Appendix 12

Air Quality Assessment

(Total No. of pages including blank pages = 14)

(Note: A colour version of this Appendix is available on the Project CD)

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Pacific Environment Limited
Consulting • Technologies • Monitoring • Toxicology

11 June 2015

Chris Dickson
Environment Consultant
RW Corkery & Co Pty Limited

Sent via email: chris@rwcorkery.com

RE: DARGUES REEF GOLD MINE 75W MODIFICATION – AIR QUALITY

Dear Chris,

1 INTRODUCTION

The Dargues Gold Mine (the Project) is owned and operated by Unity Mining Limited (UML). Project Approval PA10_0054 was granted by the Land and Environment Court on 7 February 2012, with subsequent modifications granted on:

- 12 July 2012 (MOD1) to permit the use of paste fill; and
- 24 October 2013 (MOD2) to regularise the layout following minor changes during the detailed design phase of the Project.

Construction of the Project commenced on 11 February 2013 and the Project was placed into care and maintenance in late 2013 pending finalisation of project finance and optimisation of the mining operation.

As a result of the studies undertaken to optimise the mining operation, a modification to PA10_0054 under Section 75W of the EP&A Act is to be sought to permit the following. **Figure 1-1** and **Figure 1-2** present the currently approved and proposed layout with the changes highlighted in yellow.

- An amendment to the Project Site to accommodate the recently purchased "Slings" property.
- A minor increase to the total resource to be extracted and associated extension of the life of the mine.
- Construction and use of the Eastern Waste Rock Emplacement.
- Construction and use of a vehicle crossing over Spring Creek to permit direct access between the box cut and the Tailings Storage Facility and proposed Western Waste Rock Emplacement.
- Final processing of gold concentrate on site to produce gold doré or unrefined gold bars using a conventional carbon-in-leach (CIL) processing plant.
- Construction of an enlarged Tailings Storage Facility to permit storage of additional tailings that would be produced as a result of the additional ore to be processed and the on-site final processing of gold concentrate.
- Construction and use of a replacement harvestable rights dam.
- A range of minor adjustments to the conditions of MP10_0054 to further clarify the intent of the conditions.

To support the application to modify PA10_0054 (the "Proposed Modification"), R.W. Corkery & Co. Pty Limited are preparing an Environmental Assessment. This letter report has been commissioned to assess the potential for any additional air quality impacts related to the Proposed Modification compared with the air quality assessment completed in 2010 by Pacific Environment (previously PAEHolmes) (**PAEHolmes, 2010**).

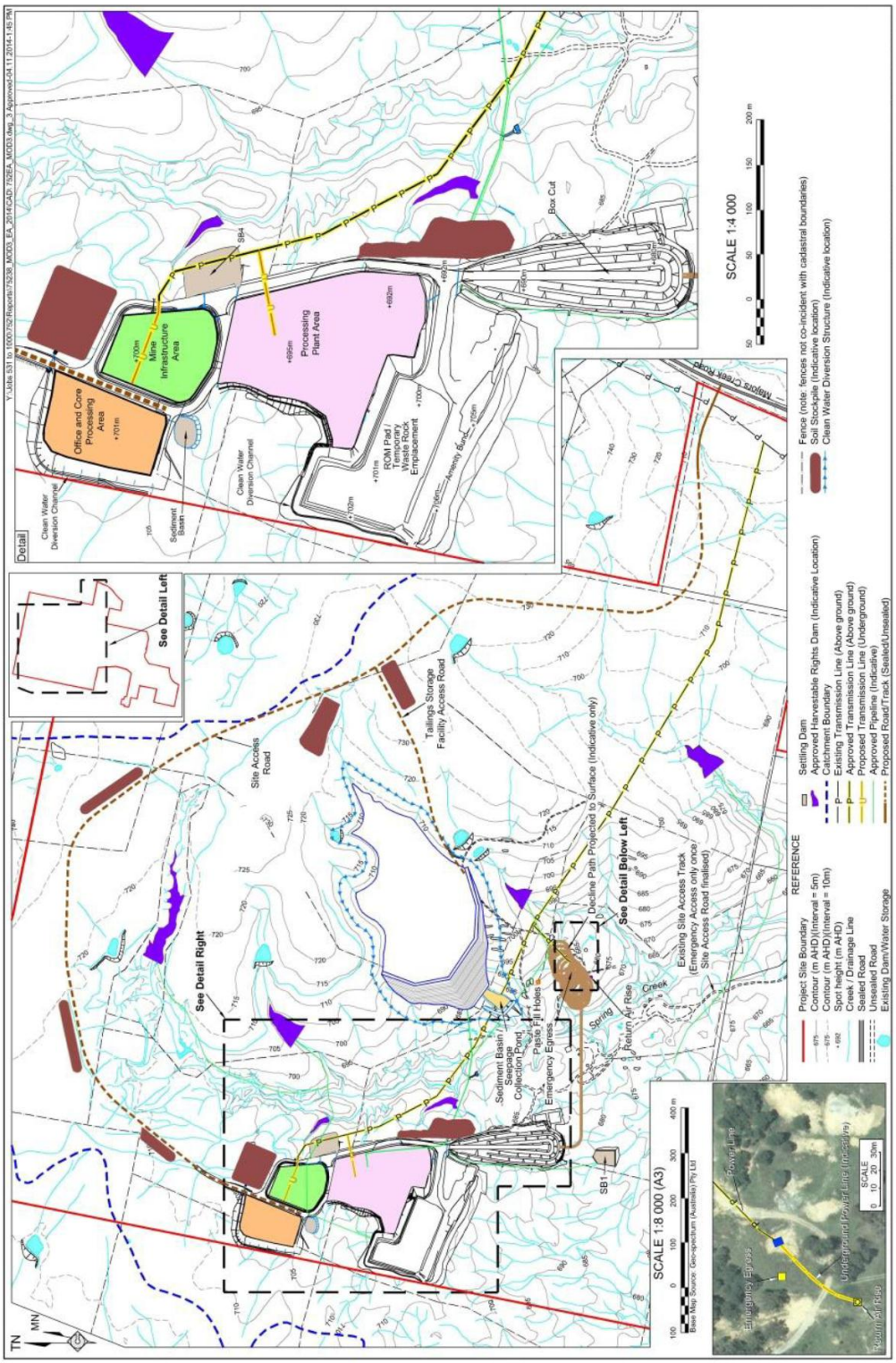

Figure 1-1: Approved Site Layout

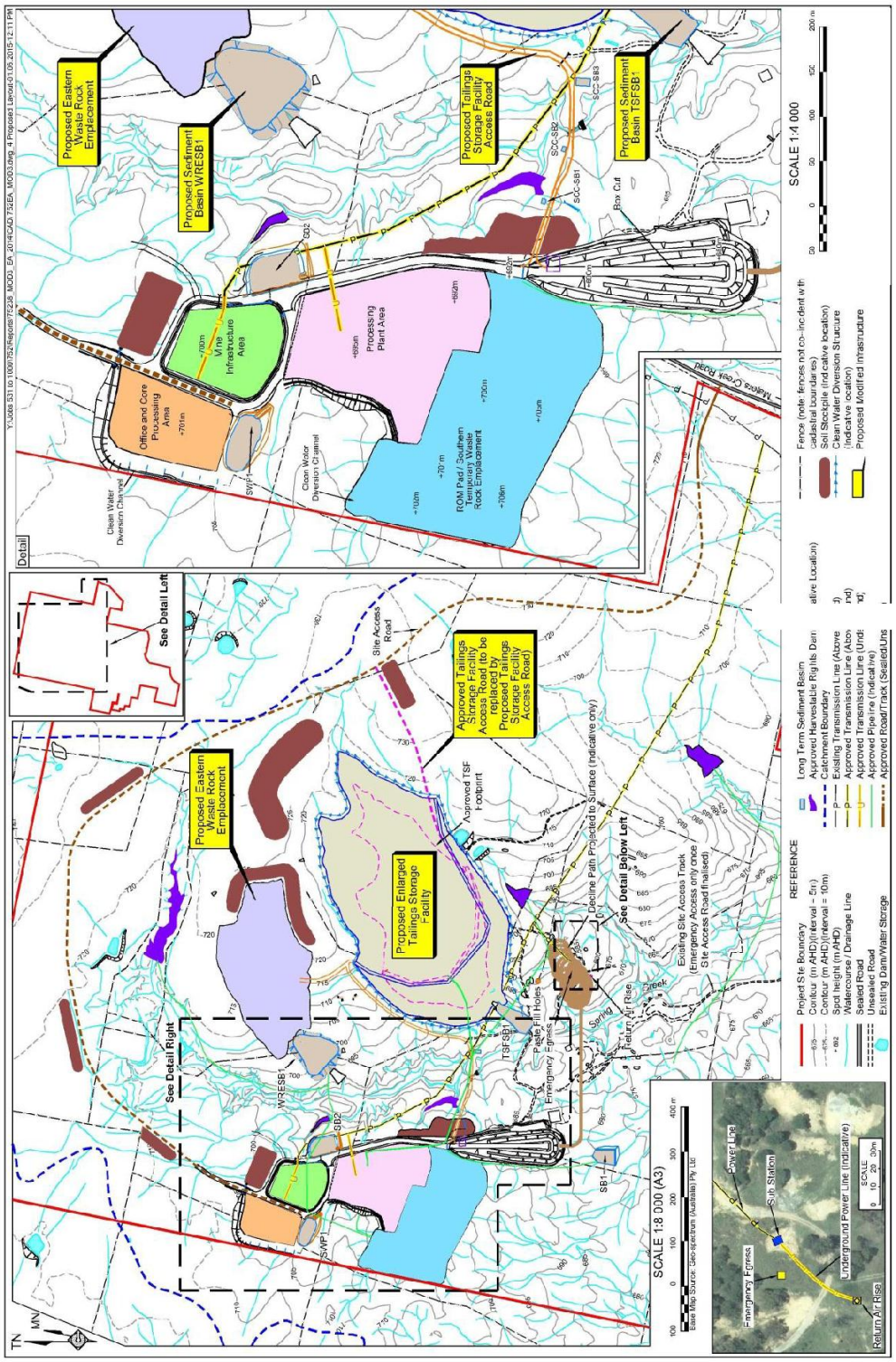

Figure 1-2: Proposed Site Layout

2 ASSESSMENT CRITERIA

Table 2-1 summarises the air quality goals for concentrations of particulate matter that are relevant to this study as outlined by *Condition 3(14)* of PA10_0054. These apply to the cumulative concentrations due to the Project and existing background.

Table 2-1: Air quality standards / goals for particulate matter concentrations

Pollutant	Averaging period	Standard / Goal	Agency
Total suspended particulate matter (TSP)	Annual mean	90 µg/m³	• National Health and Medical Research Council
Particulate matter with an equivalent aerodynamic diameter less than 10 µm (PM_{10})	24-hour maximum	50 µg/m³	• NSW EPA impact assessment criteria(NSW, EPA 2005) • NEPM reporting goal, allows five exceedances per year for bushfires and dust storms
	Annual mean	30 µg/m³	• NSW EPA impact assessment criteria (NSW, EPA 2005)

Notes: µg/m³ – micrograms per cubic metre, µm – micrometre.

Table 2-2 shows the maximum acceptable increase in dust deposition over the existing dust levels from an amenity perspective. These criteria for dust fallout levels are set to protect against nuisance impacts as outlined in **NSW EPA (2005)** and *Condition 3(14)* of PA10_0054.

Table 2-2: EPA criteria for dust (insoluble solids) fallout

Pollutant	Averaging period	Maximum increase in deposited dust level	Maximum total deposited dust level
Deposited dust	Annual	2 g/m²/month	4 g/m²/month

3 EXISTING ENVIRONMENT

3.1 Air Quality

Air quality standards and goals refer to pollutant levels that include the contribution from specific projects and existing sources. To fully assess impacts against all the relevant air quality standards and goals it is necessary to have information or estimates on existing dust concentration and deposition levels in the area in which the Modification is likely to contribute to these levels.

The following sections provide a summary of the monitoring results for dust deposition and PM_{10} in the area surrounding the Project.

3.1.1 Dust Deposition

Dust deposition is monitored using dust deposition gauges at five (5) locations in the vicinity of the Project. Dust deposition gauges use a simple device consisting of a funnel and bottle to estimate the rate at which dust settles onto the surface over a period of one month. The measured dust fallout levels include the effects of all existing sources of particulate matter including the existing mining operations.

Data collected from the gauges between July 2012 and October 2014 are summarised in **Table 3-1**. The data indicates that deposition levels are well within the EPA's annual average assessment criteria of 4 g/m²/month for insoluble solids. It is noted that the average of all data collected is 1.1 g/m²/month compared with the assumed existing background level of 2.4 g/m²/month applied in the original air quality assessment (**PAEHolmes, 2010**).

Table 3-1: Dust deposition data (insoluble solids) (g/m²/month)

Deposition Dust Gauge ID	2012[a]	2013	2014[b]
DD-1	1.8	1.9[c]	1.6
DD-2	0.6	1.1	0.9[d]
DD-3	1.1	1.5[e]	0.5[f]
DD-4	1.3[g]	0.5[h]	1.0[i]
DD-5	0.7	0.9[j]	0.7[k]
Average of all data = 1.1 g/m²/month			

Notes:
[a] 2012 data available for the period July to December unless otherwise noted.
[b] 2014 data available for the period January to October unless otherwise noted.
[c] Excludes data for June and July which were contaminated with biological matter.
[d] Excludes data for April which contained a high proportion of combustible matter not related to mining operations.
[e] Excludes data for February and March which were contaminated with biological matter
[f] Excludes data for October contaminated with biological matter.
[g] Excludes data for December which were contaminated with biological matter.
[h] Excludes data for April which were contaminated with biological matter.
[i] Excludes data for September which contained a high proportion of combustible matter not related to mining operations.
[j] Excludes data for January and July which were contaminated with biological matter.
[k] Excludes data for April and September which contained a high proportion of combustible matter not related to mining operations.

3.1.2 PM_{10} concentrations

Particulate matter (PM_{10}) concentrations have been monitored by the Project since early 2013. 24-hour average concentrations of PM_{10} are collected every sixth day using a High Volume Air Sampler (HVAS). **Figure 3-1** shows a graphical representation of all the available data.

There have been no measured concentrations above the EPA 24-hour average PM_{10} criterion of 50 µg/m³. The maximum recorded concentration was 27.7 µg/m³ on 4 February 2014.

The rolling annual average of the HVAS PM_{10} is significantly below the EPA goal of 30 µg/m³ with the average of all data calculated at 9.9 µg/m³. The original air quality assessment (**PAEHolmes, 2010**) conservatively assumed that annual average PM_{10} concentrations were 21 µg/m³.

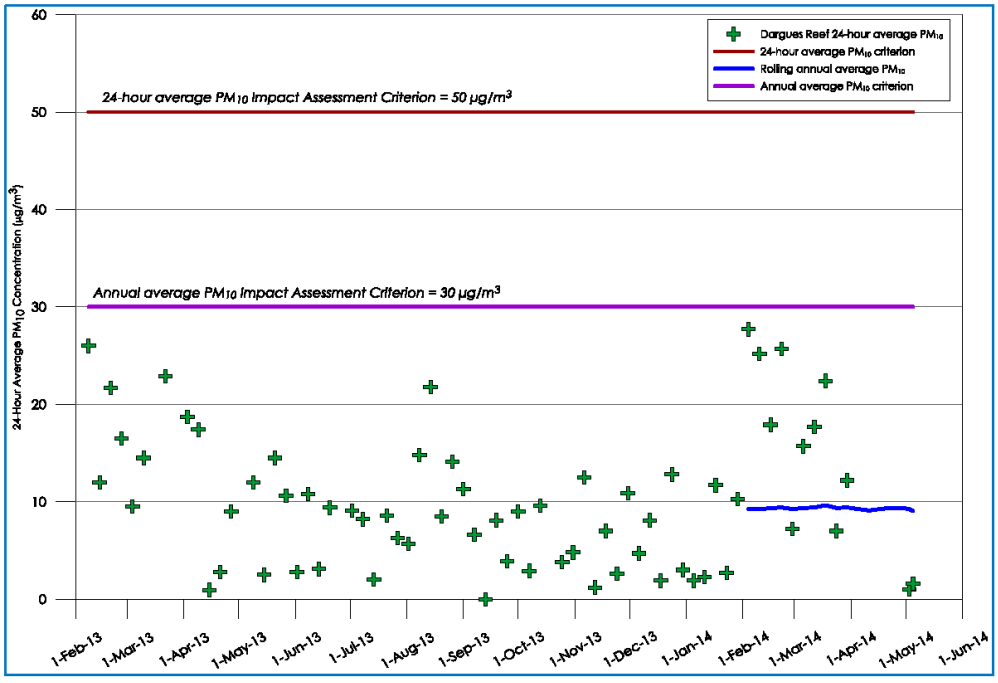

Figure 3-1: HVAS PM_{10} concentrations February 2013 to May 2014

3.2 Meteorology

The air quality assessment completed for the approved Project used meteorological data collected at the site between March 2009 and March 2010. As **Figure 3-2** shows, the prevailing wind directions and wind speeds have remained consistent with the data applied in the assessment.

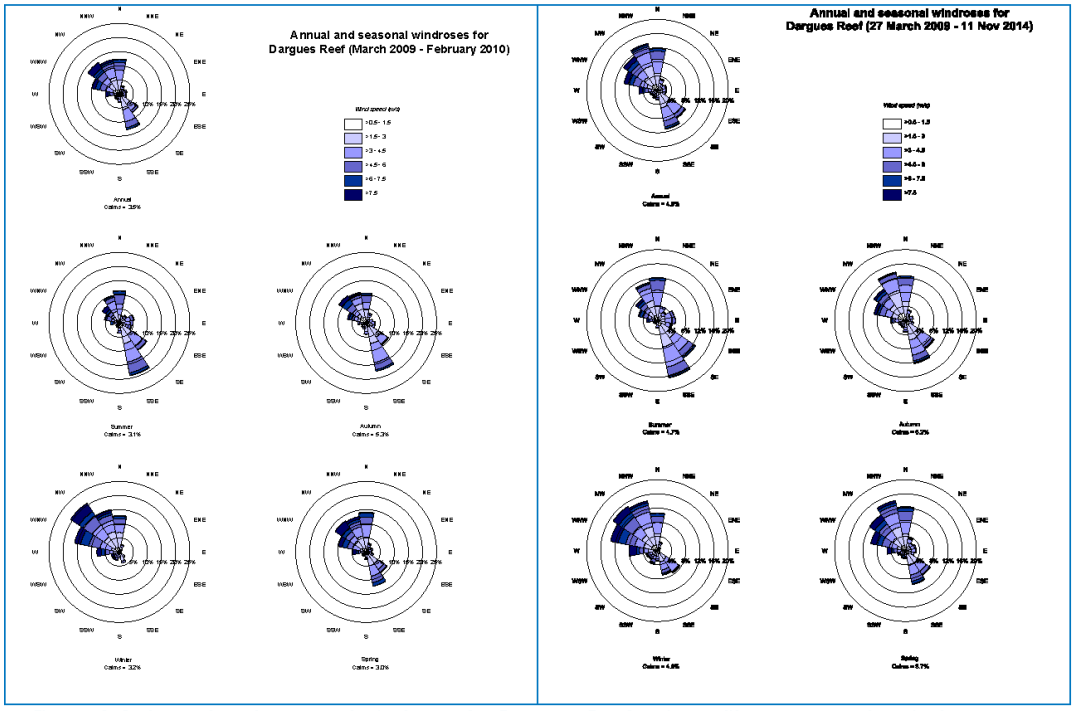

Figure 3-2: Annual and seasonal windroses for Dargues Reef – air quality assessment period compared with all available data

4 IMPACT ASSESSMENT

4.1 Dust emissions

The air quality impact assessment completed for the Dargues Reef Gold Environmental Assessment in 2010 (**PAEHolmes, 2010**) made emissions estimates for Year 3 of operations as this represented the year of greatest material movement and production and hence was the year likely to generate the highest emissions from the Project Site.

The only component of the Proposed Modification that has the potential to increase dust emissions from the Project relates to the increase in exposed area resulting from the inclusion of the Eastern Waste Rock Emplacement, equating to an additional disturbance footprint of approximately 6 ha.

Further, it is noted that the haulage distance would be shortened from a return distance of 6.7 km to 1.4 km from the box cut to the Tailings Storage Facility, utilising the proposed Spring Creek crossing rather than the Approved TSF Access Road Route. This would ultimately further reduce dust emissions from the transportation of mine waste.

As presented in **Table 4-1**, the resultant change in total TSP emissions compared with the approved activities is an increase of 6.7%. Extensive experience in dispersion modelling for extractive operations has demonstrated that a change in total emissions of less than 10-20% has a negligible difference to the predicted impacts.

Table 4-1: Summary of estimated TSP emissions from the Project (kg/y)

ACTIVITY	Approved TSP Emissions (kg/y)[a]	Proposed TSP Emissions (kg/y)
Topsoil Removal - Dozers/Excavators stripping topsoil	179	179
Topsoil removal - Wheeled loader loading topsoil from TSF	53	53
Topsoil removal - Emplacing topsoil at stockpile at TSF	53	53
Topsoil removal - Loading topsoil from stockpile near WRE to trucks	1	1
Topsoil removal - Hauling topsoil to WRE	11	11
Topsoil removal - Emplacing/respreading topsoil at WRE	1	1
WASTE (rock) - Loading rock from WRE to trucks	21	21
WASTE (rock) - Hauling from WRE to underground	696	696
ORE - Hauling ROM ore to ROM pad	5,940	5,940
ORE - Unloading ROM to stockpile	453	453
ORE - Wheeled loader rehandle ore to ROM bin	453	453
ORE - Primary Crushing	66,000	66,000
ORE - Ball milling	0	0
ORE - Screening	26,400	26,400
ORE - Unloading of crushed / processed ore (concentrate) to stockpile	6	6
ORE - Wheeled loader loading from concentrate stockpile to vehicles	12	12
ORE - Hauling concentrate off-site	5,360	5,360
WE - Eastern Waste Rock Emplacement	-	10,512
WE - Waste Rock Emplacement/ROM pad (incl. ROM stockpiles)	3,154	10,512
WE - Soil Stockpile Areas	17,170	17,170
WE - Concentrate stockpile	876	876
Grading roads	43,132	43,132
Total	**169,969**	**180,481**
% increase	**6.7**	

Notes:
[a] Source: **PAEHolmes, 2010**: Table 7-1.

The predicted concentrations for the approved operations due to the Project alone, and cumulatively with existing background levels, were all below the relevant assessment criteria, as shown in **Table 4-2**.

As discussed in **Section 3.1.1** and **Section 3.1.2**, the assumed existing background dust deposition levels and annual average PM_{10} concentrations utilised in **PAEHolmes (2010)** were significantly higher than the actual monitoring results recorded at the Project Site by the air quality monitoring network.

The cumulative results presented are therefore considered to be conservative and when considered with the minor change in total emissions, it is concluded that the Modification has limited potential to result in adverse impacts on local air quality.

Table 4-2: Model predictions due to the Project alone and the Project and other sources

Private Receptor ID	Year 3 – Project alone				Year 3 - Project and other sources		
	PM_{10} (µg/m³) 24-hour	PM_{10} (µg/m³) Annual	TSP (µg/m³) Annual	Dust Deposition (g/m²/month) Annual	PM_{10} (µg/m³) Annual	TSP (µg/m³) Annual	Dust Deposition (g/m²/month) Annual
Assessment Criteria	*50*	*N/A*	*N/A*	*2*	*30*	*90*	*4*
R53	4	0.5	0.6	0.04	22	54	2.4
R54	4	0.5	0.6	0.04	22	54	2.4
R55	4	0.6	0.6	0.05	22	54	2.4
R56	4	0.5	0.6	0.04	22	54	2.4
R57	3	0.5	0.6	0.04	21	54	2.4
R58	5	0.6	0.7	0.05	22	54	2.5
R59	5	0.6	0.7	0.05	22	54	2.5
R60	4	0.5	0.6	0.04	21	54	2.4
R61	3	0.4	0.5	0.04	21	53	2.4
R62	3	0.4	0.5	0.04	21	53	2.4
R63	3	0.3	0.4	0.03	21	53	2.4
R64	3	0.3	0.3	0.02	21	53	2.4
R65	3	0.3	0.4	0.03	21	53	2.4
R66	3	0.3	0.4	0.03	21	53	2.4
R67	3	0.3	0.3	0.03	21	53	2.4
R68	3	0.3	0.4	0.03	21	53	2.4
R69	3	0.5	0.6	0.04	22	54	2.4
R70	4	0.4	0.5	0.04	21	53	2.4
R71	4	0.6	0.7	0.05	22	54	2.5
R72	5	0.6	0.7	0.05	22	54	2.5
R73	3	0.1	0.2	0.01	21	53	2.4
R74	3	0.2	0.2	0.01	21	53	2.4
R75	3	0.2	0.2	0.01	21	53	2.4
R76	3	0.1	0.2	0.01	21	53	2.4
R77	3	0.2	0.2	0.01	21	53	2.4
R78	3	0.2	0.2	0.01	21	53	2.4
R79	3	0.2	0.2	0.01	21	53	2.4
R80	3	0.2	0.2	0.02	21	53	2.4
R81	3	0.2	0.2	0.01	21	53	2.4
R82	2	0.2	0.2	0.02	21	53	2.4
R83	2	0.2	0.3	0.02	21	53	2.4
R84	3	0.2	0.3	0.02	21	53	2.4
R85	3	0.2	0.3	0.02	21	53	2.4
R86	3	0.3	0.3	0.02	21	53	2.4
R87	3	0.3	0.3	0.02	21	53	2.4
R88	3	0.3	0.3	0.02	21	53	2.4
R89	3	0.1	0.2	0.01	21	53	2.4
R90	3	0.2	0.2	0.01	21	53	2.4
R91	3	0.3	0.3	0.02	21	53	2.4
R92	1	0.1	0.1	0.01	21	53	2.4
R93	4	0.3	0.4	0.03	21	53	2.4
R94	4	0.3	0.3	0.03	21	53	2.4
R95	1	0.1	0.1	0	21	53	2.4
R96	1	0.1	0.1	0	21	53	2.4
R97	1	0.1	0.1	0	21	53	2.4
R98	1	0.1	0.1	0	21	53	2.4
R99	1	0.1	0.1	0	21	53	2.4
R100	1	0.1	0.1	0	21	53	2.4
R101	1	0.1	0.1	0.01	21	53	2.4
R102	1	0.1	0.1	0.01	21	53	2.4
R103	1	0.1	0.1	0.01	21	53	2.4
R104	1	0.1	0.1	0.01	21	53	2.4
R105	2	0.1	0.2	0.01	21	53	2.4
R106	3	0.2	0.2	0.01	21	53	2.4
R107	4	0.3	0.3	0.02	21	53	2.4

Source: PAEHolmes (2010) Table 8.1

4.1 Processing emissions

One component of the Modification is the ability to process the gold concentrate on site to produce gold bar through the use of a proposed carbon-in-leach processing plant, a process that includes the use of cyanide to leach the gold from the ore. Cyanide is a commonly and safely used reagent in gold mines throughout Australia and the world.

ToxConsult (2014) has prepared a full assessment of the hazards and assessed the health risks to residents living near the Project Site, as well as assessing risks to wildlife associated with the use of cyanide and as such, is not considered further in this assessment.

In addition, the modified gold room would include three items that may result in non-particulate emissions to air, namely an electrowinning cell, calcining oven and furnace. Each of these would be equipped with an exhaust system and associated scrubber to remove gasses from the gold room for OHS reasons. The exhaust stack would be located in the vicinity of the gold room.

The equipment would be operated intermittently for 4 to 8 hours every 6 days. In addition, the Proponent has committed to ensuring that the emissions comply with the requirements for emissions for Group 6 non-ferrous metal facilities identified in Schedule 3 of Protection of the *Environment Operations (Clean Air) Regulation 2010* as follows.

- Solid Particles (total) – 50mg/m^3.
- Nitrogen dioxide (NO2) or nitric oxide (NO) or both, as NO2 equivalent – 350mg/m^3.
- Volatile organic compounds (VOCs), as n-propane equivalent - 40 mg/m3 VOCs or 125 mg/m3 CO.
- Type 1 (antimony, arsenic, cadmium, lead or mercury) and Type 2 (beryllium, chromium, cobalt, manganese, nickel, selenium, tin or vanadium) substances (in aggregate) – 1mg/m^3.
- Cadmium (Cd) or mercury (Hg) individually – 0.02mg/m^3.
- Smoke - Ringelmann 1 or 20% opacity.

Based on the above and the distance to the closest residential receiver of approximately 1,500m, it is likely that air emissions from the gold room would have a negligible impact on air quality.

5 MANAGEMENT AND MITIGATION MEASURES

The Proponent has previously developed an Air Quality and Greenhouse Gas Management Plan (which was subsequently approved by DP&E on 30 January 2013) that identifies the measures to be taken to manage particulate emissions from the Project Site (**Unity Mining, 2013**). This document would be updated to reflect the changes associated with the Proposed Modification.

Table 5-1 presents a summary of the management measures that will continue be implemented.

Table 5-1: Management Measures – Particulate Matter

Source	Control Procedures
Wind Blown Dust	
Areas Disturbed by Mining	■ Disturb only the minimum area necessary for mining operations. ■ Reshape, topsoil and rehabilitate the face of the waste rock emplacement/ROM Pad, Tailings Storage Facility embankment and other disturbed sections of the Project Site that are not required for mining operations as soon as practicable construction
Ore Handling Areas/Stockpiles	■ Maintain ore handling areas / stockpiles in a moist condition as required by using water carts to minimise wind-blown and traffic-generated dust.
Stockpiles	■ Have available water sprays/water carts on stockpiles to minimise the generation of dust.

Table 5-1: Management Measures – Particulate Matter (Cont'd)

Source	Control Procedures
Mine Design and Construction	
Transport of ore	■ Use the largest practicable truck size to reduce the number of movements necessary to transport ore material. ■ Use conveyors within the processing plant to transport crushed ore material. ■ Establish and use water sprays on key transfer points within the processing plant.
Waste Rock Emplacement	■ Profile all surfaces to reduce surface wind speed. ■ Contour the final landform shape to avoid strong wind flows and smooth gradients to reduce turbulence at surface.
Revegetation	■ Complete as soon as practical after disturbance. ■ Apply vegetation as widely as practical.
Mine Generated Dust	
Roads	■ All roads and trafficked areas will be watered as required using water trucks to minimise the generation of dust. ■ Enforce a speed limit of 40 km/h or less on all roads within the Project Site. ■ All roads will have edges clearly defined with marker posts or equivalent to control their locations. ■ Development of minor roads will be limited and the locations of these clearly defined. ■ Obsolete roads will be ripped and re-vegetated. ■ Ensure that all concentrate vehicles leaving the Project Site are covered to prevent concentrate material blowing from the truck.
Topsoil Stripping	■ Access tracks used by topsoil stripping equipment during their loading and unloading cycle will be watered.
Topsoil Stockpiling	■ Long term topsoil stockpiles will be re-vegetated.
Processing	■ Establish and use water sprays on key transfer points within the processing plant. ■ Minimise drop heights from the ROM bin to the primary crusher.
Blasting Operations	■ Ensure that all surface blasts are appropriately designed to minimise emission of particulate matter.
Cement Use and Storage	■ Ensure that a reverse pulse dust collector, as well as overpressure and vacuum sensors, are fitted to the cement storage silo and are operational to prevent dust emissions. ■ Deliver cement in bulk and pneumatically unload directly into the storage silo.

6 CONCLUSIONS

This letter report has investigated the likely effects on air quality from the proposed Dargues Reef Gold Mine Modification. It demonstrates that the Modification will generate minimal additional emissions compared with those approved for Project Site operations.

As the Modification is not dissimilar to that approved in the EA, it is considered that the cumulative concentrations and levels will remain below the relevant assessment criteria, supported by the results of the current monitoring of 24-hour PM_{10} concentrations and monthly deposition levels that have displayed measured levels significantly below the assessment criteria, with annual average concentrations are approximately half of those assumed as background for the approved operations,

In view of the above, it is anticipated that the Modification can continue to be managed to ensure that adverse air quality impacts do not occur at the nearest private receptors.

Please do not hesitate to contact me should you require any further information.

Judith Cox
Principal Consultant – Air Quality
Pacific Environment Limited

References

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"Air Quality and Greenhouse Gas Management Plan" available from http://www.unitymining.com.au/wp-content/uploads/2013/09/20131120-Air-Quality-GG-Man-Plan-FINAL.pdf

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