14 AIR QUALITY

14.1 CRITERIA AND IMPACT ASSESSMENT

14.1.1 PARTICULATES

Issue:

Further information was sought regarding the assumptions and criteria used in the impact assessment for airborne particulates in the Draft EIS, specifically:

- the contribution of background dust, including dust storms, to overall dust levels
- the sources of dust included in the assessment, and dust composition
- the health risks of particulates, including inhalation, ingestion (via rainwater tanks) and amenity issues in Roxby Downs and properties adjacent to the access corridor.

Submissions: 1, 2, 6, 13, 62, 71, 72, 85, 102, 173, 176, 238, 266 and 333

Response:

Contribution of background dusts to overall dust concentrations

Background dust concentrations were discussed briefly in Section 13.3.3 of the Draft EIS. To establish background concentrations, high-volume air sampling of total suspended particulates (TSP) was undertaken from 1993 to 2006 at the southern boundary of the existing municipal lease (i.e. about 10 km south of the Roxby Downs township). The results of this historic sampling indicate an average background TSP concentration of around 22 µg/m^3 (see Figure 14.1 of the Supplementary EIS).

In addition to the sampling of total particulates, background monitoring of the 10-micron particle fraction (i.e. PM_{10}) ground-level concentrations was undertaken at the Roxby Downs pastoral lease homestead, some 30 km south of Olympic Dam. The results of this monitoring indicate an average background PM_{10} concentration of around 16 µg/m^3 (see Figure 14.1 of the Supplementary EIS).

Since the publication of the Draft EIS, a real-time dust monitoring system, monitoring TSP, PM_{10} and $PM_{2.5}$ simultaneously, has been installed in Roxby Downs at the existing air quality monitoring site adjacent to the existing wastewater treatment plant to the west of town. Although only limited data has been collected from this system to date (see Figure 14.1 of the Supplementary EIS), the results of this monitoring indicate existing average ground-level concentrations for TSP, PM_{10} and $PM_{2.5}$ at 27, 15 and 4 µg/m^3, respectively. These results are consistent with those of the historic background monitoring. The frequency distribution of 24-hour average background dust concentrations for the PM_{10} and $PM_{2.5}$ size fractions is presented in Figure 14.2, and an analysis of the particulate concentration with respect to prevailing wind direction and speed is presented in Figures 14.3 and 14.4, respectively.

These data suggest that local instantaneous wind speed bears little correlation to short-term background dust concentrations (except at very high wind speeds) and that the background dust concentrations are skewed very slightly in a north-south direction.

Table 13.23 of the Draft EIS listed the predicted annual ground-level concentrations of TSP and PM_{10} attributed to the proposed expansion at Roxby Downs and the proposed Hiltaba Village.

If the contribution of average background dust levels were added to those predicted for the expanded operation, annual dust levels at both Roxby Downs and Hiltaba Village would remain below the relevant ambient air quality goals (see Table 14.1)

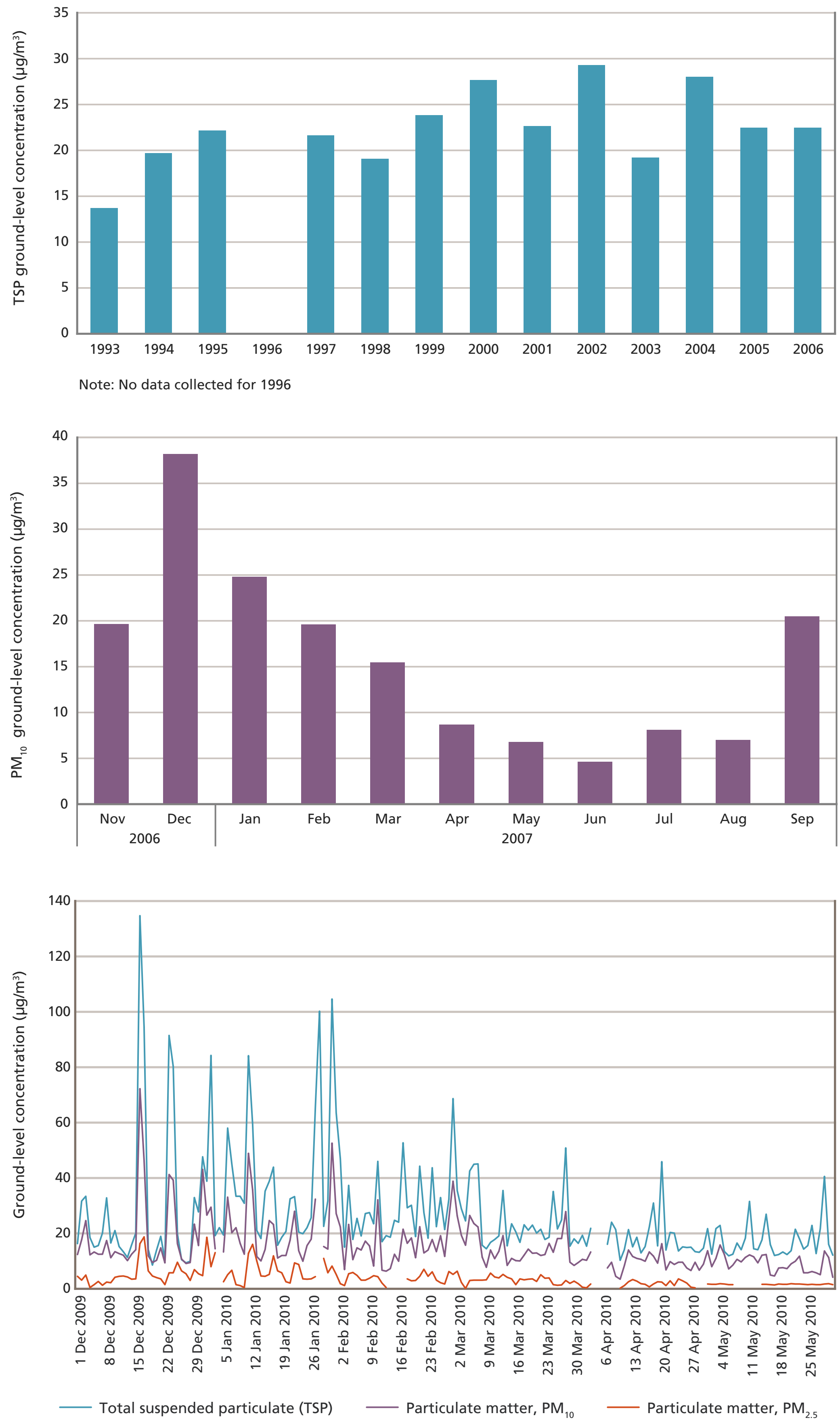

Figure 14.1 Existing background TSP, PM_{10} and $PM_{2.5}$ ground-level concentrations

Table 14.1 Annual particulate concentrations at Roxby Downs and Hiltaba Village (ug/m³)

Receiver	Background	Expanded operation contribution	Combined	Criteria
TSP				
Roxby Downs	22	5.7	27.7	90
Hiltaba Village	22	7.1	29.1	
PM_{10}				
Roxby Downs	16	4.3	20.3	30
Hiltaba Village	16	5	21	

With regard to dust storms, Section 8.4.5 of the Draft EIS discussed the frequency of these storms in the project area and this was summarised in Table 8.9 of the Draft EIS, and reproduced in the Supplementary EIS as Table 14.2 below.

Table 14.2 Average dust storm frequency per year[1]

Frequency	Roxby Downs	Woomera	Port Augusta	Whyalla	Adelaide	Darwin
	2	2	1	~0.4	0.6	0.5

[1] Sourced from Middleton 1984.

The concentration of particulate in any dust storm is highly variable. However, the CSIRO suggests that a dust concentration of 1,000 μg/m³ constitutes a severe dust storm, and concentrations can peak at levels as high as 7,200 μg/m³ (CSIRO 2009). The short-term (eight-hour average) occupational exposure limit for dust inhalation is 10,000 μg/m³ (NOHSC 1995). Therefore, the contribution of dust levels from the expanded operation would be an insignificant fraction of the levels generated by natural dust storms.

The proposed Operational Dust Management Plan and associated monitoring plan would aim to collect additional data to further understand the factors that influence background dust concentrations and to allow some prediction of conditions that are conducive to elevated dust concentrations at Roxby Downs and Hiltaba Village.

The frequency distribution of predicted operationally contributed 24-hour average PM_{10} and $PM_{2.5}$ ground-level concentrations at Roxby Downs is presented in Figure 14.5. The proposed monitoring plan would require sufficient data collection to allow the contribution of the proposed operation to overall 24-hour average dust concentrations to be apportioned.

Dust sources included in the air quality assessment

The dust sources included in the air quality modelling were detailed in Table 13.22 of the Draft EIS, and reproduced in the Supplementary EIS as Table 14.3 below.

Table 14.3 Estimated particulate emission rates for the proposed expanded operation (kilograms per day (kg/d))

Activity	Particulate (TSP)	Particulate (PM_{10})	Particulate ($PM_{2.5}$)
Drilling	103	54	n.a.
Blasting	457	237	n.a.
Dozing and grading	4,300	780	450
Ore crushing	38,400	3,850	n.a.
Loading	14,750	13,100	280
Haul roads	19,450	8,200	4,750
Unloading	13,500	4,850	n.a.
Road maintenance	0	0	n.a.
Wind erosion	175	90	n.a.

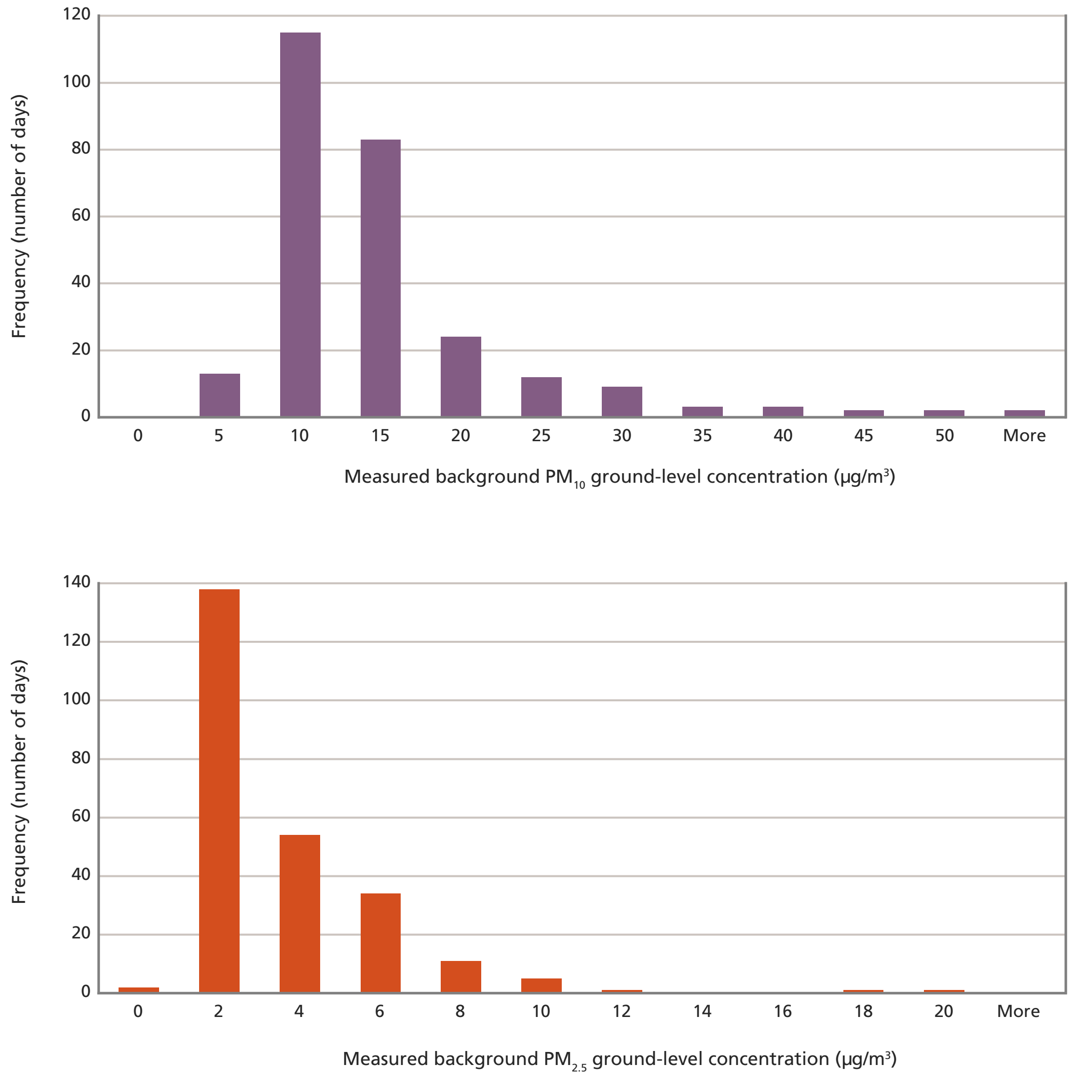

Figure 14.2 Existing background particulate 24-hour average ground-level concentration frequency distribution

While there may be other potential sources of particulate emissions, the amounts they contribute would be minimal compared to the sources described in Table 14.1 and were therefore not included in the air quality modelling. However, a review of the emissions inventory for the existing operation has also been undertaken and the likely sources and emission rates have been predicted for the expanded operation. They are provided in Table 14.4.

Figure 14.3 Existing background particulate ground-level concentrations with wind direction

Table 14.4 Estimated emission rates from other on-site particulate sources (kg/d)

Stack	Particulate (TSP)	Particulate (PM_{10})
Main smelter stack	294	147
Acid plant tails gas stack	4	4
Smelter #1 shaft furnace stack	18	5
Calciner A stack	8	7
Calciner B stack	8	7
Slimes treatment roaster stack	2	2
Slimes treatment NOx stack	0	0
Concentrate dryer stack	15	11
New acid plant tails gas stack	4	4
New sulphur-burning acid plant stack 1	4	4
New sulphur-burning acid plant stack 2	4	4
New calciner stack	8	7
Combined cycle gas turbine	506[1]	253
Tailings storage facility (wind erosion)[2]	0	0

1 Estimated based on PM_{10} being 50% of TSP.
2 See Section 26.2.3 of the Supplementary EIS for a description regarding potential dust emissions from the TSF.

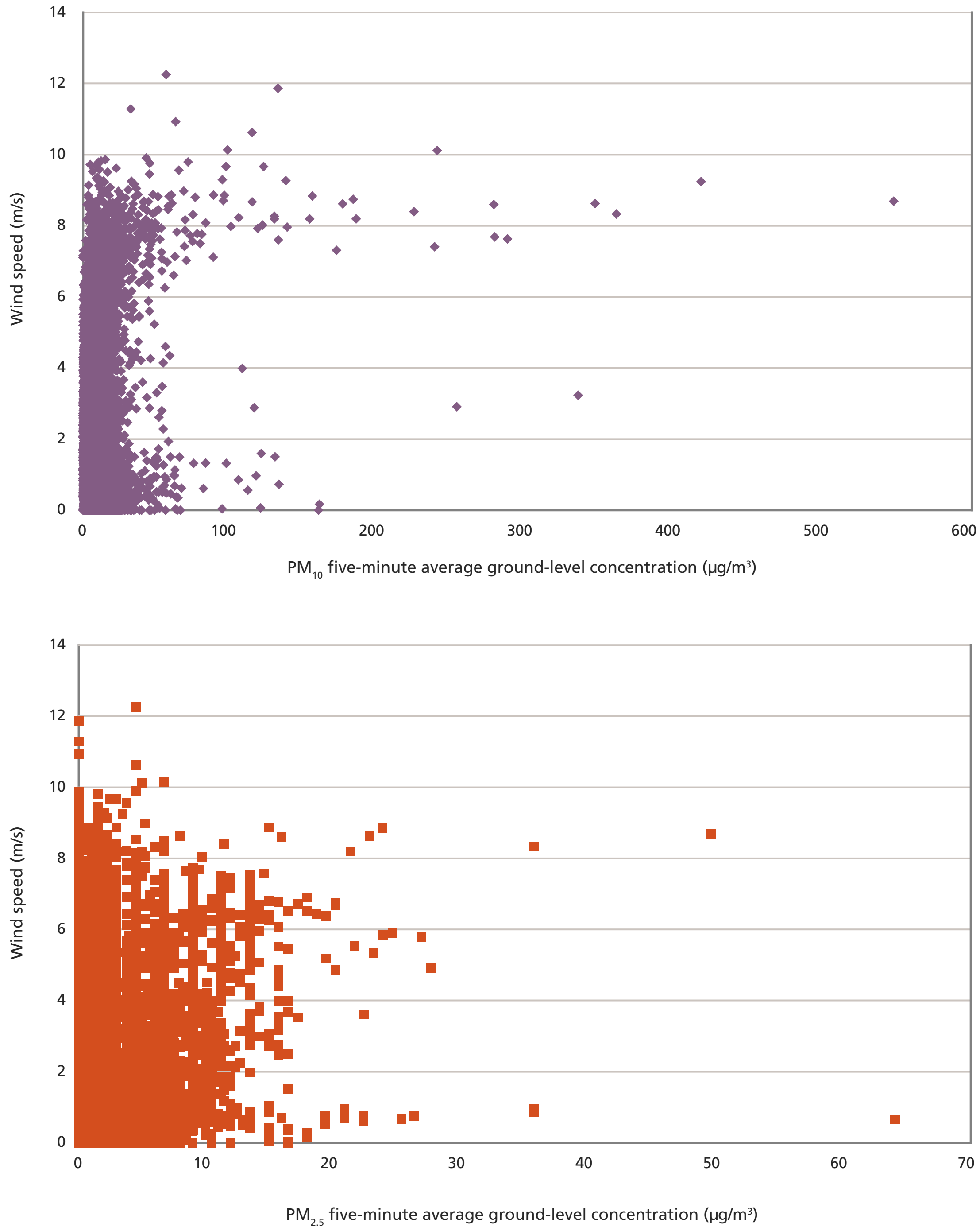

Figure 14.4 Existing background particulate ground-level concentrations with wind speed

The total contribution from these additional sources represents a very small fraction of the emissions from the modelled sources (i.e. 1% for TSP and 1.5% for PM_{10}). Therefore, including the additional sources would not have had an effect on compliance against the applicable limits.

Composition of emitted dusts

Section 13.3.2 of the Draft EIS listed the emitted elements and compounds studied in the air quality assessment and established that these were selected on the basis of listed Class 1 substances in the SA EPA Guideline (Air quality impact assessment using design ground-level pollutant concentrations: EPA 2006) and the materials specified in the National Environment Protection (Ambient Air Quality) Measure. Some additional compounds were also assessed based on the prior experience of operating at Olympic Dam.

With specific regard to dust composition, the emitted elements would vary depending on the lithology of the material being mined at any point in time. Table 14.4 of the Supplementary EIS provides an indication of the likely composition and proportion of elements generated from mining the ore during the expanded operation, based on the composition of the ore mined in the existing operation. It is noted that the ore grade mined at the existing operation is higher than the grade that would be mined in the expansion, and as such the proportions shown in Table 14.5 would vary.

Table 14.5 Composition and proportion of elements within ore mined from the existing operation

Material	Proportion (%)	Material	Proportion (%)	Material	Proportion (%)	Material	Proportion (%)
Al	3.65	F	0.69	Nd	0.009	Tb	<0.005
As	<0.005	Fe	28.7	Pb	0.009	Th	<0.005
Bi	<0.005	Gd	<0.005	Pr	0.009	Tm	<0.005
Ca	1.28	Hf	<0.005	Sb	<0.005	U	0.06
Ce	0.071	Ho	<0.005	Sc	<0.005	Y	<0.005
Cu	1.89	K	1.97	Se	0.006	Yb	<0.005
Dy	<0.005	La	0.037	Si	14.9	Zr	0.029
Er	<0.005	Lu	<0.005	Sm	<0.005		
Eu	<0.005	Mg	0.11	Ta	<0.005		

Potential health risks of dust exposure

The potential health risks associated with exposure to particulate matter, particularly PM_{10} and $PM_{2.5}$ particles, have been researched extensively by both the United States Environmental Protection Agency (EPA) and the World Health Organisation (WHO) (US EPA 2009, WHO 2006). While acknowledging that there are potential health effects associated with exposure to particulates, even at very low concentrations, these studies have resulted in the development of air quality guidelines and criteria designed to provide an adequate level of protection for the health and well-being of members of the public. These criteria are applied in Australia via state legislation and guidelines, and nationally through the implementation of the National Environment Protection (Ambient Air Quality) Measure (NEPM). It is noted, however, that the NEPM does not apply to monitoring or controlling peak concentrations from major sources such as industry or near major roads.

The criteria adopted for the Draft EIS are consistent with these guidelines and criteria, and are therefore considered adequate for the protection of the health of residents of Roxby Downs and the proposed Hiltaba Village. In order to minimise the potential for adverse health impacts associated with particulate exposures, BHP Billiton would seek to manage operationally contributed particulate concentrations to levels as low as reasonably practicable, and no greater than the criteria described in Table 14.6.

Table 14.6 Particulate criteria for the expanded operation

Particulate size fraction	Averaging period	Ambient air quality criteria (µg/m^3)
TSP	Annual	90[1]
	Deposition (g/m^2/month)	4[1]
PM_{10}	24-hour	50
	Annual	30[1]
$PM_{2.5}$	24-hour	25
	Annual	8

[1] From *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales 2005*, in the absence of guidance in the National Environment Protection (Ambient Air Quality) Measure 2003, and any South Australian-specific guidelines.

A comparison of the above-mentioned criteria (where comparable) to those of the US EPA, the Australian National Environment Protection (Ambient Air Quality) Measure and the interim targets advised by the World Health Organisation (WHO) is provided in Table 14.7 of the Supplementary EIS. It is noted that there is no South Australian-specific legislation or guidance on acceptable levels of particulates.

Table 14.7 International particulate ground-level concentration criteria

Particulate size fraction	Averaging period	Ambient air quality criteria (µg/m³)						
		US EPA	WHO IT[1]	WHO IT[2]	WHO IT[3]	WHO Goal	NEPM[1]	Draft EIS[2]
PM_{10}	24-hour	150	150	100	75	50	50	50
	Annual	n.a.	70	50	30	20	n.a.	30
$PM_{2.5}$	24-hour	35	75	50	37.5	25	25	25
	Annual	15	35	25	15	10	8	8

1 The National Environment Protection (Ambient Air Quality) Measure applies broadly to air sheds, and was not developed for implementation in areas with a single source of airborne emissions.
2 Operationally contributed only. US EPA and WHO criteria include all emissions sources.

Dust in rainwater tanks

Concerns were expressed that increased dust deposition associated with mining and infrastructure-related activities may result in negative health impacts associated with dust ingestion via the capture of roof run-off in rainwater tanks, particularly in Andamooka and along the proposed access corridor. An investigation of the potential impacts of dust ingestion via rainwater tanks indicates that the additional risk associated with dust deposition from the expanded operation would be negligible.

The access corridor from the landing facility to the Port Augusta pre-assembly yard would comprise a compacted gravel, unsealed surface, which creates some potential for dust emissions as a result of wind erosion and dust lift-off as vehicles travel on the roadway. A water cart would be used to keep the roadway sufficiently moist to avoid generating dust during operations. Over time, this would create a surface that was less likely to produce dust during non-operational times. It is anticipated that with this measure and the realignment of the access corridor away from nearby residences (see Figure 5.17 of the Supplementary EIS for details), dust emissions associated with the proposed expansion would not cause additional risks associated with inhalation and/or ingestion via rainwater capture.

There is expected to be little, if any, increase in dust deposition in Andamooka associated with the proposed expansion, and therefore the additional health risk associated with the consumption of captured rainwater is considered negligible. An information paper produced by the Health Department of NSW (NSW Health 2007) described steps that should be taken in the operation and maintenance of rainwater tanks to minimise the risks associated with the consumption of this rainwater, including:

- using 'drinking water' grade PVC water fittings (the use of lead or galvanised fittings can result in high lead and zinc concentrations in the water)
- washing and flushing new tanks before first use
- covering tanks to reduce the potential for algal growth
- covering tank inlets and outlets with mesh to keep out animals
- not allowing roof-mounted appliances such as air-conditioners to drain into tanks
- fitting first-flush devices, or disconnecting the inlet pipe, to prevent bird droppings and dust from the roof entering the tank after the first rains
- cleaning roof catchments and gutters every three or four months and inspecting them every two to three years to determine the need for de-sludging (emptying the tank of solids).

Amenity issues associated with dust emissions

The effects of particulate emissions from the proposed expansion on regional amenity were discussed in Section 13.3.5 of the Draft EIS, with particular reference to two studies of public perception and response to dust undertaken in the Hunter Valley (Dean et al. 1987, ACARP 1999). These studies indicated that people's perception of dust did not correlate to measured dust concentrations, and that the major influences on people's perception of dust was existing or previous exposure to dust-rich environments and the rate of change of dust concentrations over time, with greater perception of dust with increased dust concentration fluctuations. The studies suggested that community perception of dust was more likely based on visual cues associated with dust (such as general haze, or dust fallout onto roofs or cars) rather than measured dust concentration.

As a consequence, and as stated in the Draft EIS, it remains likely that there would be a moderate impact on amenity in Roxby Downs associated with the expanded operation. This is a reflection of the difference between existing air quality and that predicted for the proposed expansion, rather than the actual increase in measured dust levels (which, as shown in the Draft EIS and in an above response, would be below applicable limits).

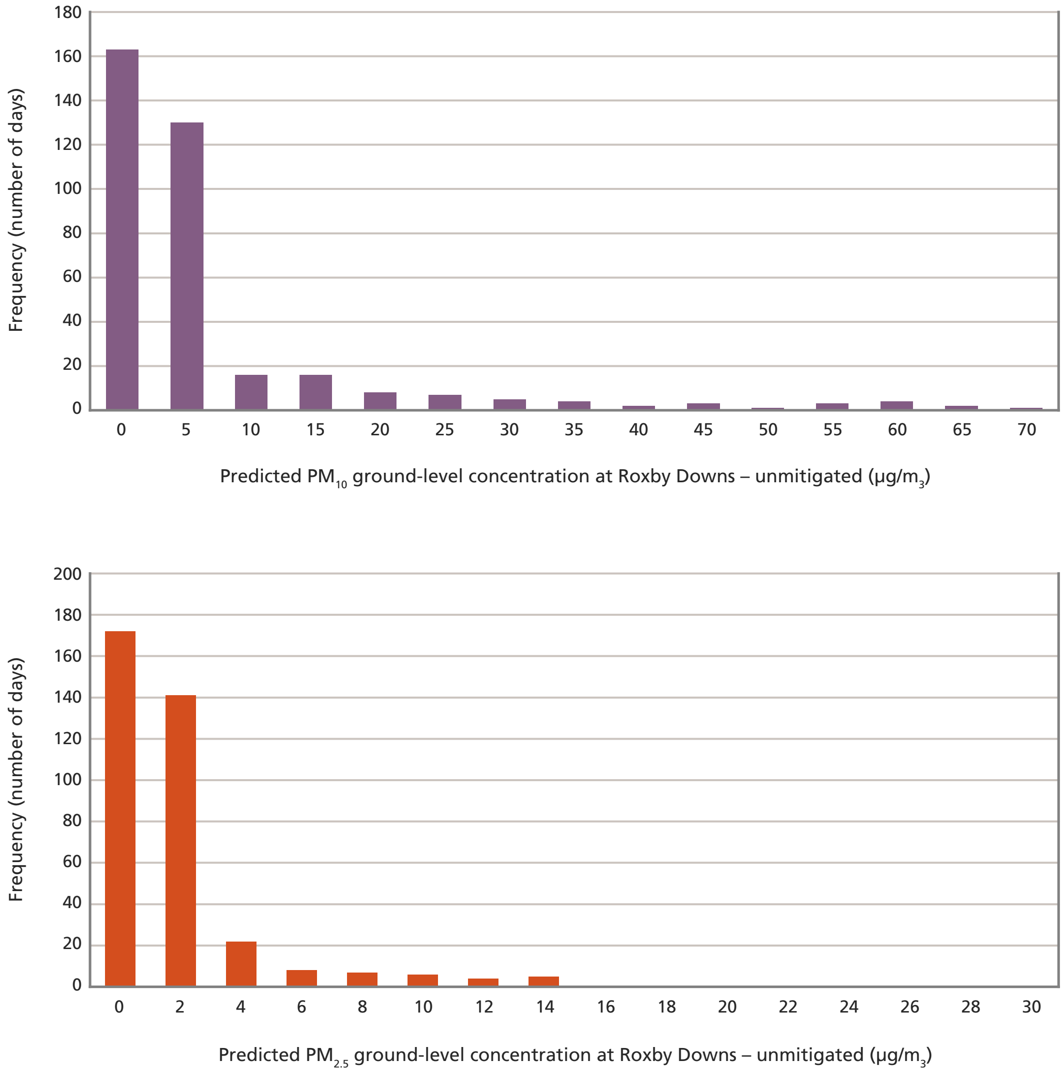

Figure 14.5 Predicted particulate 24-hour average ground-level concentration frequency distribution

14.1.2 SULPHUR DIOXIDE

Issue:

Questions were raised regarding the assessment criteria used to determine sulphur dioxide (SO_2) impacts, specifically about aligning the assessment criteria to those proposed by the World Health Organisation (WHO).

Submissions: 2 and 391

Response:

The Draft EIS, and specifically Table 13.14, compared the predicted SO_2 concentrations to applicable and current Australian and South Australian legislation and guidelines established by the South Australian EPA, the Australian Government's National Environment Protection (Ambient Air Quality) Measure and the Australian Government's National Health and Medical Research Council. BHP Billiton considers that compliance with Australian-based legislation provides adequate protection of human health for those potentially impacted by the proposed Olympic Dam expansion.

The results of predictive modelling of SO_2 ground-level concentrations at Roxby Downs and Hiltaba Village were presented in Section 13.3.5 of the Draft EIS and illustrated in Figure 13.20a, repeated in Appendix G to the Supplementary EIS. Figure 14.6 of the Supplementary EIS illustrates the distribution of predicted one-hour average SO_2 concentrations at Roxby Downs for the proposed expansion, indicating that over 99% of modelled one-hour SO_2 concentrations would be below 33 $\mu g/m^3$.

The WHO quotes far more stringent SO_2 ground-level criteria than currently exist in Australia, as its data is based on an investigation into the effect of SO_2 on exercising asthmatics over various exposure times in the context of ambient SO_2 concentrations in Europe (note that ambient concentrations in Europe are typically very low and trending lower because of the use of low-sulphur fuels in vehicles and for heating). The 10-minute SO_2 guideline, for example, found the minimum concentration at which ventilatory capacity in heavily exercising asthmatics was reduced was 572 $\mu g/m^3$, with only 10% of the participants being negatively affected at 1,144 $\mu g/m^3$. The WHO has subsequently set the 10-minute average guideline at 500 $\mu g/m^3$. The current South Australian guidelines (last updated in early 2006) do not reference a 10-minute criterion, and the relevance of the WHO research to Australian scenarios is unknown.

BHP Billiton would cooperate with the Australian and/or South Australian governments in any review of applicable SO_2 criteria in an Australian context.

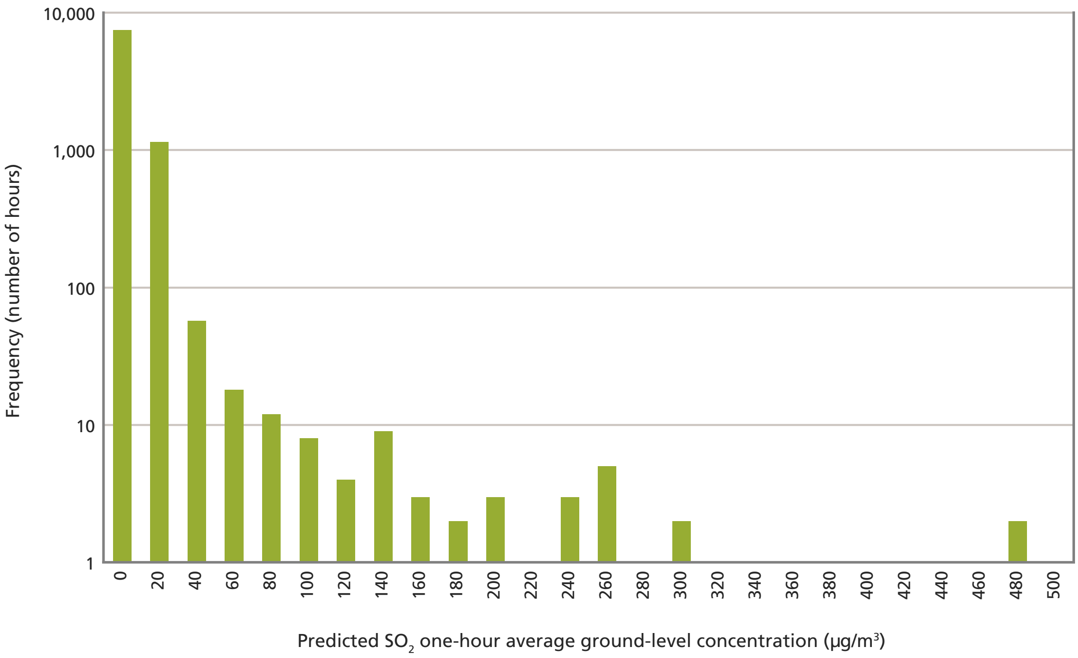

Figure 14.6 Predicted SO_2 one-hour average ground-level concentration frequency distribution

14.1.3 OTHER EMISSIONS

Issue:

Additional information was sought about the predicted ground-level concentrations of polycyclic aromatic hydrocarbons (PAHs) and volatile organic compounds (VOCs) following completion of the proposed expansion. The presentation of contour plots of predicted ground-level concentrations rather than 'under-and-over plots' was also requested. Also, clarification of the modelled oxides of nitrogen sources was sought, as was a commitment to maintain awareness of the progress of international air pollutant and health impact research.

Submission: 2

Response:

PAH and VOC ground-level concentrations

An assessment of the estimated worst-case polycyclic aromatic hydrocarbon (PAH) and volatile organic compound (VOC) ground-level concentrations was undertaken using the air quality model developed and detailed in Section 13.2.2 of the Draft EIS. The findings predicted no exceedance of the nominated criteria. The pollutants modelled, and the criteria against which they were assessed, were derived from the National Environment Protection (Air Toxics) Measure, as shown in Table 14.8 of the Supplementary EIS.

Table 14.8 Air quality criteria

Pollutant	Averaging period	Criteria	Units
Benzene	Annual average	10	µg/m³
Polycyclic Aromatic Hydrocarbons (as Benzo(a)pyrene)	Annual average	0.3	ng/m³
Formaldehyde	24-hour	40	µg/m³
Toluene	24-hour	3.8	mg/m³
	Annual average	0.38	mg/m³
Xylenes	24-hour	1	mg/m³
	Annual average	0.9	mg/m³

Emission factors from the National Pollutant Inventory Emission Estimation Techniques manuals, together with details of the estimated consumption of hydrocarbon materials from the Draft EIS, were used to develop an emissions inventory for the expanded operation, shown in Table 14.9 of the Supplementary EIS.

Table 14.9 Estimated on-site emissions inventory for the expanded operation

Emission rates (kg/a)	Benzene	PAHs	Toluene	Xylenes	VOCs	Formaldehyde
Off-highway truck diesel	–	207	–	–	560,000	325,500
Processing diesel	–	3	–	–	368	–
Sodaberg paste	–	197	–	–	–	–
Fuel oil	–	3	–	–	322	–
LPG	–	–	–	–	979	–
Storage emissions	177	–	121	133	18,178	–
Existing operation	101	234	42	28	85,600	–
Total	**278**	**644**	**163**	**161**	**665,447**	**325,500**

The ground-level concentrations of the pollutants mentioned earlier were predicted using the CALPUFF air quality model detailed in Section 13.3.2 of the Draft EIS, and are shown below in Table 14.10, and illustrated in Figures 14.7a and 14.7b of the Supplementary EIS.

Table 14.10 Predicted pollutant ground-level concentrations

Pollutant	Roxby Downs		Hiltaba Village		Criteria	
	Annual average	24-hour maximum average	Annual average	24-hour maximum average	Annual average	24-hour maximum average
Benzene (μg/m^3)	0.00012	n.a.	0.00011	n.a.	10	n.a.
PAH (ng/m^3)	0.00028	n.a.	0.00024	n.a.	0.3	n.a.
Toluene (mg/m^3)	0.00007	0.0022	0.00006	0.0024	0.38	3.8
Xylene (mg/m^3)	0.00007	0.0022	0.00006	0.0024	0.9	1
VOC (μg/m^3)	0.28	5.05	0.24	6.65	n.a.	n.a.
Formaldehyde (μg/m^3)	n.a.	2.73	n.a.	3.00	n.a.	40

The results show that the criteria are met at all times at both Roxby Downs and Hiltaba Village under the worst-case scenario modelled.

Predicted ground-level concentration contour plots

Ground-level concentration isopleths for the major identified air pollutants were provided as Figures 13.18a to 13.18d and Figures 13.20a to 13.20f in the Draft EIS. These provided an indication of the distance from the expanded operation at which the nominated air quality criteria would be met. Graduated contour lines were omitted from the figures to promote simplicity and clarity for the Draft EIS target audience. For completeness, the full contour plots for all of the 16 modelled scenarios have been provided in Appendix G of the Supplementary EIS.

Oxides of nitrogen emission sources

The sources of oxides of nitrogen (NOx) emissions modelled for the Draft EIS and their respective emission rate were presented in Tables 13.19 and 13.21 of the Draft EIS. A summary of these is provided in Table 14.11 of the Supplementary EIS, with the predicted ground-level concentrations shown in Table 14.12 of the Supplementary EIS.

Table 14.11 Sources of NOx for the expanded operation

Stack	NOx (mg/Nm^3)
Main smelter stack	50
Acid plant tails gas stack	75
Smelter #1 shaft furnace stack	20
Calciner A stack	0
Calciner B stack	0
Slimes treatment roaster stack	700
Slimes treatment NOx stack	170
Concentrate dryer stack	35
New acid plant tails gas stack	75
New sulphur-burning acid plant stack 1	75
New sulphur-burning acid plant stack 2	75
New calciner stack	0
Combined cycle gas turbine	4,620,000[1]

[1] Emission rate in kg/a as per National Pollutant Inventory estimation.

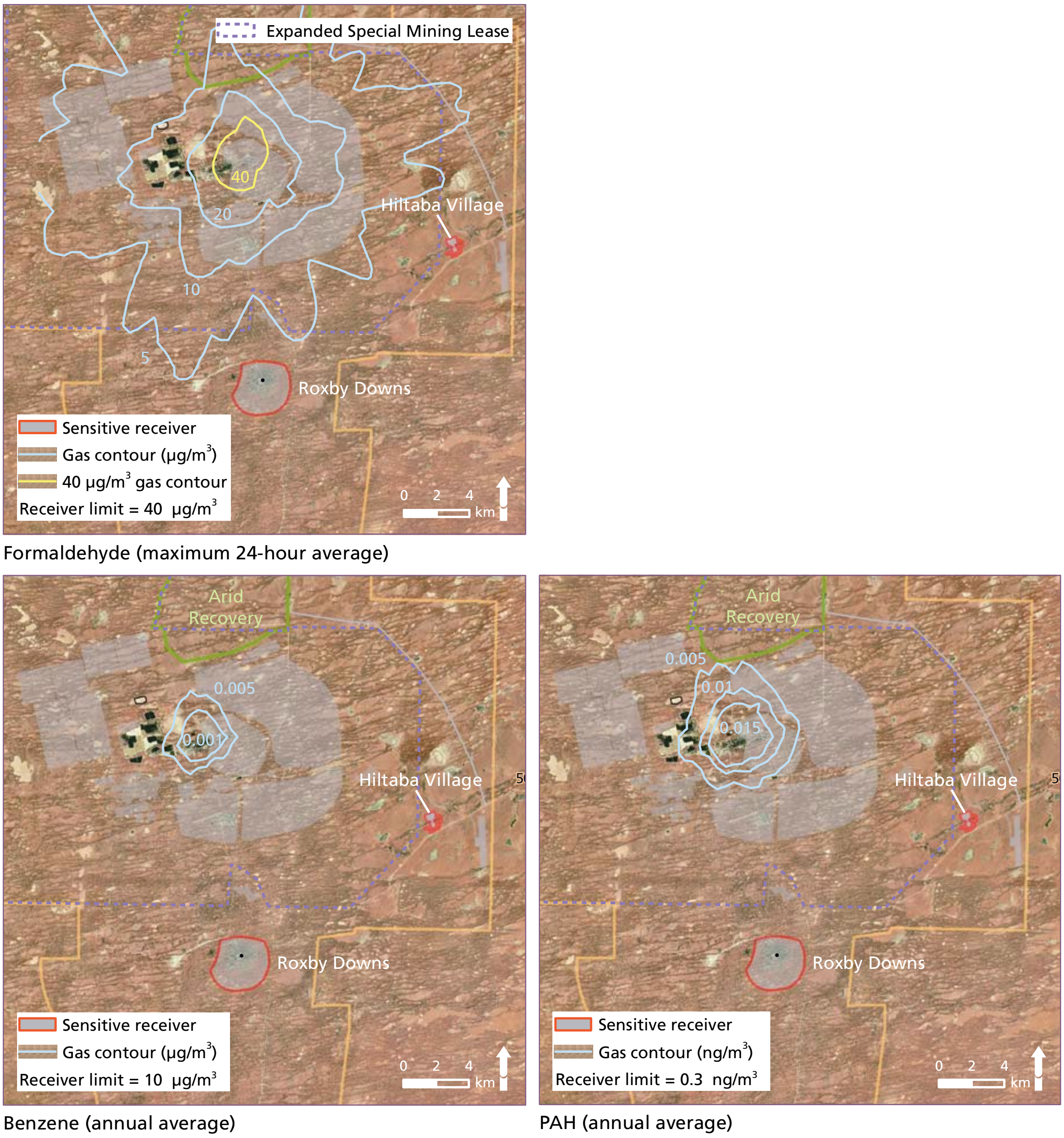

Figure 14.7a Predicted gas ground-level concentrations

Table 14.12 Predicted ground-level concentration of NOx for the expanded operation

Receiver	One-hour maximum average (ug/m³)	Annual average (ug/m³)	Criteria	
			One-hour maximum average	Annual average
Roxby Downs	87.7	0.44	158	60
Hiltaba Village	70.7	0.33		

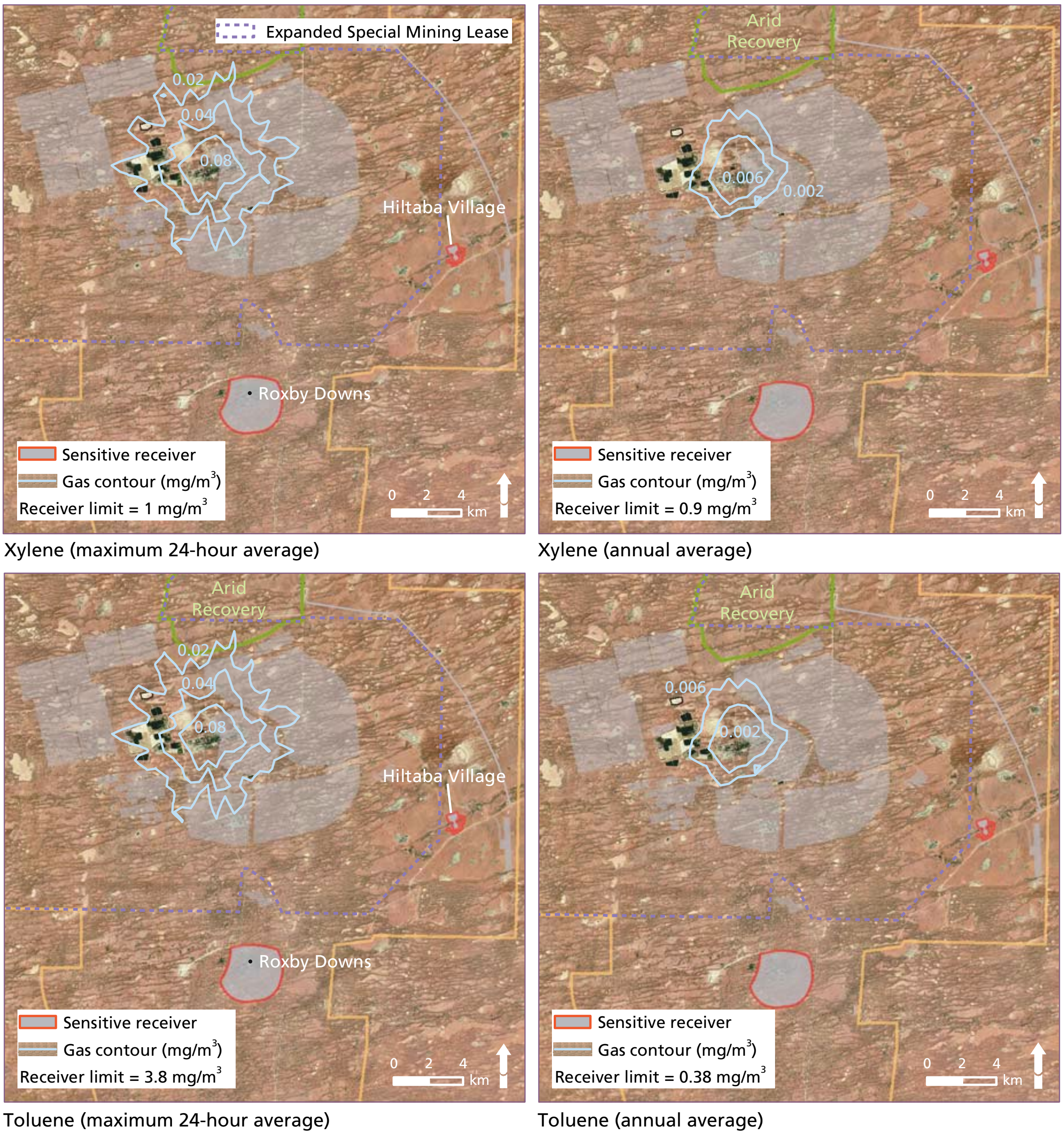

Figure 14.7b Predicted gas ground-level concentrations

Air pollutant health impact studies

The BHP Billiton Group Sustainable Development Policy outlines the company's goal of Zero Harm to its people, their host communities and the environment in which it operates. The Policy also commits the company to contributing lasting benefits to society by considering the health, safety, social, environmental, ethical and economic aspects of the activities it undertakes. To this end, BHP Billiton is committed to ensuring that emissions from the expanded operation do not adversely impact the health and well-being of nearby communities through adhering to relevant emissions criteria, and cooperating with government in the development of future emissions limits as necessary to reflect the increasing body of knowledge surrounding the health impacts of air pollutants.