	6	2
7	3	8	6	6	3	7	4	6	3
8	4	9	4	5	1	5	1	5	1
9	8	9	1	5	-3	6	-2	5	-3
10	11	15	4	12	1	12	1	11	1
11	14	17	3	13	-2	13	-1	12	-2
12	17	19	3	16	-1	16	-1	15	-1

Daily maximum

				Sufficient data available (use 2010 Jan and Feb)		Sufficient data available (use 2010 Jan and Feb)		Sufficient data available	
Month	LTM	BOM measured		Measured Airstrip		Measured Emperor		Measured Shogun	
	Discrete	Discrete	Difference	Discrete	Difference	Discrete	Difference	Discrete	Difference
1	41	37	-4	26	-15	26	-15	26	-15
2	43	31	-12	27	-16	27	-16	27	-15
3	38	29	-9	26	-12	26	-13	26	-12
4	33	29	-4	27	-6	26	-7	27	-6
5	28	21	-6	20	-8	20	-8	20	-8
6	22	18	-4	18	-4	18	-4	18	-4
7	22	18	-4	18	-4	18	-4	18	-4
8	26	22	-4	21	-5	21	-4	22	-4
9	28	25	-3	24	-4	23	-5	24	-4
10	33	28	-4	25	-7	25	-8	25	-7
11	38	32	-6	30	-8	29	-9	30	-8
12	40	33	-6	31	-8	31	-8	32	-8



Review of monitoring data
Temperature Summary

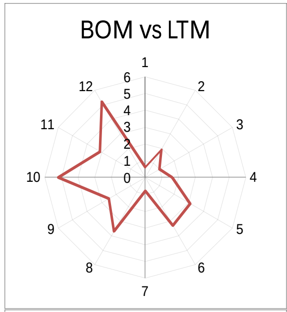
Assessment Year 2012

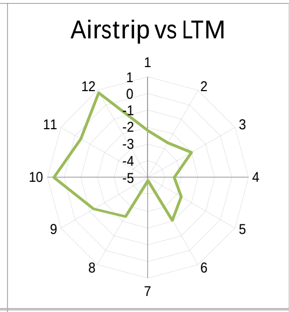
Daily minimum

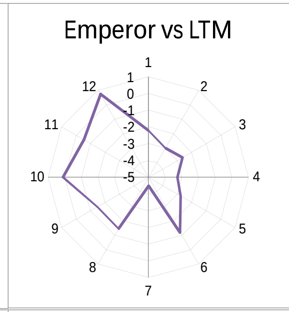
Month	LTM	BOM measured		Measured Airstrip (Sufficient data available (use 2010 Jan and Feb)		Measured Emperor (Sufficient data available (use 2010 Jan and Feb))		Measured Shogun (Sufficient data available)	
	Discrete	Discrete	Difference	Discrete	Difference	Discrete	Difference	Discrete	Difference
1	20	20	1	18	-2	17	-2	17	-3
2	19	21	2	16	-3	16	-3	16	-3
3	16	17	1	14	-2	13	-3	13	-3
4	12	14	2	8	-3	9	-3	8	-4
5	6	10	3	4	-3	4	-3	3	-4
6	4	8	3	2	-2	3	-1	2	-2
7	3	4	1	-2	-5	-2	-4	-2	-5
8	4	8	4	2	-2	3	-1	2	-2
9	8	10	3	7	-1	6	-1	6	-2
10	11	16	5	11	1	11	0	11	0
11	14	17	3	14	0	14	-1	13	-1
12	17	22	5	17	1	17	1	17	1

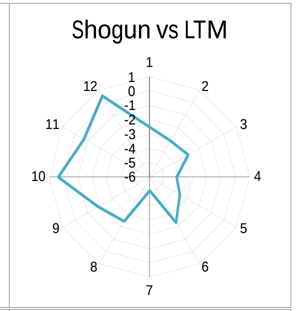
Daily maximum

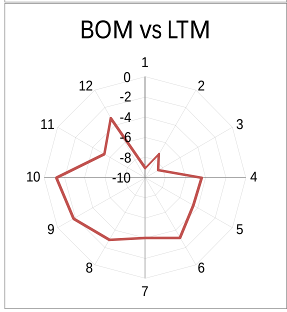
Month	LTM	BOM measured		Measured Airstrip (Sufficient data available (use 2010 Jan and Feb)		Measured Emperor (Sufficient data available (use 2010 Jan and Feb))		Measured Shogun (Sufficient data available)	
	Discrete	Discrete	Difference	Discrete	Difference	Discrete	Difference	Discrete	Difference
1	41	32	-9	32	-9	31	-10	32	-9
2	43	35	-7	32	-11	32	-11	32	-11
3	38	30	-9	28	-10	28	-10	28	-10
4	33	28	-4	28	-5	27	-5	28	-5
5	28	23	-5	22	-6	22	-6	22	-6
6	22	19	-3	19	-4	18	-4	18	-4
7	22	18	-4	18	-4	18	-4	18	-4
8	26	23	-3	22	-4	22	-4	22	-4
9	28	26	-2	25	-3	25	-3	25	-3
10	33	31	-1	30	-3	30	-3	30	-3
11	38	32	-5	31	-7	30	-7	31	-7
12	40	36	-3	34	-6	33	-6	34	-6

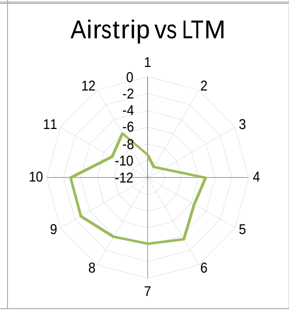


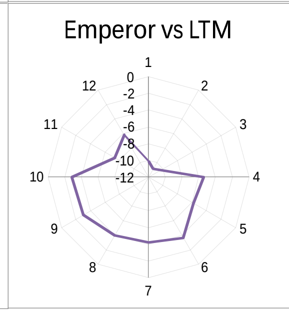


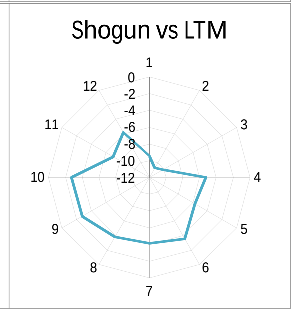












Review of monitoring data
Temperature Summary

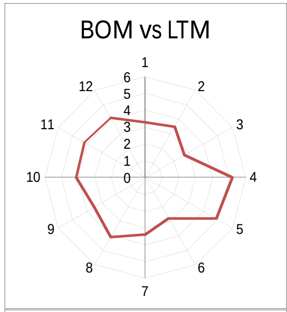
Assessment Year 2013

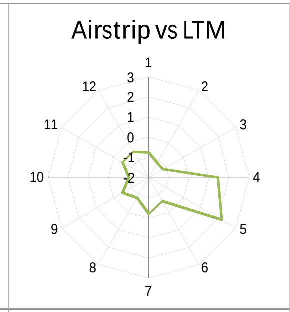
Daily minimum

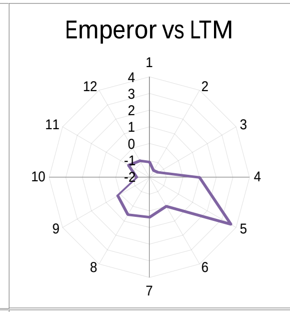
Month	LTM	BOM measured		Measured Airstrip (Sufficient data available (use 2010 Jan and Feb))		Measured Emperor (Sufficient data available (use 2010 Jan and Feb))		Measured Shogun (Sufficient data available)	
	Discrete	Discrete	Difference	Discrete	Difference	Discrete	Difference	Discrete	Difference
1	20	23	3	19	-1	19	-1	19	-1
2	19	22	4	17	-1	17	-2	17	-2
3	16	18	3	14	-1	14	-1	14	-2
4	12	17	5	13	1	13	1	13	1
5	6	11	5	9	2	10	4	8	2
6	4	7	3	4	-1	4	0	3	-1
7	3	6	3	3	0	3	0	3	0
8	4	8	4	3	-1	5	1	3	-1
9	8	11	4	7	0	8	0	7	-1
10	11	15	4	9	-1	9	-1	9	-1
11	14	18	4	14	0	14	-1	14	-1
12	17	21	4	16	-1	16	-1	16	-1

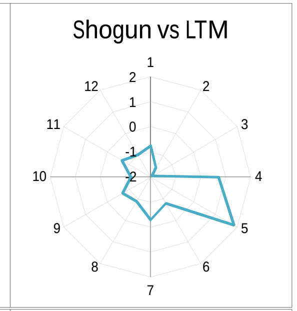
Daily maximum

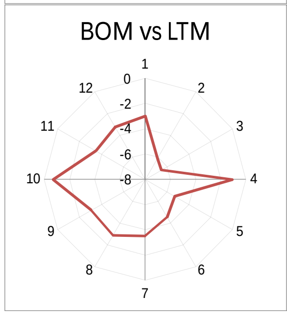
Month	LTM	BOM measured		Measured Airstrip (Sufficient data available (use 2010 Jan and Feb))		Measured Emperor (Sufficient data available (use 2010 Jan and Feb))		Measured Shogun (Sufficient data available)	
	Discrete	Discrete	Difference	Discrete	Difference	Discrete	Difference	Discrete	Difference
1	41	38	-3	36	-5	36	-5	36	-5
2	43	37	-6	34	-8	34	-8	35	-8
3	38	32	-7	30	-9	29	-9	30	-8
4	33	32	-1	30	-3	30	-3	30	-3
5	28	23	-5	23	-5	24	-4	23	-5
6	22	18	-5	18	-4	17	-5	18	-4
7	22	19	-4	19	-3	19	-3	19	-3
8	26	23	-3	23	-3	22	-3	23	-3
9	28	25	-3	25	-3	25	-3	25	-3
10	33	32	-1	30	-2	30	-3	30	-2
11	38	34	-4	30	-8	30	-8	30	-8
12	40	36	-3	33	-7	33	-7	33	-7

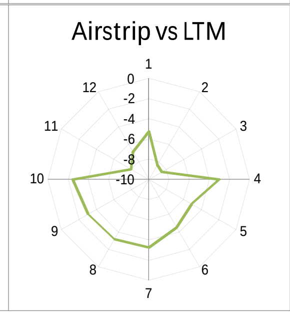


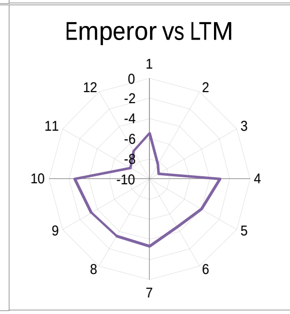


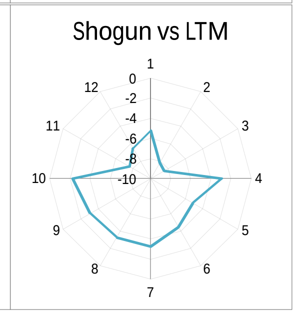












Review of monitoring data
Temperature Summary

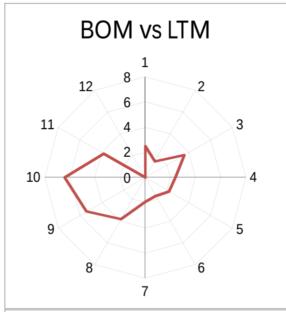
Assessment Year: 2014

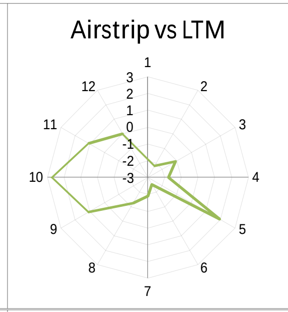
Daily minimum

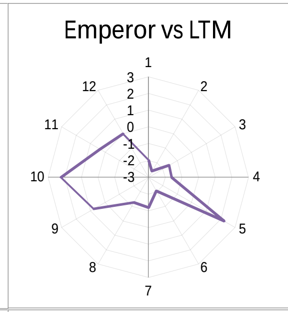
Month	LTM	BOM measured		Measured Airstrip (Sufficient data available (use 2010 Jan and Feb))		Measured Emperor (Sufficient data available (use 2010 Jan and Feb))		Measured Shogun (Sufficient data available)	
	Discrete	Discrete	Difference	Discrete	Difference	Discrete	Difference	Discrete	Difference
1	20	22	3	18	-2	18	-2	18	-2
2	19	20	2	16	-2	16	-3	16	-3
3	16	19	4	15	-1	14	-2	14	-2
4	12	14	2	10	-2	10	-2	10	-2
5	6	9	2	8	2	9	2	8	2
6	4	6	2	2	-3	2	-2	2	-2
7	3	5	2	1	-2	2	-1	1	-2
8	4	8	4	3	-1	3	-1	2	-2
9	8	13	5	9	1	9	1	9	1
10	11	17	6	13	3	13	2	13	2
11	14	18	4	15	1	15	0	15	1
12	17								

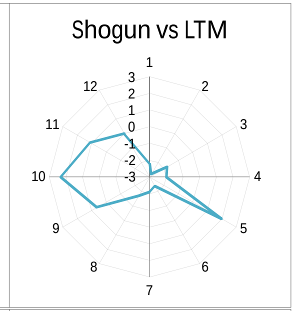
Daily maximum

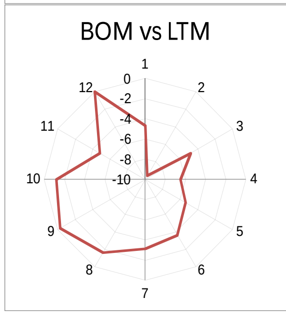
Month	LTM	BOM measured		Measured Airstrip (Sufficient data available (use 2010 Jan and Feb))		Measured Emperor (Sufficient data available (use 2010 Jan and Feb))		Measured Shogun (Sufficient data available)	
	Discrete	Discrete	Difference	Discrete	Difference	Discrete	Difference	Discrete	Difference
1	41	36	-5	34	-7	34	-7	34	-7
2	43	33	-10	31	-12	30	-12	31	-12
3	38	33	-5	31	-7	31	-7	31	-7
4	33	26	-7	27	-6	25	-7	26	-7
5	28	22	-5	23	-5	22	-5	23	-5
6	22	18	-4	18	-4	18	-4	19	-3
7	22	19	-3	19	-3	19	-3	19	-3
8	26	24	-2	23	-3	23	-3	23	-3
9	28	28	0	26	-2	26	-2	26	-2
10	33	31	-1	31	-2	30	-2	31	-2
11	38	33	-5	31	-7	31	-7	31	-7
12	40								

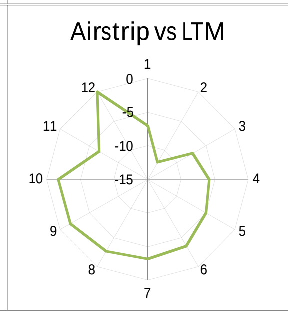


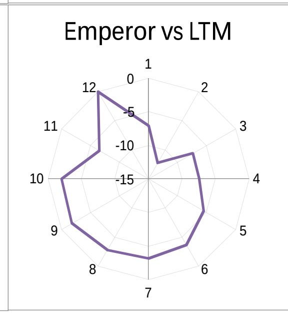


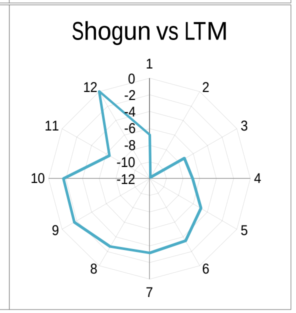












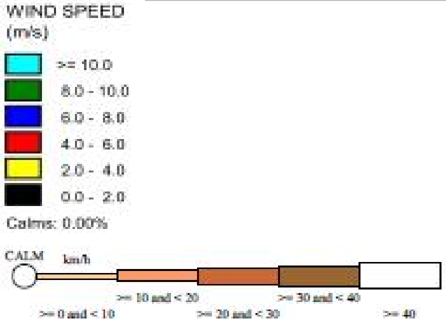
Review of monitoring data

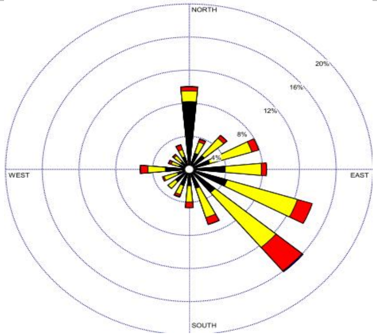
Wind rose and speed summary

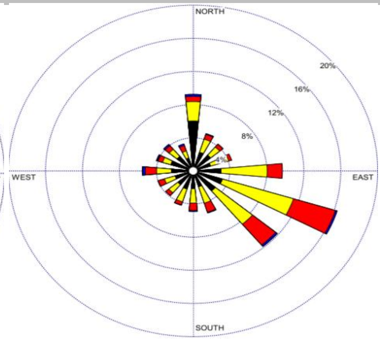
Monitoring year 2010

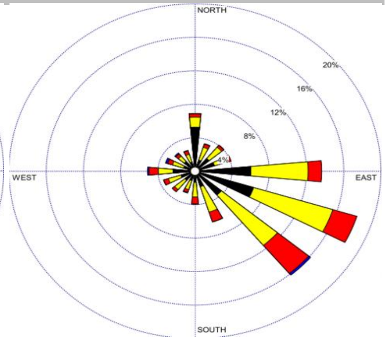
Leonora	**Airstrip**	**Emperor**	**Shogun**

ALL HOURS



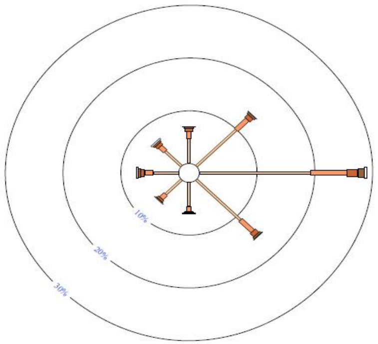


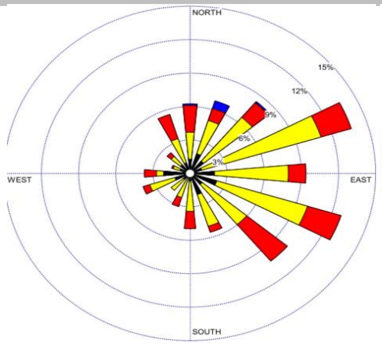


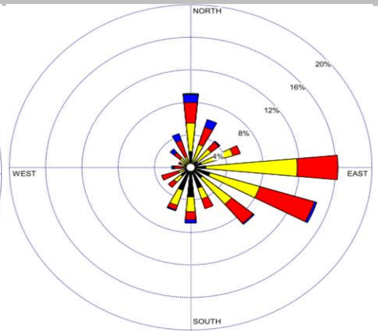


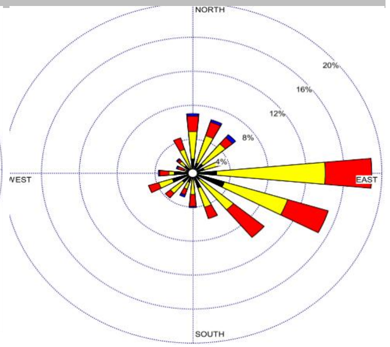
	Avg	2.31 m/s	Avg	2.51 m/s	Avg	2.45 m/s

9:00 AM



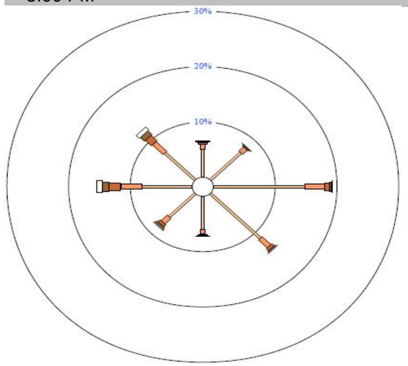


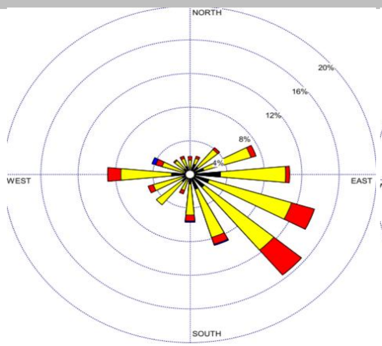


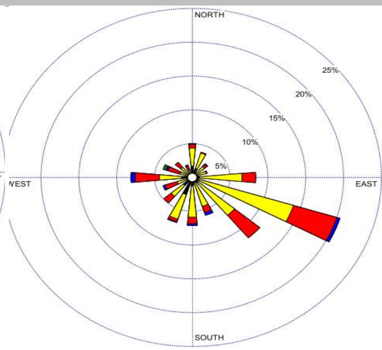


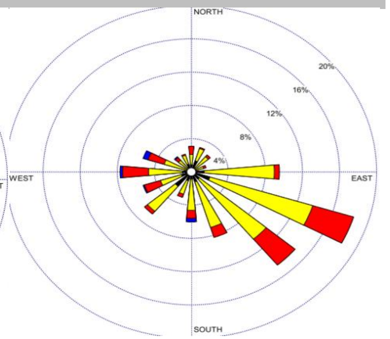
Avg	2.7 m/s	(all recorded years)	Avg	3.03 m/s	Avg	3.29 m/s	Avg	3.12 m/s

3:00 PM







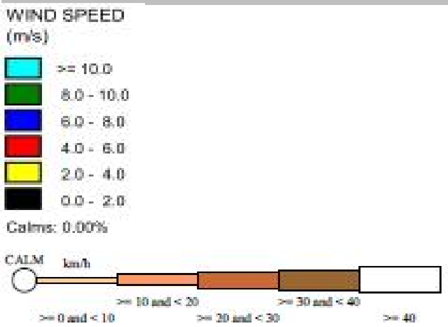


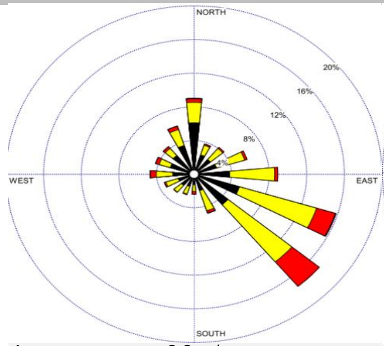
Avg	2.7 m/s	(all recorded years)	Avg	2.86 m/s	Avg	3.3 m/s	Avg	3.12 m/s

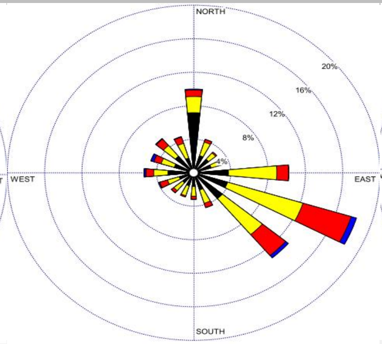
Review of monitoring data
Wind rose and speed summary
Monitoring year 2011

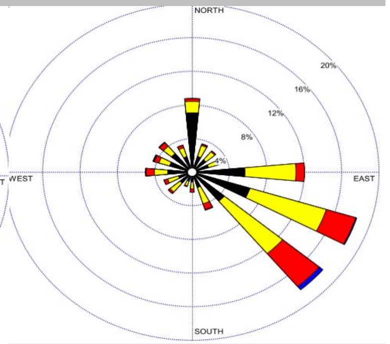
Leonora	**Airstrip**	**Emperor**	**Shogun**

ALL HOURS



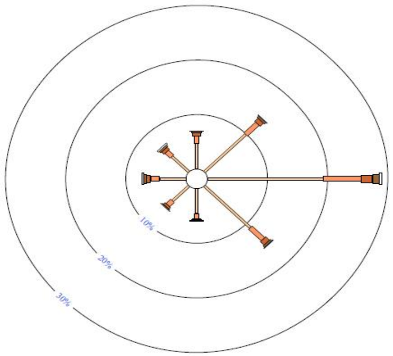


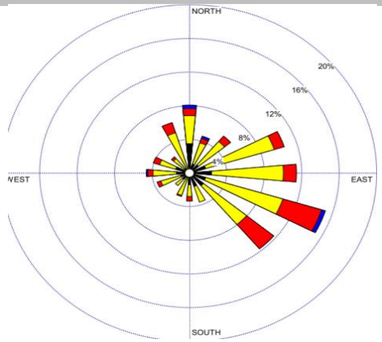


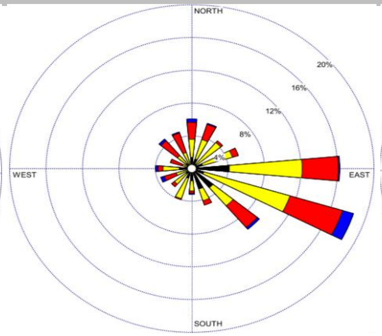


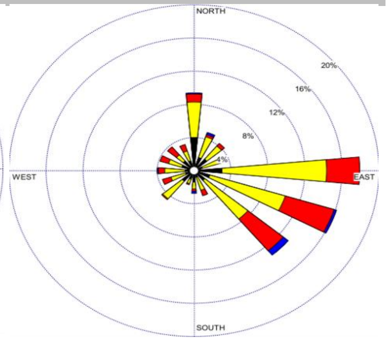
Avg 2.2 m/s | Avg 2.47 m/s | Avg 2.26 m/s

9:00 AM



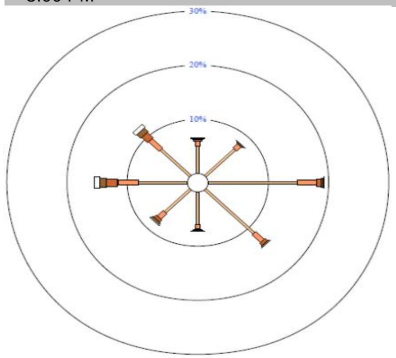


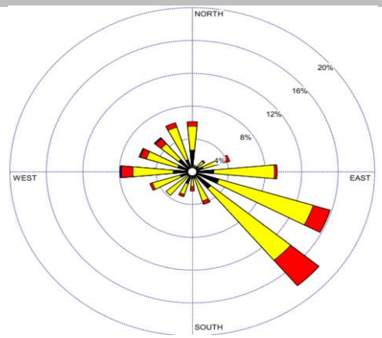


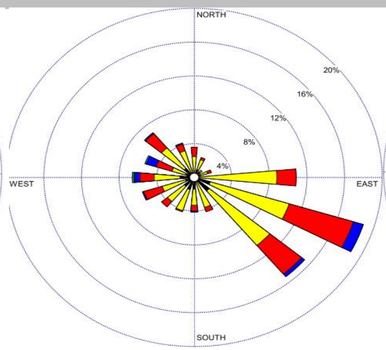


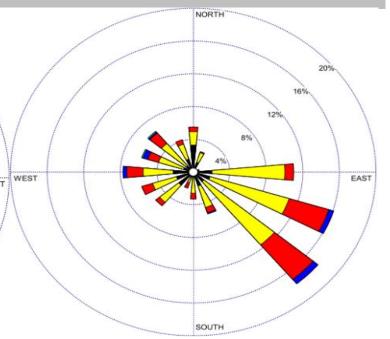
Avg 2.7 m/s (all recorded years) | Avg 2.88 m/s | Avg 3.22 m/s | Avg 2.92 m/s

3:00 PM







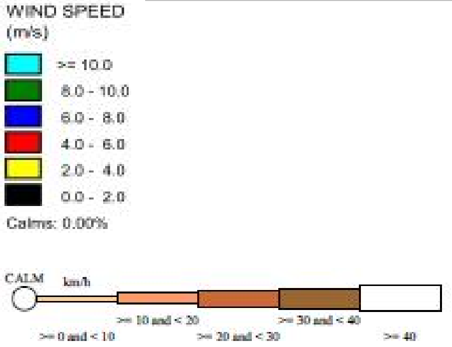


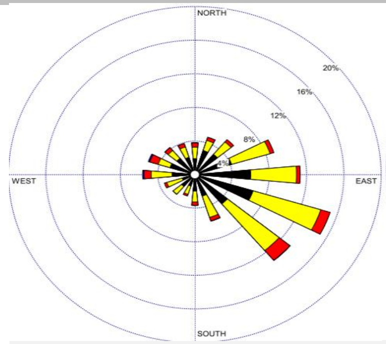
Avg 2.7 m/s (all recorded years) | Avg 2.73 m/s | Avg 3.31 m/s | Avg 2.95 m/s

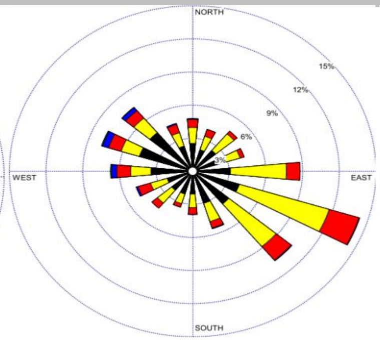
Review of monitoring data
Wind rose and speed summary
Monitoring year 2012

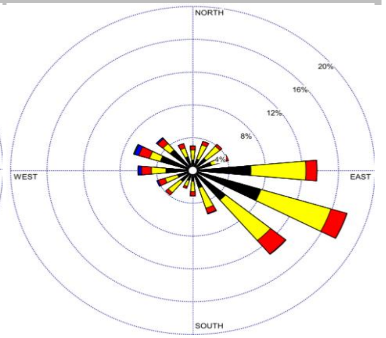
Leonora	Airstrip	Emperor	Shogun

ALL HOURS



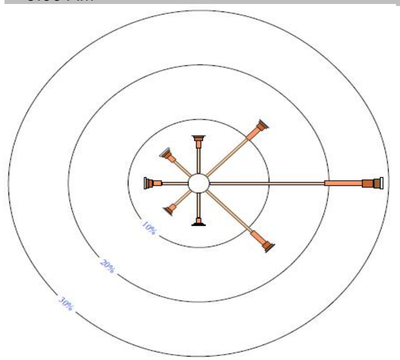


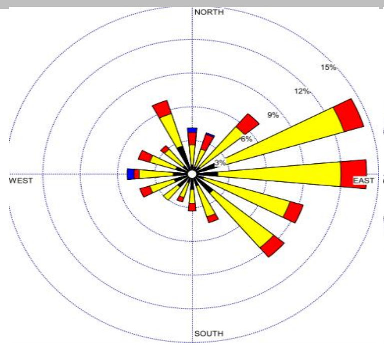


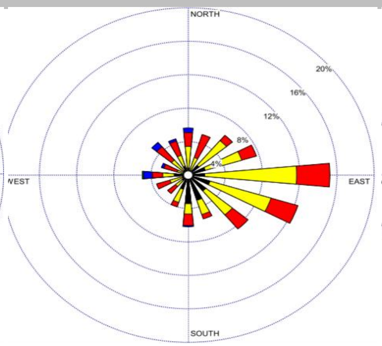


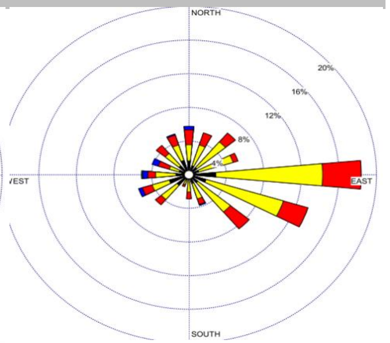
	Airstrip	Emperor	Shogun
	Avg 2.14 m/s	Avg 2.35 m/s	Avg 2.34 m/s

9:00 AM



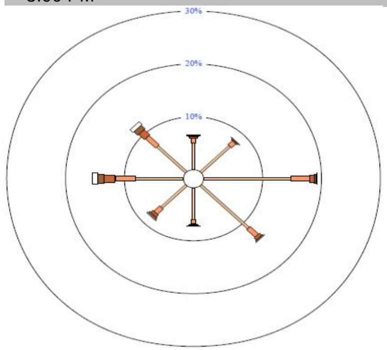


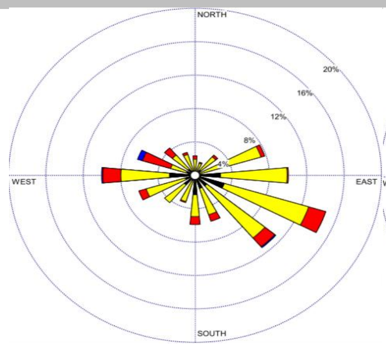


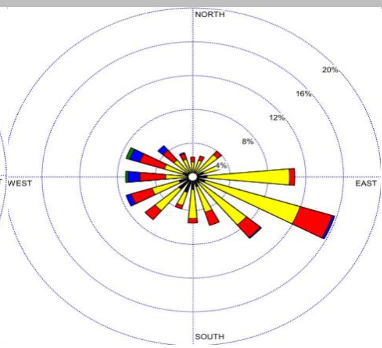


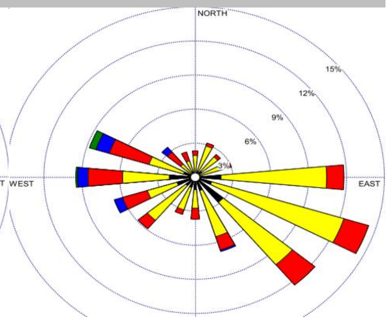
Leonora	Airstrip	Emperor	Shogun
Avg 2.7 m/s (all recorded years)	Avg 2.89 m/s	Avg 3.14 m/s	Avg 3.07 m/s

3:00 PM









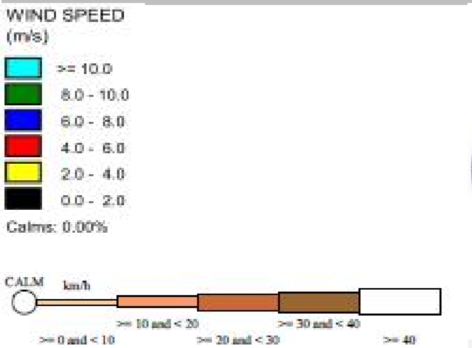
Leonora	Airstrip	Emperor	Shogun
Avg 2.7 m/s (all recorded years)	Avg 2.81 m/s	Avg 3.28 m/s	Avg 3.2 m/s

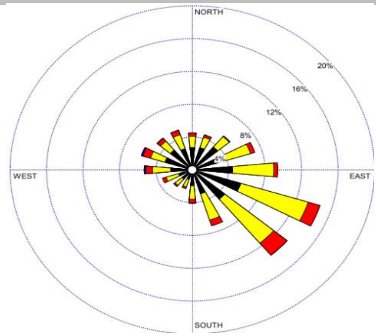
Review of monitoring data

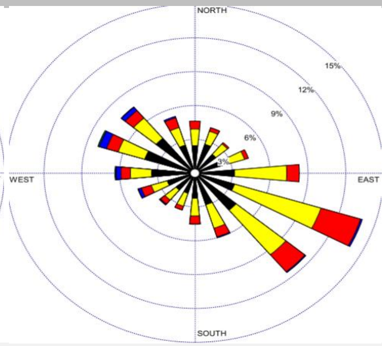
Wind rose and speed summary

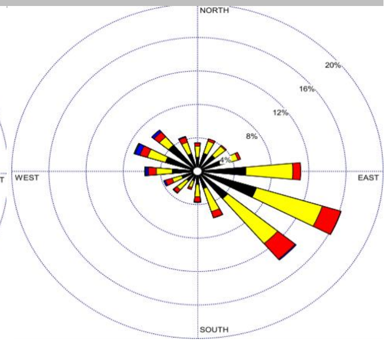
Monitoring year 2013

Leonora	**Airstrip**		**Emperor**		**Shogun**	
ALL HOURS						



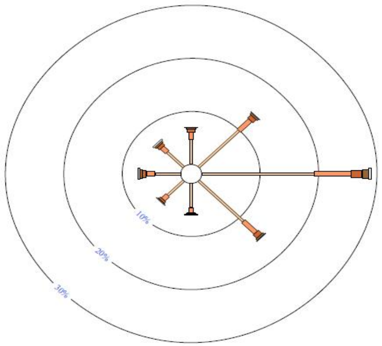


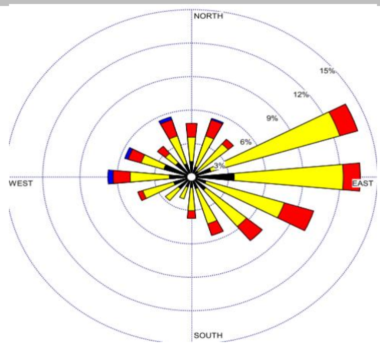


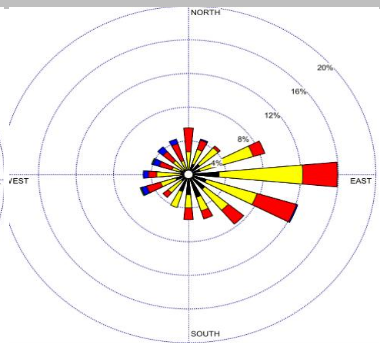


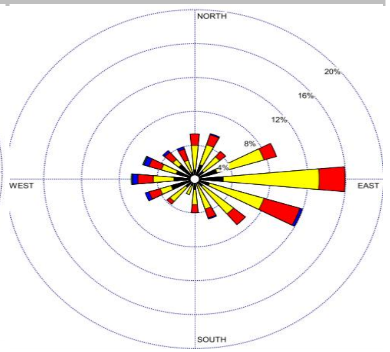
	Avg	2.19 m/s	Avg	2.4 m/s	Avg	2.36 m/s

9:00 AM



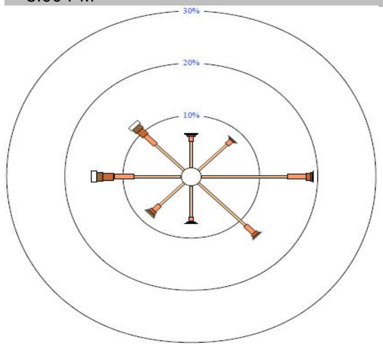


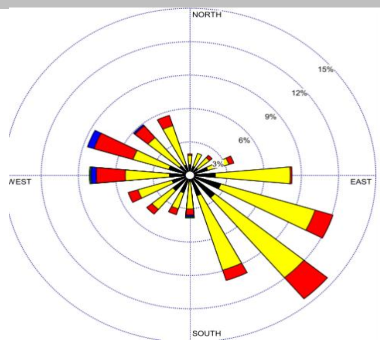


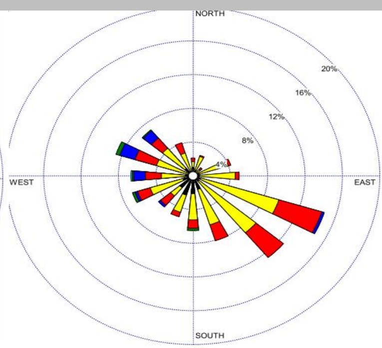


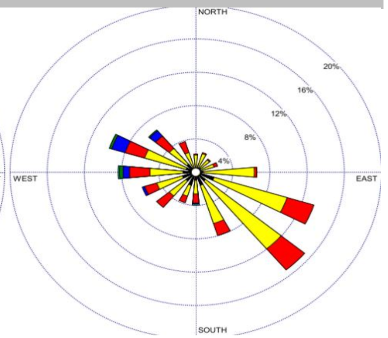
Avg	2.7 m/s	(all recorded years)	Avg	2.89 m/s	Avg	3.11 m/s	Avg	3.04 m/s

3:00 PM







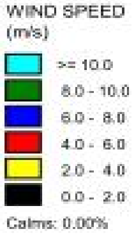


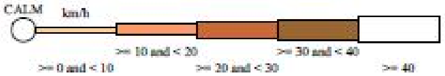
Avg	2.7 m/s	(all recorded years)	Avg	2.92 m/s	Avg	3.41 m/s	Avg	3.28 m/s

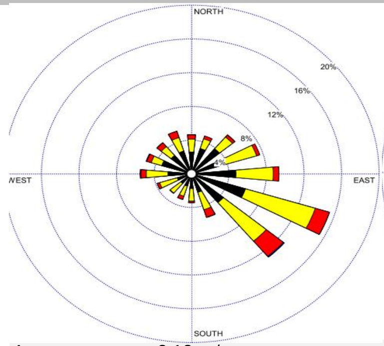
Review of monitoring data
Wind rose and speed summary
Monitoring year 2014

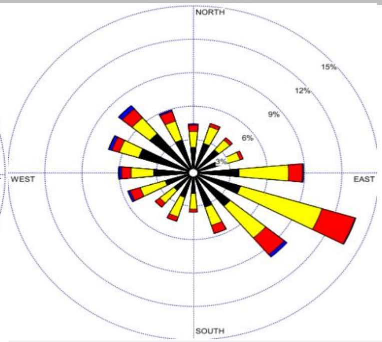
Leonora	**Airstrip**	**Emperor**	**Shogun**

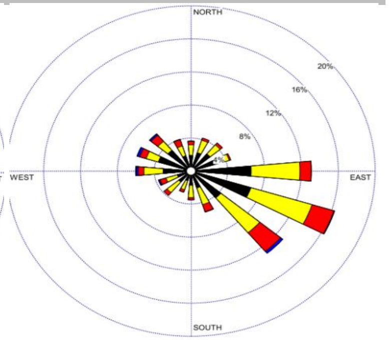
ALL HOURS





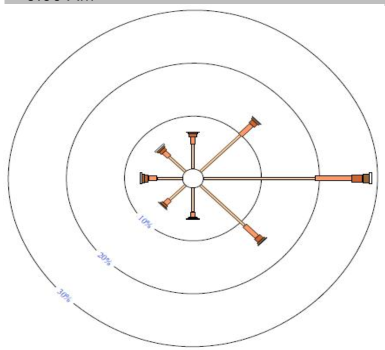


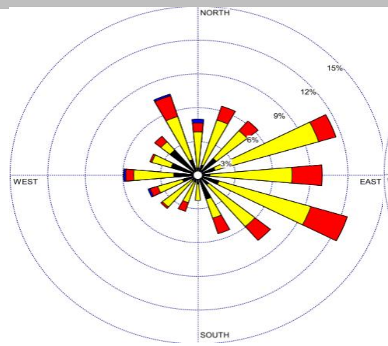


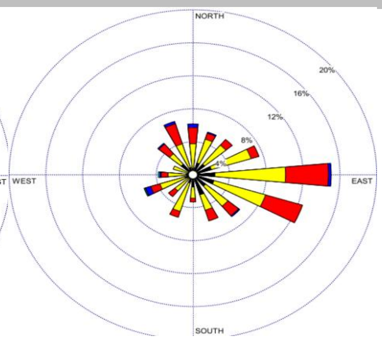


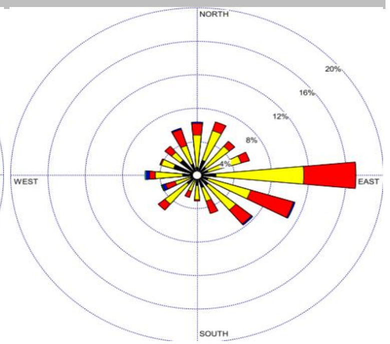
		Avg	2.18 m/s	Avg	2.28 m/s	Avg	2.32 m/s

9:00 AM



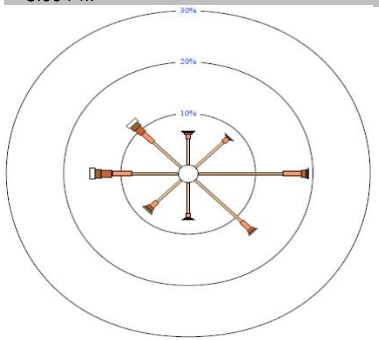


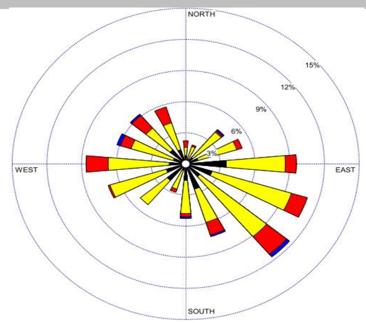


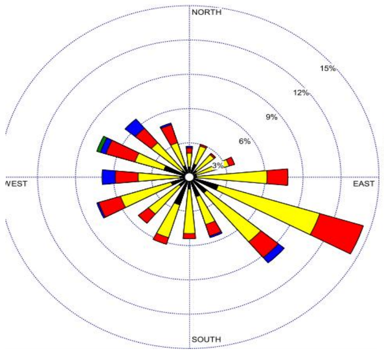


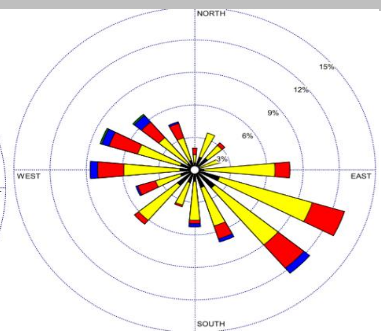
Avg	2.7 m/s	(all recorded years)	Avg	2.9 m/s	Avg	3.06 m/s	Avg	3.04 m/s

3:00 PM









Avg	2.7 m/s	(all recorded years)	Avg	2.81 m/s	Avg	3.19 m/s	Avg	3.13 m/s

Appendix B – Dust emissions

Summary details for dust emissions, Scenarios 1 through 4

Scenario 1, Year 3

input data

Throughput		
Mining rate	**Mtpa**	**t/day**
Total (ore + waste rock)	18.16	52343
Ore (pre-bene)	2.38	6859
Ore (post-bene)	1.67	4801
Overburden	15.78	45485
Processing plant (ore)	**Mtpa**	**t/day**
Product	0.79	2274
Tailings (solids)	0.88	2527
Mining rate for stockpile	**Mtpa**	**t/day**
Total (ore + waste rock)	0.00	0
Ore (pre-bene)	0.00	0
Ore (post-bene)	0.00	0
Overburden	0.00	0

Ratios, factors and reductions	
Pre-bene to post-bene reduction	0.3
Waste rock to product ratio	0.05
Tailings to product ratio	0.9
Swell factor	0.15

Operational times		
Days per year	347	*(95% up-time)*
Hours per day	24	

Density	
Ore density (dry) (t/bcm)	1.20
Waste rock density (t/bcm)	1.85

Moisture and silt content		
Product	**Moisture (%)**	**Silt (%)**
Ore	20.0	6.6
Waste rock	5.0	4.0
Haul roads/sands	5.0	2.0

Areas					
Active pits	**m2**	**width (m)**	**height(m)**	**Centre, Easting, Northing (m)**	
Active Pit A - Scenario 1, Year 3	150,000	387	387	579,000	6,682,500
Active Pit B - Scenario 1, Year 3	NA	0	0	NA	NA
Overburden landform	**m2**	**width (m)**	**height(m)**	**Centre, Easting, Northing (m)**	
Princess 1 - Scenario 1, Year 3	72,222	269	269	580,031	6,683,781
Ambassador 1 - Scenario 1, Year 3	113,889	337	337	580,941	6,682,591
Ambassador 2 - Scenario 1, Year 3	88,889	298	298	575,030	6,682,101
Shogun - Scenario 1, Year 3	119,444	346	346	561,778	6,687,771
Emperor - Scenario 1, Year 3	311,111	558	558	560,460	6,691,005
Tailings (wet tailings)	**m2**	**width (m)**	**height(m)**	**Centre, Easting, Northing (m)**	
Tailings_Surface - Scenario 1, Year 3	398,000	631	631	576,590	6,683,530
Processing plant stockpile	**m2**	**width (m)**	**height(m)**	**Centre, Easting, Northing (m)**	
Proc. Plant - Scenario 1, Year 3	0	0	0	NA	NA
Capped landforms	**m2**	**width (m)**	**height(m)**	**Centre, Easting, Northing (m)**	
Capped pit 1 year rehab	600000	775	775	579600	6682900
Capped pit 2 year rehab (A)	600000	775	775	580500	6683000
Capped pit 2 year rehab (B)	0	0	0	0	0
Capped pit 3 year rehab (A)	0	0	0	0	0
Capped pit 3 year rehab (B)	0	0	0	0	0
Capped pit 4 year rehab	0	0	0	0	0
Capped pit 5 year rehab	0	0	0	0	0

Haul road areas (for wind erosion)			
Pit to Processing Plant	**m2**	**width (m)**	**length (m)**
Total haul road areas	1626500	20	81325
Total LV road areas	384542	6	64090

Landform production rates			
Active landforms	**ha**	**m3/yr**	**m/yr**
Active pit	150,000	10,514,770	0.00701
Overburden	705,556	1,279,716	0.00018
Active tailings	398,000	297,500	0.00007

Fleet details					
Mine equipment fleet	**Model**	**Number**	**Payload (t)**	**Weight (t)**	
Haul truck	Cat 793D	NA	218	384	
Dozer	not provided	2	NA	NA	
Grader	not provided	2	NA	NA	
Back hoe	not provided	3	NA	NA	
Forklift	not provided	3	NA	NA	
Crane	not provided	2	NA	NA	
Truck with hiab	not provided	2	NA	NA	
Ambulance	not provided	1	NA	NA	
Buses	not provided	3	NA	NA	assume 3 hours use each per day
Light vehicles	mine spec	23	NA	NA	assume 4 hours use each per day

Scenario 1, Year 3

data input

Constants			
Parameter	**Ore**	**Waste rock**	**Tailings**
Mean wind speed (m/s)	3.5	3.5	3.5
Moisture (%)	20.0	5.0	20.0
Silt (%)	6.6	6.0	6.6

Parameter	Value	Unit	
K tsp	0.74		
K pm10	0.35		
Mean grader speed - haul roads	10	km/hr	
Area of blasting	0	m2	none
Depth of blasting	0	m	
Holes per blast	0		
Moisture content	High		

Haul Road Parameters	Value	Unit
Vehicle gross mass (haul truck)	384	t
Vehicle gross mass (ancillary vehicles)	5	t
Moisture	5	%
Silt content	2	%
Haul Road width	20	m
Mean LV speed	40	km/hr

Mechanical Emission Factors[1]			
Excav, shov. & FEL	**Ore**	**Waste Rock**	**Tailings**
EF TSP (kg/t)	0.0001	0.0006	0.0001
EF PM10 (kg/t)	0.0000	0.0003	0.0000
Bulldozers	**Ore**	**Waste Rock**	**Tailings**
EF TSP (kg/hr)	0.51	2.75	0.51
EF PM10 (kg/hr)	0.09	0.52	0.09
Trucks (unloading)	**Ore**	**Waste Rock**	**Tailings**
EF TSP (kg/t)	0.012	0.012	0.012
EF PM10 (kg/t)	0.0043	0.0043	0.0043
Grader	**Ore**	**Waste Rock**	**Tailings**
EF TSP (kg/VKT)	1.08	1.08	1.08
EF PM10 (kg/VKT)	0.34	0.34	0.34

Haul Road distances		
	Pit to PP	**Pit to WR**
Daily haul rate (tpd)	4801	7852
Return distance (m)	2000	2000
Truck payload (t)	218	218
Truck trips	22	36
VKT (km)	44	72
Trucks per hour	0.9	1.5
Haul road area (ha)	2.0	2.0

Crushing emission factors[1]	
Primary	
EF TSP (kg/t)	0.010
EF PM10 (kg/t)	0.004
Secondary	
EF TSP (kg/t)	0.030
EF PM10 (kg/t)	0.012
Tertiary	
EF TSP (kg/t)	0.030
EF PM10 (kg/t)	0.010
Conveying, transfer etc.	
EF TSP (kg/t)	0.005
EF PM10 (kg/t)	0.002
Screening	
EF TSP (kg/t)	0.08
EF PM10 (kg/t)	0.06

Wheel generated dust factors[1]	
Haul trucks	
EF TSP (kg/VKT)	3.65
EF PM10 (kg/VKT)	0.78
Ancillary vehicles	
EF TSP (kg/VKT)	0.09
EF PM10 (kg/VKT)	0.01

1. NPI Mining 3.1 (2012)

Summary of emissions sources for dispersion modelling

Scenario 1, Year 3, Standard Dust Suppression.

Scenario 1, Year 3

Source Type	Description of Source	Model ID (Area or Volume Source)	Model Run Source On/Off	Emission Regime	Total Area (ha)	Avg annual emissions TSP g/s	Avg annual emissions PM10 g/s	Overall Control TSP	Overall Control PM10	Control Factor Breakdown: Pit Retention	Water	Wind Breaks	Equipment	Re-veg	Avg annual emissions (controlled) TSP g/s	TSP g/s/ha	PM10 g/s	PM10 g/s/ha
Mech	Loading ore	OreLoad (V)	On	A		0.01	0.003	1	1						0.01		0.003	
Mech	Loading overburden	WRLoad (V)	On	A		0.3	0.1	1	1						0.3		0.1	
Mech	Hauling overburden	HaulWaste (A)	On	A	2.0	40	9	0.3	0.3		0.75				10	5	2	1.1
Mech	Hauling Ore	HaulOre (A)	On	A	2.0	2	0	0.3	0.3		0.75				0	0.2	0.1	0.05
Mech	Roads - grading haul roads	Grading (A)	On	A	2.0	6	2	0.3	0.3		0.75				1	0.7	0.5	0.2
Mech	Roads - misc vehicle traffic	TravelMisc (A)	On	A	38.5	0.1	0.02	0.3	0.3		0.75				0.03	0.001	0.004	0.0001
Mech	Overburden dumping	DumpWaste (V)	On	A		6	2	1	1						6		2	
Mech	PP - Dumping	DumpOre (V)	On	A		0.7	0.2	1	1						0.7		0.2	
Mech	PP - Conveyor to crusher	Convey1 (V)	On	A		0.00	0.002	1	1						0.00		0.002	
Mech	PP - Conveyor to ball mill	Convey2 (V)	On	A		0.6	0.2	1	1						0.6		0.2	
Mech	Dozing - overburden	DozeWaste (A)	On	A		2	0.3	1	1						2		0.3	
Wind	Wind Erosion - Pit A	WE-PtA (A)	On	B	15.0	2	0.9	1	1						1.7	0.1	0.9	0.06
Wind	Wind Erosion - Pit B	WE-PtB (A)	On	B	0.0	0	0.0	1	1						0.0		0.0	
Wind	Wind Erosion - overburden, Princess	WE-OP (A)	On	B	7.2	0.8	0.4	0.75	0.75		0.5				0.6	0.09	0.3	0.04
Wind	Wind Erosion - overburden, Ambassador 1	WE-OA1 (A)	On	B	11.4	1.2	0.6	0.75	0.75		0.5				0.9	0.08	0.5	0.04
Wind	Wind Erosion - overburden, Ambassador 2	WE-OA2 (A)	On	B	8.9	0.9	0.5	0.75	0.75		0.5				0.7	0.08	0.3	0.04
Wind	Wind Erosion - overburden, Shogun	WE-OS (A)	On	B	11.9	1.2	0.6	0.75	0.75		0.5				0.9	0.08	0.5	0.04
Wind	Wind Erosion - overburden, Emperor	WE-OE (A)	On	B	31.1	3.0	1.5	0.75	0.75		0.5				2.3	0.07	1.1	0.04
Wind	Wind Erosion - LV roads	WE-LV (A)	On	B	162.7	15	8	0.37	0.37		0.7				6	0.03	3	0.02
Wind	Wind Erosion - Haul roads	WE-HV (A)	On	B	38.5	3	2	0.37	0.37		0.7				1	0.03	0.6	0.02
Wind	Wind Erosion - PP Stockpile	WE-PP (A)	On	B	0.0	0	0	0.55	0.55		0.5				0		0	
Wind	Wind Erosion - Tailings dam (surface)	WE-T (A)	On	B	39.8	5	2	0.55	0.55		0.5				2	0.06	1	0.03
Wind	Wind Erosion - capped pit 1 year rehab	Cap-1 (A)	On	B	60.0	7	3	0.7	0.7					0.3	5	0.08	2	0.04
Wind	Wind Erosion - capped pit 2 year rehab (A)	Cap-2 (A)	On	B	60.0	7	3	0.6	0.6					0.4	4	0.07	2	0.03
Wind	Wind Erosion - capped pit 2 year rehab (B)	Cap-3 (A)	On	B	0.0	0	0	0.6	0.6					0.4	0		0	
Wind	Wind Erosion - capped pit 3 year rehab (A)	Cap-4 (A)	On	B	0.0	0	0	0.4	0.4					0.6	0		0	
Wind	Wind Erosion - capped pit 3 year rehab (B)	Cap-5 (A)	On	B	0.0	0	0	0.4	0.4					0.6	0		0	
Wind	Wind Erosion - capped pit 4 year rehab	Cap-6 (A)	On	B	0.0	0	0	0.1	0.1					0.9	0		0	
Wind	Wind Erosion - capped pit 5 year rehab	Cap-7 (A)	On	B	0.0	0	0	0.1	0.1					0.9	0		0	

	TSP g/s	%	PM10 g/s	%
Total Emissions	46.8		18.6	
Total Mech Emissions	21.4	46%	5.9	32%
Total Wind Emissions	25.4	54%	12.7	68%

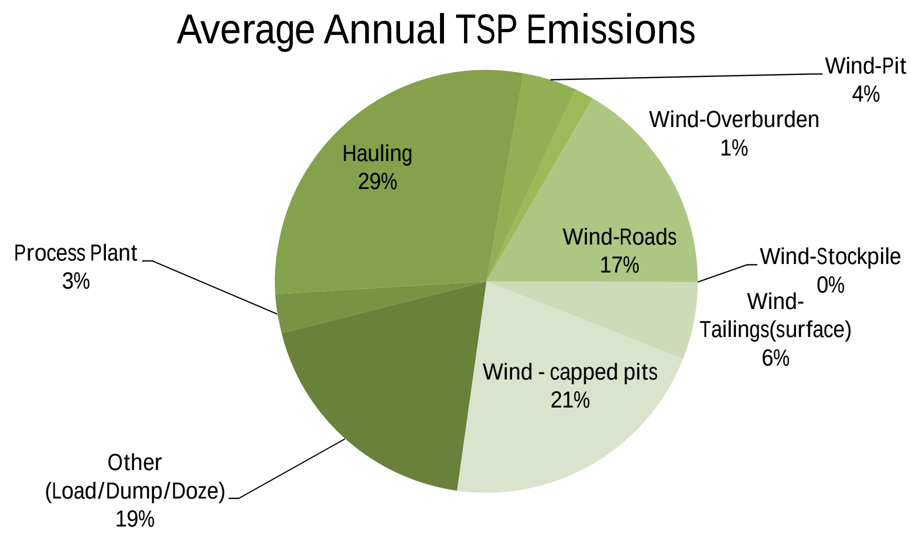
Total TSP emissions (tonnes/year)	6,811
Total PM10 emissions (tonnes/year)	3,254

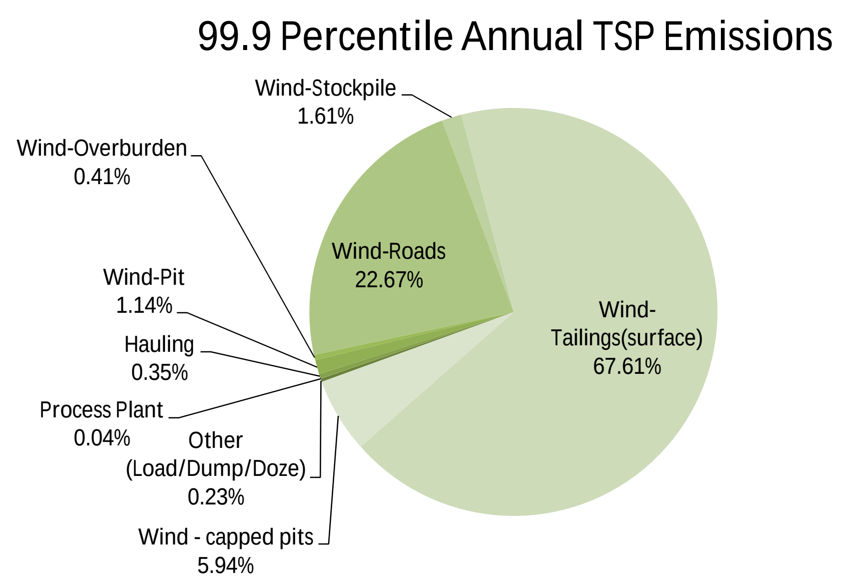
Breakdown of dust emission regimes

A	Continuous constant
B	Calculated hourly

Control Factor Key

Pit Retention	On = 50% (TSP) or 5% (PM10) reduction
Watering / water spray (W)	Hauling - level 2 watering (>2L/m2/hr) = 75% reduction
	Unloading Trucks - water sprays = 70% reduction
	Loading stockpiles - water sprays = 50% reduction
	conveying/misc transfer - water spray + chemicals = 90% reduction
	Wind erosion from stockpiles - water sprays = 50% reduction
Wind Breaks	Wind erosion from stockpiles - wind breaks = 30% reduction
Equipment	primary crusher - hooding with scrubbers = 75% reduction
Re-veg (RV)	wind erosion - primary rehabilitation = 30%
	wind erosion - vegetation established, but not self-sustaining = 40%
	wind erosion - secondary rehabilitation = 60%
	wind erosion -revegetation = 90 %
	wind erosion - fully rehabilitated vegetation = 100%
Sprays (SS)	wind erosion surfaces - surface sprays = 90% reduction





Wind Erosion Areas Breakdown with associated control factors

	Total Area (ha)	Disturbed Controlled % of Area	Disturbed Controlled Controls	Disturbed Uncontrolled % of Area	Disturbed Uncontrolled Controls	Undisturbed Areas [1] % of Area	Undisturbed Areas [1] Controls
Pit A	15	0%	none	100%	none	0%	none
Pit B	0	0%	none	100%	none	0%	none
Overburden - P	7.2	50%	W	50%	none	0%	none
Overburden - A1	11.4	50%	W	50%	none	0%	none
Overburden - A2	8.9	50%	W	50%	none	0%	none
Overburden - S	11.9	50%	W	50%	none	0%	none
Overburden - E	31.1	50%	W	50%	none	0%	none
LV Roads	162.7	90%	W	10%	none	0%	none
Haul Roads	38.5	90%	W	10%	none	0%	none
PP Stockpile	0.0	90%	W	10%	none	0%	none
Tailings (surface)	39.8	90%	W	10%	none	0%	none
Capped 1	60.0	100%	RV	0%	none	0%	none
Capped 2 (A)	60.0	100%	RV	0%	none	0%	none
Capped 2 (B)	0.0	100%	RV	0%	none	0%	none
Capped 3 (A)	0.0	100%	RV	0%	none	0%	none
Capped 3 (B)	0.0	100%	RV	0%	none	0%	none
Capped 4	0.0	100%	RV	0%	none	0%	none
Capped 5	0.0	100%	RV	0%	none	0%	none

[1] Undisturbed areas have dust emissions of background values (control factor = 0)

Total area	54	ha	100%
Total disturbed	223	ha	410%
Total undisturbed	-	ha	0%

Total disturbed area	223	ha	100%
Area with controls	185	ha	83%
Area without controls	39	ha	17%

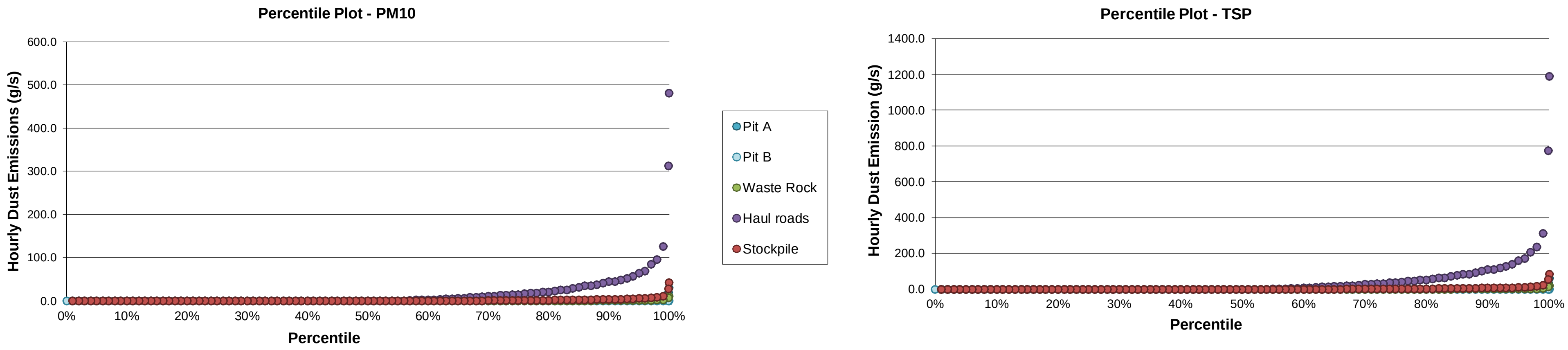
Average annual emissions from disturbed areas (TSP)

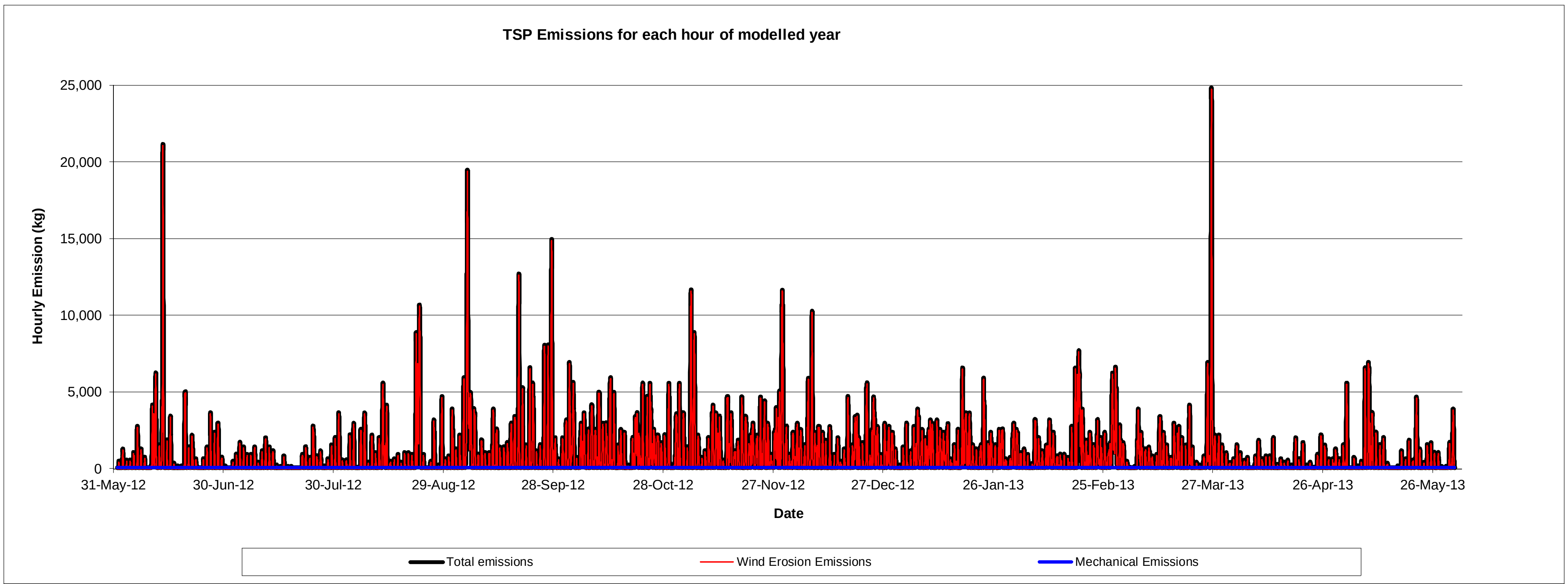
	Disturbed Controlled Areas (MANAGED) area (ha)	% of area	ER (g/s)	% of ER	Disturbed Uncontrolled Areas (ACTIVE) area (ha)	% of area	ER (g/s)	% of ER
Pit A	0.0	0%	0.0	0%	15.0	100%	1.7	100%
Pit B	0.0	0%	0.0	0%	0.0	100%	0.0	0%
Overburden - P	3.6	50%	0.2	33%	3.6	50%	0.4	67%
Overburden - A1	5.7	50%	0.3	35%	5.7	50%	0.6	65%
Overburden - A2	4.4	50%	0.3	36%	4.4	50%	0.4	64%
Overburden - S	6.0	50%	0.3	38%	6.0	50%	0.6	63%
Overburden - E	15.6	50%	0.9	39%	15.6	50%	1.4	61%
LV Roads	146.4	90%	5.0	88%	16.3	10%	0.7	12%
Haul Roads	34.6	90%	1.2	91%	3.8	10%	0.1	9%
PP Stockpile	0.0	90%	0.0	0%	0	10%	0.0	0%
Tailings (surface)	35.8	90%	2.0	82%	3.98	10%	0.5	18%
Capped 1	60.0	100%	4.8	100%	0	0%	0.0	0%
Capped 2 (A)	60.0	100%	4.1	100%	0	0%	0.0	0%
Capped 2 (B)	0.0	100%	0.0	0%	0	0%	0.0	0%
Capped 3 (A)	0.0	100%	0.0	0%	0	0%	0.0	0%
Capped 3 (B)	0.0	100%	0.0	0%	0	0%	0.0	0%
Capped 4	0.0	100%	0.0	0%	0	0%	0.0	0%
Capped 5	0.0	100%	0.0	0%	0	0%	0.0	0%

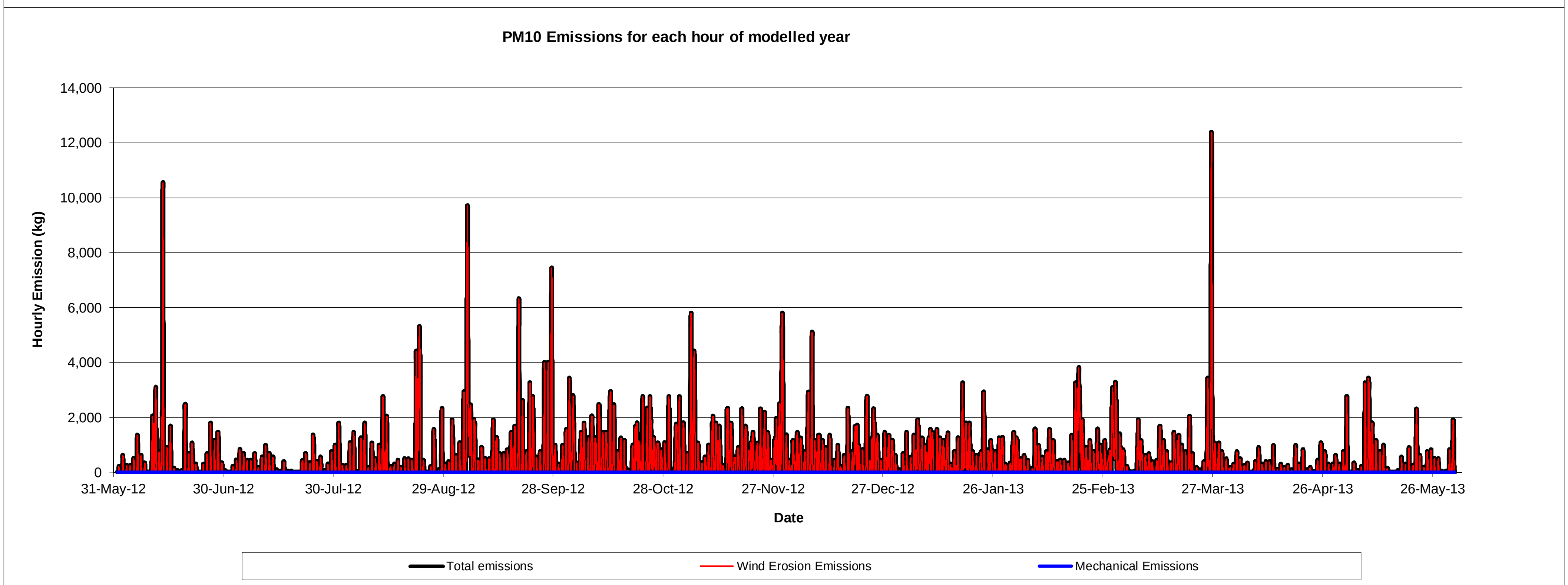
Hourly calculated emissions statistics for 1 Nov 2007 to 31 Oct 2008

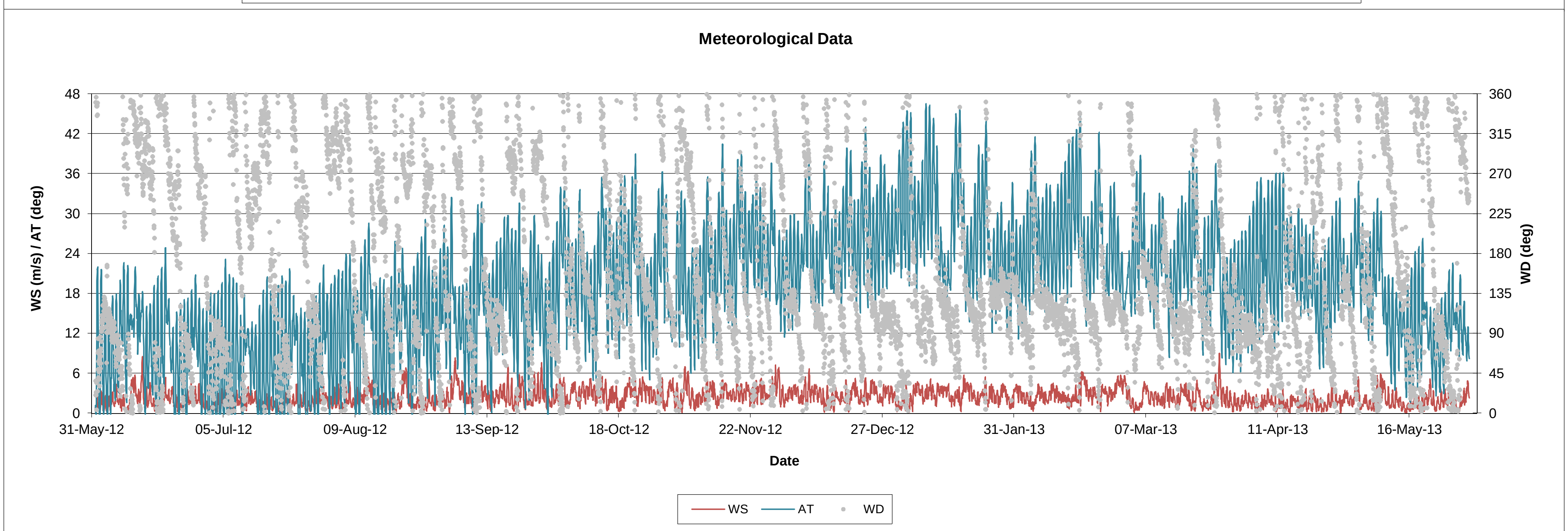
	TSP Emissions (g/s) Max	99.9 %ile	75 %ile	Ann avg	PM10 Emissions (g/s) Max	99.9 %ile	75%ile	Ann avg
Pit A	60	39	2	2	30	20	1	1
Pit B	0	0	0	0	0	0	0	0
Overburden - P	22	14	1	1	11	7	0	0
Overburden - A1	34	22	1	1	17	11	1	0
Overburden - A2	27	17	1	1	13	9	0	0
Overburden - S	36	23	1	1	18	12	1	1
Overburden - E	93	61	3	3	47	30	1	1
Roads	1,192	775	37	34	482	313	15	14
Stockpile	85	55	3	2	42	28	1	1
Tailings (surf.)	3,611	2,311	55	79	5,383	3,446	82	117
Capped 1	168	109	5	5	84	55	3	2
Capped 2 (A)	144	94	4	4	144	94	4	2
Capped 2 (B)	0	0	0	0	0	0	0	0
Capped 3 (A)	0	0	0	0	0	0	0	0
Capped 3 (B)	0	0	0	0	0	0	0	0
Capped 4	0	0	0	0	0	0	0	0
Capped 5	0	0	0	0	0	0	0	0

Summary of total emissions for AUSPLUME dispersion modelling
Scenario 1, Year 3, Standard Dust Suppression.









Scenario 2, Year 10

input data

Throughput		
Mining rate	**Mtpa**	**t/day**
Total (ore + waste rock)	35.72	102927
Ore (pre-bene)	4.68	13487
Ore (post-bene)	3.28	9441
Overburden	31.04	89440
Processing plant (ore)	**Mtpa**	**t/day**
Product	1.55	4472
Tailings (solids)	1.72	4969
Mining rate for stockpile	**Mtpa**	**t/day**
Total (ore + waste rock)	0.00	0
Ore (pre-bene)	0.00	0
Ore (post-bene)	0.00	0
Overburden	0.00	0

Ratios, factors and reductions	
Pre-bene to post-bene reduction	0.3
Waste rock to product ratio	0.05
Tailings to product ratio	0.9
Swell factor	0.15

Operational times		
Days per year	347	*(95% up-time)*
Hours per day	24	

Density	
Ore density (dry) (t/bcm)	1.20
Waste rock density (t/bcm)	1.85

Moisture and silt content		
Product	**Moisture (%)**	**Silt (%)**
Ore	20.0	9.7
Waste rock	5.0	4.0
Haul roads/sands	5.0	2.0

Areas					
Active pits	**m2**	**width (m)**	**height(m)**	**Centre, Easting, Northing (m)**	
Active Pit A - Scenario 2, Year 10	200,000	447	447	575,350	6,680,100
Active Pit B - Scenario 2, Year 10	NA	0	0	NA	NA
Overburden landform	**m2**	**width (m)**	**height(m)**	**Centre, Easting, Northing (m)**	
Princess 1 - Scenario 2, Year 10	72,222	269	269	580,031	6,683,781
Ambassador 1 - Scenario 2, Year 10	113,889	337	337	580,941	6,682,591
Ambassador 2 - Scenario 2, Year 10	88,889	298	298	575,030	6,682,101
Shogun - Scenario 2, Year 10	119,444	346	346	561,778	6,687,771
Emperor - Scenario 2, Year 10	311,111	558	558	560,460	6,691,005
Tailings (wet tailings)	**m2**	**width (m)**	**height(m)**	**Centre, Easting, Northing (m)**	
Tailings_Surface - Scenario 2, Year 10	In pit	In pit	In pit	In pit	In pit
Processing plant stockpile	**m2**	**width (m)**	**height(m)**	**Centre, Easting, Northing (m)**	
Proc. Plant - Scenario 2, Year 10	0	0	0	NA	NA
Capped landforms	**m2**	**width (m)**	**height(m)**	**Centre, Easting, Northing (m)**	
Capped pit 1 year rehab	900000	949	949	575600	6680800
Capped pit 2 year rehab (A)	800000	894	894	579000	6681200
Capped pit 2 year rehab (B)	0	0	0	0	0
Capped pit 3 year rehab (A)	700000	837	837	576350	6681950
Capped pit 3 year rehab (B)	0	0	0	0	0
Capped pit 4 year rehab	600000	775	775	576750	6682250
Capped pit 5 year rehab	600000	775	775	577250	6682400

Haul road areas (for wind erosion)			
Pit to Processing Plant	**m2**	**width (m)**	**length (m)**
Total haul road areas	1626500	20	81325
Total LV road areas	384542	6	64090

Landform production rates			
Active landforms	**ha**	**m3/yr**	**m/yr**
Active pit	200,000	20,676,102	0.01034
Overburden	705,556	2,516,415	0.00036
Active tailings	In pit	585,000	--

Fleet details					
Mine equipment fleet	**Model**	**Number**	**Payload (t)**	**Weight (t)**	
Haul truck	Cat 793D	NA	218	384	
Dozer	not provided	2	NA	NA	
Grader	not provided	2	NA	NA	
Back hoe	not provided	3	NA	NA	
Forklift	not provided	3	NA	NA	
Crane	not provided	2	NA	NA	
Truck with hiab	not provided	2	NA	NA	
Ambulance	not provided	1	NA	NA	
Buses	not provided	3	NA	NA	assume 3 hours use each per day
Light vehicles	mine spec	23	NA	NA	assume 4 hours use each per day

Scenario 2, Year 10

data input

Constants			
Parameter	**Ore**	**Waste rock**	**Tailings**
Mean wind speed (m/s)	3.5	3.5	3.5
Moisture (%)	20.0	5.0	20.0
Silt (%)	9.7	6.0	9.7

Parameter	Value	Unit	
K tsp	0.74		
K pm10	0.35		
Mean grader speed - haul roads	10	km/hr	
Area of blasting	0	m2	none
Depth of blasting	0	m	
Holes per blast	0		
Moisture content	High		

Haul Road Parameters	Value	Unit
Vehicle gross mass (haul truck)	384	t
Vehicle gross mass (ancillary vehicles)	5	t
Moisture	5	%
Silt content	2	%
Haul Road width	20	m
Mean LV speed	40	km/hr

Mechanical Emission Factors[1]			
Excav, shov. & FEL	**Ore**	**Waste Rock**	**Tailings**
EF TSP (kg/t)	0.0001	0.0006	0.0001
EF PM10 (kg/t)	0.0000	0.0003	0.0000
Bulldozers	**Ore**	**Waste Rock**	**Tailings**
EF TSP (kg/hr)	0.81	2.75	0.81
EF PM10 (kg/hr)	0.15	0.52	0.15
Trucks (unloading)	**Ore**	**Waste Rock**	**Tailings**
EF TSP (kg/t)	0.012	0.012	0.012
EF PM10 (kg/t)	0.0043	0.0043	0.0043
Grader	**Ore**	**Waste Rock**	**Tailings**
EF TSP (kg/VKT)	1.08	1.08	1.08
EF PM10 (kg/VKT)	0.34	0.34	0.34

Haul Road distances		
	Pit to PP	**Pit to WR**
Daily haul rate (tpd)	9441	15439
Return distance (m)	2000	2000
Truck payload (t)	218	218
Truck trips	43	71
VKT (km)	87	142
Trucks per hour	1.8	3.0
Haul road area (ha)	2.0	2.0

Crushing emission factors[1]	
Primary	
EF TSP (kg/t)	0.010
EF PM10 (kg/t)	0.004
Secondary	
EF TSP (kg/t)	0.030
EF PM10 (kg/t)	0.012
Tertiary	
EF TSP (kg/t)	0.030
EF PM10 (kg/t)	0.010
Conveying, transfer etc.	
EF TSP (kg/t)	0.005
EF PM10 (kg/t)	0.002
Screening	
EF TSP (kg/t)	0.08
EF PM10 (kg/t)	0.06

Wheel generated dust factors[1]	
Haul trucks	
EF TSP (kg/VKT)	3.65
EF PM10 (kg/VKT)	0.78
Ancillary vehicles	
EF TSP (kg/VKT)	0.09
EF PM10 (kg/VKT)	0.01

1. NPI Mining 3.1 (2012)

Summary of emissions sources for dispersion modelling

Scenario 2, Year 10, Standard Dust Suppression.

Scenario 2, Year 10

Source Type	Description of Source	Model ID (Area or Volume Source)	Model Run Source On/Off	Emission Regime	Total Area (ha)	Avg annual emissions TSP g/s	Avg annual emissions PM10 g/s	Overall Control TSP	Overall Control PM10	Control Factor Breakdown: Pit Retention	Water	Wind Breaks	Equipment	Re-veg	Avg annual emissions (controlled) TSP g/s	TSP g/s/ha	PM10 g/s	PM10 g/s/ha
Mech	Loading ore	OreLoad (V)	On	A		0.01	0.006	1	1						0.01		0.006	
Mech	Loading overburden	WRLoad (V)	On	A		0.6	0.3	1	1						0.6		0.3	
Mech	Hauling overburden	HaulWaste (A)	On	A	2.0	79	17	0.3	0.3		0.75				20	10	4	2.1
Mech	Hauling Ore	HaulOre (A)	On	A	2.0	4	1	0.3	0.3		0.75				1	0.5	0.2	0.10
Mech	Roads - grading haul roads	Grading (A)	On	A	2.0	6	2	0.3	0.3		0.75				1	0.7	0.5	0.2
Mech	Roads - misc vehicle traffic	TravelMisc (A)	On	A	38.5	0.1	0.02	0.3	0.3		0.75				0.03	0.001	0.004	0.0001
Mech	Overburden dumping	DumpWaste (V)	On	A		12	4	1	1						12		4	
Mech	PP - Dumping	DumpOre (V)	On	A		1.3	0.5	1	1						1.3		0.5	
Mech	PP - Conveyor to crusher	Convey1 (V)	On	A		0.01	0.004	1	1						0.01		0.004	
Mech	PP - Conveyor to ball mill	Convey2 (V)	On	A		1.1	0.4	1	1						1.1		0.4	
Mech	Dozing - overburden	DozeWaste (A)	On	A		2	0.3	1	1						2		0.3	
Wind	Wind Erosion - Pit A	WE-PtA (A)	On	B	20.0	2	1.1	1	1						2.3	0.1	1.1	0.06
Wind	Wind Erosion - Pit B	WE-PtB (A)	On	B	0.0	0	0.0	1	1						0.0		0.0	
Wind	Wind Erosion - overburden, Princess	WE-OP (A)	On	B	7.2	0.8	0.4	0.75	0.75		0.5				0.6	0.09	0.3	0.04
Wind	Wind Erosion - overburden, Ambassador 1	WE-OA1 (A)	On	B	11.4	1.2	0.6	0.75	0.75		0.5				0.9	0.08	0.5	0.04
Wind	Wind Erosion - overburden, Ambassador 2	WE-OA2 (A)	On	B	8.9	0.9	0.5	0.75	0.75		0.5				0.7	0.08	0.3	0.04
Wind	Wind Erosion - overburden, Shogun	WE-OS (A)	On	B	11.9	1.2	0.6	0.75	0.75		0.5				0.9	0.08	0.5	0.04
Wind	Wind Erosion - overburden, Emperor	WE-OE (A)	On	B	31.1	3.0	1.5	0.75	0.75		0.5				2.3	0.07	1.1	0.04
Wind	Wind Erosion - LV roads	WE-LV (A)	On	B	162.7	15	8	0.37	0.37		0.7				6	0.03	3	0.02
Wind	Wind Erosion - Haul roads	WE-HV (A)	On	B	38.5	3	2	0.37	0.37		0.7				1	0.03	0.6	0.02
Wind	Wind Erosion - PP Stockpile	WE-PP (A)	On	B	0.0	0	0	0.55	0.55		0.5				0		0	
Wind	Wind Erosion - Tailings dam (surface)	WE-T (A)	On	B	0.0	0	0	0.55	0.55		0.5				0		0	
Wind	Wind Erosion - capped pit 1 year rehab	Cap-1 (A)	On	B	90.0	10	5	0.7	0.7					0.3	7	0.08	4	0.04
Wind	Wind Erosion - capped pit 2 year rehab (A)	Cap-2 (A)	On	B	80.0	9	5	0.6	0.6					0.4	5	0.07	3	0.03
Wind	Wind Erosion - capped pit 2 year rehab (B)	Cap-3 (A)	On	B	0.0	0	0	0.6	0.6					0.4	0		0	
Wind	Wind Erosion - capped pit 3 year rehab (A)	Cap-4 (A)	On	B	70.0	8	4	0.4	0.4					0.6	3	0.05	2	0.02
Wind	Wind Erosion - capped pit 3 year rehab (B)	Cap-5 (A)	On	B	0.0	0	0	0.4	0.4					0.6	0		0	
Wind	Wind Erosion - capped pit 4 year rehab	Cap-6 (A)	On	B	60.0	7	3	0.1	0.1					0.9	1	0.01	0	0.01
Wind	Wind Erosion - capped pit 5 year rehab	Cap-7 (A)	On	B	60.0	7	3	0.1	0.1					0.9	1	0.01	0	0.01

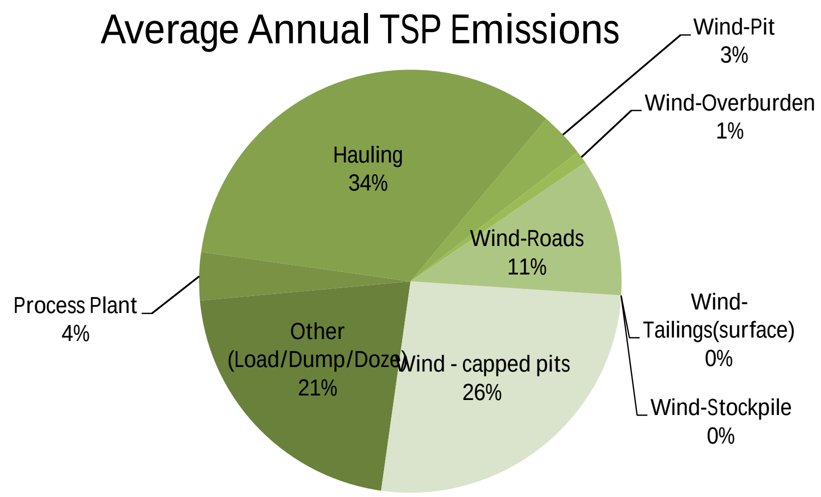
Total Emissions	70.9		26.7	
Total Mech Emissions	39.2	55%	10.8	41%
Total Wind Emissions	31.8	45%	15.9	59%

Total TSP emissions (tonnes/year)	7,508
Total PM10 emissions (tonnes/year)	3,479

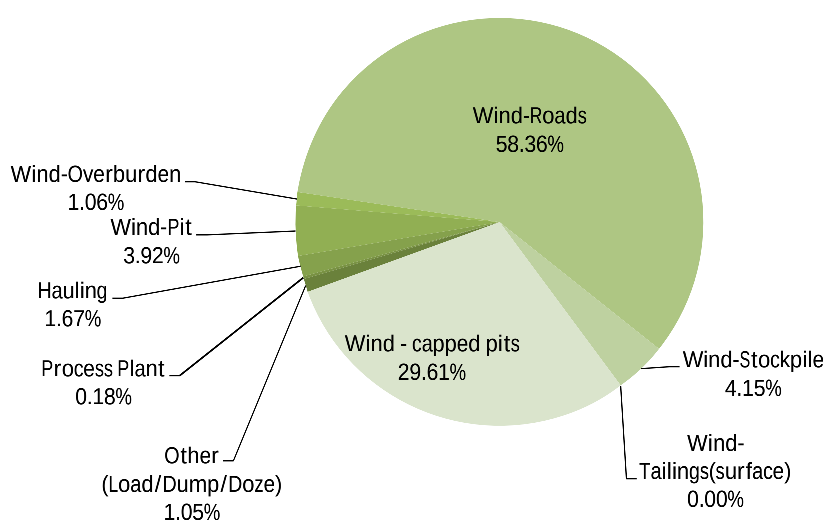
Breakdown of dust emission regimes	
A	Continuous constant
B	Calculated hourly

Control Factor Key	
Pit Retention	On = 50% (TSP) or 5% (PM10) reduction
Watering / water spray (W)	Hauling - level 2 watering (>2L/m2/hr) = 75% reduction
	Unloading Trucks - water sprays = 70% reduction
	Loading stockpiles - water sprays = 50% reduction
	conveying/misc transfer - water spray + chemicals = 90% reduction
	Wind erosion from stockpiles - water sprays = 50% reduction
Wind Breaks	Wind erosion from stockpiles - wind breaks = 30% reduction
Equipment	primary crusher - hooding with scrubbers = 75% reduction
Re-veg (RV)	wind erosion - primary rehabilitation = 30%
	wind erosion - vegetation established, but not self-sustaining = 40%
	wind erosion - secondary rehabilitation = 60%
	wind erosion -revegetation = 90 %
	wind erosion - fully rehabilitated vegetation = 100%
Sprays (SS)	wind erosion surfaces - surface sprays = 90% reduction

Average Annual TSP Emissions



99.9 Percentile Annual TSP Emissions



Wind Erosion Areas Breakdown with associated control factors

	Total Area (ha)	Disturbed Controlled % of Area	Disturbed Controlled Controls	Disturbed Uncontrolled % of Area	Disturbed Uncontrolled Controls	Undisturbed Areas [1] % of Area	Undisturbed Areas [1] Controls
Pit A	20	0%	none	100%	none	0%	none
Pit B	0	0%	none	100%	none	0%	none
Overburden - P	7.2	50%	W	50%	none	0%	none
Overburden - A1	11.4	50%	W	50%	none	0%	none
Overburden - A2	8.9	50%	W	50%	none	0%	none
Overburden - S	11.9	50%	W	50%	none	0%	none
Overburden - E	31.1	50%	W	50%	none	0%	none
LV Roads	162.7	90%	W	10%	none	0%	none
Haul Roads	38.5	90%	W	10%	none	0%	none
PP Stockpile	0.0	90%	W	10%	none	0%	none
Tailings (surface)	0.0	90%	W	10%	none	0%	none
Capped 1	90.0	100%	RV	0%	none	0%	none
Capped 2 (A)	80.0	100%	RV	0%	none	0%	none
Capped 2 (B)	0.0	100%	RV	0%	none	0%	none
Capped 3 (A)	70.0	100%	RV	0%	none	0%	none
Capped 3 (B)	0.0	100%	RV	0%	none	0%	none
Capped 4	60.0	100%	RV	0%	none	0%	none
Capped 5	60.0	100%	RV	0%	none	0%	none

[1] Undisturbed areas have dust emissions of background values (control factor = 0)

Total area	59	ha	100%
Total disturbed	228	ha	384%
Total undisturbed	-	ha	0%

Total disturbed area	228	ha	100%
Area with controls	185	ha	81%
Area without controls	44	ha	19%

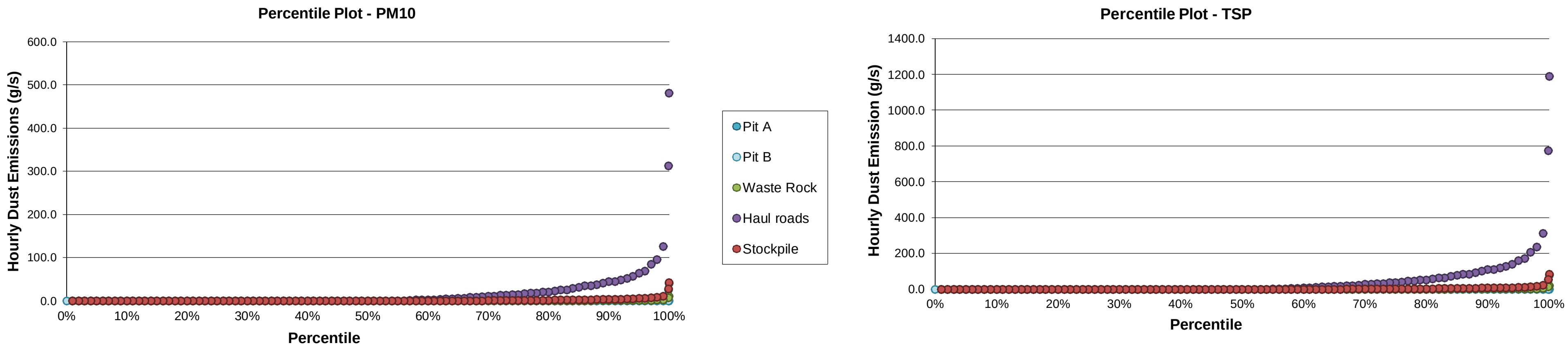
Average annual emissions from disturbed areas (TSP)

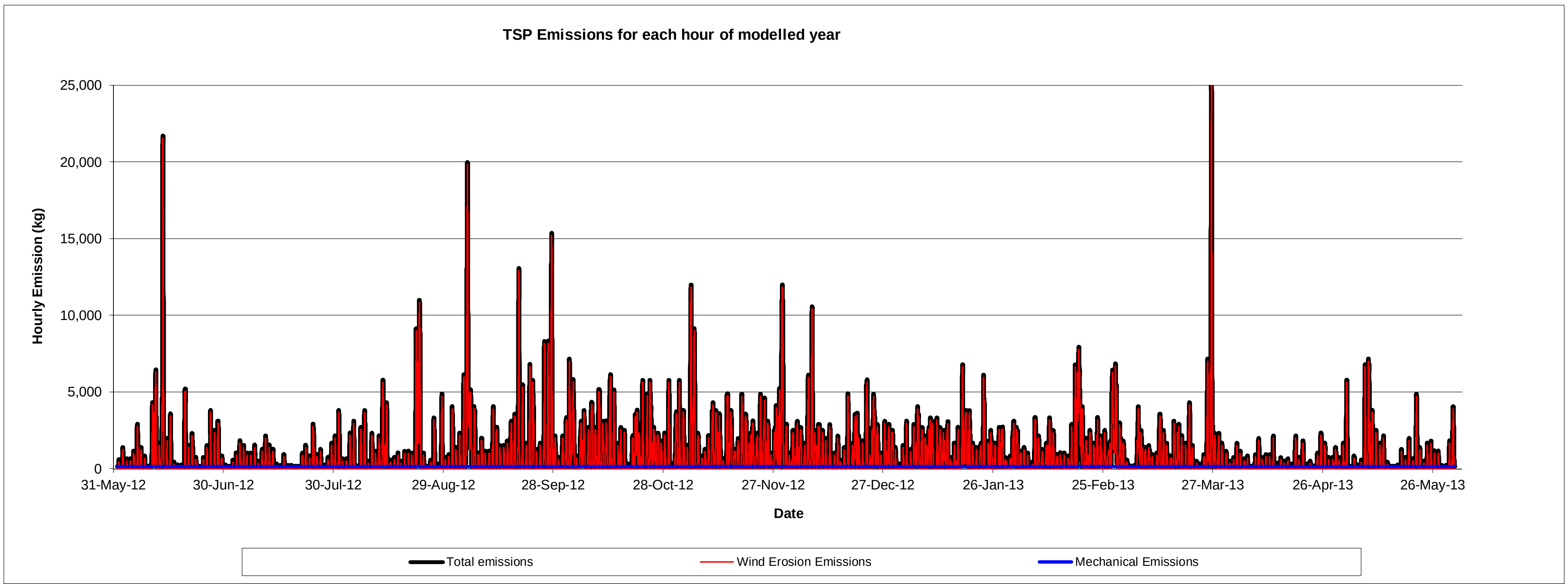
	Disturbed Controlled Areas (MANAGED) area (ha)	% of area	ER (g/s)	% of ER	Disturbed Uncontrolled Areas (ACTIVE) area (ha)	% of area	ER (g/s)	% of ER
Pit A	0.0	0%	0.0	0%	20.0	100%	2.3	100%
Pit B	0.0	0%	0.0	0%	0.0	100%	0.0	0%
Overburden - P	3.6	50%	0.2	33%	3.6	50%	0.4	67%
Overburden - A1	5.7	50%	0.3	35%	5.7	50%	0.6	65%
Overburden - A2	4.4	50%	0.3	36%	4.4	50%	0.4	64%
Overburden - S	6.0	50%	0.3	38%	6.0	50%	0.6	63%
Overburden - E	15.6	50%	0.9	39%	15.6	50%	1.4	61%
LV Roads	146.4	90%	5.0	88%	16.3	10%	0.7	12%
Haul Roads	34.6	90%	1.2	91%	3.8	10%	0.1	9%
PP Stockpile	0.0	90%	0.0	0%	0	10%	0.0	0%
Tailings (surface)	0.0	90%	0.0	0%	0	10%	0.0	0%
Capped 1	90.0	100%	7.1	100%	0	0%	0.0	0%
Capped 2 (A)	80.0	100%	5.4	100%	0	0%	0.0	0%
Capped 2 (B)	0.0	100%	0.0	0%	0	0%	0.0	0%
Capped 3 (A)	70.0	100%	3.2	100%	0	0%	0.0	0%
Capped 3 (B)	0.0	100%	0.0	0%	0	0%	0.0	0%
Capped 4	60.0	100%	0.7	100%	0	0%	0.0	0%
Capped 5	60.0	100%	0.7	100%	0	0%	0.0	0%

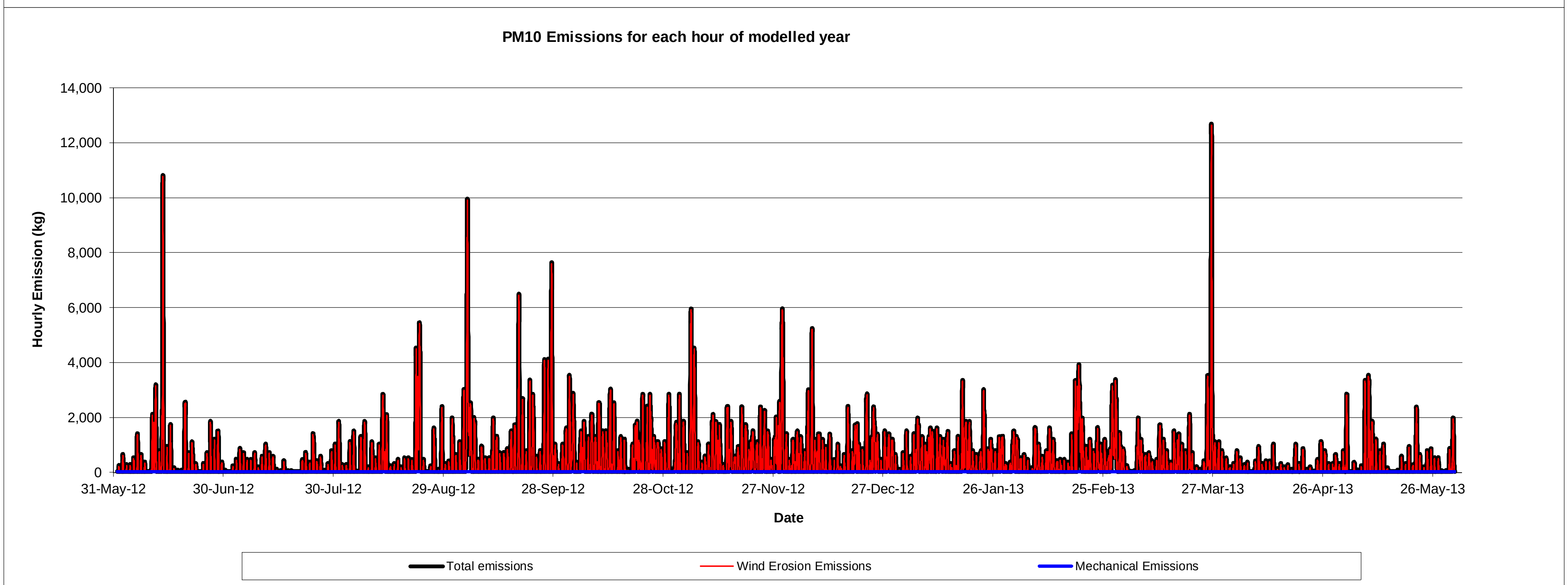
Hourly calculated emissions statistics for 1 Nov 2007 to 31 Oct 2008

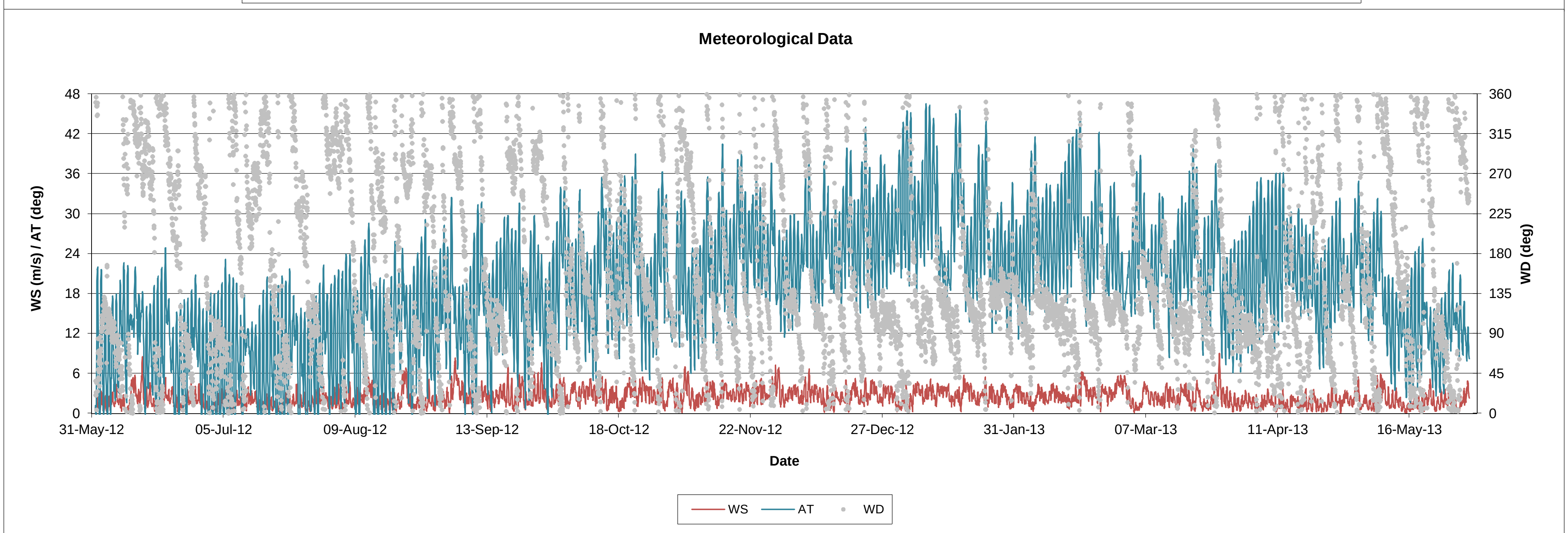
	TSP Emissions (g/s) Max	99.9 %ile	75 %ile	Ann avg	PM10 Emissions (g/s) Max	99.9 %ile	75%ile	Ann avg
Pit A	80	52	2	2	40	26	1	1
Pit B	0	0	0	0	0	0	0	0
Overburden - P	22	14	1	1	11	7	0	0
Overburden - A1	34	22	1	1	17	11	1	0
Overburden - A2	27	17	1	1	13	9	0	0
Overburden - S	36	23	1	1	18	12	1	1
Overburden - E	93	61	3	3	47	30	1	1
Roads	1,192	775	37	34	482	313	15	14
Stockpile	85	55	3	2	42	28	1	1
Tailings (surf.)	0	0	0	0	0	0	0	0
Capped 1	252	164	8	7	126	82	4	4
Capped 2 (A)	192	125	6	5	192	125	6	3
Capped 2 (B)	0	0	0	0	0	0	0	0
Capped 3 (A)	112	73	3	3	56	36	2	2
Capped 3 (B)	0	0	0	0	0	0	0	0
Capped 4	24	16	1	1	12	8	0	0
Capped 5	24	16	1	1	12	8	0	0

Summary of total emissions for AUSPLUME dispersion modelling
Scenario 2, Year 10, Standard Dust Suppression.









Scenario 3, Year 11

input data

Throughput		
Mining rate	**Mtpa**	**t/day**
Total (ore + waste rock)	25.11	72357
Ore (pre-bene)	3.29	9481
Ore (post-bene)	2.30	6637
Overburden	21.82	62876
Processing plant (ore)	**Mtpa**	**t/day**
Product	1.09	3144
Tailings (solids)	1.21	3493
Mining rate for stockpile	**Mtpa**	**t/day**
Total (ore + waste rock)	0.00	0
Ore (pre-bene)	0.00	0
Ore (post-bene)	0.00	0
Overburden	0.00	0

Ratios, factors and reductions	
Pre-bene to post-bene reduction	0.3
Waste rock to product ratio	0.05
Tailings to product ratio	0.9
Swell factor	0.15

Operational times		
Days per year	347	*(95% up-time)*
Hours per day	24	

Density	
Ore density (dry) (t/bcm)	1.20
Waste rock density (t/bcm)	1.85

Moisture and silt content		
Product	**Moisture (%)**	**Silt (%)**
Ore	20.0	6.6
Waste rock	5.0	4.0
Haul roads/sands	5.0	2.0

Areas					
Active pits	**m2**	**width (m)**	**height(m)**	**Centre, Easting, Northing (m)**	
Active Pit A - Scenario 3, Year 11	150,000	387	387	576,500	6,679,400
Active Pit B - Scenario 3, Year 11	120,000	346	346	563,000	6,688,000
Overburden landform	**m2**	**width (m)**	**height(m)**	**Centre, Easting, Northing (m)**	
Princess 1 - Scenario 3, Year 11	72,222	269	269	580,031	6,683,781
Ambassador 1 - Scenario 3, Year 11	113,889	337	337	580,941	6,682,591
Ambassador 2 - Scenario 3, Year 11	88,889	298	298	575,030	6,682,101
Shogun - Scenario 3, Year 11	119,444	346	346	561,778	6,687,771
Emperor - Scenario 3, Year 11	311,111	558	558	560,460	6,691,005
Tailings (wet tailings)	**m2**	**width (m)**	**height(m)**	**Centre, Easting, Northing (m)**	
Tailings_Surface - Scenario 3, Year 11	In pit	In pit	In pit	In pit	In pit
Processing plant stockpile	**m2**	**width (m)**	**height(m)**	**Centre, Easting, Northing (m)**	
Proc. Plant - Scenario 3, Year 11	0	0	0	NA	NA
Capped landforms	**m2**	**width (m)**	**height(m)**	**Centre, Easting, Northing (m)**	
Capped pit 1 year rehab	900000	949	949	575350	6680100
Capped pit 2 year rehab (A)	900000	949	949	575600	6680800
Capped pit 2 year rehab (B)	0	0	0	0	0
Capped pit 3 year rehab (A)	800000	894	894	579000	6681200
Capped pit 3 year rehab (B)	0	0	0	0	0
Capped pit 4 year rehab	700000	837	837	576350	6681950
Capped pit 5 year rehab	600000	775	775	576750	6682250

Haul road areas (for wind erosion)			
Pit to Processing Plant	**m2**	**width (m)**	**length (m)**
Total haul road areas	1626500	20	81325
Total LV road areas	384542	6	64090

Landform production rates			
Active landforms	**ha**	**m3/yr**	**m/yr**
Active pit	270,000	14,535,123	0.00538
Overburden	705,556	1,769,018	0.00025
Active tailings	In pit	411,250	--

Fleet details					
Mine equipment fleet	**Model**	**Number**	**Payload (t)**	**Weight (t)**	
Haul truck	Cat 793D	NA	218	384	
Dozer	not provided	2	NA	NA	
Grader	not provided	2	NA	NA	
Back hoe	not provided	3	NA	NA	
Forklift	not provided	3	NA	NA	
Crane	not provided	2	NA	NA	
Truck with hiab	not provided	2	NA	NA	
Ambulance	not provided	1	NA	NA	
Buses	not provided	3	NA	NA	assume 3 hours use each per day
Light vehicles	mine spec	23	NA	NA	assume 4 hours use each per day

Scenario 3, Year 11

data input

Constants			
Parameter	**Ore**	**Waste rock**	**Tailings**
Mean wind speed (m/s)	3.5	3.5	3.5
Moisture (%)	20.0	5.0	20.0
Silt (%)	6.6	6.0	6.6

Parameter	Value	Unit	
K tsp	0.74		
K pm10	0.35		
Mean grader speed - haul roads	10	km/hr	
Area of blasting	0	m2	none
Depth of blasting	0	m	
Holes per blast	0		
Moisture content	High		

Haul Road Parameters	Value	Unit
Vehicle gross mass (haul truck)	384	t
Vehicle gross mass (ancillary vehicles)	5	t
Moisture	5	%
Silt content	2	%
Haul Road width	20	m
Mean LV speed	40	km/hr

Mechanical Emission Factors[1]			
Excav, shov. & FEL	**Ore**	**Waste Rock**	**Tailings**
EF TSP (kg/t)	0.0001	0.0006	0.0001
EF PM10 (kg/t)	0.0000	0.0003	0.0000
Bulldozers	**Ore**	**Waste Rock**	**Tailings**
EF TSP (kg/hr)	0.51	2.75	0.51
EF PM10 (kg/hr)	0.09	0.52	0.09
Trucks (unloading)	**Ore**	**Waste Rock**	**Tailings**
EF TSP (kg/t)	0.012	0.012	0.012
EF PM10 (kg/t)	0.0043	0.0043	0.0043
Grader	**Ore**	**Waste Rock**	**Tailings**
EF TSP (kg/VKT)	1.08	1.08	1.08
EF PM10 (kg/VKT)	0.34	0.34	0.34

Haul Road distances		
	Pit to PP	**Pit to WR**
Daily haul rate (tpd)	6637	10854
Return distance (m)	2000	1300
Truck payload (t)	218	218
Truck trips	30	50
VKT (km)	61	65
Trucks per hour	1.3	2.1
Haul road area (ha)	2.0	1.3

Crushing emission factors[1]	
Primary	
EF TSP (kg/t)	0.010
EF PM10 (kg/t)	0.004
Secondary	
EF TSP (kg/t)	0.030
EF PM10 (kg/t)	0.012
Tertiary	
EF TSP (kg/t)	0.030
EF PM10 (kg/t)	0.010
Conveying, transfer etc.	
EF TSP (kg/t)	0.005
EF PM10 (kg/t)	0.002
Screening	
EF TSP (kg/t)	0.08
EF PM10 (kg/t)	0.06

Wheel generated dust factors[1]	
Haul trucks	
EF TSP (kg/VKT)	3.65
EF PM10 (kg/VKT)	0.78
Ancillary vehicles	
EF TSP (kg/VKT)	0.09
EF PM10 (kg/VKT)	0.01

1. NPI Mining 3.1 (2012)

Summary of emissions sources for dispersion modelling

Scenario 3, Year 11, Standard Dust Suppression.

Scenario 3, Year 11

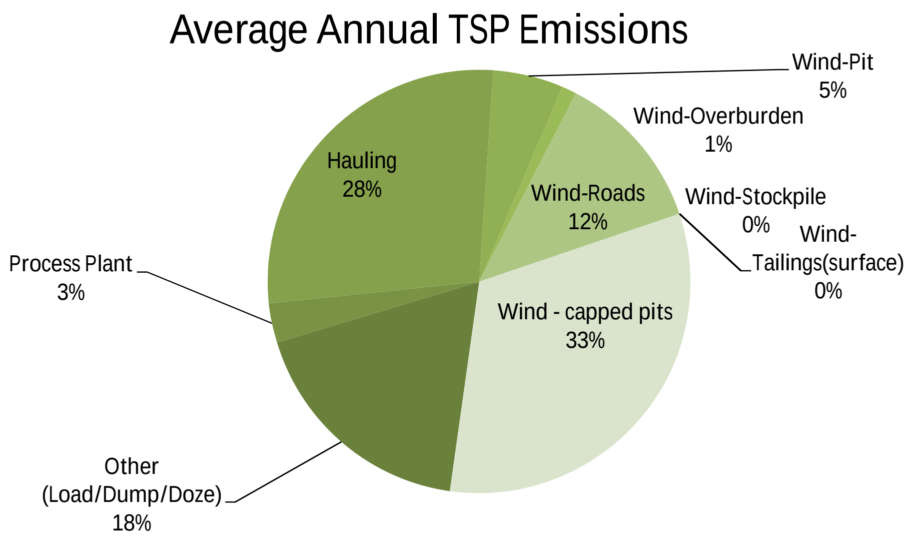
Source Type	Description of Source	Model ID (Area or Volume Source)	Model Run Source On/Off	Emission Regime	Total Area (ha)	Avg annual emissions TSP g/s	Avg annual emissions PM10 g/s	Overall Control TSP	Overall Control PM10	Control Factor Breakdown: Pit Retention	Water	Wind Breaks	Equipment	Re-veg	Avg annual emissions (controlled) TSP g/s	TSP g/s/ha	PM10 g/s	PM10 g/s/ha
Mech	Loading ore	OreLoad (V)	On	A		0.01	0.004	1	1						0.01		0.004	
Mech	Loading overburden	WRLoad (V)	On	A		0.4	0.2	1	1						0.4		0.2	
Mech	Hauling overburden	HaulWaste (A)	On	A	1.3	54	12	0.3	0.3		0.75				14	10	3	2.2
Mech	Hauling Ore	HaulOre (A)	On	A	2.0	3	1	0.3	0.3		0.75				1	0.3	0.1	0.07
Mech	Roads - grading haul roads	Grading (A)	On	A	2.0	6	2	0.3	0.3		0.75				1	0.7	0.5	0.2
Mech	Roads - misc vehicle traffic	TravelMisc (A)	On	A	38.5	0.1	0.02	0.3	0.3		0.75				0.03	0.001	0.004	0.0001
Mech	Overburden dumping	DumpWaste (V)	On	A		9	3	1	1						9		3	
Mech	PP - Dumping	DumpOre (V)	On	A		0.9	0.3	1	1						0.9		0.3	
Mech	PP - Conveyor to crusher	Convey1 (V)	On	A		0.01	0.003	1	1						0.01		0.003	
Mech	PP - Conveyor to ball mill	Convey2 (V)	On	A		0.8	0.3	1	1						0.8		0.3	
Mech	Dozing - overburden	DozeWaste (A)	On	A		2	0.3	1	1						2		0.3	
Wind	Wind Erosion - Pit A	WE-PtA (A)	On	B	15.0	2	0.9	1	1						1.7	0.1	0.9	0.06
Wind	Wind Erosion - Pit B	WE-PtB (A)	On	B	12.0	1	0.7	1	1						1.4	0.1	0.7	0.06
Wind	Wind Erosion - overburden, Princess	WE-OP (A)	On	B	7.2	0.8	0.4	0.75	0.75		0.5				0.6	0.09	0.3	0.04
Wind	Wind Erosion - overburden, Ambassador 1	WE-OA1 (A)	On	B	11.4	1.2	0.6	0.75	0.75		0.5				0.9	0.08	0.5	0.04
Wind	Wind Erosion - overburden, Ambassador 2	WE-OA2 (A)	On	B	8.9	0.9	0.5	0.75	0.75		0.5				0.7	0.08	0.3	0.04
Wind	Wind Erosion - overburden, Shogun	WE-OS (A)	On	B	11.9	1.2	0.6	0.75	0.75		0.5				0.9	0.08	0.5	0.04
Wind	Wind Erosion - overburden, Emperor	WE-OE (A)	On	B	31.1	3.0	1.5	0.75	0.75		0.5				2.3	0.07	1.1	0.04
Wind	Wind Erosion - LV roads	WE-LV (A)	On	B	162.7	15	8	0.37	0.37		0.7				6	0.03	3	0.02
Wind	Wind Erosion - Haul roads	WE-HV (A)	On	B	38.5	3	2	0.37	0.37		0.7				1	0.03	0.6	0.02
Wind	Wind Erosion - PP Stockpile	WE-PP (A)	On	B	0.0	0	0	0.55	0.55		0.5				0		0	
Wind	Wind Erosion - Tailings dam (surface)	WE-T (A)	On	B	0.0	0	0	0.55	0.55		0.5				0		0	
Wind	Wind Erosion - capped pit 1 year rehab	Cap-1 (A)	On	B	90.0	10	5	0.7	0.7					0.3	7	0.08	4	0.04
Wind	Wind Erosion - capped pit 2 year rehab (A)	Cap-2 (A)	On	B	90.0	10	5	0.6	0.6					0.4	6	0.07	3	0.03
Wind	Wind Erosion - capped pit 2 year rehab (B)	Cap-3 (A)	On	B	0.0	0	0	0.6	0.6					0.4	0		0	
Wind	Wind Erosion - capped pit 3 year rehab (A)	Cap-4 (A)	On	B	80.0	9	5	0.4	0.4					0.6	4	0.05	2	0.02
Wind	Wind Erosion - capped pit 3 year rehab (B)	Cap-5 (A)	On	B	0.0	0	0	0.4	0.4					0.6	0		0	
Wind	Wind Erosion - capped pit 4 year rehab	Cap-6 (A)	On	B	70.0	8	4	0.1	0.1					0.9	1	0.01	0	0.01
Wind	Wind Erosion - capped pit 5 year rehab	Cap-7 (A)	On	B	60.0	7	3	0.1	0.1					0.9	1	0.01	0	0.01

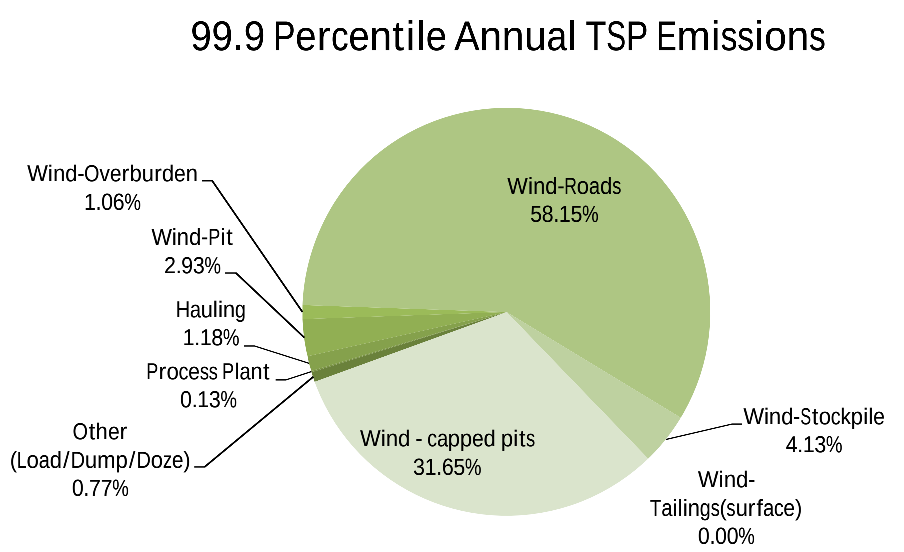
	TSP g/s	%	PM10 g/s	%
Total Emissions	61.9		24.7	
Total Mech Emissions	28.1	45%	7.8	32%
Total Wind Emissions	33.8	55%	16.9	68%

Total TSP emissions (tonnes/year)	7,022
Total PM10 emissions (tonnes/year)	3,313

Breakdown of dust emission regimes	
A	Continuous constant
B	Calculated hourly

Control Factor Key	
Pit Retention	On = 50% (TSP) or 5% (PM10) reduction
Watering / water spray (W)	Hauling - level 2 watering (>2L/m2/hr) = 75% reduction
	Unloading Trucks - water sprays = 70% reduction
	Loading stockpiles - water sprays = 50% reduction
	conveying/misc transfer - water spray + chemicals = 90% reduction
	Wind erosion from stockpiles - water sprays = 50% reduction
Wind Breaks	Wind erosion from stockpiles - wind breaks = 30% reduction
Equipment	primary crusher - hooding with scrubbers = 75% reduction
Re-veg (RV)	wind erosion - primary rehabilitation = 30%
	wind erosion - vegetation established, but not self-sustaining = 40%
	wind erosion - secondary rehabilitation = 60%
	wind erosion -revegetation = 90 %
	wind erosion - fully rehabilitated vegetation = 100%
Sprays (SS)	wind erosion surfaces - surface sprays = 90% reduction





Wind Erosion Areas Breakdown with associated control factors

	Total Area (ha)	Disturbed Controlled % of Area	Disturbed Controlled Controls	Disturbed Uncontrolled % of Area	Disturbed Uncontrolled Controls	Undisturbed Areas [1] % of Area	Undisturbed Areas [1] Controls
Pit A	15	0%	none	100%	none	0%	none
Pit B	12	0%	none	100%	none	0%	none
Overburden - P	7.2	50%	W	50%	none	0%	none
Overburden - A1	11.4	50%	W	50%	none	0%	none
Overburden - A2	8.9	50%	W	50%	none	0%	none
Overburden - S	11.9	50%	W	50%	none	0%	none
Overburden - E	31.1	50%	W	50%	none	0%	none
LV Roads	162.7	90%	W	10%	none	0%	none
Haul Roads	38.5	90%	W	10%	none	0%	none
PP Stockpile	0.0	90%	W	10%	none	0%	none
Tailings (surface)	0.0	90%	W	10%	none	0%	none
Capped 1	90.0	100%	RV	0%	none	0%	none
Capped 2 (A)	90.0	100%	RV	0%	none	0%	none
Capped 2 (B)	0.0	100%	RV	0%	none	0%	none
Capped 3 (A)	80.0	100%	RV	0%	none	0%	none
Capped 3 (B)	0.0	100%	RV	0%	none	0%	none
Capped 4	70.0	100%	RV	0%	none	0%	none
Capped 5	60.0	100%	RV	0%	none	0%	none

[1] Undisturbed areas have dust emissions of background values (control factor = 0)

Total area	66	ha	100%
Total disturbed	223	ha	336%
Total undisturbed	-	ha	0%

Total disturbed area	223	ha	100%
Area with controls	185	ha	83%
Area without controls	39	ha	17%

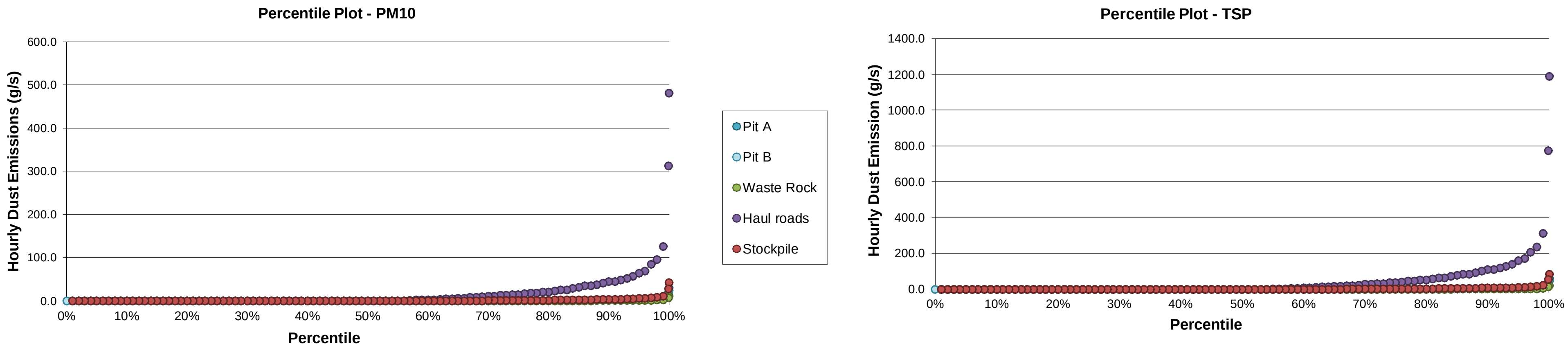
Average annual emissions from disturbed areas (TSP)

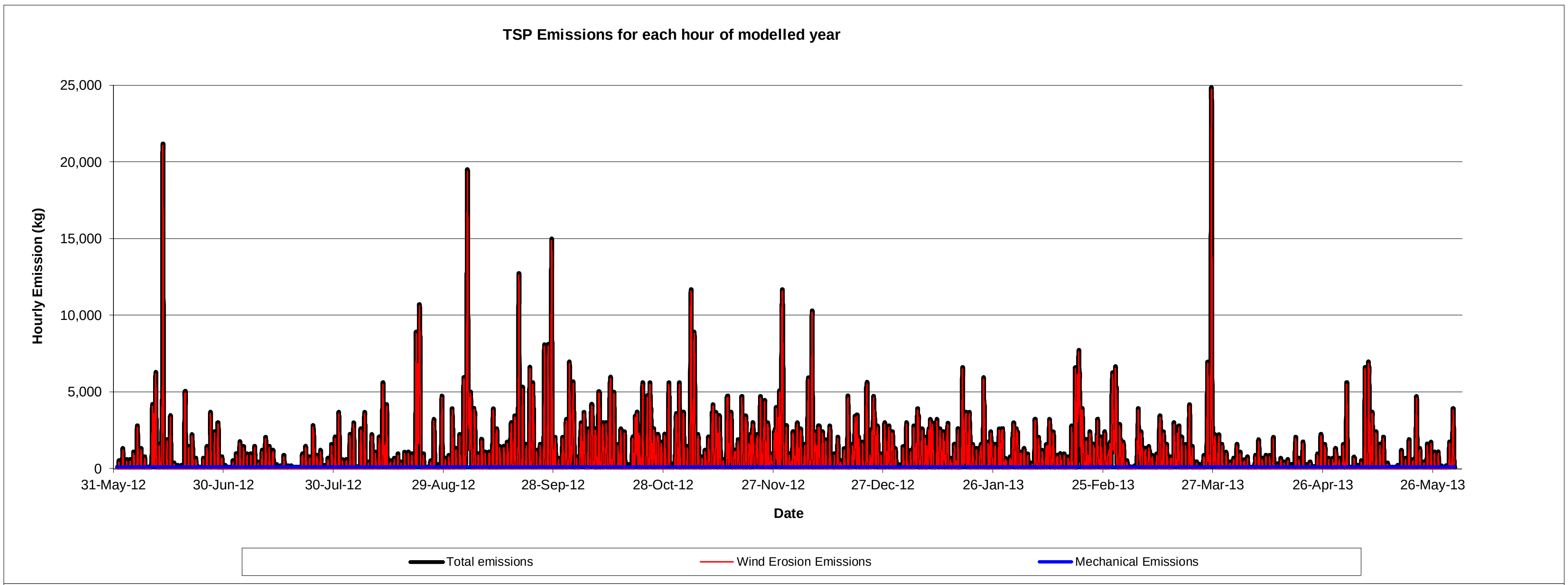
	Disturbed Controlled Areas (MANAGED) area (ha)	% of area	ER (g/s)	% of ER	Disturbed Uncontrolled Areas (ACTIVE) area (ha)	% of area	ER (g/s)	% of ER
Pit A	0.0	0%	0.0	0%	15.0	100%	1.7	100%
Pit B	0.0	0%	0.0	0%	12.0	100%	1.4	100%
Overburden - P	3.6	50%	0.2	33%	3.6	50%	0.4	67%
Overburden - A1	5.7	50%	0.3	35%	5.7	50%	0.6	65%
Overburden - A2	4.4	50%	0.3	36%	4.4	50%	0.4	64%
Overburden - S	6.0	50%	0.3	38%	6.0	50%	0.6	63%
Overburden - E	15.6	50%	0.9	39%	15.6	50%	1.4	61%
LV Roads	146.4	90%	5.0	88%	16.3	10%	0.7	12%
Haul Roads	34.6	90%	1.2	91%	3.8	10%	0.1	9%
PP Stockpile	0.0	90%	0.0	0%	0	10%	0.0	0%
Tailings (surface)	0.0	90%	0.0	0%	0	10%	0.0	0%
Capped 1	90.0	100%	7.1	100%	0	0%	0.0	0%
Capped 2 (A)	90.0	100%	6.1	100%	0	0%	0.0	0%
Capped 2 (B)	0.0	100%	0.0	0%	0	0%	0.0	0%
Capped 3 (A)	80.0	100%	3.6	100%	0	0%	0.0	0%
Capped 3 (B)	0.0	100%	0.0	0%	0	0%	0.0	0%
Capped 4	70.0	100%	0.8	100%	0	0%	0.0	0%
Capped 5	60.0	100%	0.7	100%	0	0%	0.0	0%

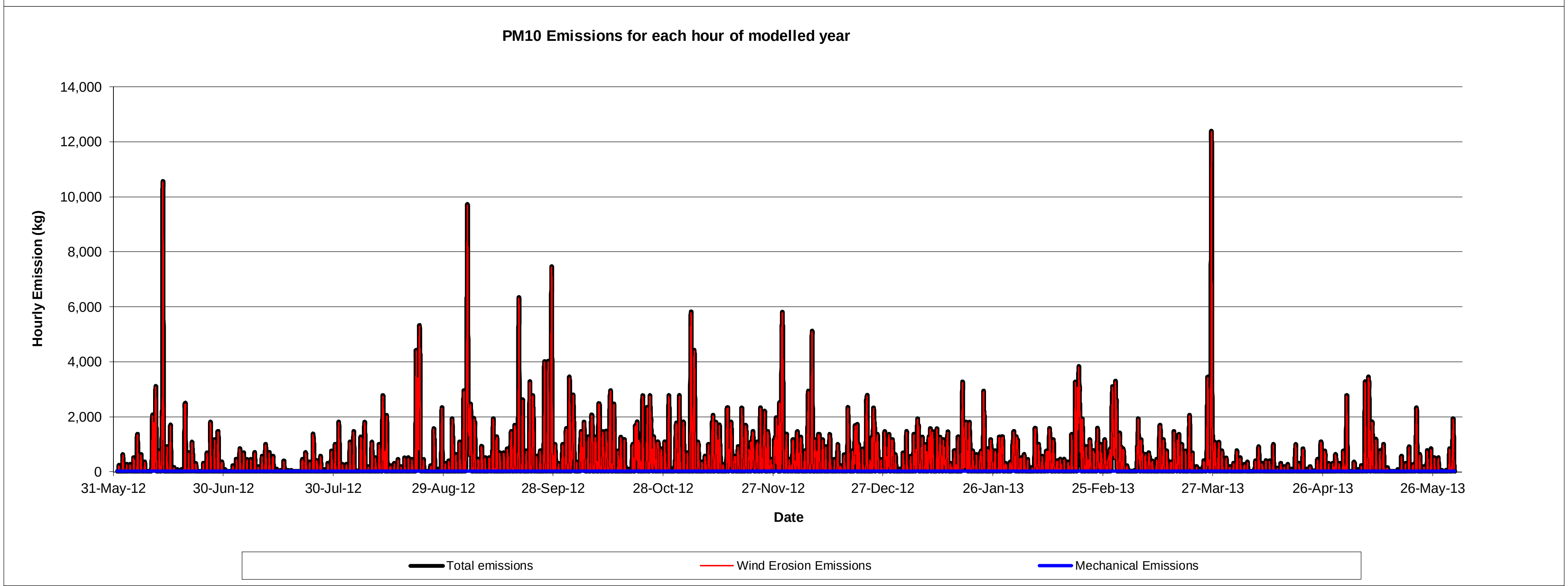
Hourly calculated emissions statistics for 1 Nov 2007 to 31 Oct 2008

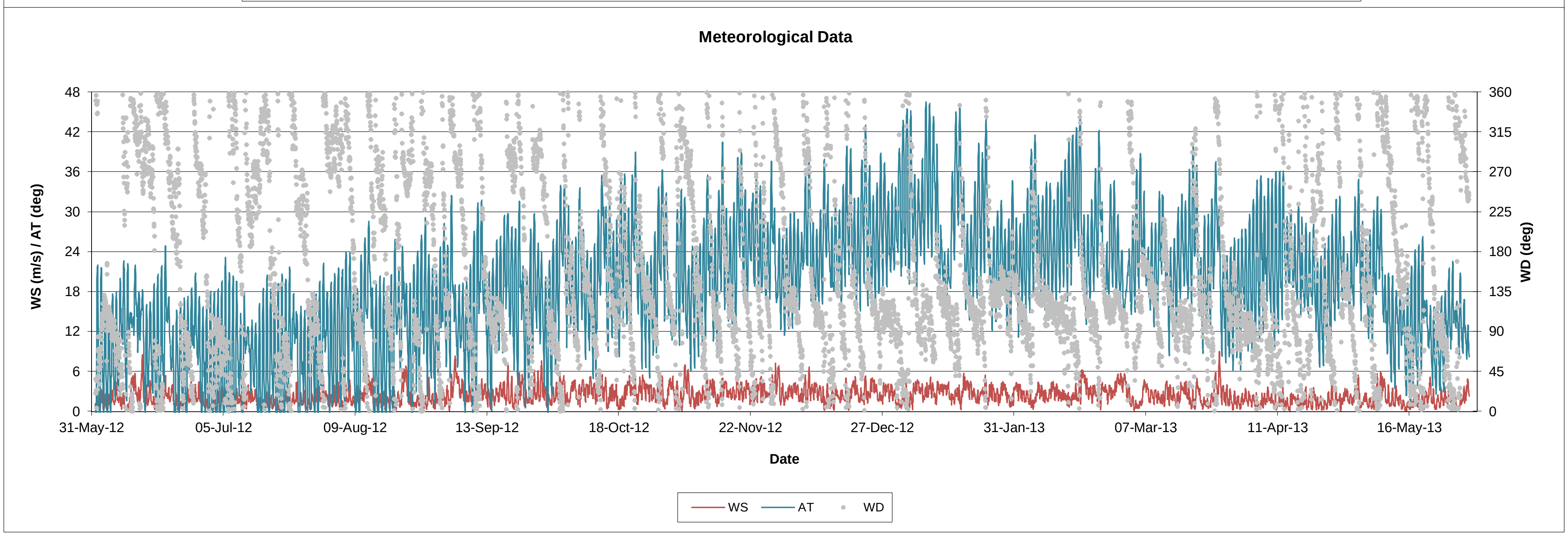
	TSP Emissions (g/s) Max	99.9 %ile	75 %ile	Ann avg	PM10 Emissions (g/s) Max	99.9 %ile	75%ile	Ann avg
Pit A	60	39	2	2	30	20	1	1
Pit B	48	31	1	1	24	16	1	1
Overburden - P	22	14	1	1	11	7	0	0
Overburden - A1	34	22	1	1	17	11	1	0
Overburden - A2	27	17	1	1	13	9	0	0
Overburden - S	36	23	1	1	18	12	1	1
Overburden - E	93	61	3	3	47	30	1	1
Roads	1,192	775	37	34	482	313	15	14
Stockpile	85	55	3	2	42	28	1	1
Tailings (surf.)	0	0	0	0	0	0	0	0
Capped 1	252	164	8	7	126	82	4	4
Capped 2 (A)	216	141	7	6	216	141	7	3
Capped 2 (B)	0	0	0	0	0	0	0	0
Capped 3 (A)	128	83	4	4	64	42	2	2
Capped 3 (B)	0	0	0	0	0	0	0	0
Capped 4	28	18	1	1	14	9	0	0
Capped 5	24	16	1	1	12	8	0	0

Summary of total emissions for AUSPLUME dispersion modelling
Scenario 3, Year 11, Standard Dust Suppression.









Scenario 4, Year 14

input data

Throughput		
Mining rate	**Mtpa**	**t/day**
Total (ore + waste rock)	27.24	78515
Ore (pre-bene)	3.57	10288
Ore (post-bene)	2.50	7202
Overburden	23.67	68227
Processing plant (ore)	**Mtpa**	**t/day**
Product	1.18	3411
Tailings (solids)	1.32	3790
Mining rate for stockpile	**Mtpa**	**t/day**
Total (ore + waste rock)	16.79	48385
Ore (pre-bene)	2.20	6340
Ore (post-bene)	1.54	4438
Overburden	14.59	42045

Ratios, factors and reductions	
Pre-bene to post-bene reduction	0.3
Waste rock to product ratio	0.05
Tailings to product ratio	0.9
Swell factor	0.15

Operational times		
Days per year	347	*(95% up-time)*
Hours per day	24	

Density	
Ore density (dry) (t/bcm)	1.20
Waste rock density (t/bcm)	1.85

Moisture and silt content		
Product	**Moisture (%)**	**Silt (%)**
Ore	20.0	6.6
Waste rock	5.0	4.0
Haul roads/sands	5.0	2.0

Areas					
Active pits	**m2**	**width (m)**	**height(m)**	**Centre, Easting, Northing (m)**	
Active Pit A - Scenario 4, Year 14	100,000	316	316	563,000	6,688,000
Active Pit B - Scenario 4, Year 14	150,000	387	387	557,500	6,691,250
Overburden landform	**m2**	**width (m)**	**height(m)**	**Centre, Easting, Northing (m)**	
Princess 1 - Scenario 4, Year 14	72,222	269	269	580,031	6,683,781
Ambassador 1 - Scenario 4, Year 14	113,889	337	337	580,941	6,682,591
Ambassador 2 - Scenario 4, Year 14	88,889	298	298	575,030	6,682,101
Shogun - Scenario 4, Year 14	119,444	346	346	561,778	6,687,771
Emperor - Scenario 4, Year 14	311,111	558	558	560,460	6,691,005
Tailings (wet tailings)	**m2**	**width (m)**	**height(m)**	**Centre, Easting, Northing (m)**	
Tailings_Surface - Scenario 4, Year 14	In pit	In pit	In pit	In pit	In pit
Processing plant stockpile	**m2**	**width (m)**	**height(m)**	**Centre, Easting, Northing (m)**	
Proc. Plant - Scenario 4, Year 14	200,000	447	447	563,520	6,687,500
Capped landforms	**m2**	**width (m)**	**height(m)**	**Centre, Easting, Northing (m)**	
Capped pit 1 year rehab	900000	949	949	557500	6691250
Capped pit 2 year rehab (A)	600000	775	775	557500	6691250
Capped pit 2 year rehab (B)	400000	632	632	563000	6688000
Capped pit 3 year rehab (A)	200000	447	447	563000	6688000
Capped pit 3 year rehab (B)	600000	775	775	576500	6679400
Capped pit 4 year rehab	900000	949	949	575350	6680100
Capped pit 5 year rehab	900000	949	949	575600	6680800

Haul road areas (for wind erosion)			
Pit to Processing Plant	**m2**	**width (m)**	**length (m)**
Total haul road areas	1626500	20	81325
Total LV road areas	384542	6	64090

Landform production rates			
Active landforms	**ha**	**m3/yr**	**m/yr**
Active pit	250,000	15,772,155	0.00631
Overburden	705,556	1,919,573	0.00027
Active tailings	In pit	446,250	--

Fleet details					
Mine equipment fleet	**Model**	**Number**	**Payload (t)**	**Weight (t)**	
Haul truck	Cat 793D	NA	218	384	
Dozer	not provided	2	NA	NA	
Grader	not provided	2	NA	NA	
Back hoe	not provided	3	NA	NA	
Forklift	not provided	3	NA	NA	
Crane	not provided	2	NA	NA	
Truck with hiab	not provided	2	NA	NA	
Ambulance	not provided	1	NA	NA	
Buses	not provided	3	NA	NA	assume 3 hours use each per day
Light vehicles	mine spec	23	NA	NA	assume 4 hours use each per day

Scenario 4, Year 14

data input

Constants

Parameter	Ore	Waste rock	Tailings
Mean wind speed (m/s)	3.5	3.5	3.5
Moisture (%)	20.0	5.0	20.0
Silt (%)	6.6	6.0	6.6

Parameter	Value	Unit	
K tsp	0.74		
K pm10	0.35		
Mean grader speed - haul roads	10	km/hr	
Area of blasting	0	m2	none
Depth of blasting	0	m	
Holes per blast	0		
Moisture content	High		

Haul Road Parameters	Value	Unit
Vehicle gross mass (haul truck)	384	t
Vehicle gross mass (ancillary vehicles)	5	t
Moisture	5	%
Silt content	2	%
Haul Road width	20	m
Mean LV speed	40	km/hr

Mechanical Emission Factors[1]

Excav, shov. & FEL	Ore	Waste Rock	Tailings
EF TSP (kg/t)	0.0001	0.0006	0.0001
EF PM10 (kg/t)	0.0000	0.0003	0.0000
Bulldozers	**Ore**	**Waste Rock**	**Tailings**
EF TSP (kg/hr)	0.51	2.75	0.51
EF PM10 (kg/hr)	0.09	0.52	0.09
Trucks (unloading)	**Ore**	**Waste Rock**	**Tailings**
EF TSP (kg/t)	0.012	0.012	0.012
EF PM10 (kg/t)	0.0043	0.0043	0.0043
Grader	**Ore**	**Waste Rock**	**Tailings**
EF TSP (kg/VKT)	1.08	1.08	1.08
EF PM10 (kg/VKT)	0.34	0.34	0.34

Haul Road distances

	Pit to PP	Pit to WR
Daily haul rate (tpd)	7202	11777
Return distance (m)	2000	3000
Truck payload (t)	218	218
Truck trips	33	54
VKT (km)	66	162
Trucks per hour	1.4	2.3
Haul road area (ha)	2.0	3.0

Crushing emission factors[1]

Primary	
EF TSP (kg/t)	0.010
EF PM10 (kg/t)	0.004
Secondary	
EF TSP (kg/t)	0.030
EF PM10 (kg/t)	0.012
Tertiary	
EF TSP (kg/t)	0.030
EF PM10 (kg/t)	0.010
Conveying, transfer etc.	
EF TSP (kg/t)	0.005
EF PM10 (kg/t)	0.002
Screening	
EF TSP (kg/t)	0.08
EF PM10 (kg/t)	0.06

Wheel generated dust factors[1]

Haul trucks	
EF TSP (kg/VKT)	3.65
EF PM10 (kg/VKT)	0.78
Ancillary vehicles	
EF TSP (kg/VKT)	0.09
EF PM10 (kg/VKT)	0.01

1. NPI Mining 3.1 (2012)

Summary of emissions sources for dispersion modelling

Scenario 4, Year 14, Standard Dust Suppression.

Scenario 4, Year 14

Source Type	Description of Source	Model ID (Area or Volume Source)	Model Run Source On/Off	Emission Regime	Total Area (ha)	Avg annual emissions TSP g/s	Avg annual emissions PM10 g/s	Overall Control TSP	Overall Control PM10	Control Factor Breakdown: Pit Retention	Water	Wind Breaks	Equipment	Re-veg	Avg annual emissions (controlled) TSP g/s	TSP g/s/ha	PM10 g/s	PM10 g/s/ha
Mech	Loading ore	OreLoad (V)	On	A		0.01	0.005	1	1						0.01		0.005	
Mech	Loading overburden	WRLoad (V)	On	A		0.5	0.2	1	1						0.5		0.2	
Mech	Hauling overburden	HaulWaste (A)	On	A	3.0	62	13	0.3	0.3		*0.75*				16	5	3	1.1
Mech	Hauling Ore	HaulOre (A)	On	A	2.0	3	1	0.3	0.3		*0.75*				1	0.3	0.1	0.07
Mech	Roads - grading haul roads	Grading (A)	On	A	2.0	6	2	0.3	0.3		*0.75*				1	0.7	0.5	0.2
Mech	Roads - misc vehicle traffic	TravelMisc (A)	On	A	38.5	0.1	0.02	0.3	0.3		*0.75*				0.03	0.001	0.004	0.0001
Mech	Overburden dumping	DumpWaste (V)	On	A		9	3	1	1						9		3	
Mech	PP - Dumping	DumpOre (V)	On	A		1.0	0.4	1	1						1.0		0.4	
Mech	PP - Conveyor to crusher	Convey1 (V)	On	A		0.01	0.003	1	1						0.01		0.003	
Mech	PP - Conveyor to ball mill	Convey2 (V)	On	A		0.8	0.3	1	1						0.8		0.3	
Mech	Dozing - overburden	DozeWaste (A)	On	A		2	0.3	1	1						2		0.3	
Wind	Wind Erosion - Pit A	WE-PtA (A)	On	B	10.0	1	0.6	1	1						1.1	0.1	0.6	0.06
Wind	Wind Erosion - Pit B	WE-PtB (A)	On	B	15.0	2	0.9	1	1						1.7	0.1	0.9	0.06
Wind	Wind Erosion - overburden, Princess	WE-OP (A)	On	B	7.2	0.8	0.4	0.75	0.75		*0.5*				0.6	0.09	0.3	0.04
Wind	Wind Erosion - overburden, Ambassador 1	WE-OA1 (A)	On	B	11.4	1.2	0.6	0.75	0.75		*0.5*				0.9	0.08	0.5	0.04
Wind	Wind Erosion - overburden, Ambassador 2	WE-OA2 (A)	On	B	8.9	0.9	0.5	0.75	0.75		*0.5*				0.7	0.08	0.3	0.04
Wind	Wind Erosion - overburden, Shogun	WE-OS (A)	On	B	11.9	1.2	0.6	0.75	0.75		*0.5*				0.9	0.08	0.5	0.04
Wind	Wind Erosion - overburden, Emperor	WE-OE (A)	On	B	31.1	3.0	1.5	0.75	0.75		*0.5*				2.3	0.07	1.1	0.04
Wind	Wind Erosion - LV roads	WE-LV (A)	On	B	162.7	15	8	0.37	0.37		*0.7*				6	0.03	3	0.02
Wind	Wind Erosion - Haul roads	WE-HV (A)	On	B	38.5	3	2	0.37	0.37		*0.7*				1	0.03	0.6	0.02
Wind	Wind Erosion - PP Stockpile	WE-PP (A)	On	B	20.0	2	1	0.55	0.55		*0.5*				1	0.06	1	0.03
Wind	Wind Erosion - Tailings dam (surface)	WE-T (A)	On	B	0.0	0	0	0.55	0.55		*0.5*				0		0	
Wind	Wind Erosion - capped pit 1 year rehab	Cap-1 (A)	On	B	90.0	10	5	0.7	0.7					*0.3*	7	0.08	4	0.04
Wind	Wind Erosion - capped pit 2 year rehab (A)	Cap-2 (A)	On	B	60.0	7	3	0.6	0.6					*0.4*	4	0.07	2	0.03
Wind	Wind Erosion - capped pit 2 year rehab (B)	Cap-3 (A)	On	B	40.0	5	2	0.6	0.6					*0.4*	3	0.07	1	0.03
Wind	Wind Erosion - capped pit 3 year rehab (A)	Cap-4 (A)	On	B	20.0	2	1	0.4	0.4					*0.6*	1	0.05	0	0.02
Wind	Wind Erosion - capped pit 3 year rehab (B)	Cap-5 (A)	On	B	60.0	7	3	0.4	0.4					*0.6*	3	0.05	1	0.02
Wind	Wind Erosion - capped pit 4 year rehab	Cap-6 (A)	On	B	90.0	10	5	0.1	0.1					*0.9*	1	0.01	1	0.01
Wind	Wind Erosion - capped pit 5 year rehab	Cap-7 (A)	On	B	90.0	10	5	0.1	0.1					*0.9*	1	0.01	1	0.01

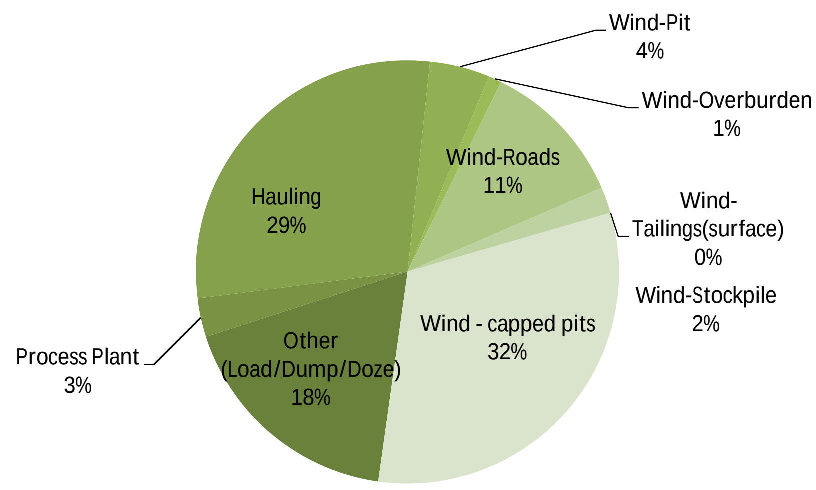
	TSP g/s		PM10 g/s	
Total Emissions	67.2		26.6	
Total Mech Emissions	31.1	46%	8.6	32%
Total Wind Emissions	36.1	54%	18.0	68%

Total TSP emissions (tonnes/year)	7,528
Total PM10 emissions (tonnes/year)	3,544

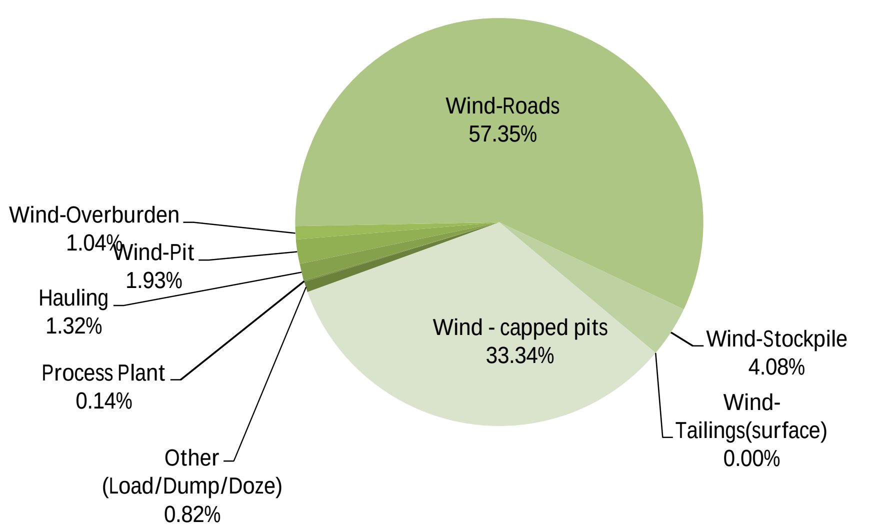
Breakdown of dust emission regimes	
A	Continuous constant
B	Calculated hourly

Control Factor Key	
Pit Retention	On = 50% (TSP) or 5% (PM10) reduction
Watering / water spray (W)	Hauling - level 2 watering (>2L/m2/hr) = 75% reduction
	Unloading Trucks - water sprays = 70% reduction
	Loading stockpiles - water sprays = 50% reduction
	conveying/misc transfer - water spray + chemicals = 90% reduction
	Wind erosion from stockpiles - water sprays = 50% reduction
Wind Breaks	Wind erosion from stockpiles - wind breaks = 30% reduction
Equipment	primary crusher - hooding with scrubbers = 75% reduction
Re-veg (RV)	wind erosion - primary rehabilitation = 30%
	wind erosion - vegetation established, but not self-sustaining = 40%
	wind erosion - secondary rehabilitation = 60%
	wind erosion -revegetation = 90 %
	wind erosion - fully rehabilitated vegetation = 100%
Sprays (SS)	wind erosion surfaces - surface sprays = 90% reduction

Average Annual TSP Emissions



99.9 Percentile Annual TSP Emissions



Wind Erosion Areas Breakdown with associated control factors

	Total Area (ha)	Disturbed Controlled % of Area	Disturbed Controlled Controls	Disturbed Uncontrolled % of Area	Disturbed Uncontrolled Controls	Undisturbed Areas [1] % of Area	Undisturbed Areas [1] Controls
Pit A	10	0%	none	100%	none	0%	none
Pit B	15	0%	none	100%	none	0%	none
Overburden - P	7.2	50%	W	50%	none	0%	none
Overburden - A1	11.4	50%	W	50%	none	0%	none
Overburden - A2	8.9	50%	W	50%	none	0%	none
Overburden - S	11.9	50%	W	50%	none	0%	none
Overburden - E	31.1	50%	W	50%	none	0%	none
LV Roads	162.7	90%	W	10%	none	0%	none
Haul Roads	38.5	90%	W	10%	none	0%	none
PP Stockpile	20.0	90%	W	10%	none	0%	none
Tailings (surface)	0.0	90%	W	10%	none	0%	none
Capped 1	90.0	100%	RV	0%	none	0%	none
Capped 2 (A)	60.0	100%	RV	0%	none	0%	none
Capped 2 (B)	40.0	100%	RV	0%	none	0%	none
Capped 3 (A)	20.0	100%	RV	0%	none	0%	none
Capped 3 (B)	60.0	100%	RV	0%	none	0%	none
Capped 4	90.0	100%	RV	0%	none	0%	none
Capped 5	90.0	100%	RV	0%	none	0%	none

[1] Undisturbed areas have dust emissions of background values (control factor = 0)

Total area	64	ha	100%
Total disturbed	238	ha	370%
Total undisturbed	-	ha	0%

Total disturbed area	238	ha	100%
Area with controls	203	ha	85%
Area without controls	36	ha	15%

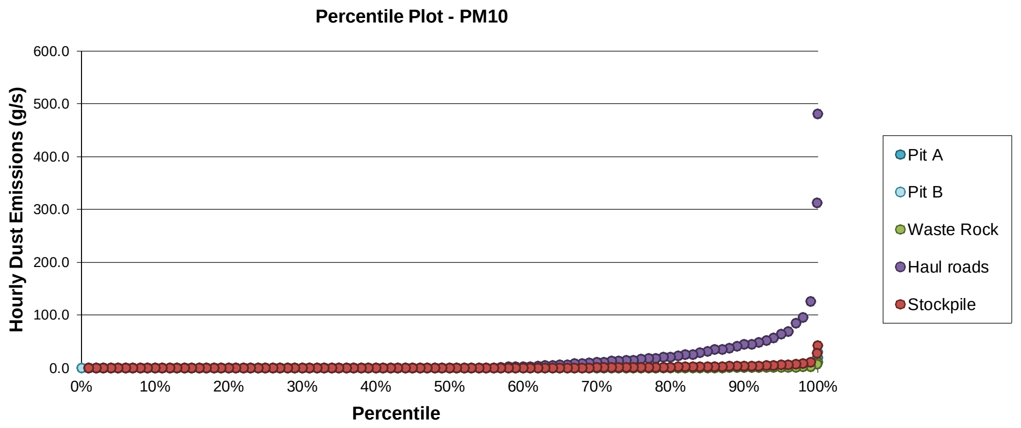
Average annual emissions from disturbed areas (TSP)

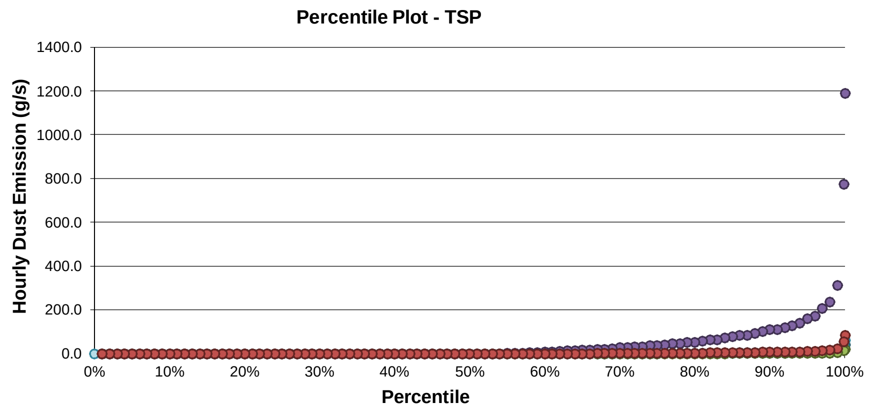
	Disturbed Controlled Areas (MANAGED) area (ha)	% of area	ER (g/s)	% of ER	Disturbed Uncontrolled Areas (ACTIVE) area (ha)	% of area	ER (g/s)	% of ER
Pit A	0.0	0%	0.0	0%	10.0	100%	1.1	100%
Pit B	0.0	0%	0.0	0%	15.0	100%	1.7	100%
Overburden - P	3.6	50%	0.2	33%	3.6	50%	0.4	67%
Overburden - A1	5.7	50%	0.3	35%	5.7	50%	0.6	65%
Overburden - A2	4.4	50%	0.3	36%	4.4	50%	0.4	64%
Overburden - S	6.0	50%	0.3	38%	6.0	50%	0.6	63%
Overburden - E	15.6	50%	0.9	39%	15.6	50%	1.4	61%
LV Roads	146.4	90%	5.0	88%	16.3	10%	0.7	12%
Haul Roads	34.6	90%	1.2	91%	3.8	10%	0.1	9%
PP Stockpile	18.0	90%	1.0	82%	2	10%	0.2	18%
Tailings (surface)	0.0	90%	0.0	0%	0	10%	0.0	0%
Capped 1	90.0	100%	7.1	100%	0	0%	0.0	0%
Capped 2 (A)	60.0	100%	4.1	100%	0	0%	0.0	0%
Capped 2 (B)	40.0	100%	2.7	100%	0	0%	0.0	0%
Capped 3 (A)	20.0	100%	0.9	100%	0	0%	0.0	0%
Capped 3 (B)	60.0	100%	2.7	100%	0	0%	0.0	0%
Capped 4	90.0	100%	1.0	100%	0	0%	0.0	0%
Capped 5	90.0	100%	1.0	100%	0	0%	0.0	0%

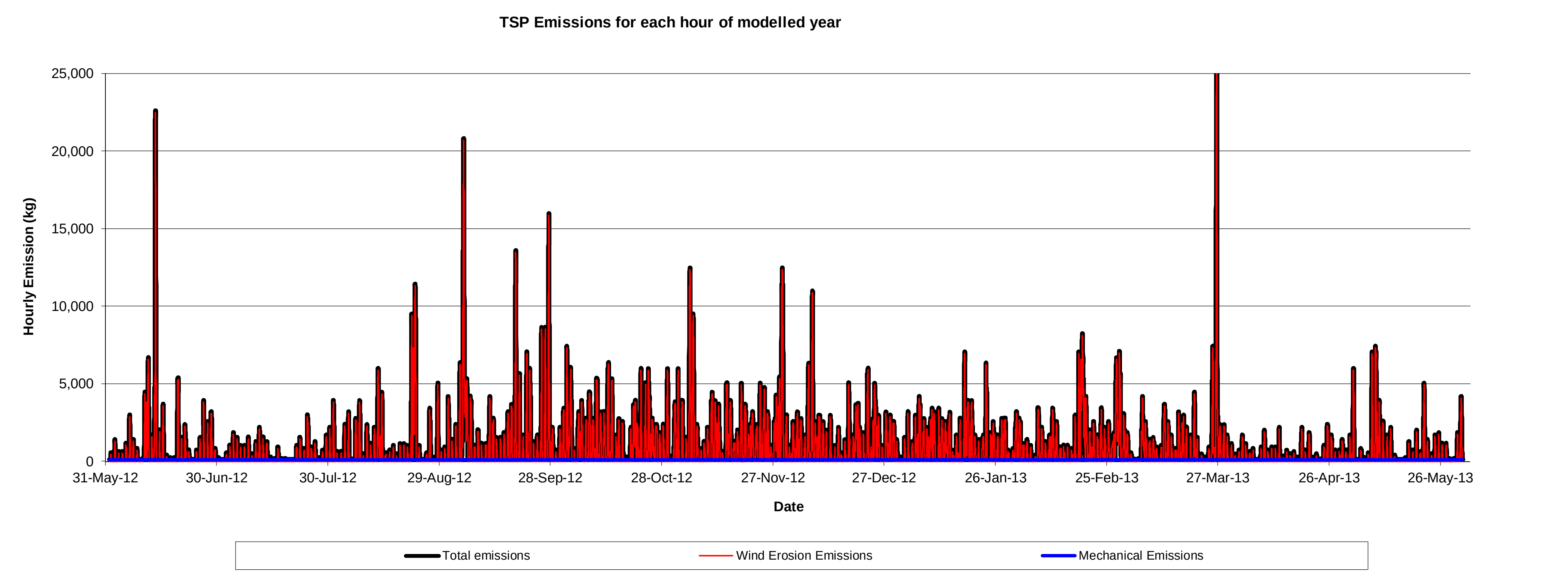
Hourly calculated emissions statistics for 1 Nov 2007 to 31 Oct 2008

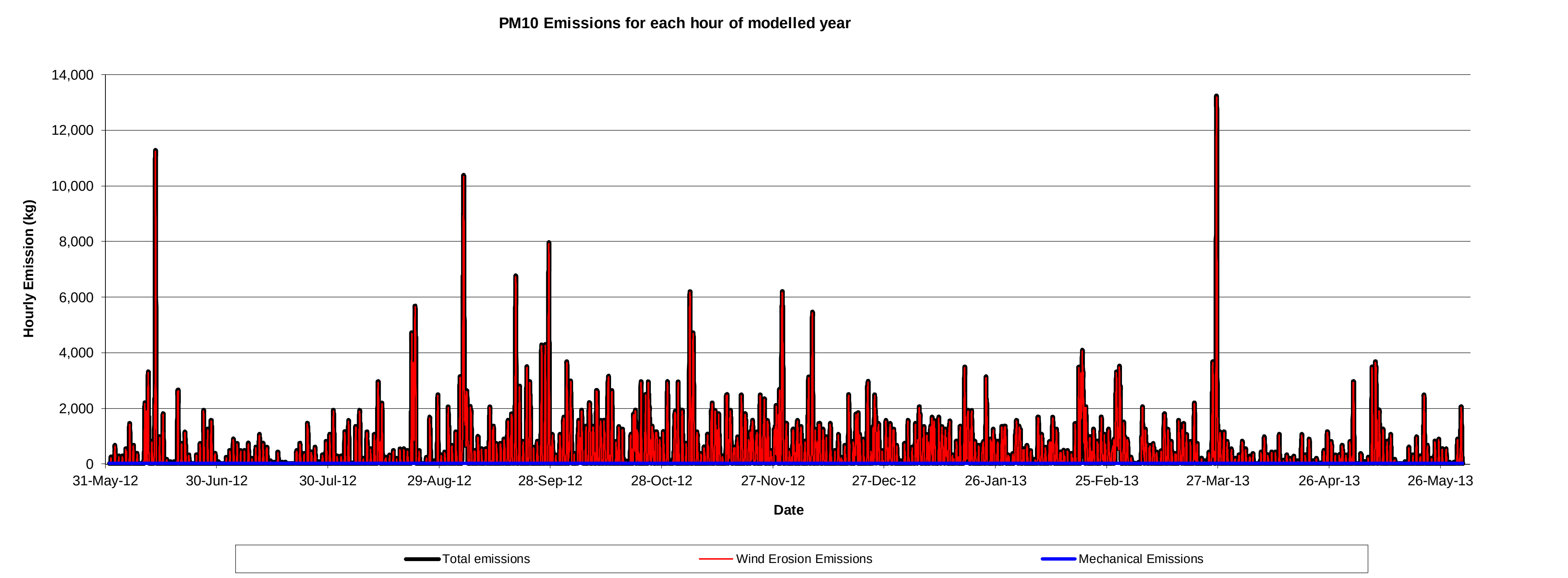
	TSP Emissions (g/s) Max	99.9 %ile	75 %ile	Ann avg	PM10 Emissions (g/s) Max	99.9 %ile	75%ile	Ann avg
Pit A	40	26	1	1	20	13	1	1
Pit B	60	39	2	2	30	20	1	1
Overburden - P	22	14	1	1	11	7	0	0
Overburden - A1	34	22	1	1	17	11	1	0
Overburden - A2	27	17	1	1	13	9	0	0
Overburden - S	36	23	1	1	18	12	1	1
Overburden - E	93	61	3	3	47	30	1	1
Roads	1,192	775	37	34	482	313	15	14
Stockpile	85	55	3	2	42	28	1	1
Tailings (surf.)	0	0	0	0	0	0	0	0
Capped 1	252	164	8	7	126	82	4	4
Capped 2 (A)	144	94	4	4	144	94	4	2
Capped 2 (B)	96	62	3	3	48	31	1	1
Capped 3 (A)	32	21	1	1	16	10	0	0
Capped 3 (B)	96	62	3	3	48	31	1	1
Capped 4	36	23	1	1	18	12	1	1
Capped 5	36	23	1	1	18	12	1	1

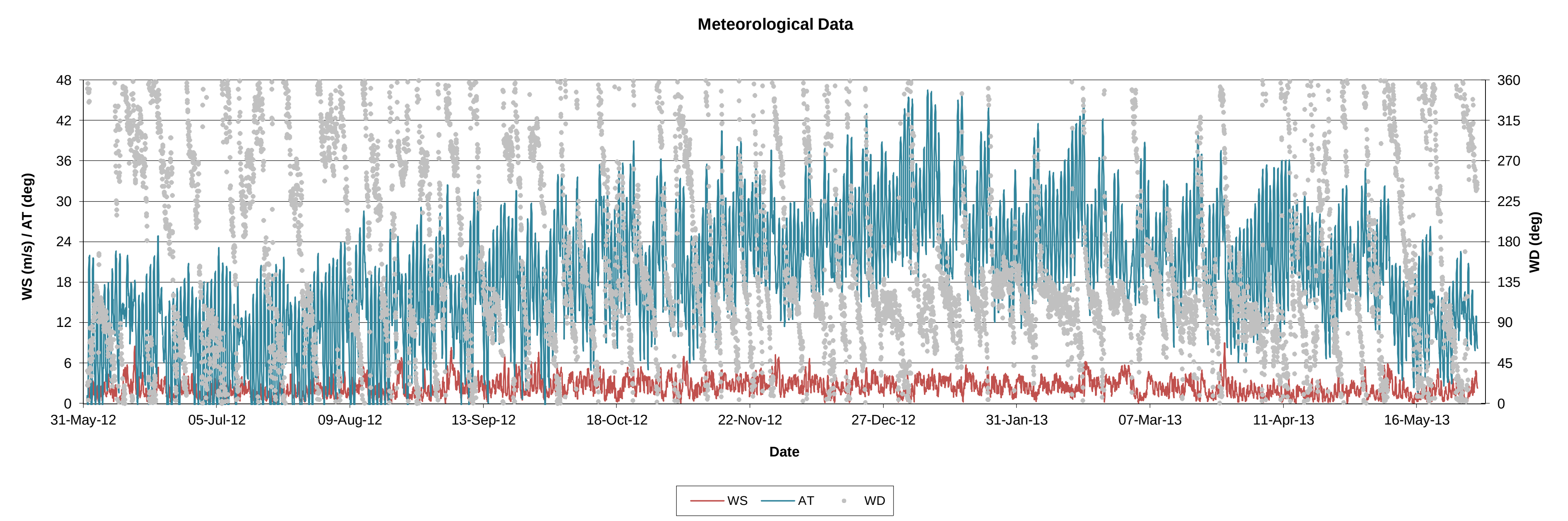
Summary of total emissions for AUSPLUME dispersion modelling
Scenario 4, Year 14, Standard Dust Suppression.











Scenario 5, closure (first year)

input data

Throughput		
Mining rate	**Mtpa**	**t/day**
Total (ore + waste rock)	0.00	0
Ore (pre-bene)	0.00	0
Ore (post-bene)	0.00	0
Overburden	0.00	0
Processing plant (ore)	**Mtpa**	**t/day**
Product	0.00	0
Tailings (solids)	0.00	0
Mining rate for stockpile	**Mtpa**	**t/day**
Total (ore + waste rock)	0.00	0
Ore (pre-bene)	0.00	0
Ore (post-bene)	0.00	0
Overburden	0.00	0

Ratios, factors and reductions	
Pre-bene to post-bene reduction	0.3
Waste rock to product ratio	0.05
Tailings to product ratio	0.9
Swell factor	0.15

Operational times		
Days per year	347	*(95% up-time)*
Hours per day	24	

Density	
Ore density (dry) (t/bcm)	1.20
Waste rock density (t/bcm)	1.85

Moisture and silt content		
Product	**Moisture (%)**	**Silt (%)**
Ore	20.0	6.6
Waste rock	5.0	4.0
Haul roads/sands	5.0	2.0

Areas					
Active pits	**m2**	**width (m)**	**height(m)**	**Centre, Easting, Northing (m)**	
Active Pit A - Scenario 5, closure (first year	0	0	0	0	0
Active Pit B - Scenario 5, closure (first year	0	0	0	0	0
Overburden landform	**m2**	**width (m)**	**height(m)**	**Centre, Easting, Northing (m)**	
Princess 1 - Scenario 5, closure (first year)	72,222	269	269	580,031	6,683,781
Ambassador 1 - Scenario 5, closure (first y	113,889	337	337	580,941	6,682,591
Ambassador 2 - Scenario 5, closure (first y	88,889	298	298	575,030	6,682,101
Shogun - Scenario 5, closure (first year)	119,444	346	346	561,778	6,687,771
Emperor - Scenario 5, closure (first year)	311,111	558	558	560,460	6,691,005
Tailings (wet tailings)	**m2**	**width (m)**	**height(m)**	**Centre, Easting, Northing (m)**	
Tailings_Surface - Scenario 5, closure (first	0	0	0	0	0
Processing plant stockpile	**m2**	**width (m)**	**height(m)**	**Centre, Easting, Northing (m)**	
Proc. Plant - Scenario 5, closure (first year)	0	0	0	0	0
Capped landforms	**m2**	**width (m)**	**height(m)**	**Centre, Easting, Northing (m)**	
Capped pit 1 year rehab	200000	447	447	563520	6687500
Capped pit 2 year rehab	600000	775	775	557500	6691250
Capped pit 3 year rehab (A)	600000	775	775	557500	6691250
Capped pit 3 year rehab (B)	500000	707	707	563000	6688000
Capped pit 4 year rehab	500000	707	707	557500	6691250
Capped pit 5 year rehab (A)	600000	775	775	557500	6691250
Capped pit 5 year rehab (B)	800000	894	894	563000	6688000

Haul road areas (for wind erosion)			
Pit to Processing Plant	**m2**	**width (m)**	**length (m)**
Total haul road areas	0	0	0
Total LV road areas	0	0	0

Landform production rates			
Active landforms	**ha**	**m3/yr**	**m/yr**
Active pit	0	0	0.00000
Overburden	0	0	0.00000
Active tailings	0	0	--

Fleet details					
Mine equipment fleet	**Model**	**Number**	**Payload (t)**	**Weight (t)**	
Haul truck	Cat 793D	NA	0	0	
Dozer	not provided	0	NA	NA	
Grader	not provided	0	NA	NA	
Back hoe	not provided	0	NA	NA	
Forklift	not provided	0	NA	NA	
Crane	not provided	0	NA	NA	
Truck with hiab	not provided	0	NA	NA	
Ambulance	not provided	0	NA	NA	
Buses	not provided	0	NA	NA	assume 3 hours use each per day
Light vehicles	mine spec	0	NA	NA	assume 4 hours use each per day

Scenario 5, closure (first year)

data input

Constants

Parameter	Ore	Waste rock	Tailings
Mean wind speed (m/s)	3.5	3.5	3.5
Moisture (%)	20.0	5.0	20.0
Silt (%)	6.6	6.0	6.6

Parameter	Value	Unit	
K tsp	0.74		
K pm10	0.35		
Mean grader speed - haul roads	10	km/hr	
Area of blasting	0	m2	none
Depth of blasting	0	m	
Holes per blast	0		
Moisture content	High		

Haul Road Parameters	Value	Unit
Vehicle gross mass (haul truck)	0	t
Vehicle gross mass (ancillary vehicles)	5	t
Moisture	5	%
Silt content	2	%
Haul Road width	0	m
Mean LV speed	40	km/hr

Mechanical Emission Factors[1]

Excav, shov. & FEL	Ore	Waste Rock	Tailings
EF TSP (kg/t)	0.0001	0.0006	0.0001
EF PM10 (kg/t)	0.0000	0.0003	0.0000
Bulldozers	**Ore**	**Waste Rock**	**Tailings**
EF TSP (kg/hr)	0.51	2.75	0.51
EF PM10 (kg/hr)	0.09	0.52	0.09
Trucks (unloading)	**Ore**	**Waste Rock**	**Tailings**
EF TSP (kg/t)	0.012	0.012	0.012
EF PM10 (kg/t)	0.0043	0.0043	0.0043
Grader	**Ore**	**Waste Rock**	**Tailings**
EF TSP (kg/VKT)	1.08	1.08	1.08
EF PM10 (kg/VKT)	0.34	0.34	0.34

Haul Road distances

	Pit to PP	Pit to WR
Daily haul rate (tpd)	0	0
Return distance (m)	0	0
Truck payload (t)	0	0
Truck trips	0	0
VKT (km)	0	0
Trucks per hour	0.0	0.0
Haul road area (ha)	0.0	0.0

Crushing emission factors[1]

Primary	
EF TSP (kg/t)	0.010
EF PM10 (kg/t)	0.004
Secondary	
EF TSP (kg/t)	0.030
EF PM10 (kg/t)	0.012
Tertiary	
EF TSP (kg/t)	0.030
EF PM10 (kg/t)	0.010
Conveying, transfer etc.	
EF TSP (kg/t)	0.005
EF PM10 (kg/t)	0.002
Screening	
EF TSP (kg/t)	0.08
EF PM10 (kg/t)	0.06

Wheel generated dust factors[1]

Haul trucks	
EF TSP (kg/VKT)	0.00
EF PM10 (kg/VKT)	0.00
Ancillary vehicles	
EF TSP (kg/VKT)	0.09
EF PM10 (kg/VKT)	0.01

1. NPI Mining 3.1 (2012)

Summary of emissions sources for dispersion modelling

Scenario 5, closure (first year), Standard Dust Suppression.

Scenario 5, closure (first year)

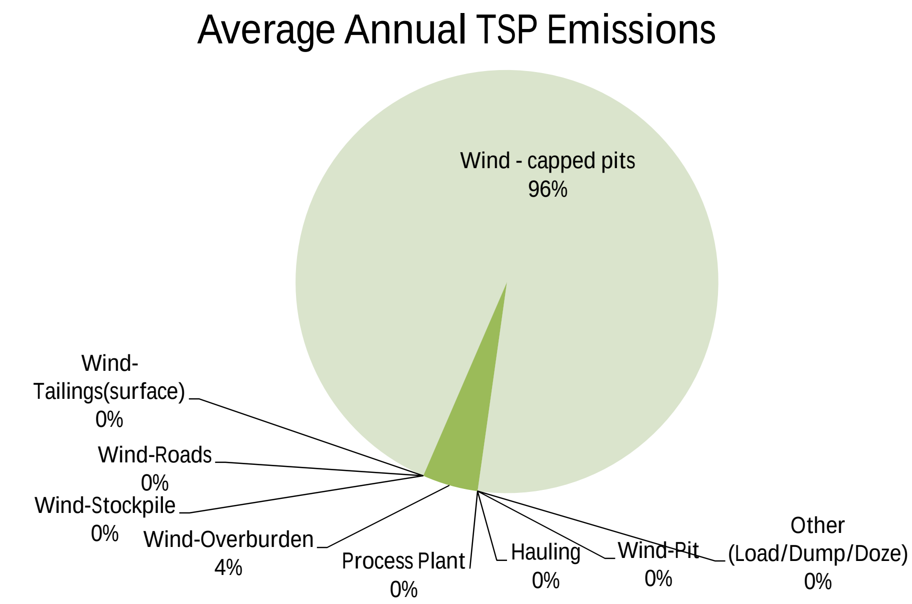
Source Type	Description of Source	Model ID (Area or Volume Source)	Model Run Source On/Off	Emission Regime	Total Area (ha)	Avg annual emissions TSP g/s	Avg annual emissions PM10 g/s	Overall Control TSP	Overall Control PM10	Pit Retention	Water	Wind Breaks	Equipment	Re-veg	Avg annual emissions (controlled) TSP g/s	TSP g/s/ha	PM10 g/s	PM10 g/s/ha
Mech	Loading ore	OreLoad (V)	On	A		0.00	0.000	1	1						0.00		0.000	
Mech	Loading overburden	WRLoad (V)	On	A		0.0	0.0	1	1						0.0		0.0	
Mech	Hauling overburden	HaulWaste (A)	On	A	0.0	0	0	0.3	0.3		0.75				0		0	
Mech	Hauling Ore	HaulOre (A)	On	A	0.0	0	0	0.3	0.3		0.75				0		0.0	
Mech	Roads - grading haul roads	Grading (A)	On	A	0.0	0	0	0.3	0.3		0.75				0		0.0	
Mech	Roads - misc vehicle traffic	TravelMisc (A)	On	A	0.0	0.0	0.00	0.3	0.3		0.75				0.00		0.000	
Mech	Overburden dumping	DumpWaste (V)	On	A		0	0	1	1						0		0	
Mech	PP - Dumping	DumpOre (V)	On	A		0.0	0.0	1	1						0.0		0.0	
Mech	PP - Conveyor to crusher	Convey1 (V)	On	A		0.00	0.000	1	1						0.00		0.000	
Mech	PP - Conveyor to ball mill	Convey2 (V)	On	A		0.0	0.0	1	1						0.0		0.0	
Mech	Dozing - overburden	DozeWaste (A)	On	A		0	0.0	1	1						0		0.0	
Wind	Wind Erosion - Pit A	WE-PtA (A)	On	B	0.0	0	0.0	1	1						0.0		0.0	
Wind	Wind Erosion - Pit B	WE-PtB (A)	On	B	0.0	0	0.0	1	1						0.0		0.0	
Wind	Wind Erosion - overburden, Princess	WE-OP (A)	On	B	7.2	0.8	0.4	0.70	0.70					0.3	0.6	0.08	0.3	0.04
Wind	Wind Erosion - overburden, Ambassador 1	WE-OA1 (A)	On	B	11.4	1.2	0.6	0.70	0.70					0.3	0.9	0.08	0.4	0.04
Wind	Wind Erosion - overburden, Ambassador 2	WE-OA2 (A)	On	B	8.9	0.9	0.5	0.70	0.70					0.3	0.7	0.07	0.3	0.04
Wind	Wind Erosion - overburden, Shogun	WE-OS (A)	On	B	11.9	1.2	0.6	0.70	0.70					0.3	0.8	0.07	0.4	0.04
Wind	Wind Erosion - overburden, Emperor	WE-OE (A)	On	B	31.1	3.0	1.5	0.70	0.70					0.3	2.1	0.07	1.1	0.03
Wind	Wind Erosion - LV roads	WE-LV (A)	On	B	0.0	0	0	0.37	0.37		0.7				0		0	
Wind	Wind Erosion - Haul roads	WE-HV (A)	On	B	0.0	0	0	0.37	0.37		0.7				0		0.0	
Wind	Wind Erosion - PP Stockpile	WE-PP (A)	On	B	0.0	0	0	0.55	0.55		0.5				0		0	
Wind	Wind Erosion - Tailings dam (surface)	WE-T (A)	On	B	0.0	0	0	0.55	0.55		0.5				0		0	
Wind	Wind Erosion - capped pit 1 year rehab	Cap-1 (A)	On	B	20.0	2	1	0.7	0.7					0.3	2	0.08	1	0.04
Wind	Wind Erosion - capped pit 2 year rehab	Cap-2 (A)	On	B	60.0	7	3	0.6	0.6					0.4	4	0.07	2	0.03
Wind	Wind Erosion - capped pit 3 year rehab (A)	Cap-3 (A)	On	B	60.0	7	3	0.4	0.4					0.6	3	0.05	1	0.02
Wind	Wind Erosion - capped pit 3 year rehab (B)	Cap-4 (A)	On	B	50.0	6	3	0.4	0.4					0.6	2	0.05	1	0.02
Wind	Wind Erosion - capped pit 4 year rehab	Cap-5 (A)	On	B	50.0	6	3	0.1	0.1					0.9	1	0.01	0	0.01
Wind	Wind Erosion - capped pit 5 year rehab (A)	Cap-6 (A)	On	B	60.0	7	3	0.1	0.1					0.9	1	0.01	0	0.01
Wind	Wind Erosion - capped pit 5 year rehab (B)	Cap-7 (A)	On	B	80.0	9	5	0.1	0.1					0.9	1	0.01	0	0.01

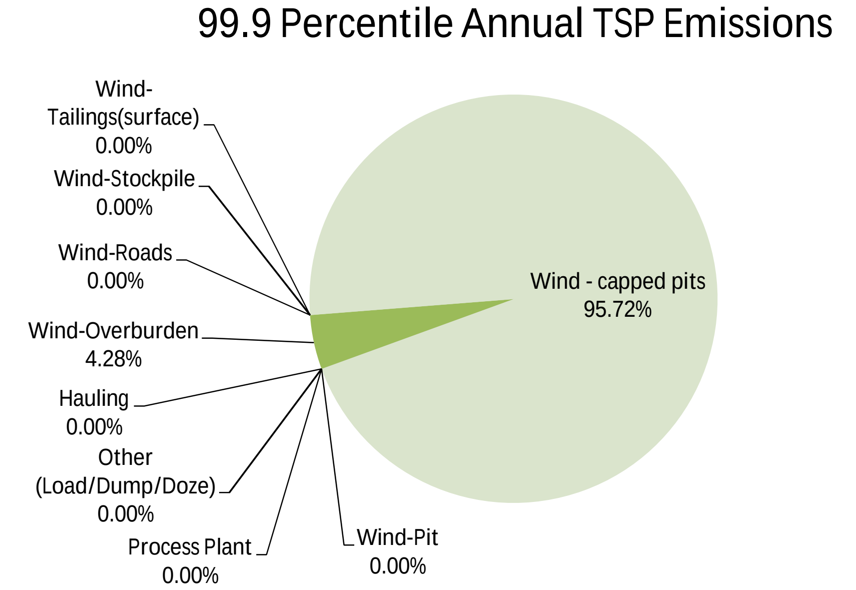
	TSP g/s		PM10 g/s	
Total Emissions	17.9		8.9	
Total Mech Emissions	0.0	0%	0.0	0%
Total Wind Emissions	17.9	100%	8.9	100%

Total TSP emissions (tonnes/year)	184
Total PM10 emissions (tonnes/year)	92

Breakdown of dust emission regimes	
A	Continuous constant
B	Calculated hourly

Control Factor Key	
Pit Retention	On = 50% (TSP) or 5% (PM10) reduction
Watering / water spray (W)	Hauling - level 2 watering (>2L/m2/hr) = 75% reduction
	Unloading Trucks - water sprays = 70% reduction
	Loading stockpiles - water sprays = 50% reduction
	conveying/misc transfer - water spray + chemicals = 90% reduction
	Wind erosion from stockpiles - water sprays = 50% reduction
Wind Breaks	Wind erosion from stockpiles - wind breaks = 30% reduction
Equipment	primary crusher - hooding with scrubbers = 75% reduction
Re-veg (RV)	wind erosion - primary rehabilitation = 30%
	wind erosion - vegetation established, but not self-sustaining = 40%
	wind erosion - secondary rehabilitation = 60%
	wind erosion -revegetation = 90 %
	wind erosion - fully rehabilitated vegetation = 100%
Sprays (SS)	wind erosion surfaces - surface sprays = 90% reduction





Wind Erosion Areas Breakdown with associated control factors

	Total Area (ha)	Disturbed Controlled % of Area	Disturbed Controlled Controls	Disturbed Uncontrolled % of Area	Disturbed Uncontrolled Controls	Undisturbed Areas [1] % of Area	Undisturbed Areas [1] Controls
Pit A	0	0%	none	100%	none	0%	none
Pit B	0	0%	none	100%	none	0%	none
Overburden - P	7.2	100%	W	0%	none	0%	none
Overburden - A1	11.4	100%	W	0%	none	0%	none
Overburden - A2	8.9	100%	W	0%	none	0%	none
Overburden - S	11.9	100%	W	0%	none	0%	none
Overburden - E	31.1	100%	W	0%	none	0%	none
LV Roads	0.0	90%	W	10%	none	0%	none
Haul Roads	0.0	90%	W	10%	none	0%	none
PP Stockpile	0.0	90%	W	10%	none	0%	none
Tailings (surface)	0.0	90%	W	10%	none	0%	none
Capped 1	20.0	100%	RV	0%	none	0%	none
Capped 2 (A)	60.0	100%	RV	0%	none	0%	none
Capped 2 (B)	60.0	100%	RV	0%	none	0%	none
Capped 3 (A)	50.0	100%	RV	0%	none	0%	none
Capped 3 (B)	50.0	100%	RV	0%	none	0%	none
Capped 4	60.0	100%	RV	0%	none	0%	none
Capped 5	80.0	100%	RV	0%	none	0%	none

[1] Undisturbed areas have dust emissions of background values (control factor = 0)

Total area	39	ha	100%
Total disturbed	7	ha	18%
Total undisturbed	-	ha	0%

Total disturbed area	7	ha	100%
Area with controls	7	ha	100%
Area without controls	-	ha	0%

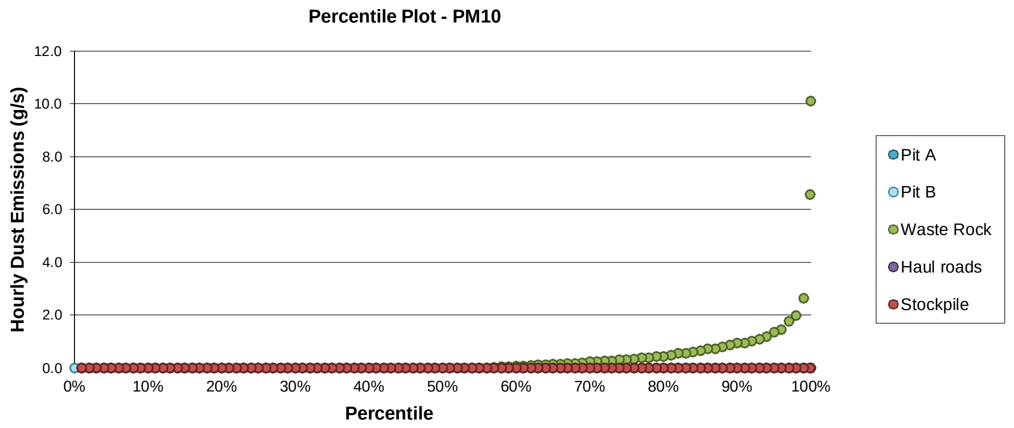
Average annual emissions from disturbed areas (TSP)

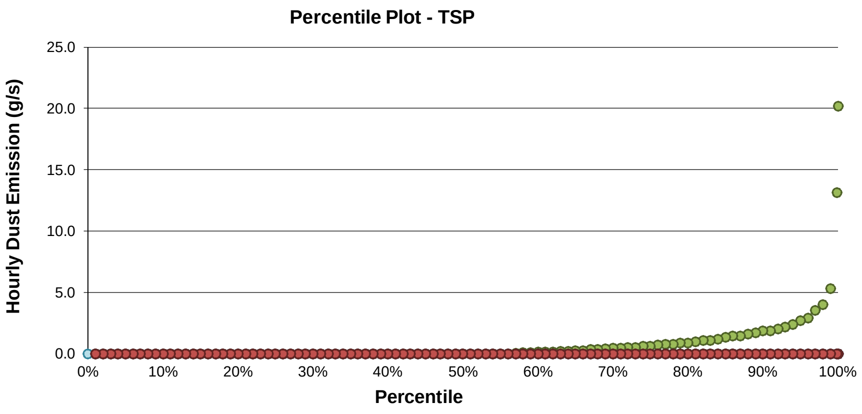
	Disturbed Controlled Areas (MANAGED) area (ha)	% of area	ER (g/s)	% of ER	Disturbed Uncontrolled Areas (ACTIVE) area (ha)	% of area	ER (g/s)	% of ER
Pit A	0.0	0%	0.0	0%	0.0	100%	0.0	0%
Pit B	0.0	0%	0.0	0%	0.0	100%	0.0	0%
Overburden - P	7.2	100%	0.6	100%	0.0	0%	0.0	0%
Overburden - A1	11.4	100%	0.9	104%	0.0	0%	0.0	-4%
Overburden - A2	8.9	100%	0.7	108%	0.0	0%	-0.1	-8%
Overburden - S	11.9	100%	0.9	113%	0.0	0%	-0.1	-13%
Overburden - E	31.1	100%	2.5	117%	0.0	0%	-0.4	-17%
LV Roads	0.0	90%	0.0	0%	0.0	10%	0.0	0%
Haul Roads	0.0	90%	0.0	0%	0.0	10%	0.0	0%
PP Stockpile	0.0	90%	0.0	0%	0	10%	0.0	0%
Tailings (surface)	0.0	90%	0.0	0%	0	10%	0.0	0%
Capped 1	20.0	100%	1.6	100%	0	0%	0.0	0%
Capped 2 (A)	60.0	100%	4.1	100%	0	0%	0.0	0%
Capped 2 (B)	60.0	100%	2.7	100%	0	0%	0.0	0%
Capped 3 (A)	50.0	100%	2.3	100%	0	0%	0.0	0%
Capped 3 (B)	50.0	100%	0.6	100%	0	0%	0.0	0%
Capped 4	60.0	100%	0.7	100%	0	0%	0.0	0%
Capped 5	80.0	100%	0.9	100%	0	0%	0.0	0%

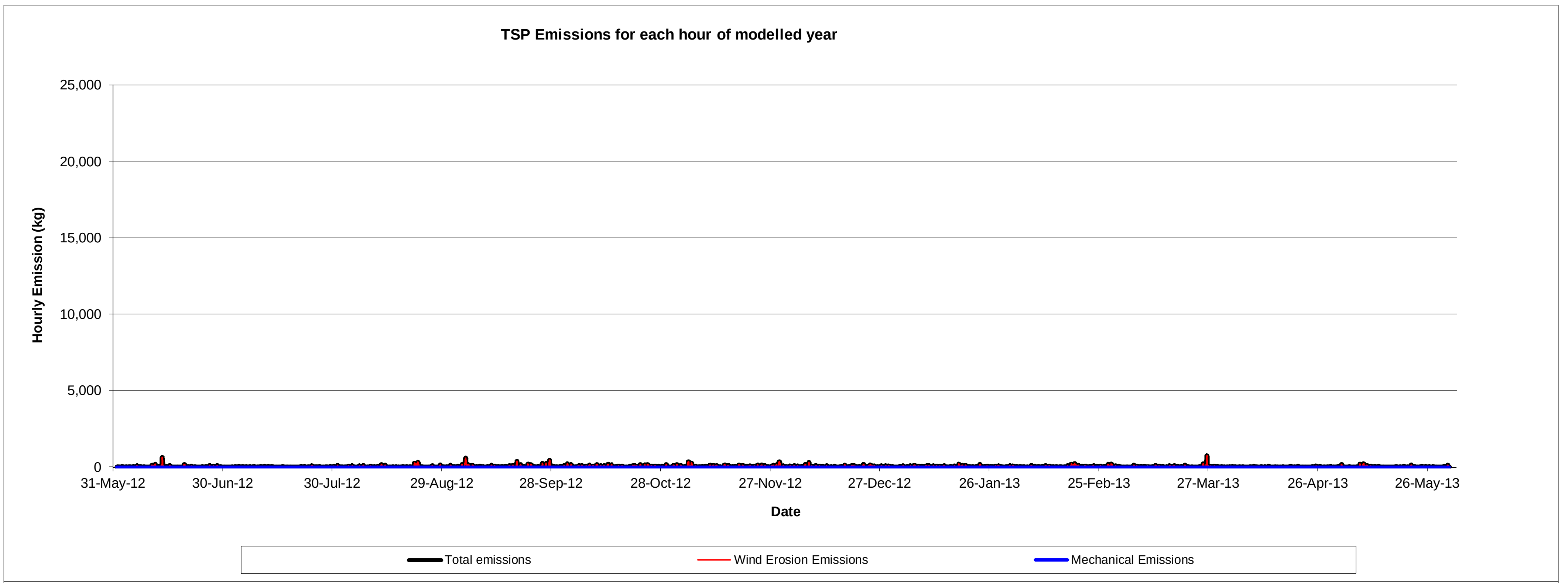
Hourly calculated emissions statistics for 1 Nov 2007 to 31 Oct 2008

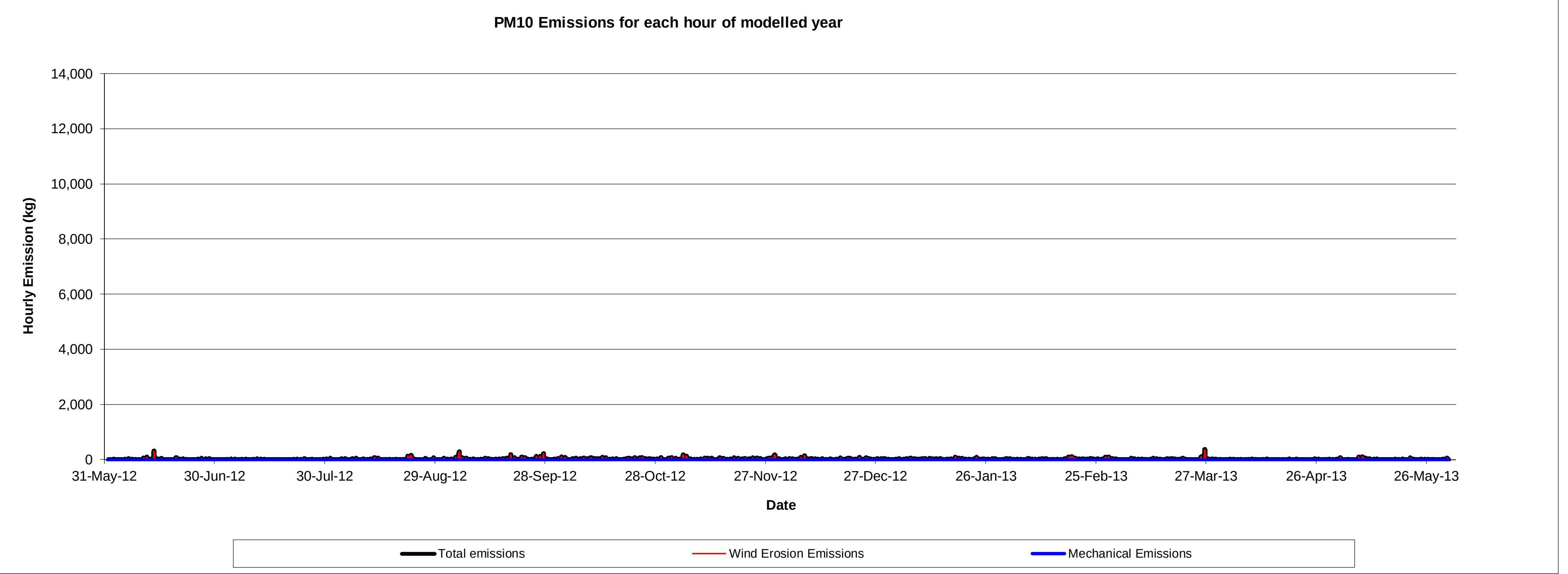
	TSP Emissions (g/s) Max	99.9 %ile	75 %ile	Ann avg	PM10 Emissions (g/s) Max	99.9 %ile	75%ile	Ann avg
Pit A	0	0	0	0	0	0	0	0
Pit B	0	0	0	0	0	0	0	0
Overburden - P	20	13	1	1	10	7	0	0
Overburden - A1	32	21	1	1	16	10	0	0
Overburden - A2	25	16	1	1	12	8	0	0
Overburden - S	33	22	1	1	17	11	1	0
Overburden - E	87	57	3	2	44	28	1	1
Roads	0	0	0	0	0	0	0	0
Stockpile	0	0	0	0	0	0	0	0
Tailings (surf.)	0	0	0	0	0	0	0	0
Capped 1	56	36	2	2	28	18	1	1
Capped 2 (A)	144	94	4	4	144	94	4	2
Capped 2 (B)	96	62	3	3	48	31	1	1
Capped 3 (A)	80	52	2	2	40	26	1	1
Capped 3 (B)	20	13	1	1	10	7	0	0
Capped 4	24	16	1	1	12	8	0	0
Capped 5	32	21	1	1	16	10	0	0

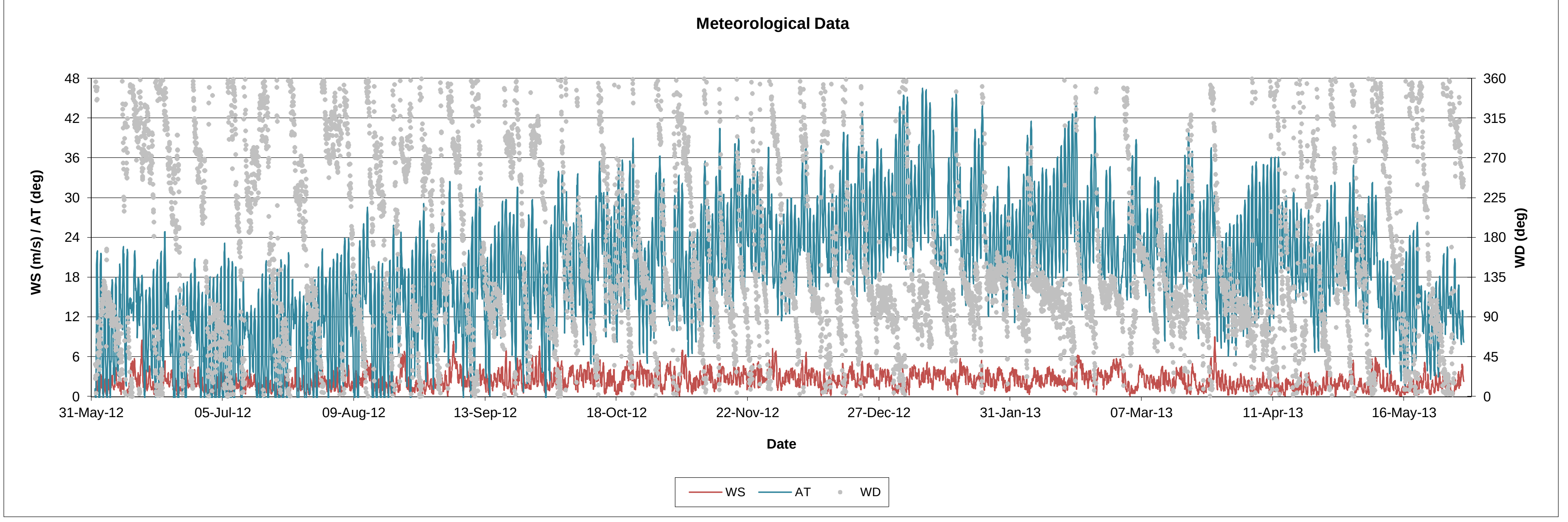
Summary of total emissions for AUSPLUME dispersion modelling
Scenario 5, closure (first year), Standard Dust Suppression.











Appendix C – Greenhouse gas calculations

Summary details for greenhouse emissions, Scenarios 1 through 4

Greenhouse gas calculations

Operational power plant - yearly estimate

1 MW gensets fuel use	330	L/hr
Number of gensets	21	

Total kl fuel used	60707	kL
Energy content factor, diesel	38.6	GJ/kL
Emissions factor	69.5	kg CO2-e/GJ
Emissions	162858	tonnes CO2-e

Operational fuel consumption - yearly estimate

Total kl fuel used*	12,200	kL
Energy content factor, diesel	38.6	GJ/kL
Emissions factor	69.9	kg CO2-e/GJ
Emissions	32,917	tonnes CO2-e

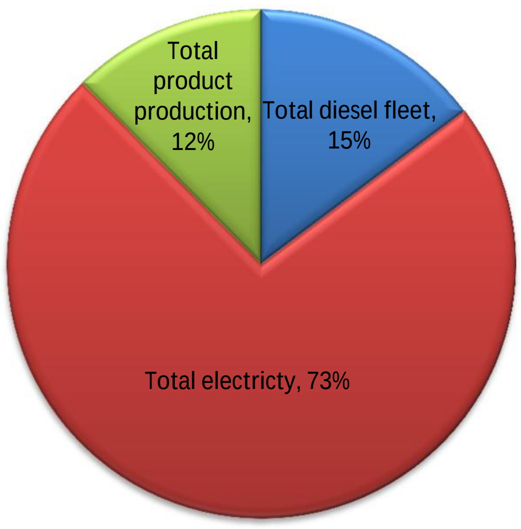
*provided by Vimy, October 2015

Operational production of product emissions - yearly estimate

Calcium carbonate consumed (annual amount)	70,000	Tonnes Carbonate
Emissions factor ($CaCO_3$)	0.396	Tonnes CO_2-e/Tonnes carbonate
Fraction material consumed	100	%
Emissions	27,720	CO_2-e tonnes

Operational total emissions - yearly estimate

Summary of total operational year	Total Emissions (tonnes CO2-e)	%
Total diesel fleet	32,917	15%
Total electricty	162,858	73%
Total product production	27,720	12%



Construction power plant - 18 month construction phase

Genset fuel use	330	L/hr	
Number of gensets	1		Assumes one genset operating at any one time

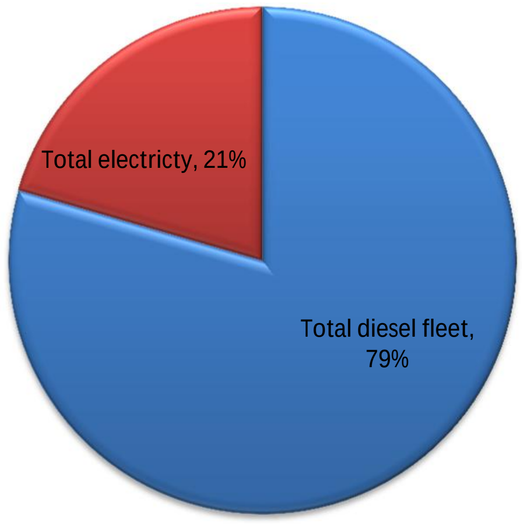
Total kl fuel used	1584	kL	Assumes active for 200 days
Energy content factor, diesel	38.6	GJ/kL	
Emissions factor	69.5	kg CO2-e/GJ	
Emissions	4249	tonnes CO2-e	

Construction fuel consumption - 18 month construction phase

Total kl fuel used	6,100	kL	assumed to be equivalent to 50% use for full production (worst case)
Energy content factor, diesel	38.6	GJ/kL	
Emissions factor	69.9	kg CO2-e/GJ	
Emissions	16,459	tonnes CO2-e	

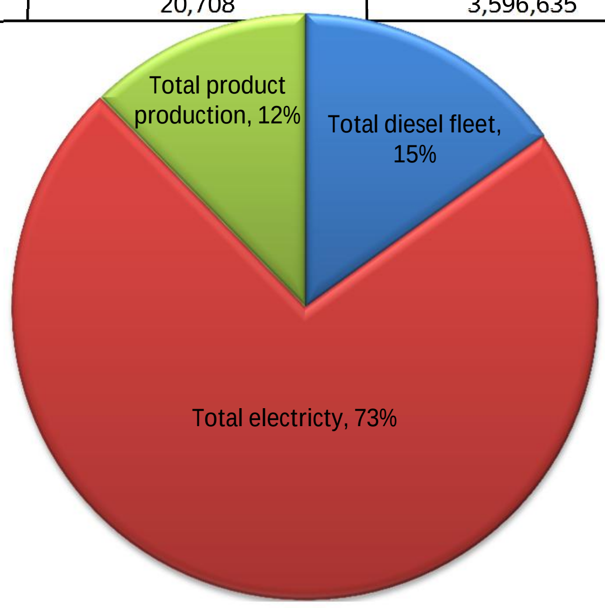
Operational total emissions - 18-month construction phase

Summary of construction	Total Emissions (tonnes CO2-e)	%
Total diesel fleet	16,459	79%
Total electricty	4,249	21%
Total product production	0	0%

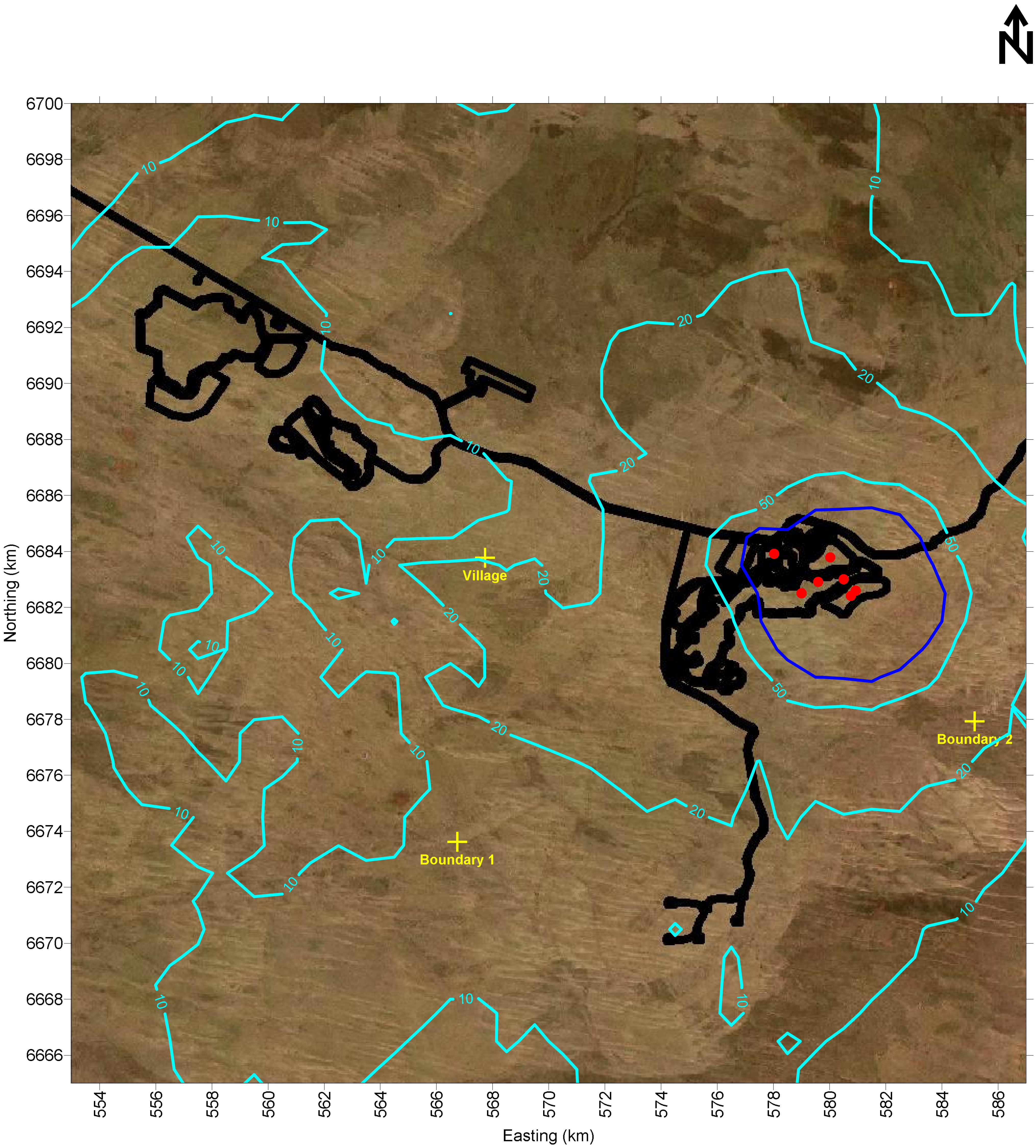


Life of mine (16 years)

Summary	Total Emissions for 16 operational years (tonnes CO2-e)	Construction phase emissions (tonnes CO2-e)	Total (tonnes (CO2-e)	%
Total diesel fleet	526,677	16,459	543,136	15%
Total electricty	2,605,730	4,249	2,609,980	73%
Total product production	443,520	0	443,520	12%
Total	3,575,927	20,708	3,596,635	100%



Appendix D – Predicted dust concentrations within the development envelope



Guideline values:
Victorian SEPP-AQM 1-hour 99.9 percentile PM10 design criteria of 80 ug/m3

LEGEND

- Proposed mine layout
- Pit and processing plant source locations
- Sensitive receptors
- Predicted 1-hr 99.9 percentile PM10 concentrations
- Victorian SEPP-AQM criteria (80 ug/m3)

SCALE

0 1 2 3 4
Kilometres (at A3)

MAP PROJECTION:
Transverse Mercator

HORIZONTAL DATUM:
Geocentric Datump of Australia (GDA)

GRID:
Map Grid of Australia 1994, Zone 51

DATA SOURCE:
LGATE_MGA51_20150220

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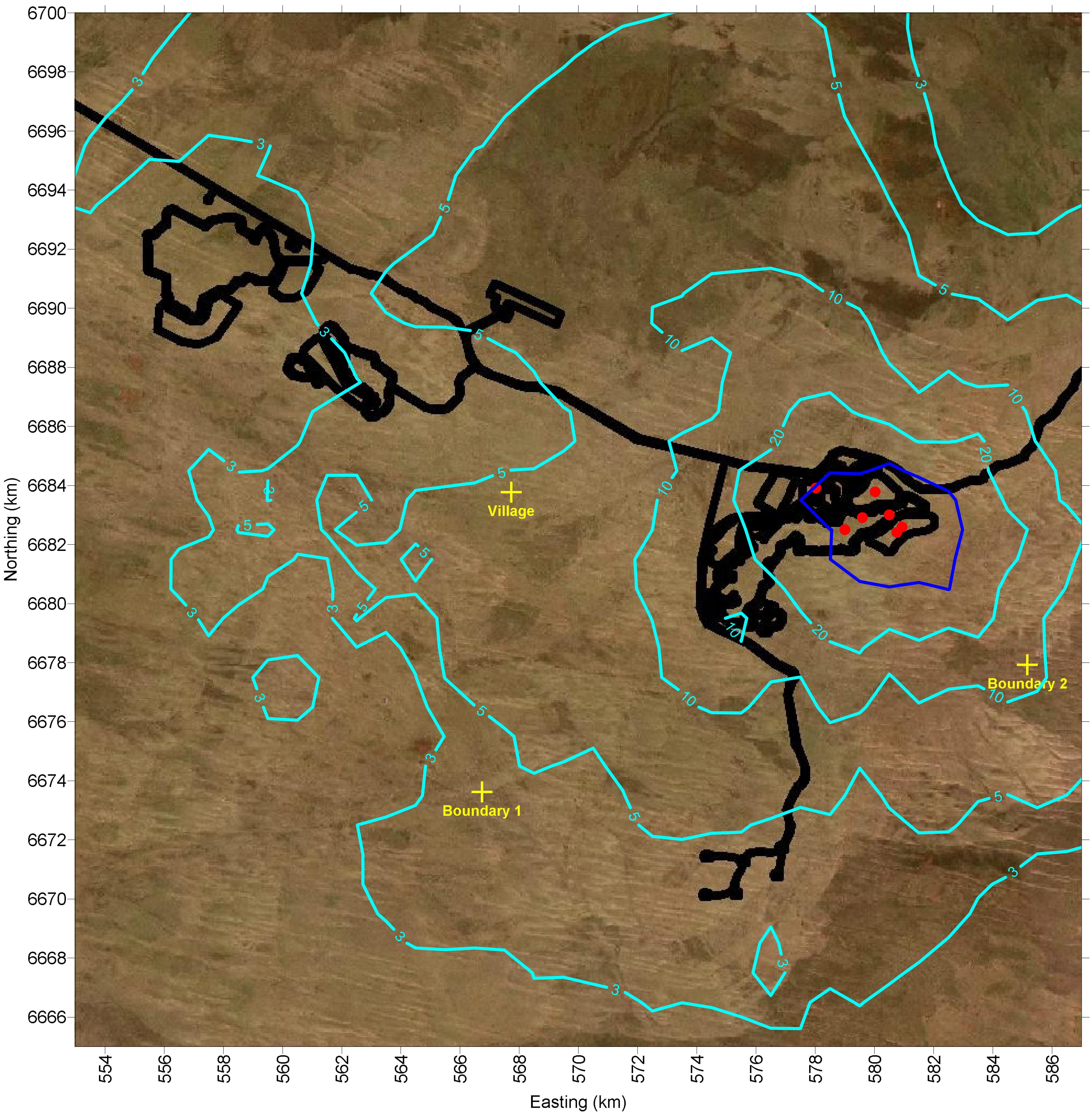
FIGURE D1

Scenario 1, Year 3
Predicted PM10 99.9 percentile 1-hour concentrations

CREATED	CHECKED	APPROVED	DATE	FILE LOCATION	DRAWING NO.	REVISION
LC	JF	JF	17.10.15	G:/61/32680/Technical/Surfer/Figure 01	Figure D1.srf	1



Guideline values:
Air NEPM 24-hour maximum PM10 concentration of 50 ug/m3

LEGEND

- Proposed mine layout
- Pit and processing plant source locations
- Sensitive receptors
- Predicted 24-hr max PM10 concentrations
- Air NEPM criteria (50 ug/m3)

SCALE

0 1 2 3 4
Kilometres (at A3)

MAP PROJECTION:
Transverse Mercator

HORIZONTAL DATUM:
Geocentric Datump of Australia (GDA)

GRID:
Map Grid of Australia 1994, Zone 51

DATA SOURCE:
LGATE_MGA51_20150220

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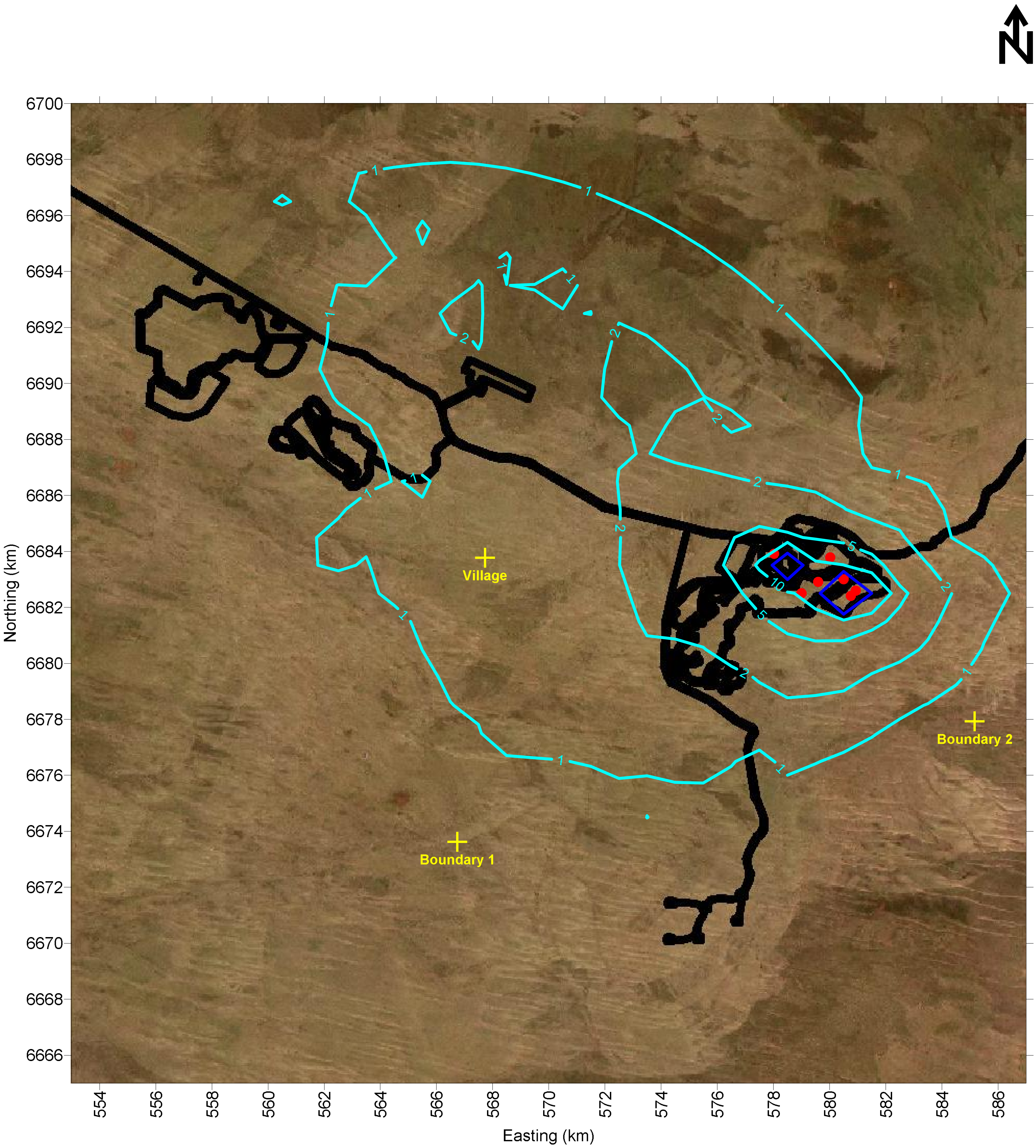
FIGURE D2

Scenario 1, Year 3
Predicted 24-hour maximum PM10 concentrations

CREATED	CHECKED	APPROVED	DATE	FILE LOCATION	DRAWING NO.	REVISION
LC	JF	JF	17.10.15	G:/61/32680/Technical/Surfer/Figure 01	Figure D2.srf	1



Guideline values:
Proposed variation to the Air NEPM for an annual PM10 concentration of 20 ug/m3

LEGEND

- Proposed mine layout
- Pit and processing plant source locations
- Sensitive receptors
- Predicted annual PM10 concentrations
- Proposed variation to Air NEPM (20 ug/m3)

SCALE

0 1 2 3 4

Kilometres (at A3)

MAP PROJECTION:
Transverse Mercator

HORIZONTAL DATUM:
Geocentric Datump of Australia (GDA)

GRID:
Map Grid of Australia 1994, Zone 51

DATA SOURCE:
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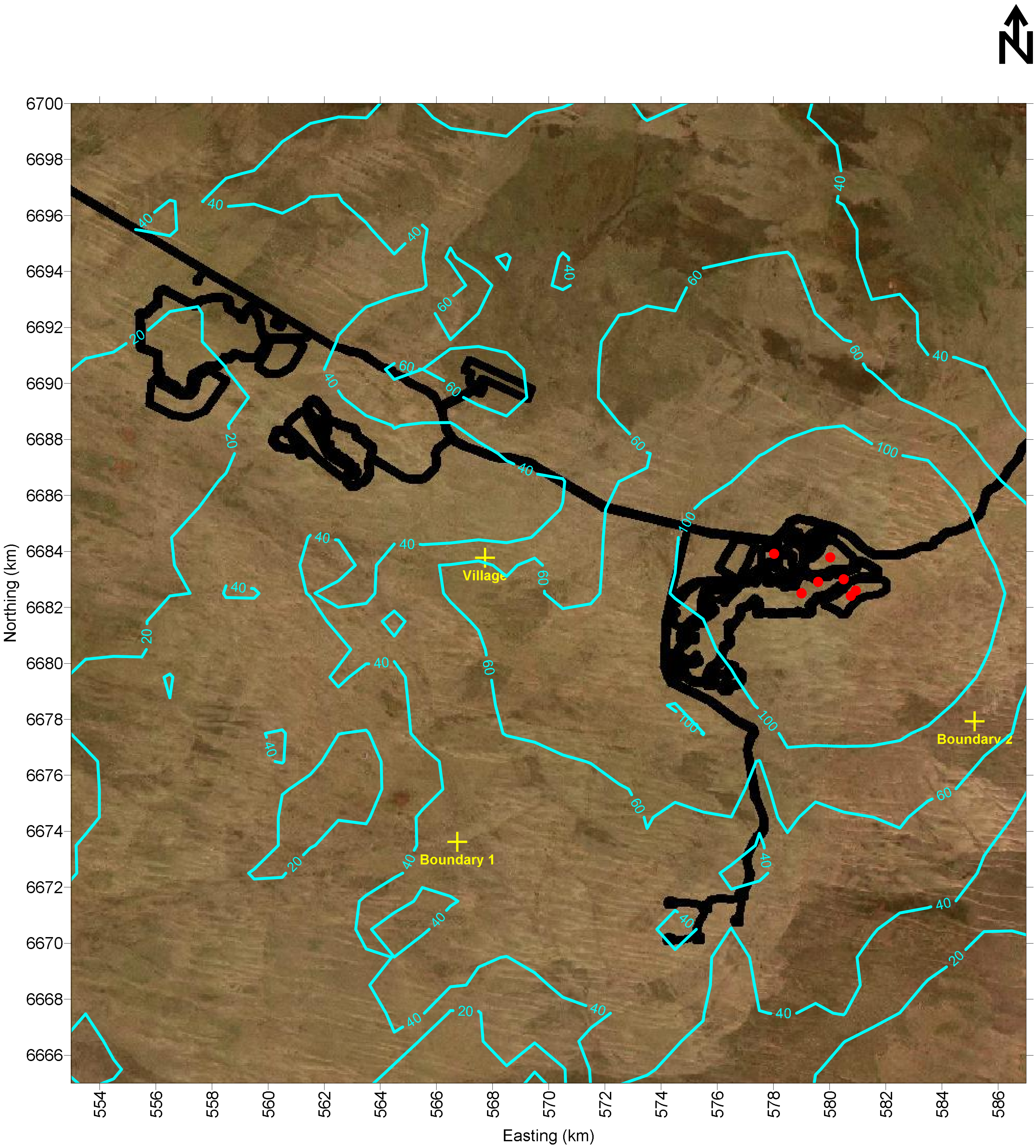
FIGURE D3

Scenario 1, Year 3
Predicted annual PM10 concentrations

CREATED	CHECKED	APPROVED	DATE	FILE LOCATION	DRAWING NO.	REVISION
LC	JF	JF	17.10.15	G:/61/32680/Technical/Surfer/Figure 01	Figure D3.srf	1



Guideline values:
Nil

LEGEND

- Proposed mine layout
- Pit and processing plant source locations
- Sensitive receptors
- Predicted 1-hr 99.9 percentile TSP concentrations

SCALE

0 1 2 3 4

Kilometres (at A3)

MAP PROJECTION:
Transverse Mercator

HORIZONTAL DATUM:
Geocentric Datum of Australia (GDA)

GRID:
Map Grid of Australia 1994, Zone 51

DATA SOURCE:
LGATE_MGA51_20150220

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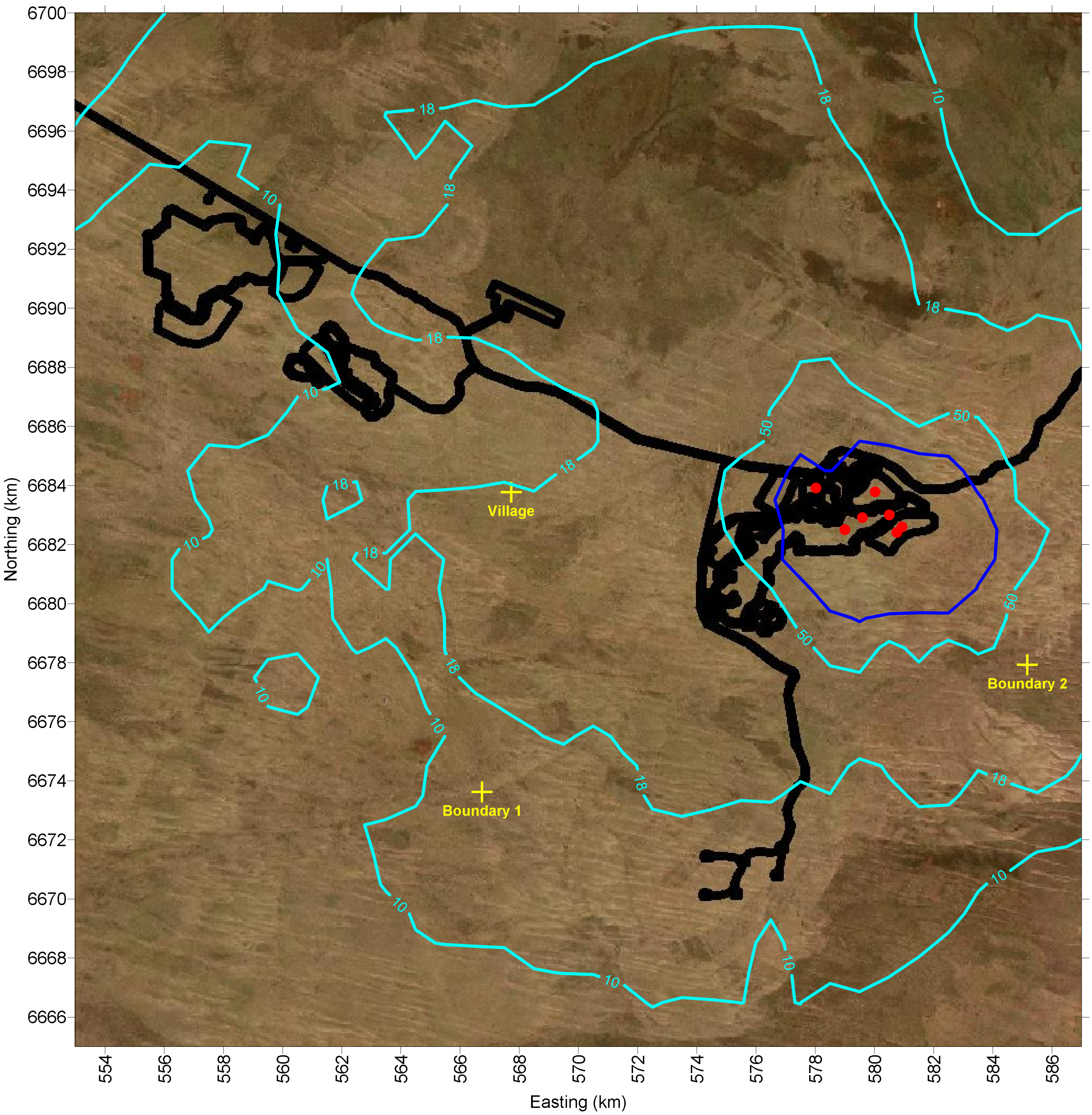
FIGURE D4

Scenario 1, Year 3
Predicted 1-hour 99.9 percentile TSP concentrations

CREATED	CHECKED	APPROVED	DATE	FILE LOCATION	DRAWING NO.	REVISION
LC	JF	JF	17.10.15	G:/61/32680/Technical/Surfer/Figure 01	Figure D4.srf	1



Guideline values:
Kwinana EPP 24-hour maximum TSP of 90 ug/m3

LEGEND

- Proposed mine layout
- Pit and processing plant source locations
- Sensitive receptors
- Predicted 24-hr max TSP concentrations
- Kwinana EPP criteria (90 ug/m3)

SCALE

0 1 2 3 4

Kilometres (at A3)

MAP PROJECTION:
Transverse Mercator

HORIZONTAL DATUM:
Geocentric Datum of Australia (GDA)

GRID:
Map Grid of Australia 1994, Zone 51

DATA SOURCE:
LGATE_MGA51_20150220

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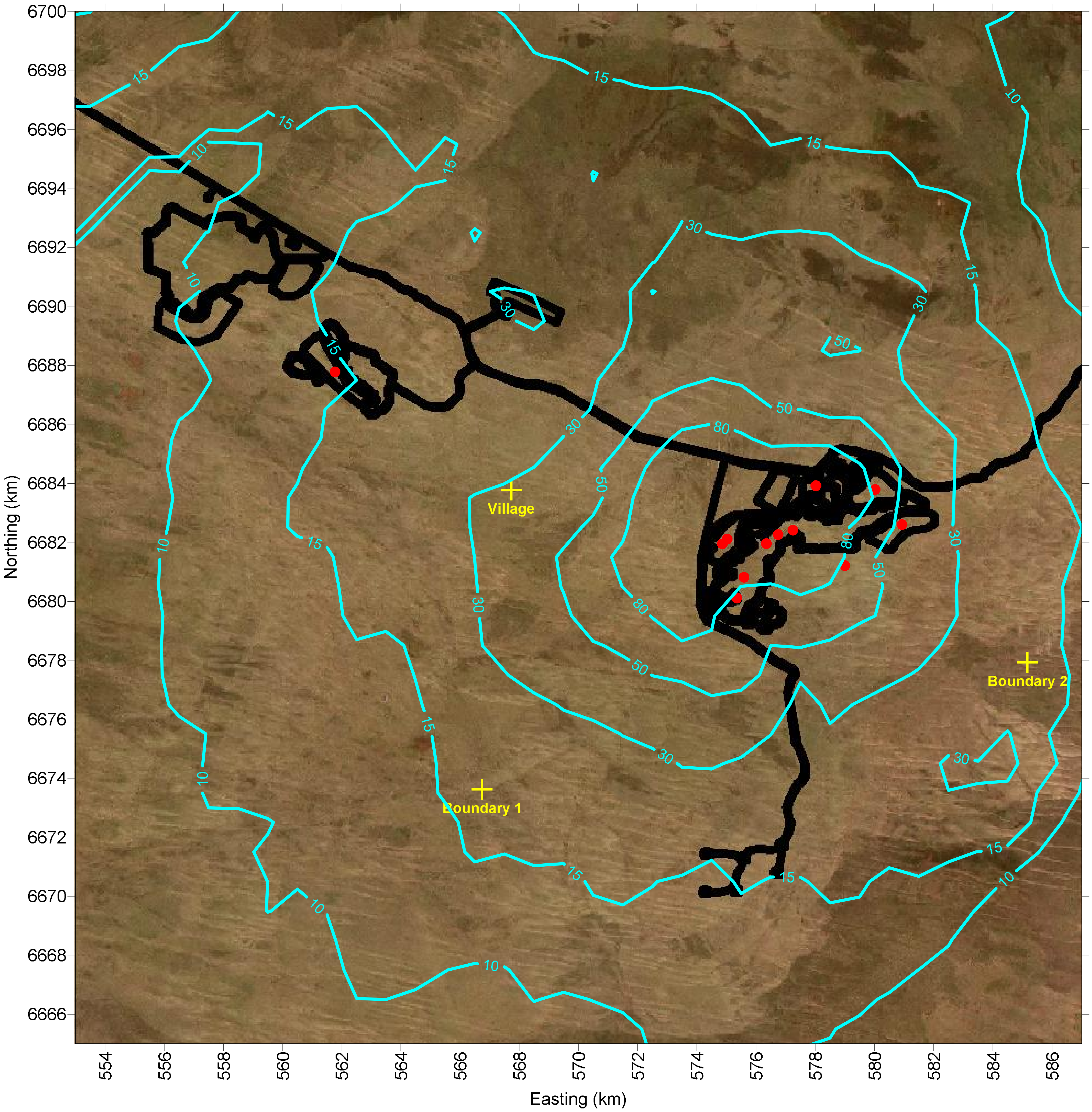
FIGURE D5

Scenario 1, Year 3
Predicted 24-hour maximum TSP concentrations

CREATED	CHECKED	APPROVED	DATE	FILE LOCATION	DRAWING NO.	REVISION
LC	JF	JF	17.10.15	G:/61/32680/Technical/Surfer/Figure 01	Figure D5.srf	1



Guideline values:
Victorian SEPP-AQM 1-hour 99.9 percentile PM10 design criteria of 80 ug/m3

LEGEND

- Proposed mine layout
- Pit and processing plant source locations
- Sensitive receptors
- Predicted 1-hr 99.9 percentile PM10 concentrations
- Victorian SEPP-AQM criteria (80 ug/m3)

SCALE

0 1 2 3 4
Kilometres (at A3)

MAP PROJECTION:
Transverse Mercator

HORIZONTAL DATUM:
Geocentric Datum of Australia (GDA)

GRID:
Map Grid of Australia 1994, Zone 51

DATA SOURCE:
LGATE_MGA51_20150220

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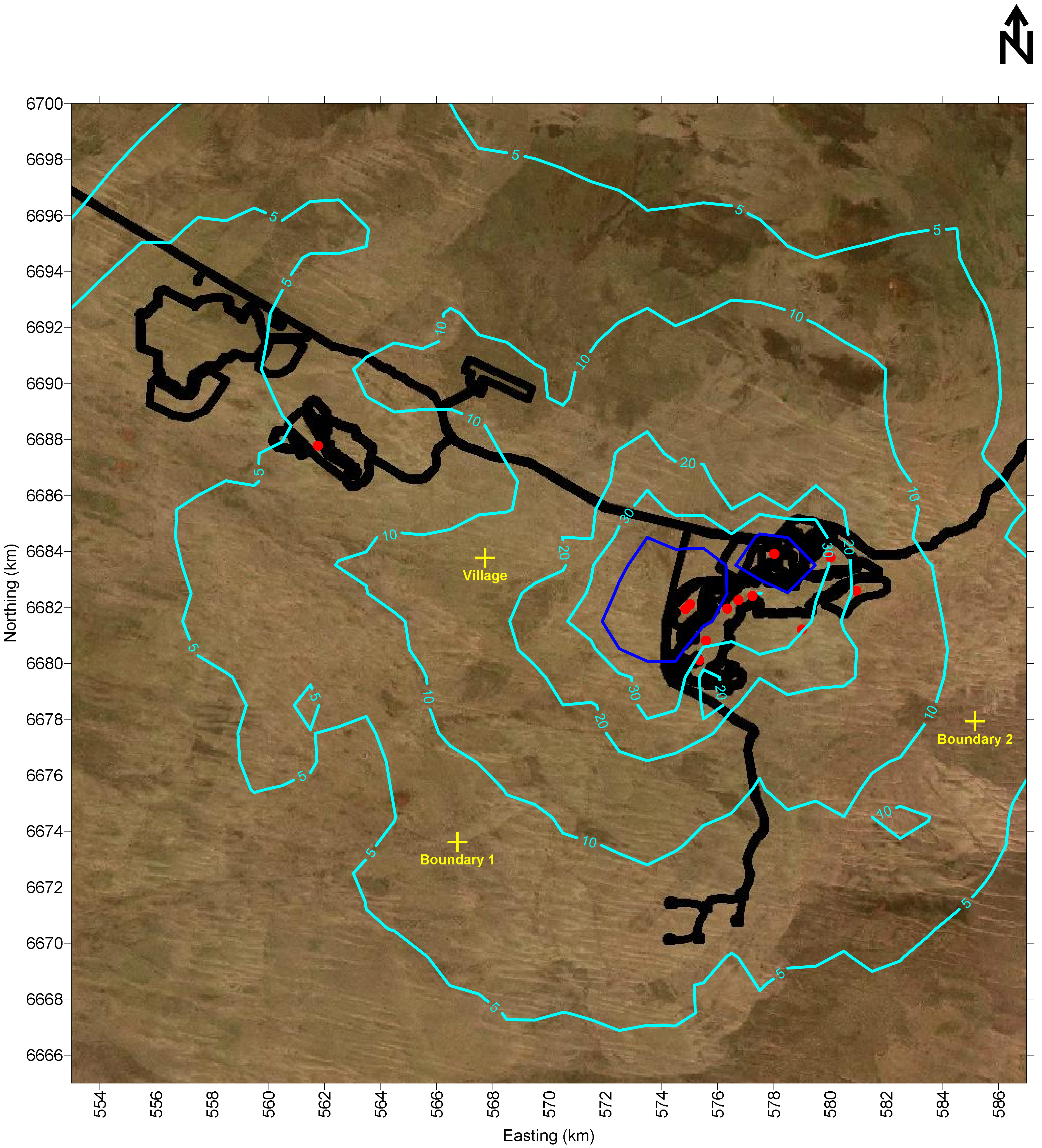
FIGURE D6

Scenario 2, Year 10
Predicted 1-hour 99.9 percentile PM10 concentrations

CREATED	CHECKED	APPROVED	DATE	FILE LOCATION	DRAWING NO.	REVISION
LC	JF	JF	17.10.15	G:/61/32680/Technical/Surfer/Figure 01	Figure D6.srf	1



Guideline values:
Air NEPM 24-hour maximum PM10 concentration of 50 ug/m3

LEGEND

- Proposed mine layout
- Pit and processing plant source locations
- Sensitive receptors
- Predicted 24-hr max PM10 concentrations
- Air NEPM criteria (50 ug/m3)

SCALE

0 1 2 3 4

Kilometres (at A3)

MAP PROJECTION: Transverse Mercator

HORIZONTAL DATUM: Geocentric Datum of Australia (GDA)

GRID: Map Grid of Australia 1994, Zone 51

DATA SOURCE: LGATE_MGA51_20150220

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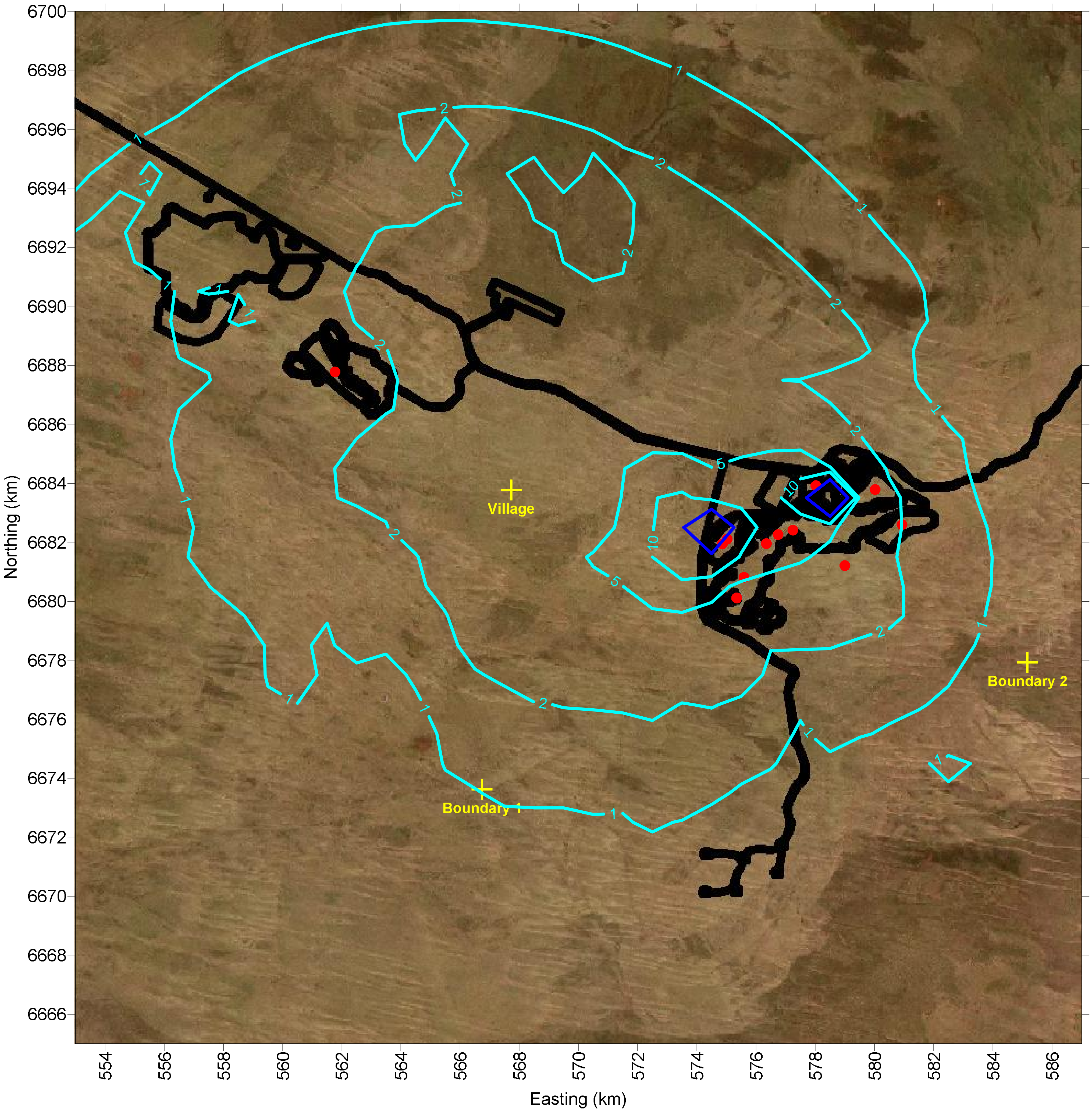
FIGURE D7

Scenario 2, Year 10
Predicted 24-hour maximum PM10 concentrations

CREATED	CHECKED	APPROVED	DATE	FILE LOCATION	DRAWING NO.	REVISION
LC	JF	JF	17.10.15	G:/61/32680/Technical/Surfer/Figure 01	Figure D7.srf	1



Guideline values:
Proposed variation to the Air NEPM for an annual maximum PM10 concentration of 20 ug/m3

LEGEND

- Proposed mine layout
- Pit and processing plant source locations
- Sensitive receptors
- Predicted annual max PM10 concentrations
- Proposed variation to Air NEPM criteria (20 ug/m3)

SCALE

0 1 2 3 4
Kilometres (at A3)

MAP PROJECTION:
Transverse Mercator

HORIZONTAL DATUM:
Geocentric Datum of Australia (GDA)

GRID:
Map Grid of Australia 1994, Zone 51

DATA SOURCE:
LGATE_MGA51_20150220

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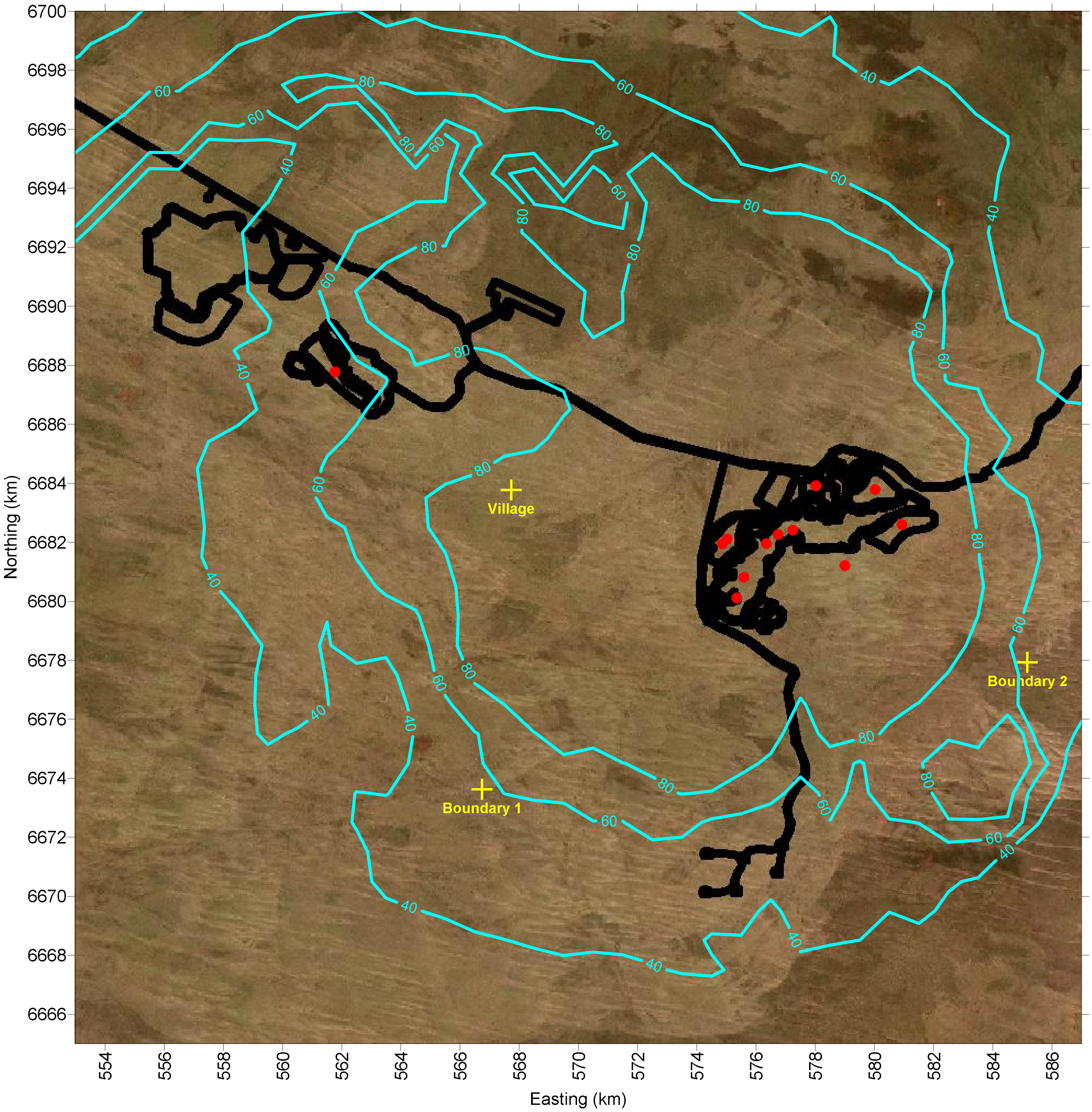
FIGURE D8

Scenario 2, Year 10
Predicted annual maximum PM10 concentrations

CREATED	CHECKED	APPROVED	DATE	FILE LOCATION	DRAWING NO.	REVISION
LC	JF	JF	17.10.15	G:/61/32680/Technical/Surfer/Figure 01	Figure D8.srf	1



Guideline values:
Nil

LEGEND

- Proposed mine layout
- Pit and processing plant source locations
- Sensitive receptors
- Predicted 1-hr 99.9 percentile TSP concentrations

SCALE

0 1 2 3 4

Kilometres (at A3)

MAP PROJECTION:
Transverse Mercator

HORIZONTAL DATUM:
Geocentric Datump of Australia (GDA)

GRID:
Map Grid of Australia 1994, Zone 51

DATA SOURCE:
LGATE_MGA50_20150220

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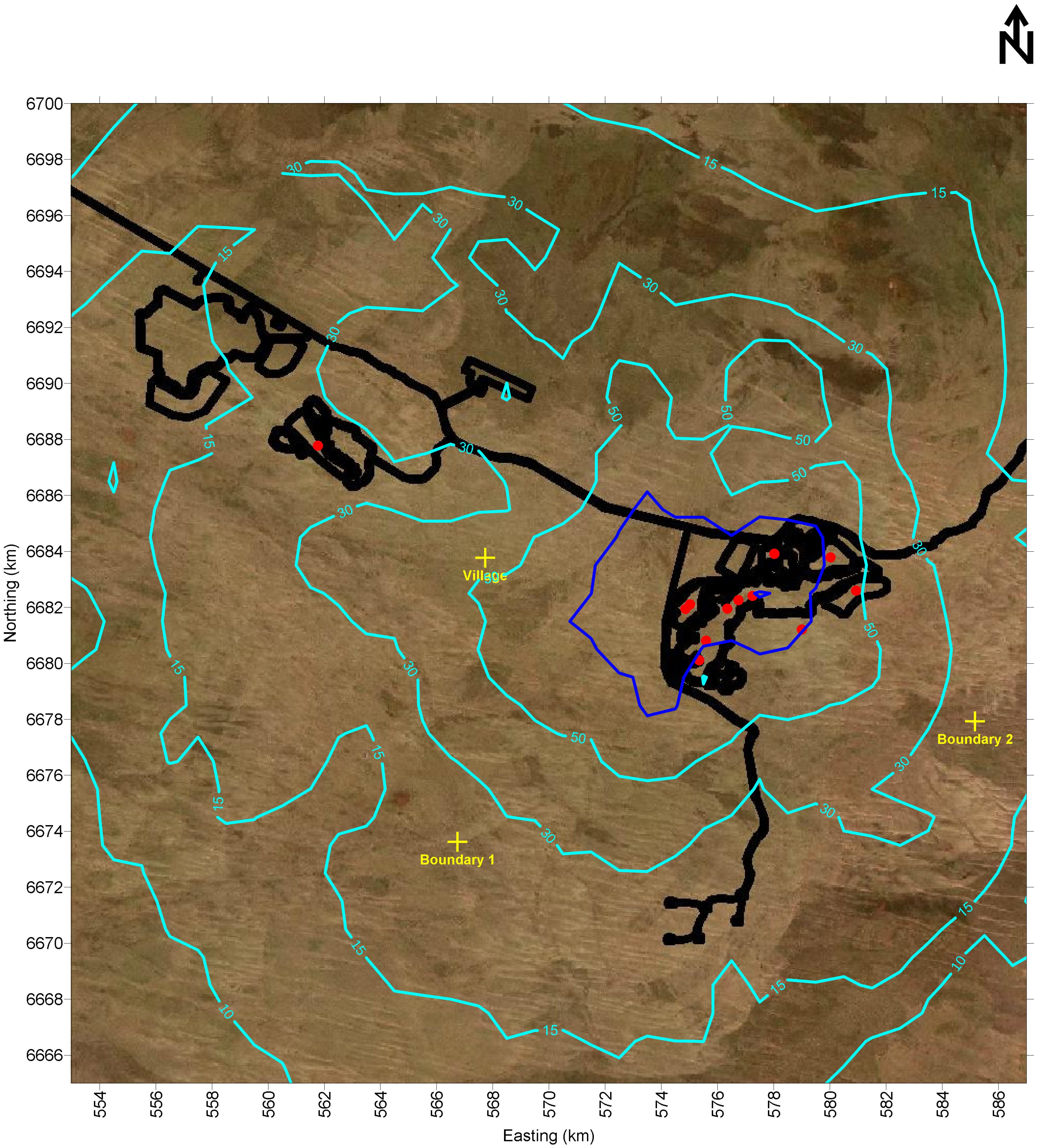
FIGURE D9

Scenario 2, Year 10
Predicted 1-hour 99.9 percentile TSP conncentrations

CREATED	CHECKED	APPROVED	DATE	FILE LOCATION	DRAWING NO.	REVISION
LC	JF	JF	17.10.15	G:/61/32680/Technical/Surfer/Figure 01	Figure D9.srf	1



Guideline values:
Kwinana EPP 24-hour maximum TSP of 90 ug/m3

LEGEND

- Proposed mine layout
- Pit and processing plant source locations
- Sensitive receptors
- Predicted 24-hr max TSP concentrations
- Predicted 24-hr max TSP concentrations

SCALE

0 1 2 3 4
Kilometres (at A3)

MAP PROJECTION: Transverse Mercator
HORIZONTAL DATUM: Geocentric Datump of Australia (GDA)
GRID: Map Grid of Australia 1994, Zone 51
DATA SOURCE: LGATE_MGA51_20150220

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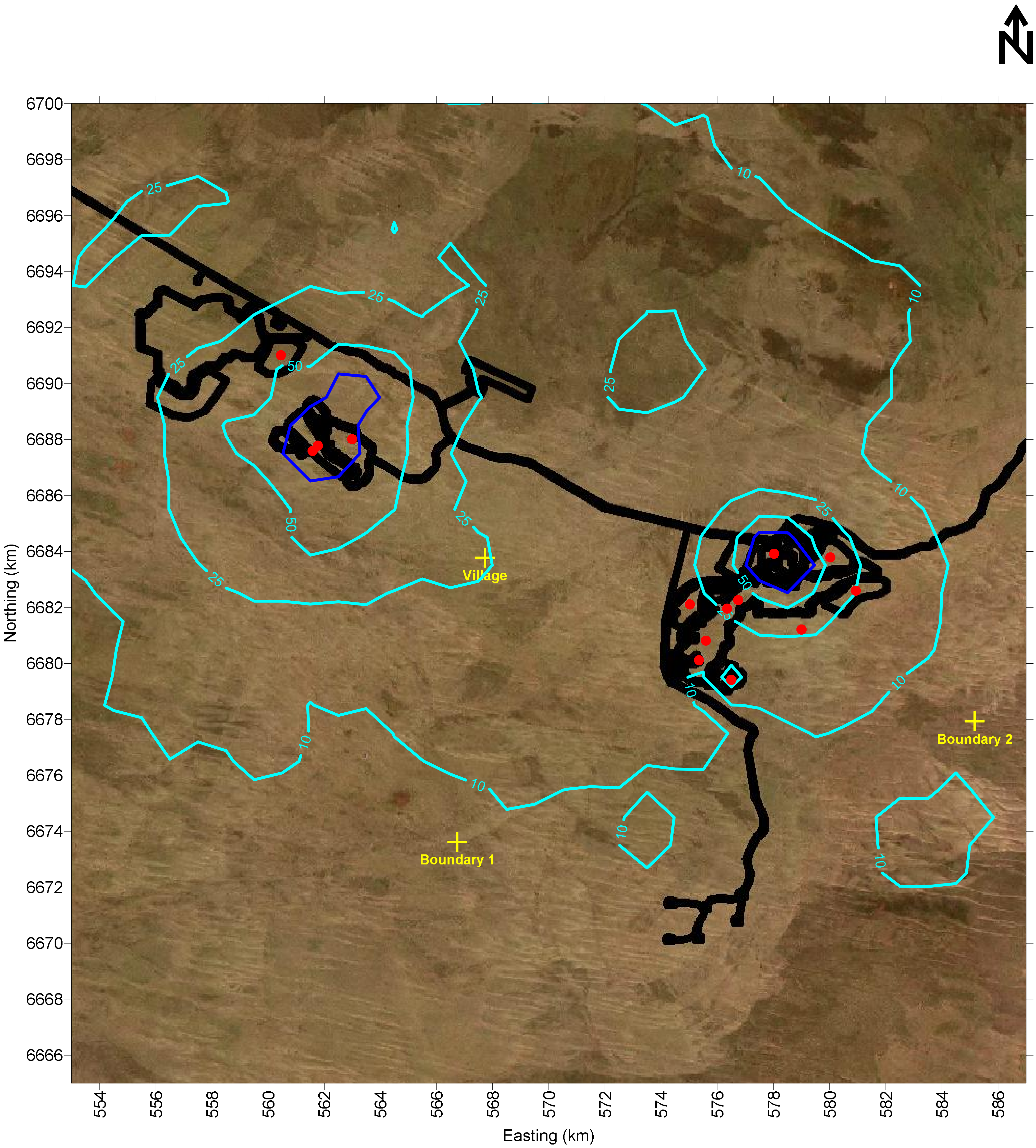
FIGURE D10

Scenario 2, Year 10
Predicted 24-hour maximum TSP concentrations

CREATED	CHECKED	APPROVED	DATE	FILE LOCATION	DRAWING NO.	REVISION
LC	JF	JF	17.10.15	G:/61/32680/Technical/Surfer/Figure 01	Figure D10.srf	1



Guideline values:
Victorian SEPP-AQM 1-hour 99.9 percentile PM10 design criteria of 80 ug/m3

LEGEND

- Proposed mine layout
- Pit and processing plant source locations
- Sensitive receptors
- Predicted 1-hr 99.9 percentile PM10 concentrations
- Victorian SEPP-AQM criteria (80 ug/m3)

SCALE

0 1 2 3 4

Kilometres (at A3)

MAP PROJECTION:
Transverse Mercator

HORIZONTAL DATUM:
Geocentric Datum of Australia (GDA)

GRID:
Map Grid of Australia 1994, Zone 51

DATA SOURCE:
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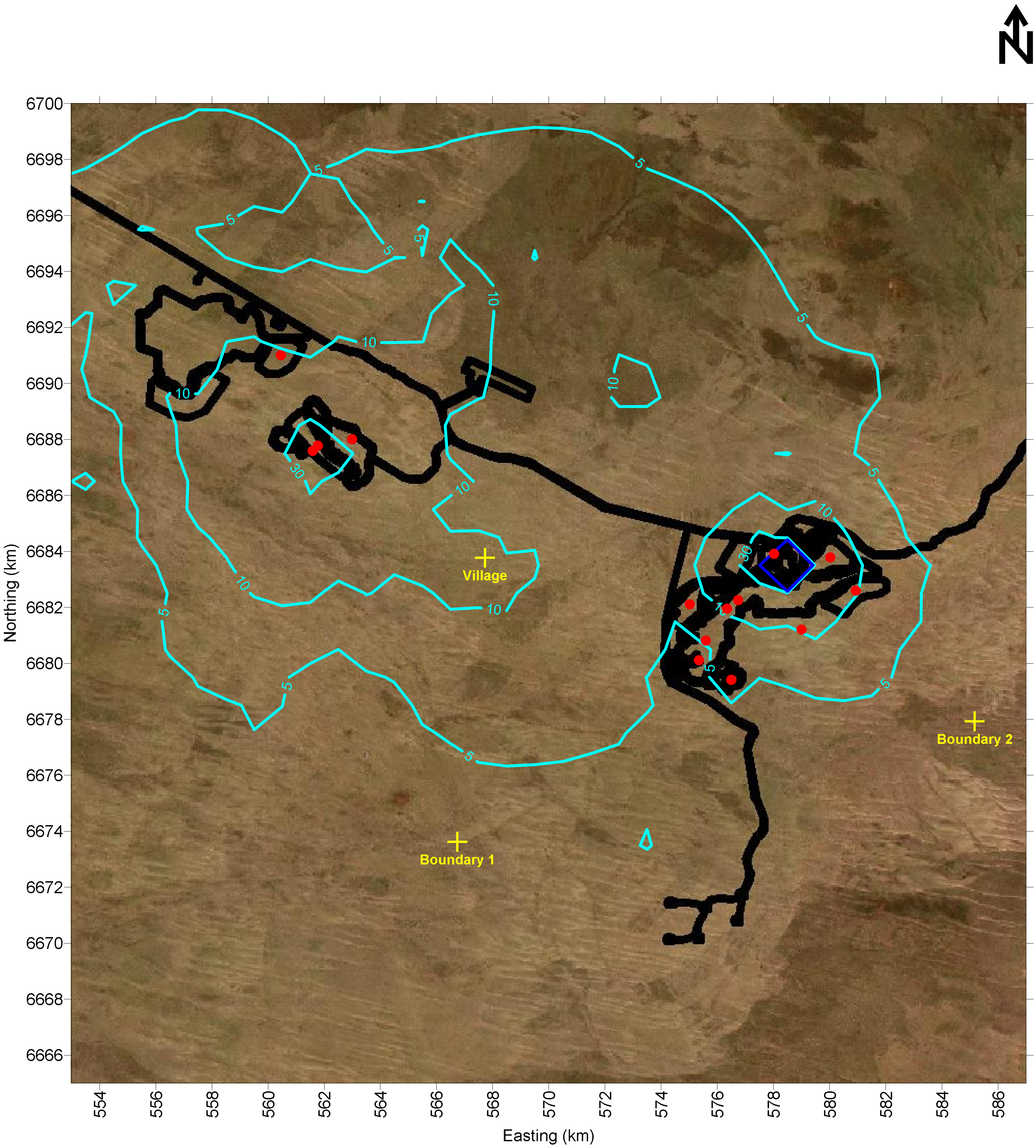
FIGURE D11

Scenario 3, Year 11
Predicted 1-hour 99.9 percentile PM10 concentrations

CREATED	CHECKED	APPROVED	DATE	FILE LOCATION	DRAWING NO.	REVISION
LC	JF	JF	17.10.15	G:/61/32680/Technical/Surfer/Figure 01	Figure D11.srf	1



Guideline values:
Air NEPM 24-hour maximum PM10 concentration of 50 ug/m3

LEGEND

- Proposed mine layout
- Pit and processing plant source locations
- Sensitive receptors
- Predicted 24-hr max PM10 concentrations
- Air NEPM criteria (50 ug/m3)

SCALE

0 1 2 3 4
Kilometres (at A3)

MAP PROJECTION: Transverse Mercator
HORIZONTAL DATUM: Geocentric Datump of Australia (GDA)
GRID: Map Grid of Australia 1994, Zone 51
DATA SOURCE: LGATE_MGA51_20150220

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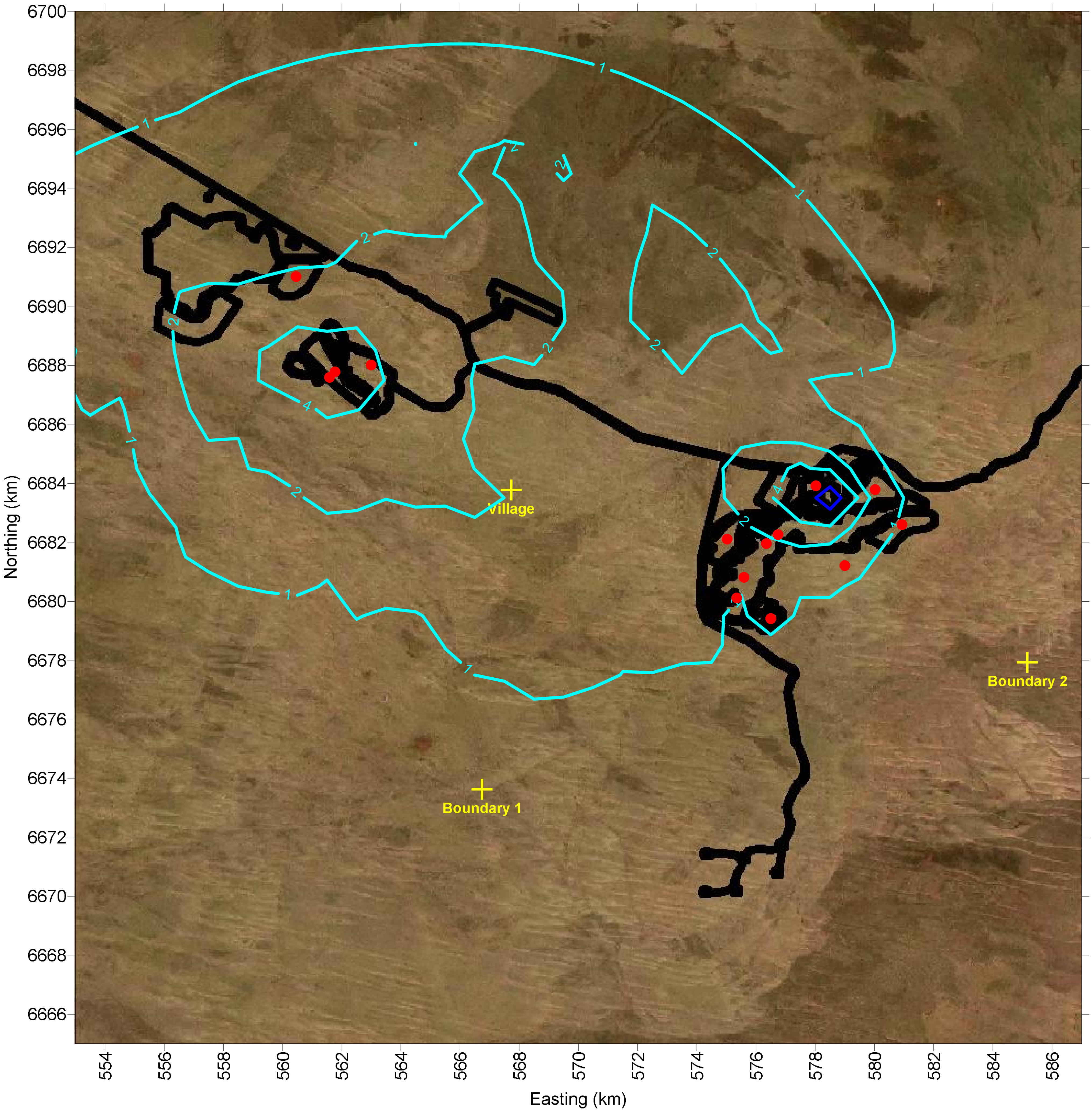
FIGURE D12

Scenario 3, Year 11
Predicted 24-hour maximum PM10 concentrations

CREATED	CHECKED	APPROVED	DATE	FILE LOCATION	DRAWING NO.	REVISION
LC	JF	JF	17.10.15	G:/61/32680/Technical/Surfer/Figure 01	Figure D12.srf	1



Guideline values:
Proposed variation to the Air NEPM for an annual maximum PM10 concentration of 20 ug/m3

LEGEND

- Proposed mine layout
- Pit and processing plant source locations
- Sensitive receptors
- Predicted annual PM10 concentrations
- Proposed variation to Air NEPM criteria (20 ug/m3)

SCALE

0 1 2 3 4

Kilometres (at A3)

MAP PROJECTION:
Transverse Mercator

HORIZONTAL DATUM:
Geocentric Datum of Australia (GDA)

GRID:
Map Grid of Australia 1994, Zone 51

DATA SOURCE:
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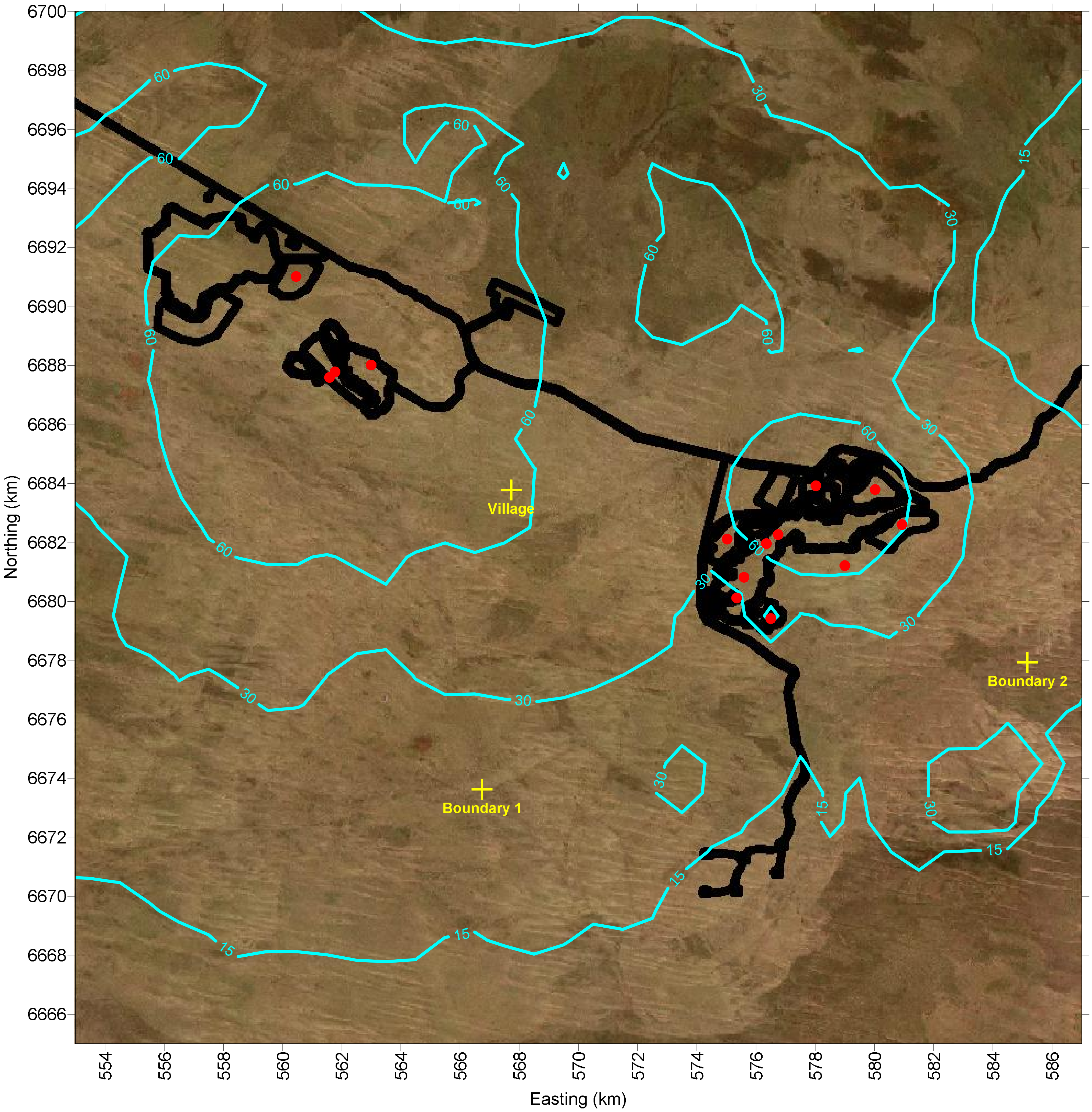
FIGURE D13

Scenario 3, Year 11
Predicted annual PM10 concentrations

CREATED	CHECKED	APPROVED	DATE	FILE LOCATION	DRAWING NO.	REVISION
LC	JF	JF	17.10.15	G:/61/32680/Technical/Surfer/Figure 01	Figure D13.srf	1



Guideline values:
Nil

LEGEND

- Proposed mine layout
- Pit and processing plant source locations
- Sensitive receptors
- Predicted 1-hr 99.9 percentile TSP concentrations

SCALE

0 1 2 3 4

Kilometres (at A3)

MAP PROJECTION:
Transverse Mercator

HORIZONTAL DATUM:
Geocentric Datum of Australia (GDA)

GRID:
Map Grid of Australia 1994, Zone 51

DATA SOURCE:
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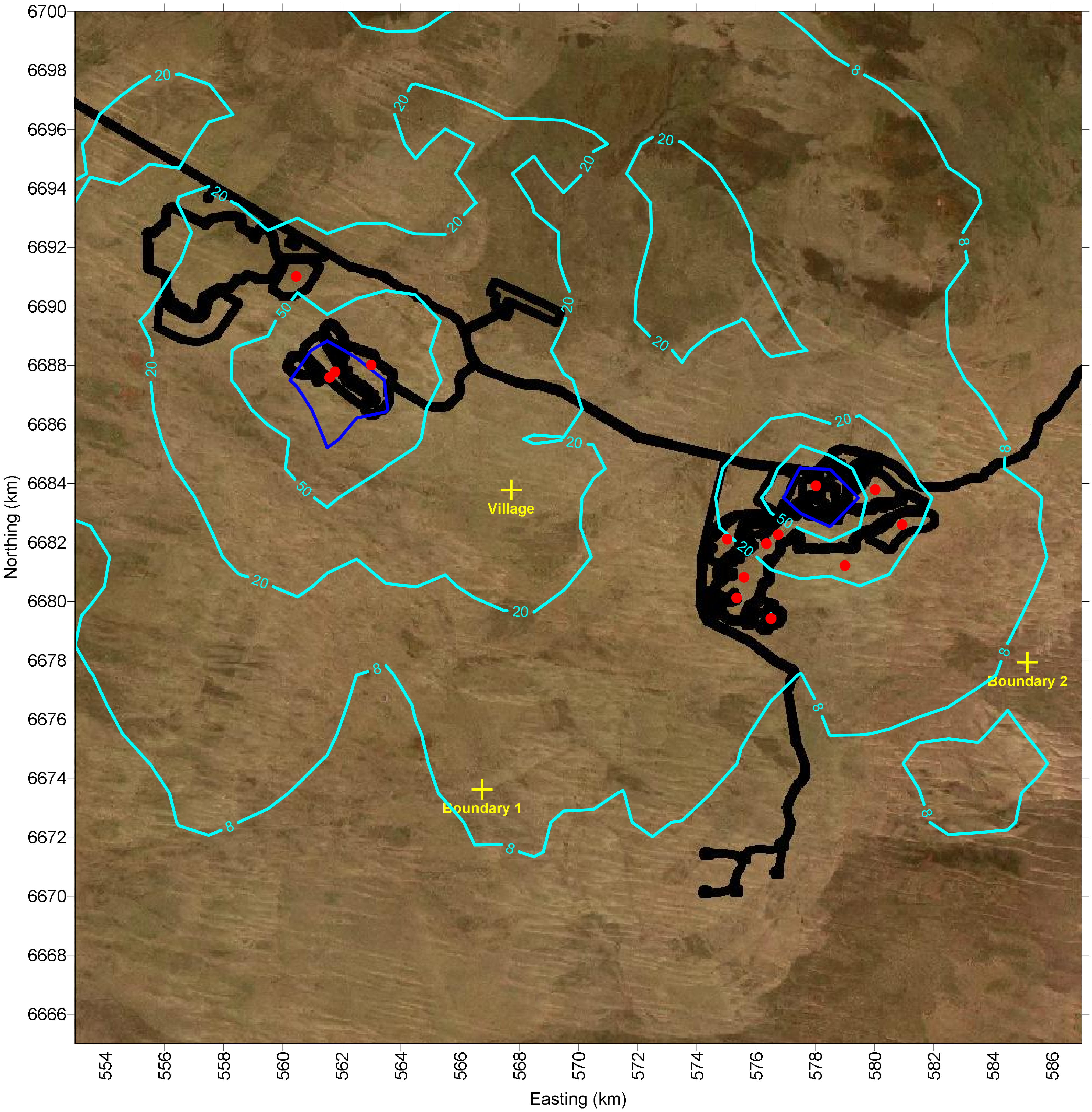
FIGURE D14

Scenario 3, Year 7
Predicted 1-hour 99.9 percentile TSP concentrations

CREATED	CHECKED	APPROVED	DATE	FILE LOCATION	DRAWING NO.	REVISION
LC	JF	JF	17.10.15	G:/61/32680/Technical/Surfer/Figure 01	Figure D14.srf	1



Guideline values:
Kwinana EPP 24-hour maximum TSP of 90 ug/m3

LEGEND

- Proposed mine layout
- Pit and processing plant source locations
- Sensitive receptors
- Predicted 24-hr max TSP concentrations
- Kwinana EPP criteria (90 ug/m3)

SCALE

0 1 2 3 4
Kilometres (at A3)

MAP PROJECTION:
Transverse Mercator

HORIZONTAL DATUM:
Geocentric Datum of Australia (GDA)

GRID:
Map Grid of Australia 1994, Zone 51

DATA SOURCE:
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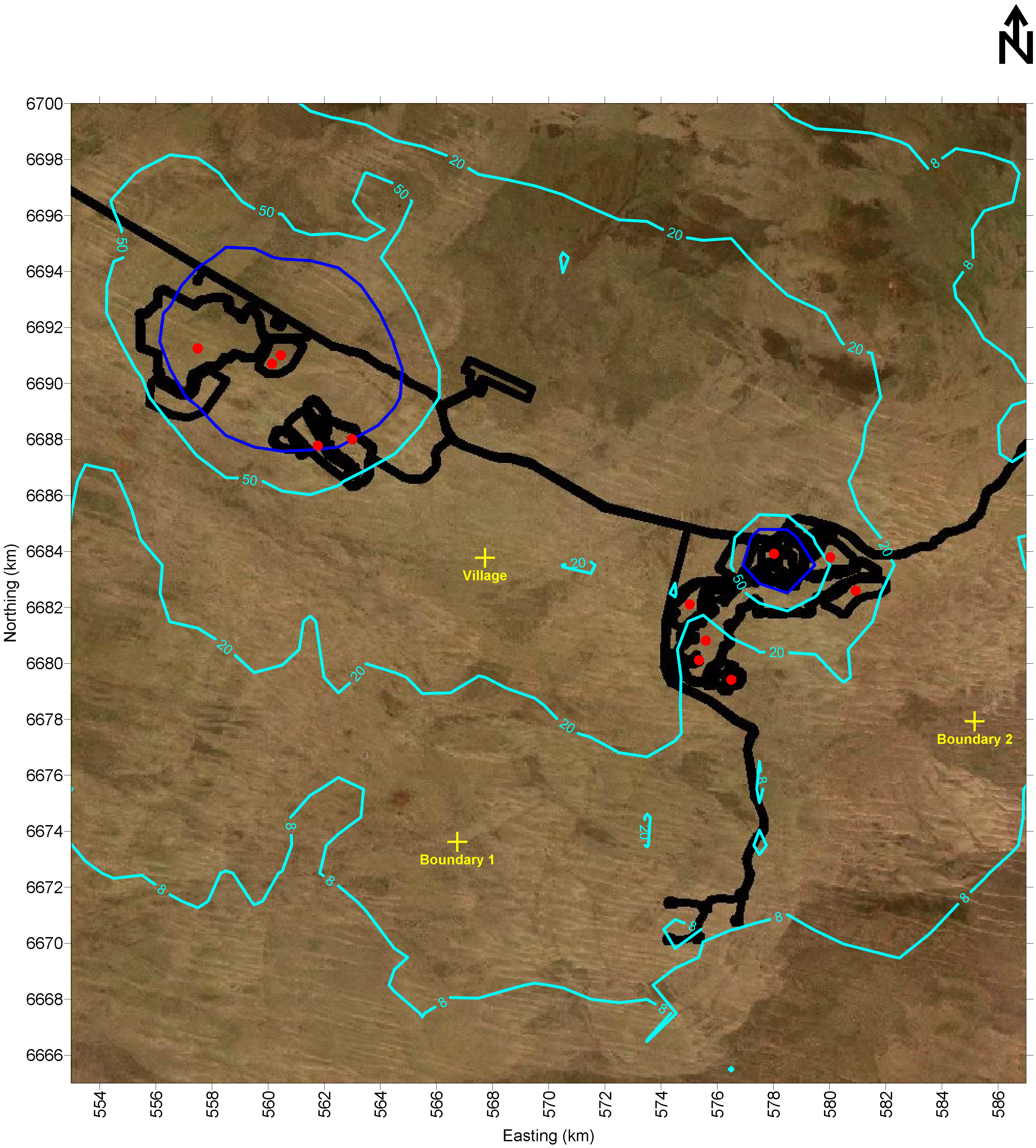
FIGURE D15

Scenario 3, Year 11
Predicted 24-hour maximum TSP contours

CREATED	CHECKED	APPROVED	DATE	FILE LOCATION	DRAWING NO.	REVISION
LC	JF	JF	17.10.15	G:/61/32680/Technical/Surfer/Figure 01	Figure D15.srf	1



Guideline values:
Victorian SEPP-AQM 1-hour 99.9 percentile PM10 design criteria of 80 ug/m3

LEGEND

- Proposed mine layout
- Pit and processing plant source locations
- Sensitive receptors
- Predicted 1-hr 99.9 percentile PM10 concentrations
- Victorian SEPP-AQM criteria (80 ug/m3)

SCALE

0 1 2 3 4

Kilometres (at A3)

MAP PROJECTION:
Transverse Mercator

HORIZONTAL DATUM:
Geocentric Datum of Australia (GDA)

GRID:
Map Grid of Australia 1994, Zone 51

DATA SOURCE:
LGATE_MGA51_20150220

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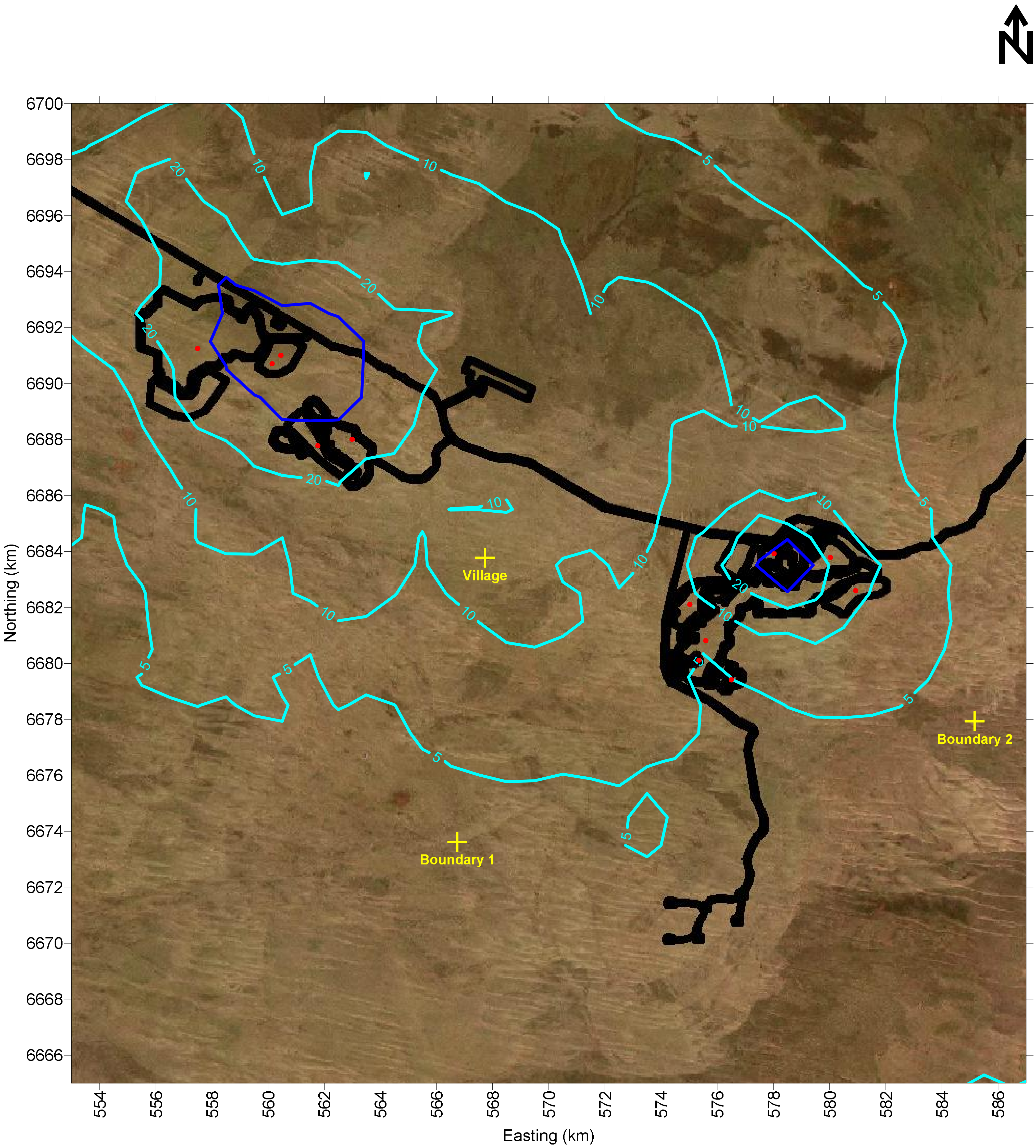
FIGURE D16

Scenario 4, Year 14
Predicted 1-hour 99.9 percentile PM10 concentrations

CREATED	CHECKED	APPROVED	DATE	FILE LOCATION	DRAWING NO.	REVISION
LC	JF	JF	17.10.15	G:/61/32680/Technical/Surfer/Figure 01	Figure D16.srf	1



Guideline values:
Air NEPM 24-hour maximum PM10 concentration of 50 ug/m3

LEGEND

- Proposed mine layout
- Pit and processing plant source locations
- Sensitive receptors
- Predicted 24-hr max PM10 concentrations
- Air NEPM criteria (50 ug/m3)

SCALE

0 1 2 3 4
Kilometres (at A3)

MAP PROJECTION: Transverse Mercator

HORIZONTAL DATUM: Geocentric Datum of Australia (GDA)

GRID: Map Grid of Australia 1994, Zone 51

DATA SOURCE: LGATE_MGA51_20150220

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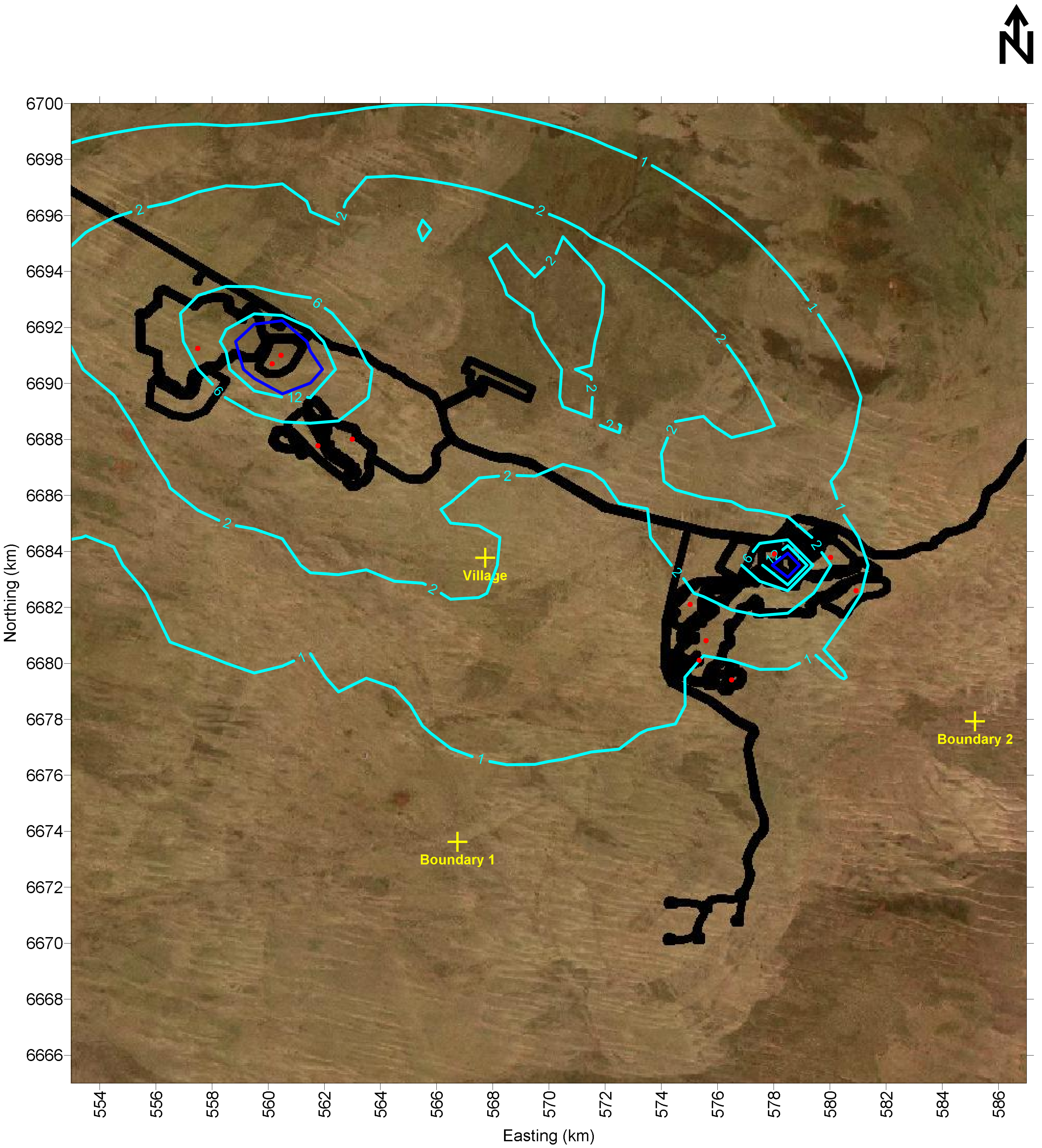
FIGURE D17

Scenario 4, Year 14
Predicted 24-hour maximum PM10 concentrations

CREATED	CHECKED	APPROVED	DATE	FILE LOCATION	DRAWING NO.	REVISION
LC	JF	JF	17.10.15	G:/61/32680/Technical/Surfer/Figure 01	Figure D17.srf	1



Guideline values:
Proposed variation to the Air NEPM for an annual maximum PM10 concentration of 20 ug/m3

LEGEND

- Proposed mine layout
- Pit and processing plant source locations
- Sensitive receptors
- Predicted annual PM10 concentrations
- Proposed variation to Air NEPM criteria (20 ug/m3)

SCALE

0 1 2 3 4
Kilometres (at A3)

MAP PROJECTION:
Transverse Mercator

HORIZONTAL DATUM:
Geocentric Datump of Australia (GDA)

GRID:
Map Grid of Australia 1994, Zone 51

DATA SOURCE:
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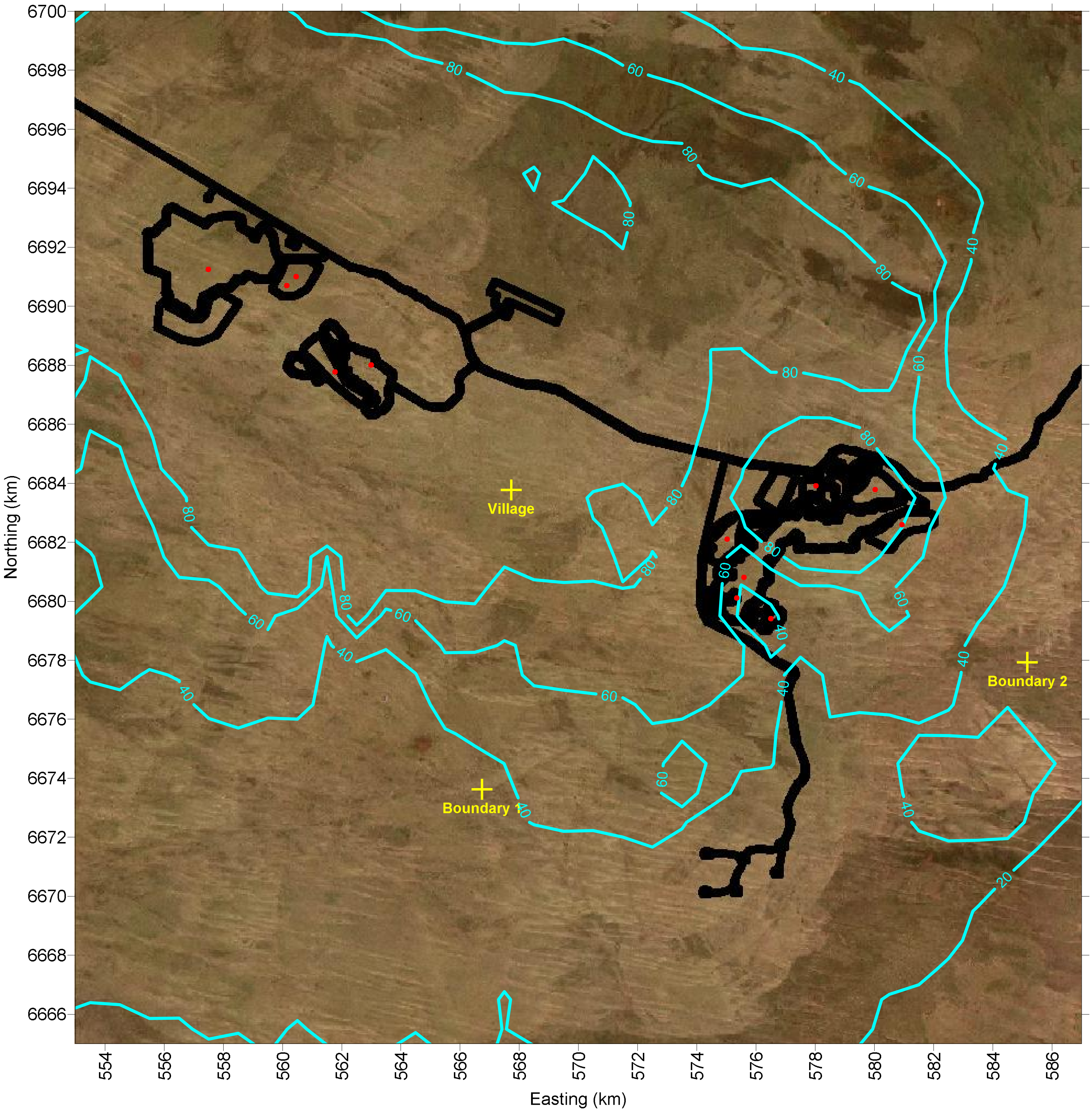
FIGURE D18

Scenario 4, Year 14
Predicted annual PM10 concentrations

CREATED	CHECKED	APPROVED	DATE	FILE LOCATION	DRAWING NO.	REVISION
LC	JF	JF	17.10.15	G:/61/32680/Technical/Surfer/Figure 01	Figure D18.srf	1



Guideline values:
Nil

LEGEND

- Proposed mine layout
- Pit and processing plant source locations
- Sensitive receptors
- Predicted 1-hr 99.9 percentile TSP concentrations

SCALE

0 1 2 3 4

Kilometres (at A3)

MAP PROJECTION:
Transverse Mercator

HORIZONTAL DATUM:
Geocentric Datum of Australia (GDA)

GRID:
Map Grid of Australia 1994, Zone 51

DATA SOURCE:
LGATE_MGA51_20150220

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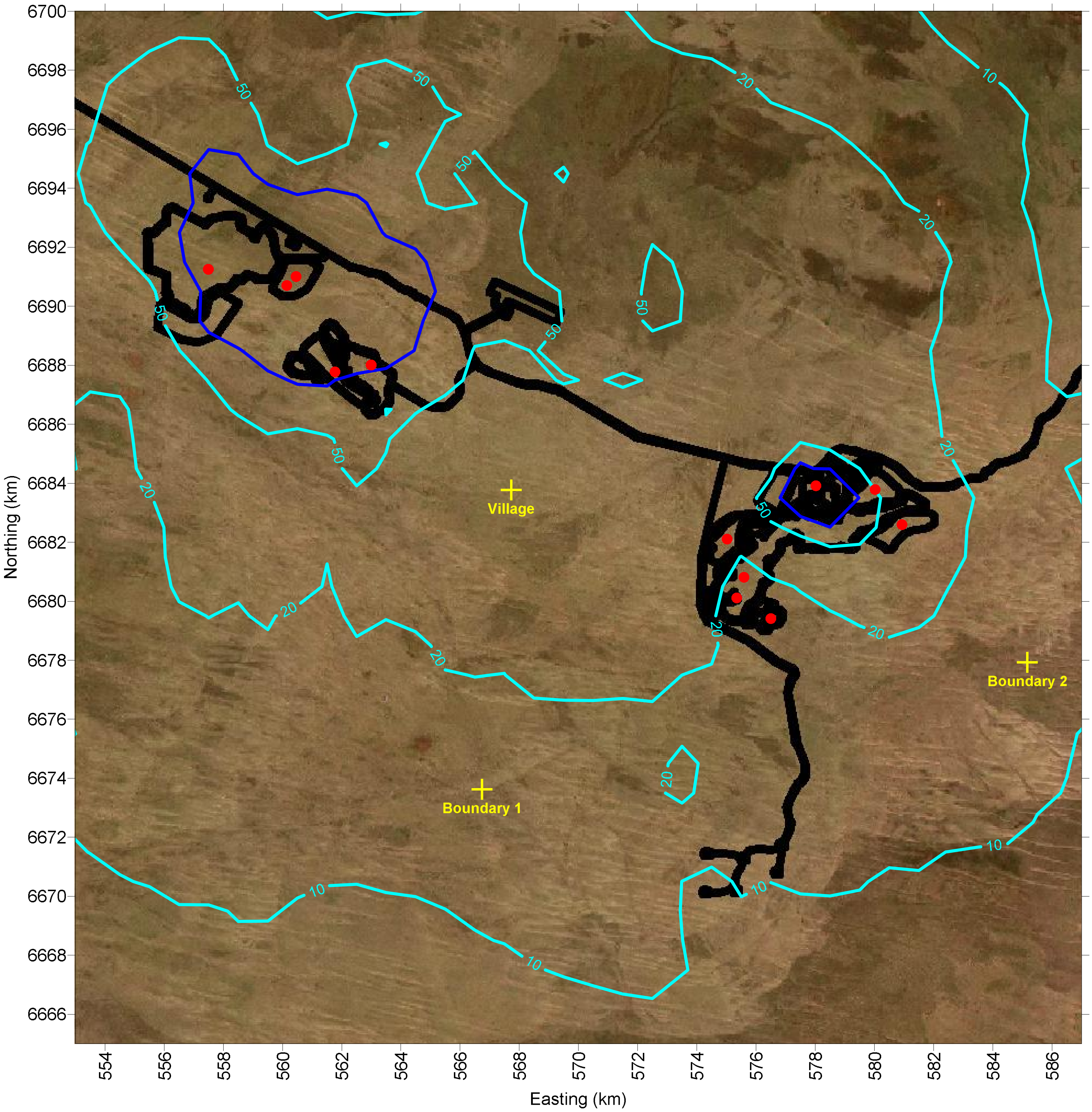
FIGURE D19

Scenario 4, Year 14
Predicted 1-hour 99.9 percentile TSP concentrations

CREATED	CHECKED	APPROVED	DATE	FILE LOCATION	DRAWING NO.	REVISION
LC	JF	JF	17.10.15	G:/61/32680/Technical/Surfer/Figure 01	Figure D19.srf	1



Guideline values:
Kwinana EPP 24-hour maximum TSP of 90 ug/m3

LEGEND

- Proposed mine layout
- Pit and processing plant source locations
- Sensitive receptors
- 24-hr max TSP contours
- Kwinana EPP criteria (90 ug/m3)

SCALE

0 1 2 3 4

Kilometres (at A3)

MAP PROJECTION:
Transverse Mercator

HORIZONTAL DATUM:
Geocentric Datum of Australia (GDA)

GRID:
Map Grid of Australia 1994, Zone 51

DATA SOURCE:
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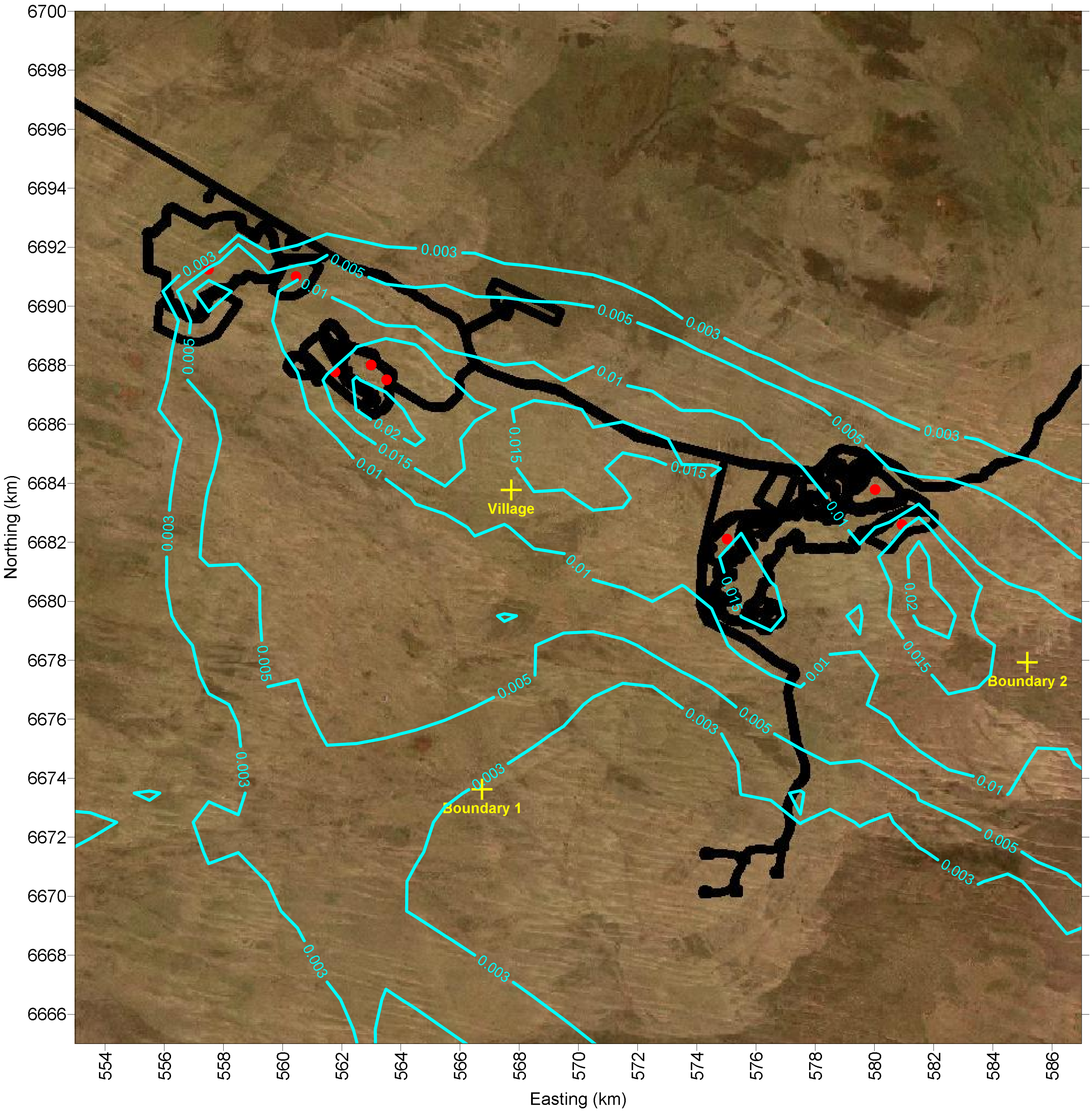
FIGURE D20

Scenario 4, Year 14
Predicted 24-hour maximum TSP concentrations

CREATED	CHECKED	APPROVED	DATE	FILE LOCATION	DRAWING NO.	REVISION
LC	JF	JF	17.10.15	G:/61/32680/Technical/Surfer/Figure 01	Figure D20.srf	1



Guideline values:
Victorian SEPP-AQM 1-hour 99.9 percentile PM10 design criteria of 80 ug/m3

LEGEND

- Proposed mine layout
- Pit and processing plant source locations
- Sensitive receptors
- Predicted 1-hr 99.9 percentile PM10 concentrations

SCALE

0 1 2 3 4

Kilometres (at A3)

MAP PROJECTION:
Transverse Mercator

HORIZONTAL DATUM:
Geocentric Datum of Australia (GDA)

GRID:
Map Grid of Australia 1994, Zone 51

DATA SOURCE:
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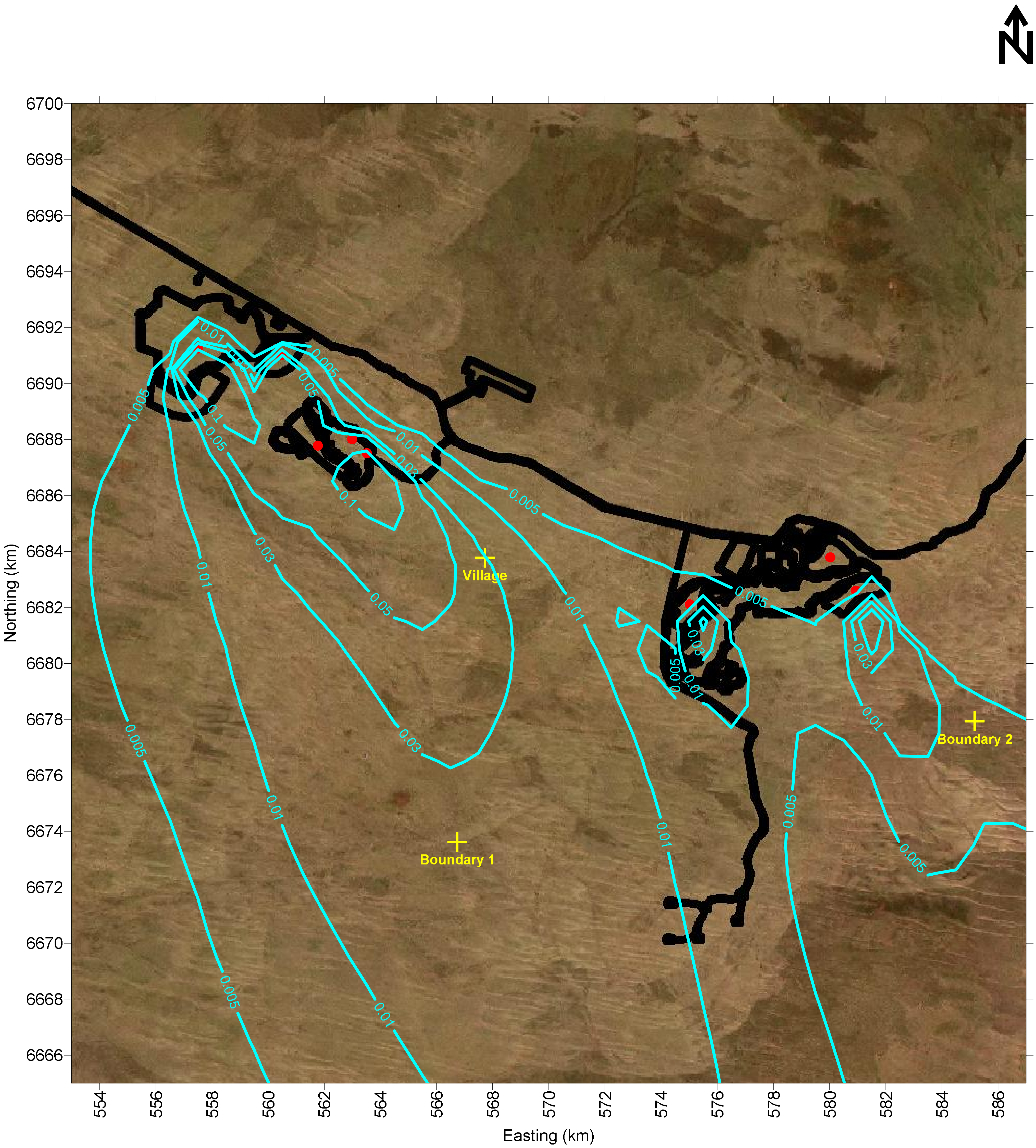
FIGURE D21

Scenario 5, closure - 1 year
Predicted 1-hour 99.9 percentile PM10 concentrations

CREATED	CHECKED	APPROVED	DATE	FILE LOCATION	DRAWING NO.	REVISION
LC	JF	JF	17.10.15	G:/61/32680/Technical/Surfer/Figure 01	Figure D21.srf	1



Guideline values:
Air NEPM 24-hour maximum PM10 concentration of 50 ug/m3

LEGEND

- Proposed mine layout
- Pit and processing plant source locations
- Sensitive receptors
- Predicted 24-hr max PM10 concentrations

SCALE

0 1 2 3 4

Kilometres (at A3)

MAP PROJECTION:
Transverse Mercator

HORIZONTAL DATUM:
Geocentric Datump of Australia (GDA)

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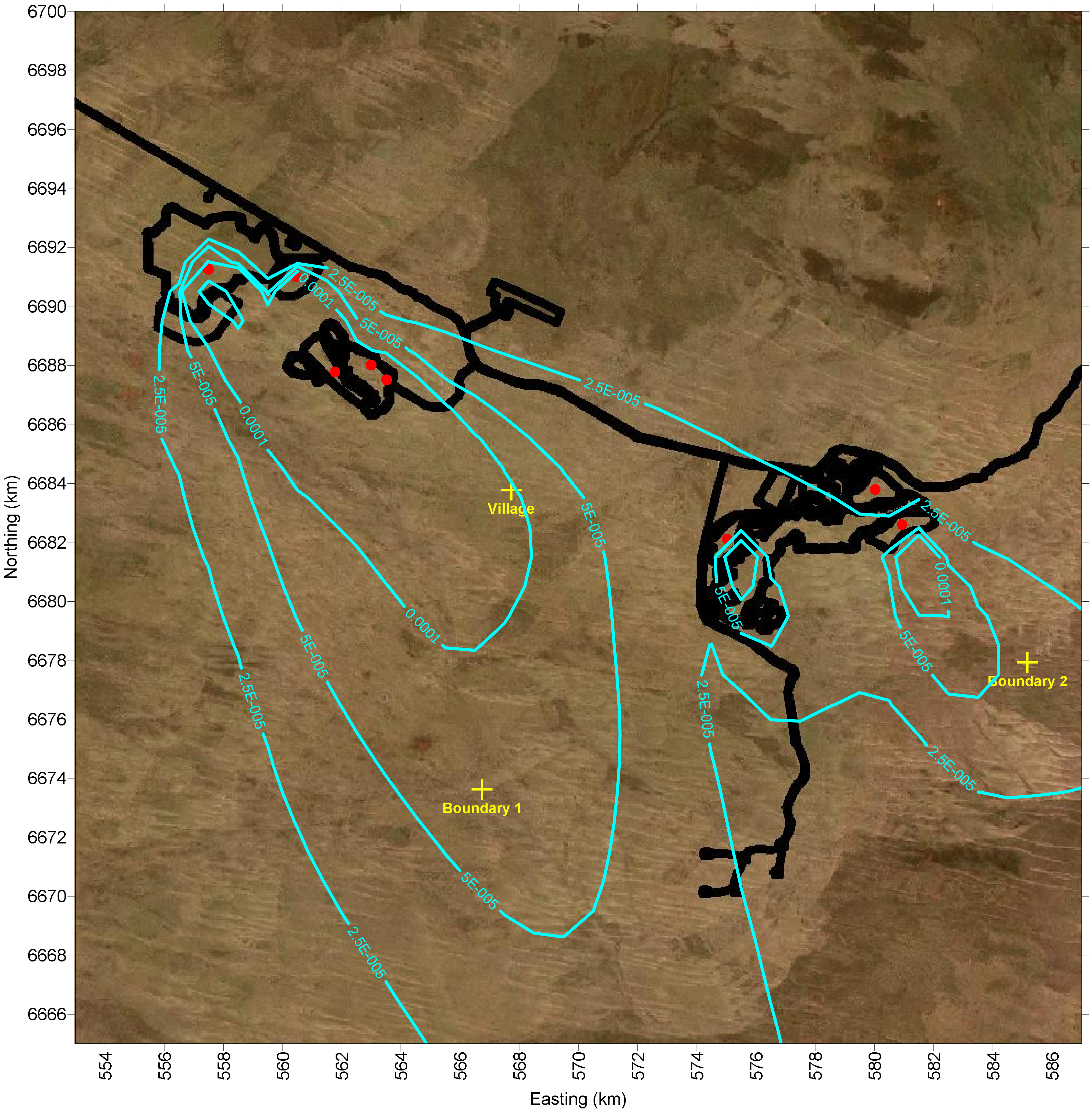
FIGURE D22

Scenario 5, closure - 1 year
Predicted 24-hour maximum PM10 concentrations

CREATED	CHECKED	APPROVED	DATE	FILE LOCATION	DRAWING NO.	REVISION
LC	JF	JF	17.10.15	G:/61/32680/Technical/Surfer/Figure 01	Figure D22.srf	1



Guideline values:
Proposed variation to the Air NEPM for an annual maximum PM10 concentration of 20 ug/m3

LEGEND

- Proposed mine layout
- Pit and processing plant source locations
- Sensitive receptors
- Predicted annual PM10 concentrations

SCALE

0 1 2 3 4
Kilometres (at A3)

MAP PROJECTION:
Transverse Mercator

HORIZONTAL DATUM:
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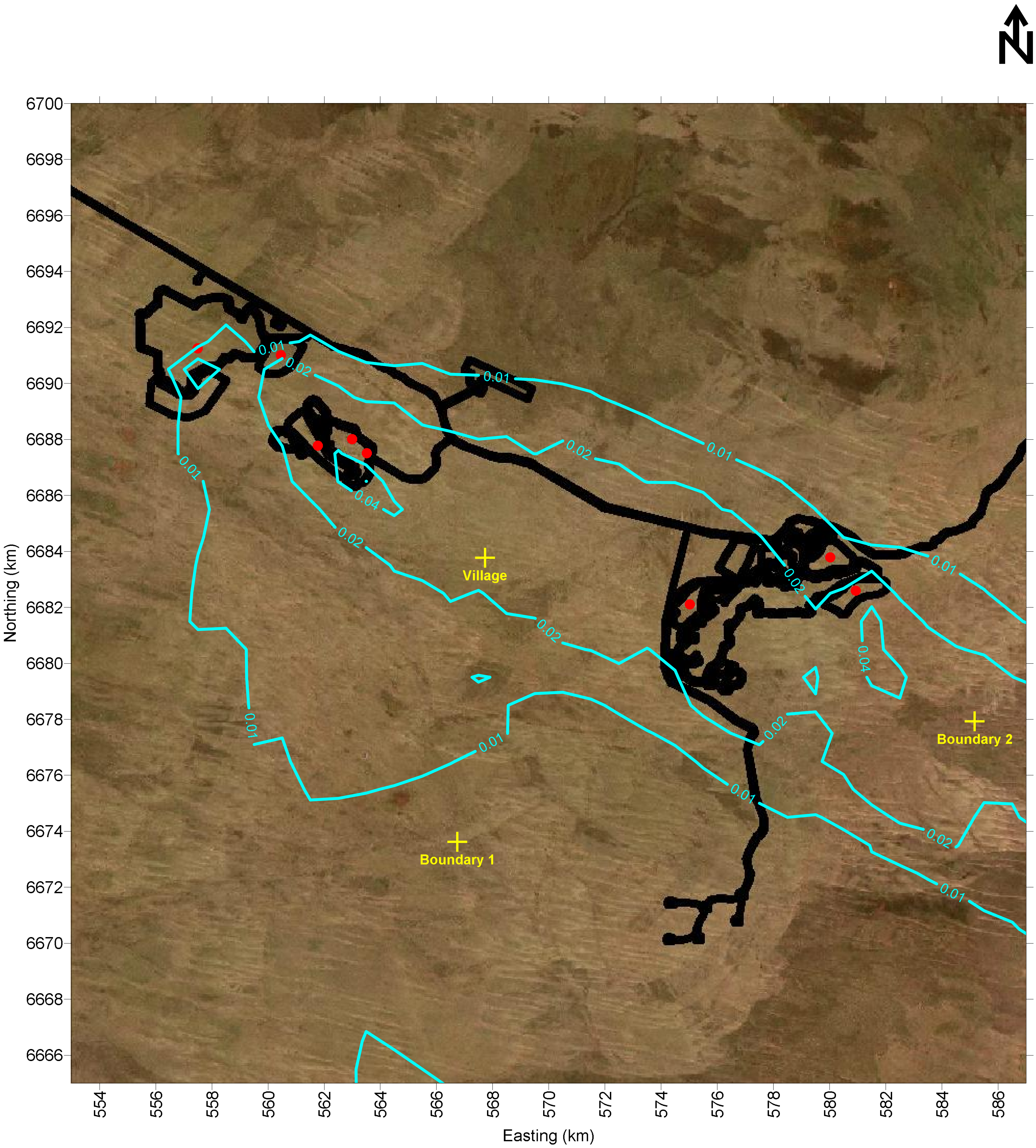
FIGURE D23

Scenario 5, closure - 1 year
Predicted annual PM10 concentrations

CREATED	CHECKED	APPROVED	DATE	FILE LOCATION	DRAWING NO.	REVISION
LC	JF	JF	17.10.15	G:/61/32680/Technical/Surfer/Figure 01	Figure D23.srf	1



Guideline values:
Nil

LEGEND

- Proposed mine layout
- Pit and processing plant source locations
- Sensitive receptors
- Predicted 1-hr 99.9 percentile TSP concentrations

SCALE

0 1 2 3 4
Kilometres (at A3)

MAP PROJECTION:
Transverse Mercator

HORIZONTAL DATUM:
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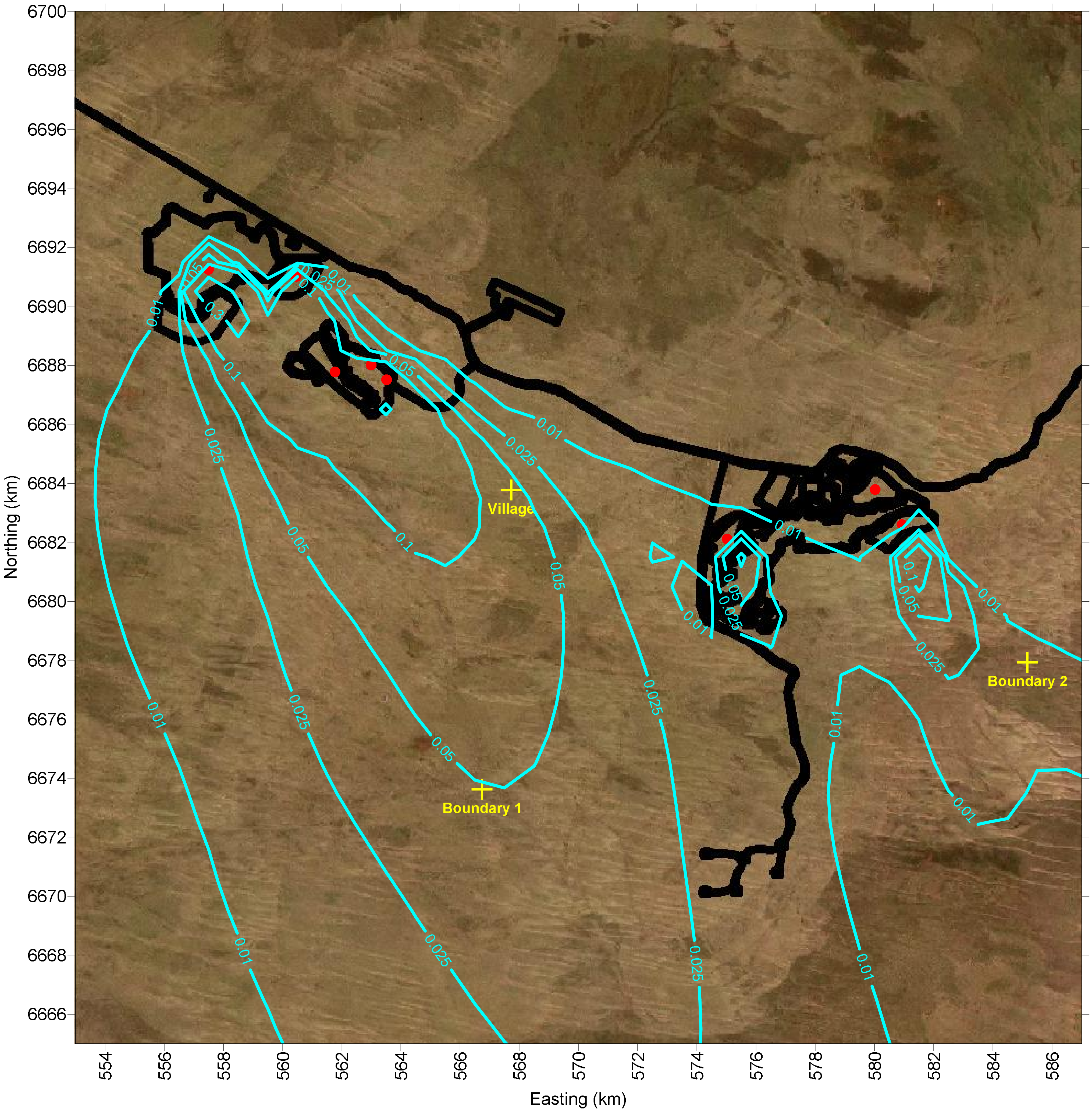
FIGURE D24

Scenario 5, closure - 1 year
Predicted 1-hour 99.9 percentile TSP concentrations

CREATED	CHECKED	APPROVED	DATE	FILE LOCATION	DRAWING NO.	REVISION
LC	JF	JF	17.10.15	G:/61/32680/Technical/Surfer/Figure 01	Figure D24.srf	1



Guideline values:
Kwinana EPP 24-hour maximum TSP of 90 ug/m3

LEGEND

- Proposed mine layout
- Pit and processing plant source locations
- Sensitive receptors
- 24-hr max TSP contours
- Kwinana EPP criteria (90 ug/m3)

SCALE

0 1 2 3 4

Kilometres (at A3)

MAP PROJECTION:
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HORIZONTAL DATUM:
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GRID:
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FIGURE D25

Scenario 5, closure - 1 year
Predicted 24-hour maximum TSP concentrations

CREATED	CHECKED	APPROVED	DATE	FILE LOCATION	DRAWING NO.	REVISION
LC	JF	JF	17.10.15	G:/61/32680/Technical/Surfer/Figure 01	Figure D25.srf	1

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Rev No.	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
0	L Clayson	J Forrest		J Forrest		23/4/15
1	L Clayson	J Forrest		J Forrest		14/5/15
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3	L Clayson	J Forrest		J Forrest		29/5/15
4	L Clayson	J Forrest		J Forrest		19/10/15
5	L Clayson	J Forrest	J Forrest		J Forrest	22/10/15

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