Ambient Air Quality Monitoring Report
2018-2019
EPBC 2008/45546

Lot 564 and 3017 Village Road
BURRUP WA 6714 Australia

3 October 2019

57512/124937 (Rev 2)

JBS&G Australia Pty Ltd T/A Strategen-JBS&G

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Abbreviations and definitions

Term	Definition	Description and context for this report
µm	Micrometre	One millionth (0.000001) of a metre
ANsol	Ammonium nitrate solution	Manufactured in the TAN Plant as part of the TAN manufacturing process
CSIRO	The Commonwealth Scientific and Industrial Research Organisation	The Commonwealth Scientific and Industrial Research Organisation is an independent Australian federal government agency responsible for scientific research.
EPBC	Environment Protection and Biodiversity Conservation	Refers to the Australian Government EPBC Act of 1999
Insoluble fraction	Component of deposited dust that is not soluble in water	Deposited dust can comprise of aqueous soluble and insoluble materials depending on mechanisms and sources of dust emissions. The insoluble fraction is typically derived from crustal materials.
MicroVol	MicroVol 1100 low volume sampler	LVAS instrument for sampling of TSP, manufactured by Ecotech
NAP	Nitric acid plant	A part of the TAN Plant
NH_3	Ammonia	Gaseous air pollutant from natural sources and industrial sources (including YPN TAN plant)
NO_2	Nitrogen dioxide	Gaseous air pollutant from combustion sources
NPI	National Pollutant Inventory	The National Pollutant Inventory provides the community, industry and government with free information about substance emissions in Australia. It has emission estimates for 93 toxic substances and the source and location of these emissions.
OEMP	Operational Environmental Management Plan	Management plant prepared by YPN in accordance with Condition 7 of the EPBC Approval (as varied on 12 September 2017)
Passive sampling	Ambient air sampling for gaseous substances involving passive samplers	Sampling technique whereby airborne gaseous pollutants are extracted from the air column onto an adsorbent material via a diffusive mechanism
PM_{10}	Particulate matter (10 micrometre)	Dust particles which are present in ambient air with equivalent aerodynamic diameter of 10 micrometres (µm)
Radiello® passive sampler	Sampler for gaseous substances in ambient air	Sampling devices manufactured by Sigma Aldrich under licence from Fondazione Salvatore Maugeri IRCCS for passively monitoring airborne concentrations of gases
SO_2	Sulfur dioxide	Gaseous air pollutant from oxidation (combustion) of sulfur containing substances
Soluble fraction	Component of deposited dust that is soluble in water	Deposited dust can comprise of aqueous soluble and insoluble materials depending on mechanisms and sources of dust emissions. The soluble fraction is typically derived from marine aerosols
TAN Plant	Technical Ammonium Nitrate Plant	YPN plant on the Burrup for production of ammonium nitrate
TSP	Total suspended particulates	Dust particles which are present in ambient air with equivalent aerodynamic diameter of 50 micrometres (µm)
YPN	Yara Pilbara Nitrates	The operator of the TAN Plant

1. Introduction

Conditions 9 and 9A of EPBC Approval 2008/4546 (as varied on 12 September 2017) for the Yara Pilbara Nitrates Pty Ltd (YPN) Technical Ammonium Nitrate Plant (TAN Plant) require monitoring of various air quality parameters. Condition 3 of the EPBC Approval outlines reporting requirements that include data from the monitoring program conducted under condition 9A. This report is provided in response to Condition 3(a) of the EPBC Approval for the reporting period 1 July 2018 to 30 June 2019.

2. Scope of monitoring program

EPBC Approval 2008/4546 required baseline monitoring to be conducted for a period of not less than 24 months from commencement of construction of the TAN Plant. YPN issued a report to the Department of the Environment and Energy on 16 June 2017 in compliance with requirements of Conditions 9(a), (b), (c) and (d) (YPN 2017).

Condition 9A of EPBC Approval 2008/4546 (as varied 12 September 2017) informed the scope of the ongoing monitoring program and is reproduced below (Figure 1).

9A. To protect the values of the Dampier Archipelago (including Burrup Peninsula) National Heritage Place, particularly the rock art sites, the person taking the action must ensure:

a) Ongoing air quality monitoring is undertaken within 30 days after this condition comes into effect (the date the relevant variation to conditions notice is signed) and until expiry of the approval.

b) Air quality monitoring parameters are monitored at the rock art sites: Site 5 (Burrup Road), Site 6 (Water tanks site) and Site 7 (Deep Gorge site) as shown in Attachment 2.

c) Monitoring of air quality at rock art sites is undertaken by a suitably qualified person (Air Quality)

The air quality monitoring parameters in the table below must be monitored at the frequencies indicated in the table below:

Element of air quality to be monitored	Specific air quality parameter to be sampled	Minimum frequency of monitoring
Ambient air concentration of gases	NH_3 (ammonia)	Continuous monitoring for at least 14 consecutive days, every month
	NO_2 (nitrogen oxide)	
	SO_2 (sulfur oxide)	
Airborne particulate concentration	Total suspended particulates up to 50 µm (TSP)	Every 6 days
Deposited dust	Total dust deposition per month (Insoluble Fraction)	Quarterly
	Total dust deposition per month (Soluble Fraction)	

Figure 1: Condition 9A of EPBC Approval 2008/4546 (as varied 12 September 2017)

Condition 3(a)i of EPBC Approval 2008/4546 (as varied 12 September 2017) requires (in part) publication of a report that includes *"...an analysis of monitoring data required under Condition 9A..."*.

The initial report for analysis of the monitoring data as required by the EPBC Approval was issued in October 2018 for the period 2017-2018 (Strategen 2018). This report presents an analysis of monitoring data obtained for the monitoring period 1 July 2018 to 30 June 2019 (referred to herein as 2018-2019).

3. YPN TAN Plant operation 2018-2019

YPN has advised that the TAN Plant was operating from 12 May to 30 June 2019 during the 2018-2019 reporting period (1 July 2018 to 30 June 2019) [1]. No emissions from the plant were recorded outside that operating period.

4. Air quality monitoring program

4.1 Gases (NH_3, NO_2, SO_2 and HNO_3)

4.1.1 Results of NH_3, NO_2, SO_2 and HNO_3 monitoring

Monitoring of gases NH_3, NO_2 and SO_2 using Radiello passive sampling was carried out continuously throughout the 2018-2019 monitoring period at the three specified monitoring sites, namely:

- Site 5 Burrup Road
- Site 6 Water Tanks
- Site 7 Deep Gorge.

A total of 24 fortnightly measurements were made of concentrations for the respective gases at each site in the period 1 July 2018 to 30 June 2019. Sampling commenced on 29 June 2018 when samplers deployed for the previous fortnight were replaced, and sampling concluded on 1 July 2019.

Results of monitoring are shown in Appendix A. The concentrations for each parameter at the respective sites are illustrated in Figure 2 for NH_3, Figure 3 for NO_2 and Figure 4 for SO_2.

Note that earlier studies carried out by CSIRO included monitoring of gaseous nitric acid (HNO_3). The EPBC Approval does not require monitoring of this substance. However, as described in the Operational Environmental Management Plan (OEMP) prepared by YPN for the EPBC Approval, YPN has continued monitoring of HNO_3 since the CSIRO studies concluded. This allows for direct comparisons of current deposition rates with the rates determined since 2003. The concentrations of HNO_3 are illustrated in Figure 5.

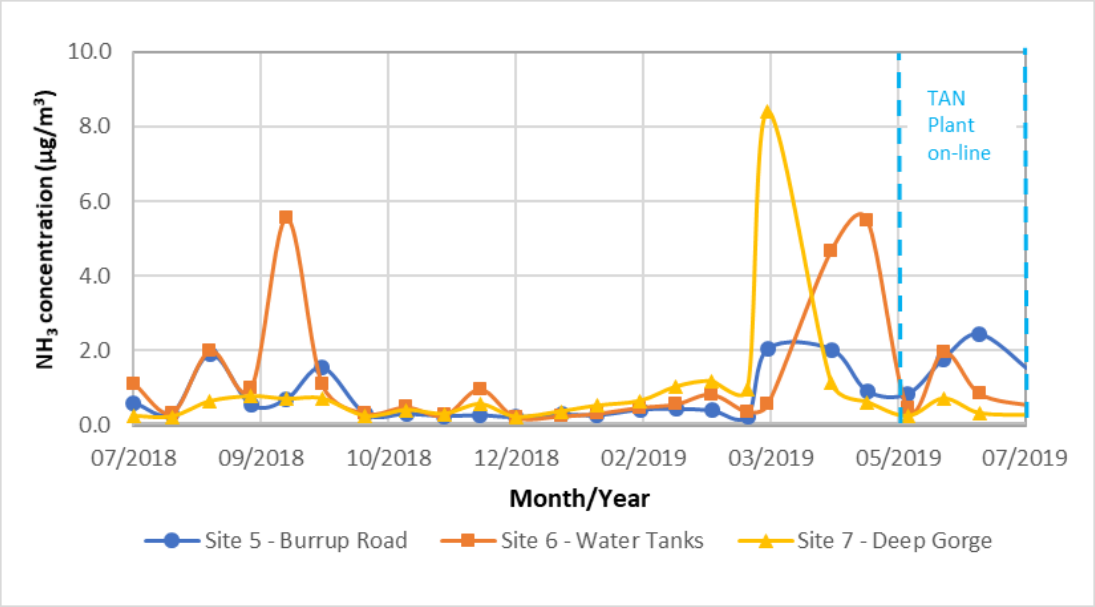

Figure 2: Measured NH_3 concentrations for 1 July 2018 to 30 June 2019

[1] The plant ceased operation on 4 July 2019 and remains off-line while the TAN Repair project works are carried out, with re-start scheduled for early 2020.

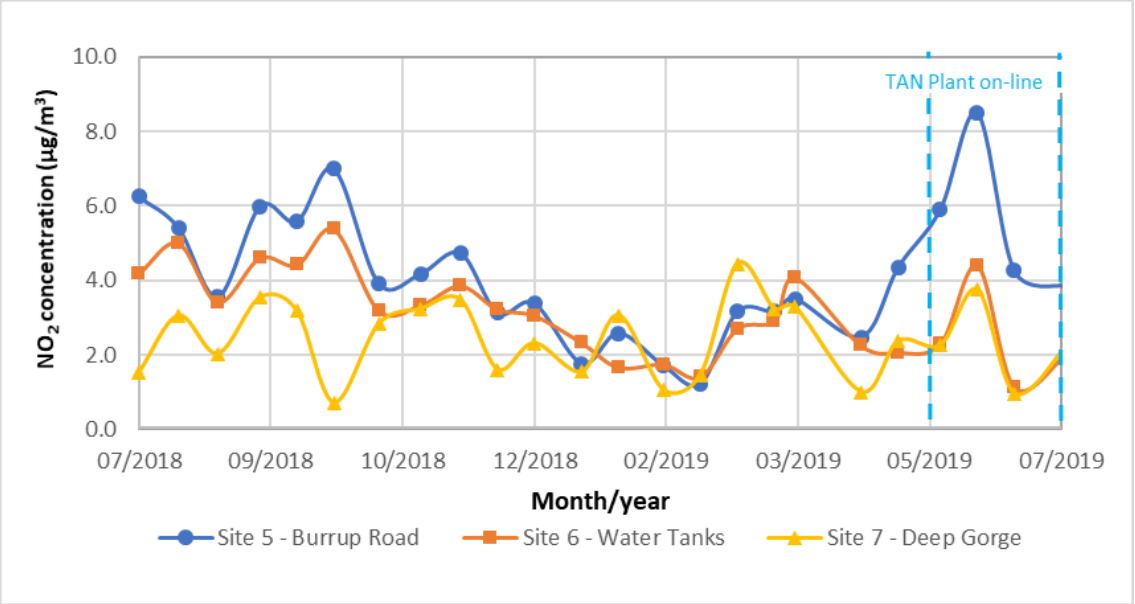

Figure 3: Measured NO_2 concentrations for 1 July 2018 to 30 June 2019

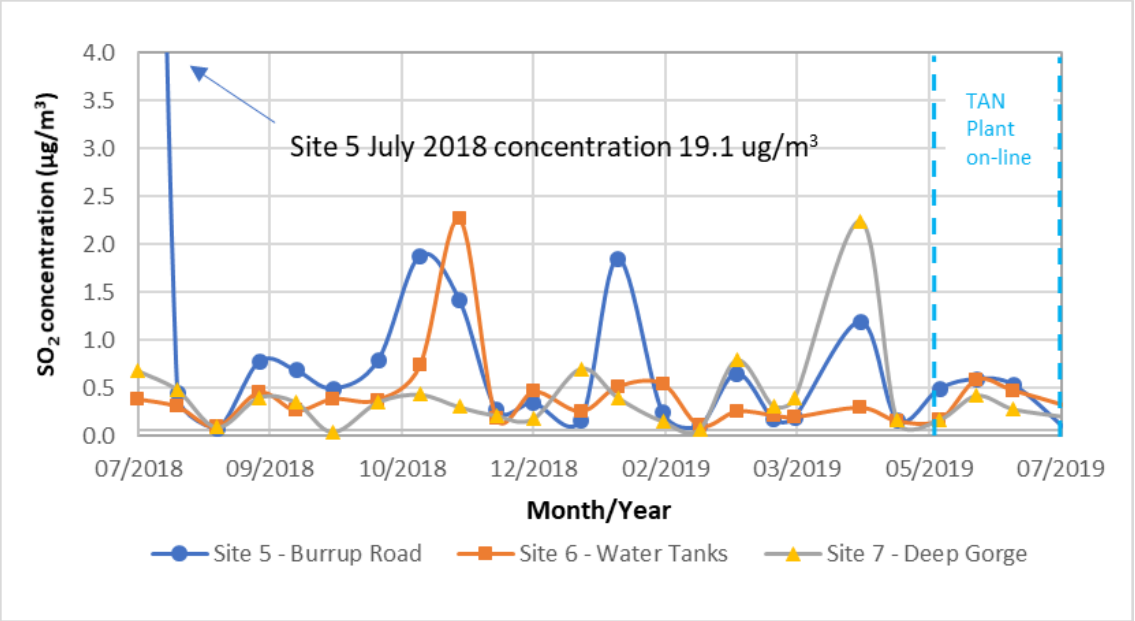

Figure 4: Measured SO_2 concentrations for 1 July 2018 to 30 June 2019

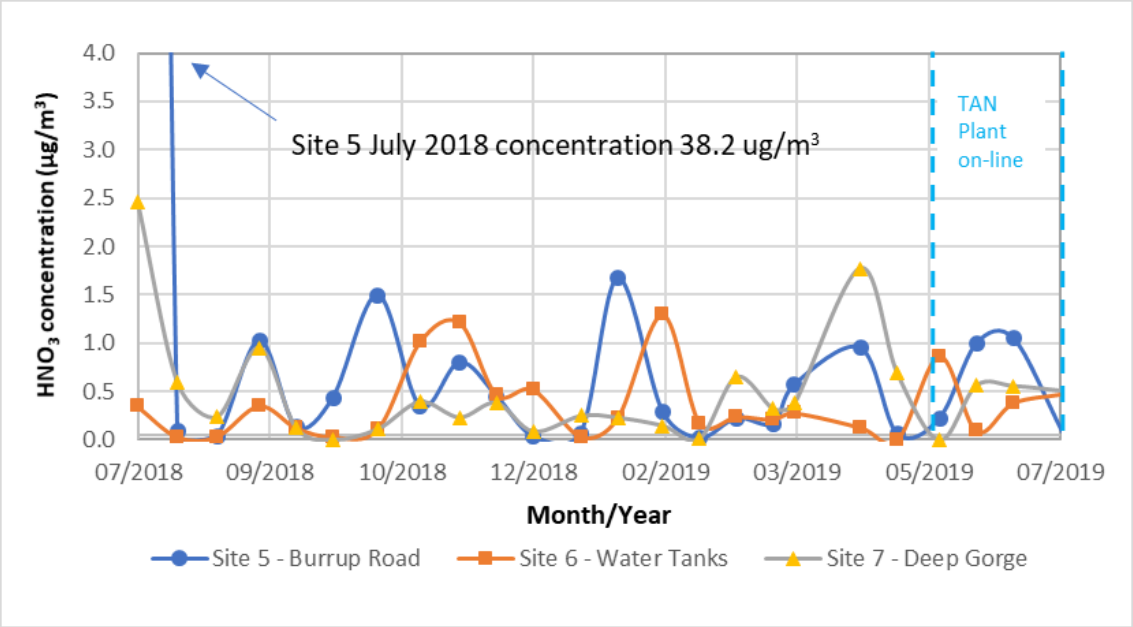

Figure 5: Measured HNO_3 concentrations for 1 July 2018 to 30 June 2019

4.1.2 Analysis of NH_3, NO_2 and SO_2 data

The analysis of measured concentrations involved comparison of descriptive statistics for 2018-2019 with those from monitoring conducted in the baseline study (YPN 2017). These statistics are shown in Table 1 for concentrations of NH_3, Table 2 for NO_2, Table 3 for SO_2 and Table 4 for HNO_3. Concentrations are calculated for the actual duration of exposure of the samplers, which were nominally 15 days but may vary a day either side of that duration for logistical reasons.

Table 1: Descriptive statistics for NH_3 concentrations (2018-2019 and baseline)

Ammonia concentration µg/m³						
	Site 5 - Burrup Rd		Site 6 - Water Tanks		Site 7 - Deep Gorge	
Statistic	2018-2019	Baseline	2018-2019	Baseline	2018-2019	Baseline
Minimum	0.22	0	0.22	0	0.22	0
Average	0.86	0.44	1.28	0.93	0.89	0.75
Maximum	2.44	1.2	5.54	3.97	8.42	4.35
Standard deviation	0.72	0.34	1.61	0.76	1.63	0.82

Table 2: Descriptive statistics for NO_2 monitoring (2018-2019 and baseline)

Nitrogen Dioxide concentration µg/m³						
	Site 5 - Burrup Rd		Site 6 - Water Tanks		Site 7 - Deep Gorge	
Statistic	2018-2019	Baseline	2018-2019	Baseline	2018-2019	Baseline
Minimum	1.22	0.38	1.13	0.31	0.71	0.4
Average	4.15	3.6	3.11	2.56	2.42	2.31
Maximum	8.50	6.53	5.38	5.27	4.45	4.12
Standard deviation	1.77	1.46	1.19	1.04	1.03	0.69

Table 3: Descriptive statistics for SO_2 monitoring (2018-2019 and baseline)

Sulfur Dioxide concentration µg/m³						
	Site 5 - Burrup Rd		Site 6 - Water Tanks		Site 7 - Deep Gorge	
Statistic	2018-2019	Baseline	2018-2019	Baseline	2018-2019	Baseline
Minimum	0.07	0.07	0.09	0	0.04	0.13
Average	1.36	1.38	0.41	0.95	0.41	0.82
Maximum	19.07	3.09	2.26	3.5	2.24	2.01
Standard deviation	3.81	0.83	0.43	0.84	0.44	0.53

Table 4: Descriptive statistics for HNO_3 monitoring (2018-2019 and baseline)

Sulfur Dioxide concentration µg/m³						
	Site 5 - Burrup Rd		Site 6 - Water Tanks		Site 7 - Deep Gorge	
Statistic	2018-2019	Baseline	2018-2019	Baseline	2018-2019	Baseline
Minimum	0.01	0.00	0.00	0.00	0.00	0.00
Average	2.06	0.59	0.36	0.54	0.49	0.48
Maximum	38.24	1.55	1.30	1.81	2.45	1.42
Standard deviation	7.72	0.45	0.38	0.48	0.57	0.37

The concentrations from 2018-2019 have been compared with the baseline (for each location) via t-test to determine if differences in the average concentrations are statistically significant. The results are summarised in Table 5.

Table 5: T-test results for comparison of 2018-2019 and baseline NH_3, NO_2, SO_2 and HNO_3 concentration data

Parameter	Monitoring period	Statistic	Site 5 - Burrup Rd	Site 6 - Water Tanks	Site 7 - Deep Gorge
NH_3	2018-2019	Average µg/m³	0.86	1.28	0.89
	baseline	Average µg/m³	0.44	0.93	0.75
		P value	0.01	0.34	0.67
NO_2	2018-2019	Average µg/m³	4.15	3.11	2.42
	baseline	Average µg/m³	3.60	2.56	2.31
		P value	0.22	0.07	0.52
SO_2	2018-2019	Average µg/m³	1.36	0.41	0.41
	baseline	Average µg/m³	1.38	0.95	0.82
		P value	0.0001	0.001	0.002
HNO_3	2018-2019	Average µg/m³	2.06	0.36	0.49
	baseline	Average µg/m³	0.58	0.54	0.48
		P value	0.36	0.10	0.97

Key findings from these data are summarised in Table 6.

Table 6: Analysis of NH_3, NO_2, SO_2 and HNO_3 concentration data

Parameter	Site	Finding
NH_3	Burrup Rd	The (higher) average concentration from 2018-2019 monitoring compared with baseline monitoring is statistically significant
	Water Tanks	Differences in average concentrations from 2018-2019 and baseline monitoring of these parameters at these sites are not statistically significant. Increases in concentrations are not attributed to the TAN Plant since the plant was not operational at those times
	Deep Gorge	
NO_2	Burrup Rd	Differences in average concentrations from 2018-2019 and baseline monitoring of these parameters at these sites are not statistically significant. Negligible impacts from TAN Plant expected due to relatively short duration of operation in 2018-2019
	Water Tanks	
	Deep Gorge	
SO_2	Burrup Rd	The (lower) average concentrations from 2018-2019 monitoring compared with baseline monitoring are statistically significant. A large spike in concentration was observed for the July 2018 sample that suggests an emission event had occurred. That event could not have originated from TAN Plant operations since the plant was off-line at that time
	Water Tanks	
	Deep Gorge	
HNO_3	Burrup Rd	Differences in average concentrations from 2018-2019 and baseline monitoring of these parameters at these sites are not statistically significant. A large spike in concentration was observed for the July 2018 sample that suggests an emission event had occurred. That event could not have originated from TAN Plant operations since the plant was off-line at that time (see discussion below)
	Water Tanks	
	Deep Gorge	

The concentrations of NH_3 detected at Water Tanks and Deep Gorge during 2018-2019 were determined to be statistically insignificant from the baseline dataset. Conversely, at Burrup Road, the concentrations of NH_3 were determined to be statistically significantly different to the baseline dataset. This site is directly downwind of the TAN Plant during an easterly wind and may be impacted by NH_3 emissions to a greater extent than the other two sites. Analysis of wind direction frequencies shows easterly winds occurred 21% of the time during the 1.5 months of TAN Plant operation, which may have contributed to the increase in NH_3 concentrations at Burrup Rd in May/June 2019 (Figure 2). Winds toward Water Tanks and Deep Gorge occurred for 2.4% and 1.7% of the time during TAN Plant operations, suggesting negligible NH_3 impacts from the TAN Plant at those locations.

The statistically insignificant differences in average concentrations of NO_2 at all three sites suggests negligible NO_2 impacts from TAN Plant operations in 2018-2019. This is not unexpected since the TAN Plant NOx emissions are minor contributors to the overall NOx emissions from industry on the Burrup[2]. The limited TAN Plant operation and relatively low frequencies of winds from the TAN Plant to the monitoring sites at that time also suggest a low impact from TAN Plant NO_2 emissions. The peak concentration (8.5 µg/m^3) for the sample collected from 30 May to 13 June 2019 is highly unlikely to be due to TAN Plant emissions since the peak emissions occur during start-up which had concluded in the early morning of 13 May.

Statistically significant differences in the SO_2 concentrations recorded during the 2018-2019 monitoring period to the baseline study were determined for all three monitoring sites. While the average concentration at Burrup Road appears to be comparable to the baseline data, a large (high concentration) outlier in the data set was obtained in the July sampling campaign. The source of this outlier is not known, but it may be attributable to emissions from other operations in the airshed. The TAN Plant does not emit significant amounts of SO_2 and was off-line at the time, therefore, cannot have caused the spike in measured concentration for July 2018 at Burrup Road. Exclusion of this outlier gives a revised average of 0.59 µg/m^3 which, while similar to the other two monitoring sites, is a lower average than derived for the baseline monitoring period and the difference is statistically significant (P=0.00005). The reasons for the apparent decrease in average SO_2 concentrations since the baseline data was recorded is not known but may reflect a reduced frequency of flaring at the two gas plants on the Burrup Peninsula or use of lower sulfur fuels in ships that visit the Dampier port.

The t-test analysis suggests that the difference in average HNO_3 concentrations for 2018-2019 and baseline are not statistically significantly (Table 5), which suggests any airborne HNO_3 emissions from the TAN Plant do not impact on the ambient HNO_3 concentrations. As previously indicated, the TAN Plant was only operational for 1.5 months in 2018-2019 which precludes any impacts outside that period. The HNO_3 concentrations at all sites during plant operations were within the ranges observed prior to commencement of operations, thereby precluding the TAN Plant as a source of HNO_3 emissions impacts.

4.1.3 Dry deposition rates - gases

Annual (total) dry deposition rates were calculated from the gas sampling at the three monitoring sites for the duration of the baseline and ongoing monitoring program monitoring. Total annual deposition rates were calculated from the combined rates for NH_3, NO_2, SO_2 and HNO_3. The results for total annual dry deposition are illustrated in Figure 6.

Monitoring periods are from the start of July to end of June in the following year, with the exception of the 2013-2014 monitoring period which is reported for September 2013 to August 2014; thus, overlapping with the 2014-2015 period to represent an entire 12-month period.

[2] NPI 2017/2018 reports show TAN Plant NOx emissions are 0.18% of total NOx emissions from industry on the Burrup Peninsula

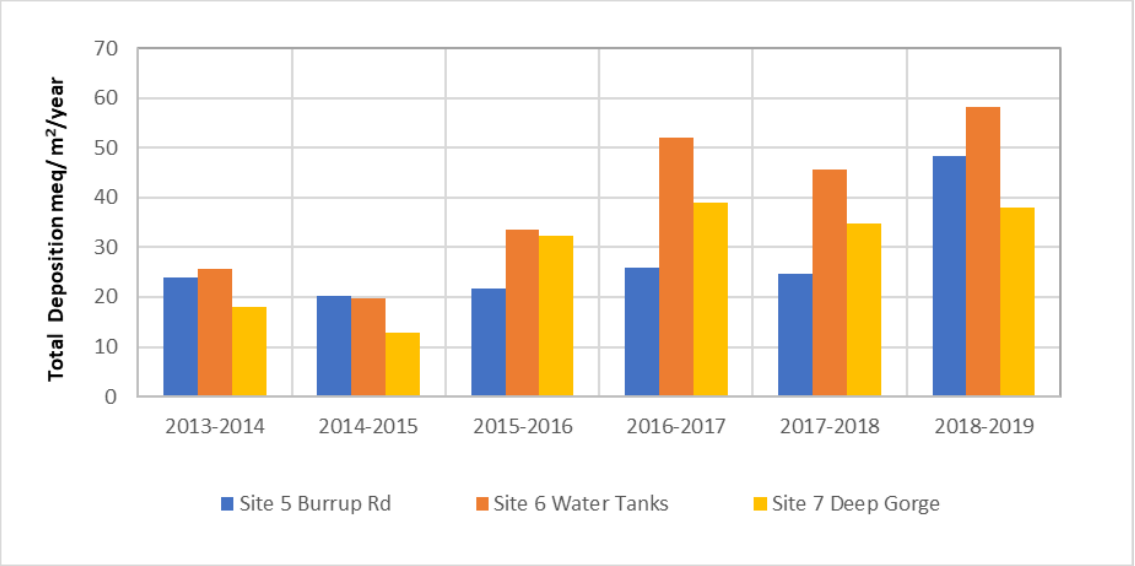

Figure 6: Annual deposition rates from measured gases (2013-2019)

The results are summarised in Table 7. Investigation levels were derived from the average of rolling monthly annual deposition rates from the baseline period plus three standard deviations (as described in the OEMP).

Table 7: Annual dry deposition rates

Year	Annual deposition rates meq/m²/year		
	Site 5 Burrup Rd	Site 6 Water Tanks	Site 7 Deep Gorge
2013-2014	23.9	25.6	17.9
2014-2015	20.2	19.8	12.9
2015-2016	21.6	33.6	32.4
2016-2017	25.9	52.0	38.9
2017-2018	24.6	45.6	34.9
2018-2019	48.3	58.2	38.0
Investigation level	27.1	48.0	57.5

Annual rates for 1 July to 30June, except for 2013-2014 which is for 1 September 2013 to 31 August 2014

Dry deposition rates of gas species have increased at all three sites in 2018-2019. The Burrup Road and Water Tanks sites were both determined to be above the investigation level in 2018-2019 while Deep Gorge remained below the investigation level. The composition of the total deposition is illustrated in Figure 7 to Figure 9.

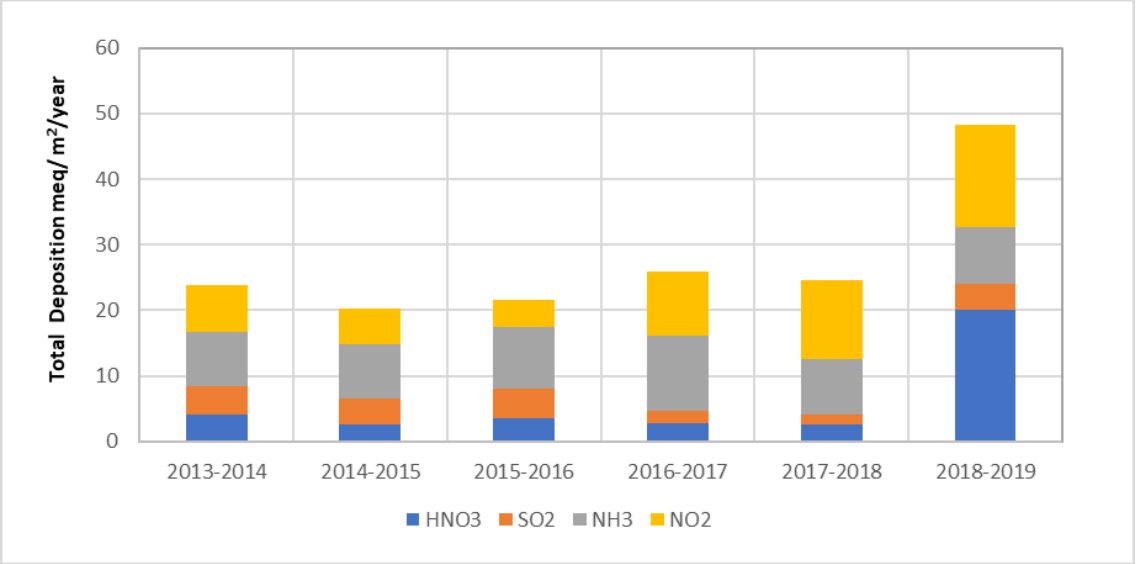

Figure 7: Burrup Road dry deposition composition

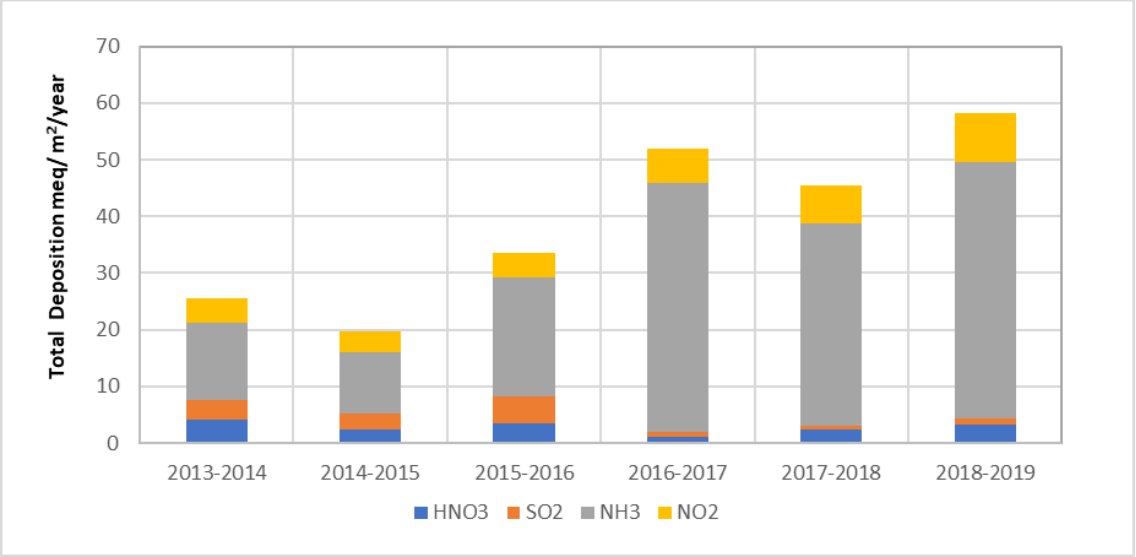

Figure 8: Water Tanks dry deposition rates

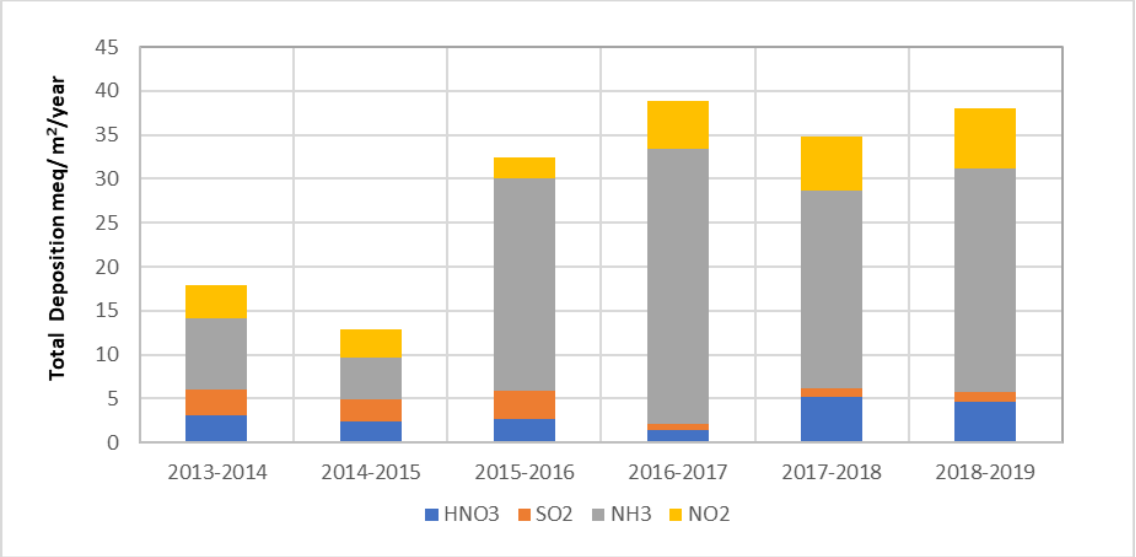

Figure 9: Deep Gorge dry deposition rates

The OEMP advised that increases in deposition rates above the control limits (now referred to as investigation levels) will trigger an investigation into the reasons for the increase. Findings from that investigation are discussed in Section 5.

4.2 Total suspended particulates

4.2.1 Results of TSP monitoring 2018-2019

Monitoring for total suspended particulate (using MicroVol samplers) showed similar trends in the concentrations from the three monitoring sites across the year (Figure 10). This suggests the monitoring data reflects TSP trends in the Burrup airshed rather than direct impacts from individual local sources.

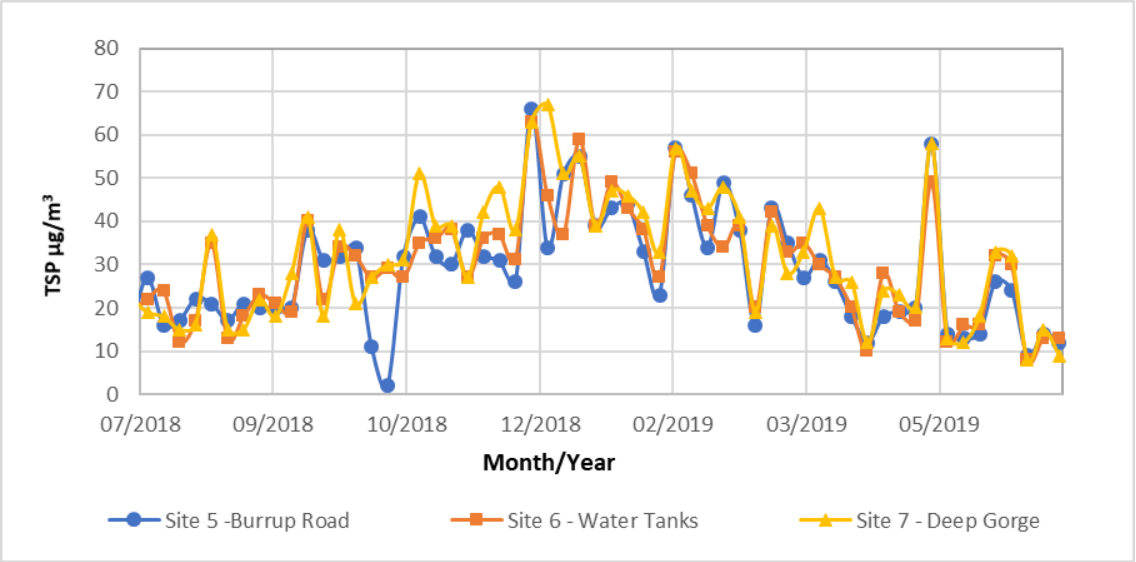

Figure 10: Measured TSP concentrations for 1 July 2018 to 30 June 2019

The baseline dataset was derived from direct TSP measurements; however, due to a lack of actual monitoring data points, estimates were also calculated from measured PM_{10} concentrations as described in the baseline report (YPN 2017). Furthermore, the measured baseline dataset for Water Tanks was impacted by local activities associated with the construction of the TAN Plant resulting in likely over-representation of background levels at that site. The 2018-2019 data were consequently compared to both the measured and calculated datasets for baseline and measured data for 2017-2018 (Figure 11).

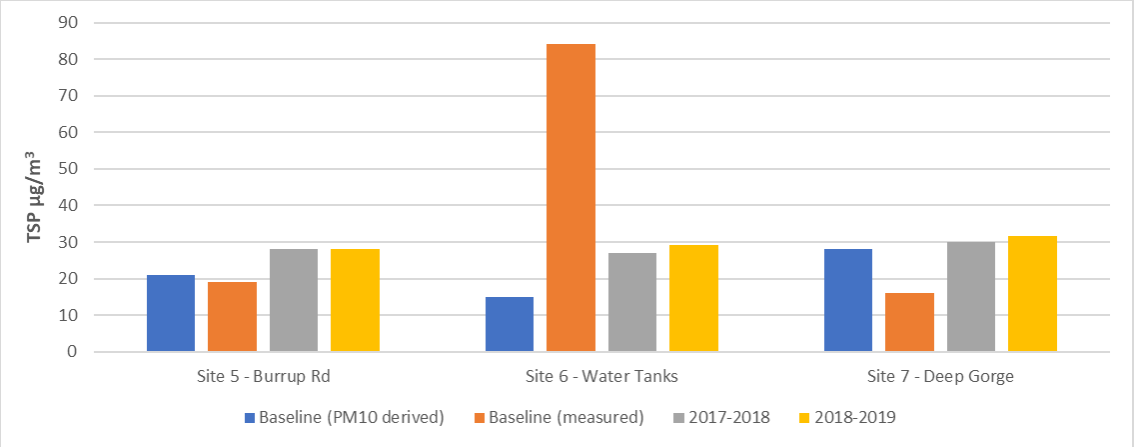

Figure 11: Measured TSP concentrations for 1 July 2018 to 30 June 2019

Descriptive statistics for 2018-2019 TSP monitoring at all three sites are shown in Table 8 alongside the monitoring data for 2017-2018.

Table 8: Descriptive statistics for TSP monitoring 2018-2019 and 2017-2018– all sites

TSP concentration µg/m³						
	Site 5 - Burrup Rd		Site 6 - Water Tanks		Site 7 - Deep Gorge	
Statistic	2018-2019	2017-2018	2018-2019	2017-2018	2018-2019	2017-2018
Minimum	2	6	8	6	8	11
Average	28	28	29	27	32	30
Maximum	66	76	63	76	67	79
Standard deviation	14	13	13	12	15	15

Comparison of the mean TSP concentrations measured during baseline and the subsequent two years of the monitoring program shows the average TSP concentration for 2018-2019 was very similar to the 2017-2018 results (Figure 11 and Table 8). The levels monitored at Site 6 in the two years subsequent to the baseline study have been lower than the baseline measured data and comparable to the levels recorded at other sites. This supports the hypothesis that the baseline measurements at the Water Tanks site were affected by construction activities.

As for the 2017-2018 monitoring period, the data from the 2018-2019 period was found, via t-test (results not shown), to be significantly different from the data derived from the baseline study. The 2018-2019 data was compared to the measured dataset from 2017-2018 to determine if there was any change in the recorded ambient TSP levels. The 2018-2019 dataset was determined not to be statistically significantly different from the 2017-2018 data.

4.3 Dust deposition

4.3.1 Results from monitoring deposited dust for 2018-2019

Results of dust deposition monitoring at the three sites are shown in Table 9. Values with a < prefix indicate deposition rates measured below the method detection limits, with the value indicating the limits.

Table 9: Results of dust deposition monitoring 2018-2019

		Site 5 - Burrup Road		Site 6 - Water Tanks		Site 7 - Deep Gorge	
Date Deployed	Date Collected	Soluble solids	Insoluble solids	Soluble solids	Insoluble solids	Soluble solids	Insoluble solids
		g/m²/month	g/m²/month	g/m²/month	g/m²/month	g/m²/month	g/m²/month
28/06/2018	31/07/2018	0.8	<0.8	<0.7	<0.8	<2	<0.8
31/07/2018	31/08/2018	1.8	<0.8	<0.7	1.1	1.9	0.8
31/08/2018	28/09/2018	<0.7	<0.8	<0.7	0.8	0.7	0.9
28/09/2018	31/10/2018	1	<0.8	<0.7	<0.8	0.8	1.1
31/10/2018	29/11/2018	0.9	1.9	0.9	2.3	<0.7	2.4
29/11/2018	31/12/2018	1.9	1.9	<0.7	1.7	1.2	1.6
31/12/2018	31/01/2019	2.4	1.7	<0.7	1.2	1.9	1.5
31/01/2019	28/02/2019	<0.7	1.5	0.9	1.8	1.2	2
28/02/2019	1/04/2019	1.7	1.8	1.2	1.3	1.7	1.4
1/04/2019	30/04/2019	1.4	1.3	1.6	1.1	1.3	1.5
30/04/2019	30/05/2019	0.8	<0.8	1.1	1.2	<0.7	<0.8
30/05/2019	1/07/2019	1.4	<0.8	1.8	<0.8	1.1	0.9

4.3.2 Analysis of dust deposition data

A comparison of the dust deposition data from 2018 – 2019 with the baseline data (insoluble fraction only) is shown in Table 10.

Table 10: Descriptive statistics for dust deposition monitoring 2018-2019 and baseline study

Statistic	Burrup Rd (g/m²/month)			Water Tanks (g/m²/month)			Deep Gorge (g/m²/month)		
	2018-2019		Baseline	2018-2019		Baseline	2018-2019		Baseline
	Soluble	Insoluble	Insoluble	Soluble	Insoluble	Insoluble	Soluble	Insoluble	Insoluble
Minimum	0.4	0.4	0.02	0.4	0.4	0.0	0.4	0.4	0.01
Average	1.2	1.0	0.88	0.8	1.1	0.84	1.1	1.2	1.07
95th percentile	2.1	1.9	1.75	1.7	2.0	1.86	1.9	2.2	2.31
Maximum	2.4	1.9	2	1.8	2.3	2.05	1.9	2.4	5.03

(1) Half method detection limit deposition rates for non-detect results were used for calculations of statistics.

Average deposition rates for the insoluble fraction are a little higher than the baseline across the three monitoring sites; however, the difference was not statistically significant at any site (determined by t-test P values >0.05).

Similar trends in the deposition rates were observed at the three sites (Figure 12). It is likely that the increase compared to baseline is due to an increase in the insoluble fraction in the airshed dust rather than influence of a specific source in the locality of the TAN Plant. Note that these comparisons reflect the use of non-detect deposition rates of half the detection limits for the 2018-2019 data. The actual deposition rates below detection limits may be lower or higher than the half detection rates.

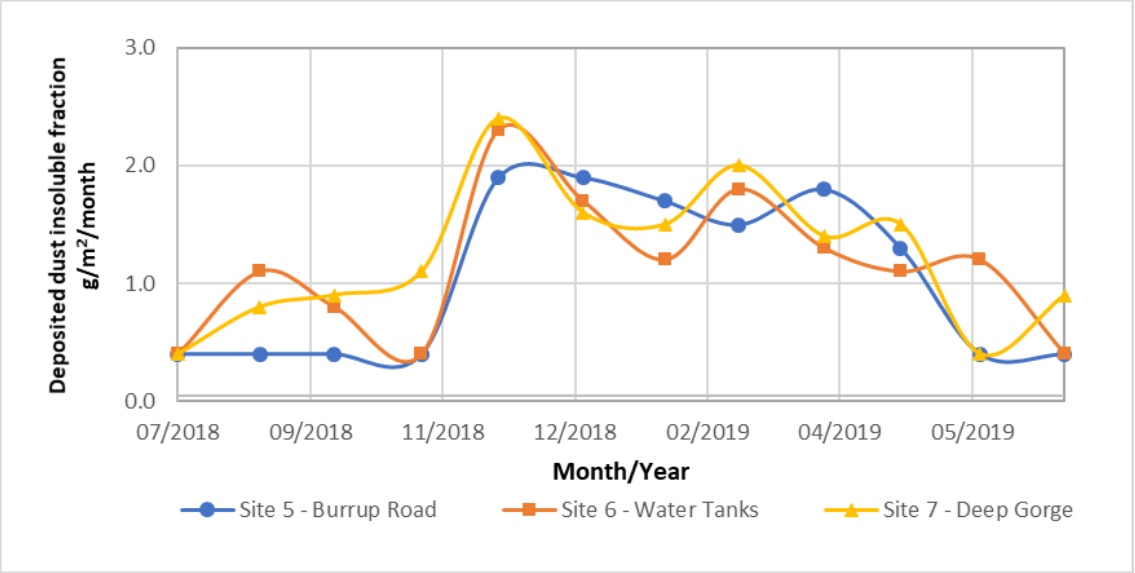

Figure 12: Deposited dust insoluble fraction 2018-2019

The soluble fraction was not determined in samples collected for the baseline study, since the EPBC Approval 2008/4546 at the time (dated 14 September 2011) only required measurements of TSP and "dust". The latter requirement was interpreted to mean the insoluble fraction of deposited dust. The amended approval of 12 September 2017 now requires both insoluble and soluble fractions of deposited dust to be monitored. In the absence of baseline data, the 2018-2019 data for the soluble fraction is compared to the data collected for the 2017-2018 monitoring period.

The average soluble fraction measured from the deposited dust collected in 2018-2019 was higher than the 2017-2018 period at all three monitoring sites (Figure 13).

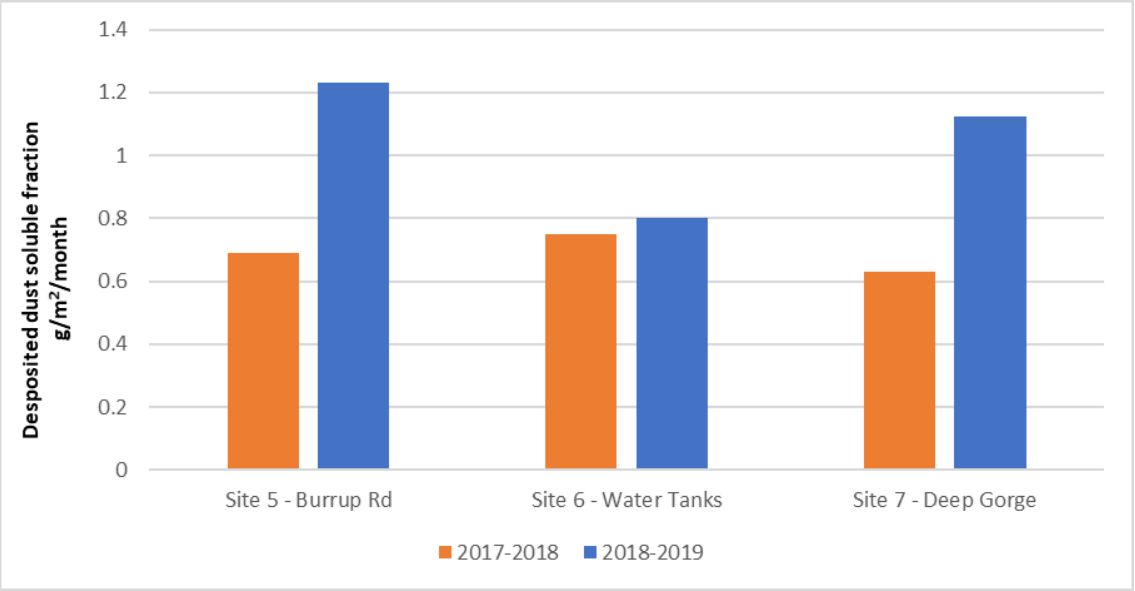

Figure 13: Deposited dust average soluble fraction 2018-2019

The monthly data reveals considerable variability in the soluble fraction of deposited dust across the three monitoring sites throughout the year (Figure 14).

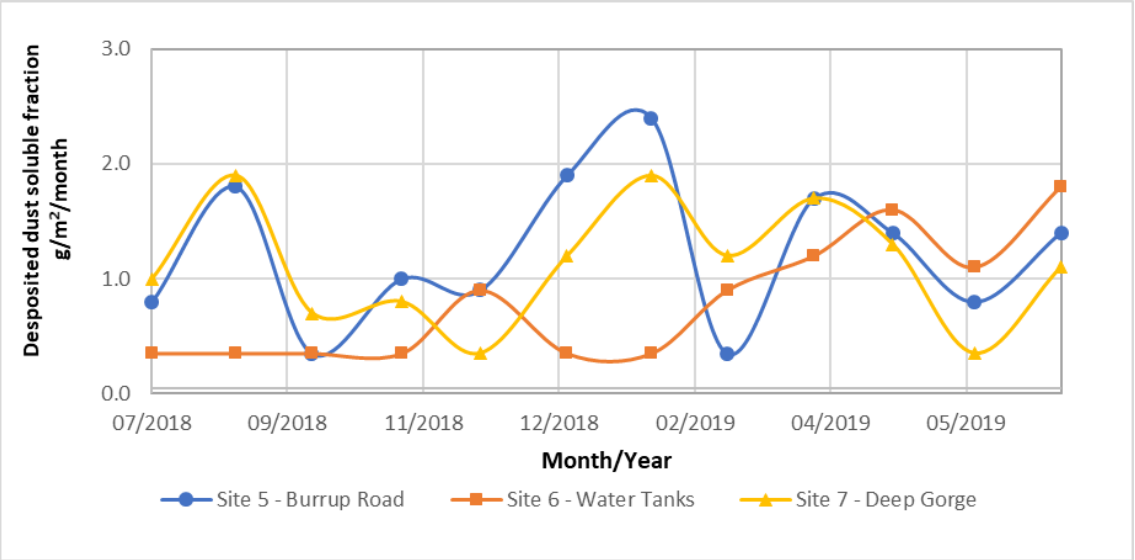

Figure 14: Deposited dust soluble fraction 2018-2019

The soluble fraction of deposited dust at Water Tanks does not trend with Burrup Road and Deep Gorge.

Water tanks had a higher proportion of non-detect samples than other sites with 6 of the 12 samples reported as <LOR. In January 2019 the Water Tanks recorded low soluble deposition while the other two sites recorded peak rates. The majority of soluble dust deposited on the Burrup is expected to be from marine sources, i.e. sea salt, which suggests similar soluble deposition rates should be observed at the three monitoring sites. The highly variable nature of soluble deposition rates is not explained at this time.

Overall, the levels of dust deposited at the monitoring sites are largely consistent with those observed from the baseline study.

5. Dry deposition rate investigation and actions

5.1 Investigation

As described in Section 4.1.3, the monitoring conducted for 2018-2019 showed an increase in dry deposition rates at Burrup Road (48.3 meq/m^2/y) and Water Tanks (58.2 meq/m^2/y) that exceeded the investigation levels (27.1 and 48.0 meq/m^2/y, respectively) established from the baseline study. This outcome has triggered an investigation as per the OEMP.

Key factors examined include trends and contributions of individual gases to the total deposition rates, TAN Plant availability, TAN Plant stack emissions performance, other emissions sources, and wind direction data.

Trends in deposition rates since 2014 (as monthly rolling annual total rates) are illustrated in Figure 15 (Burrup Road), Figure 16 (Water Tanks) and Figure 17 (Deep Gorge). The TAN Plant 2018-2019 operating period is indicated in the graphs.

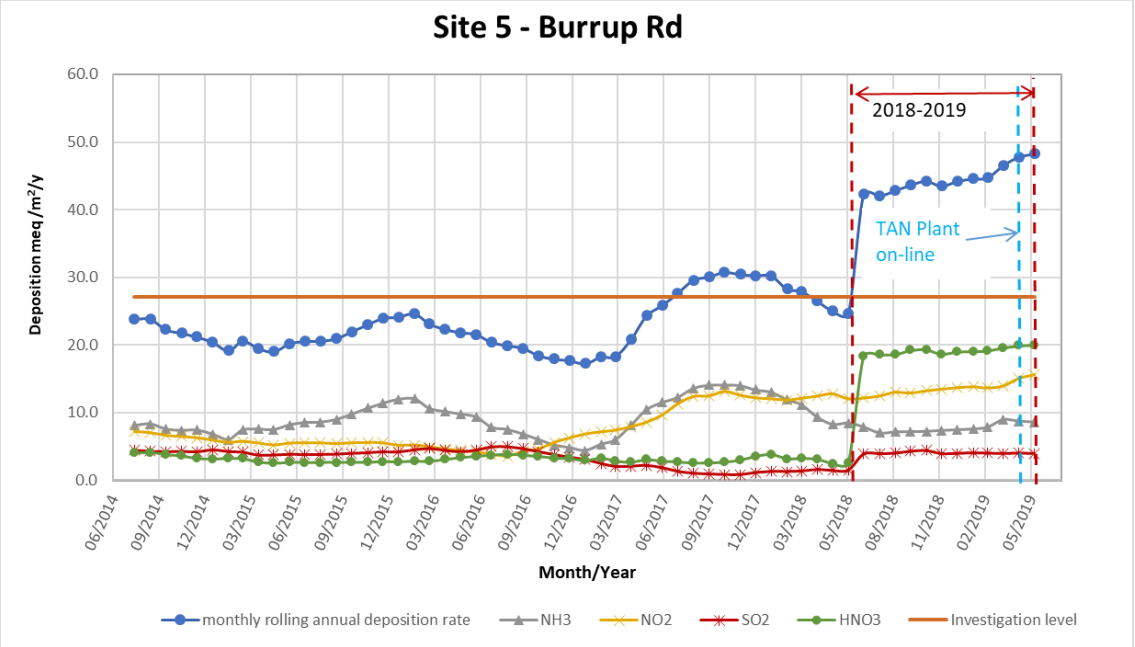

Figure 15: Monthly rolling annual total and individual gas dry deposition rates – Burrup Road

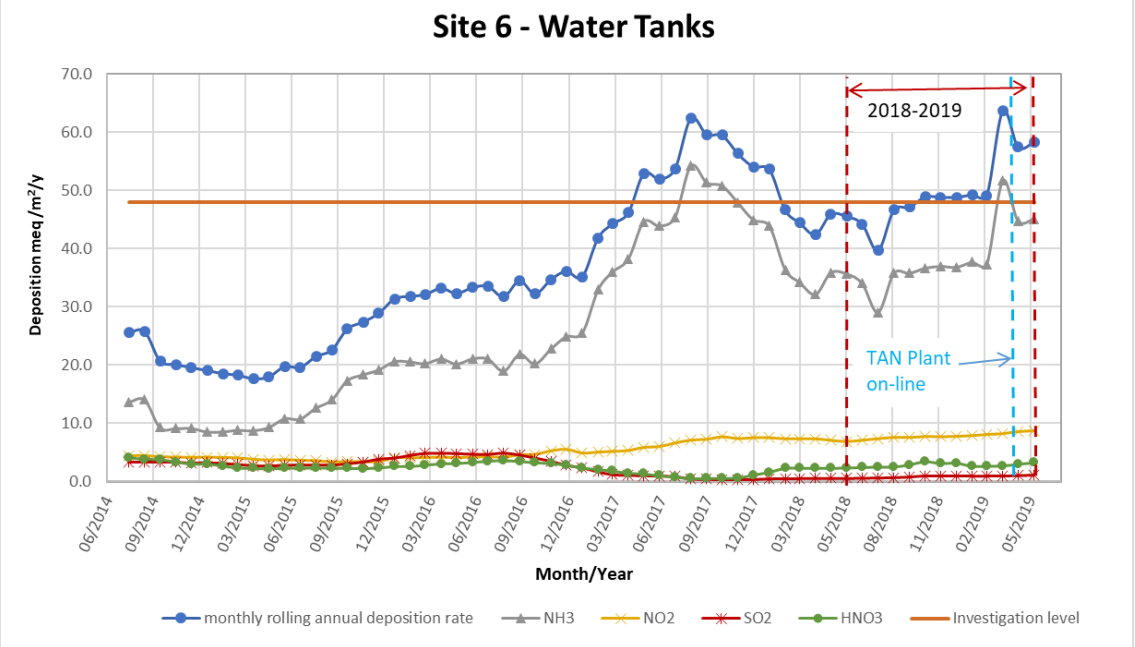

Figure 16: Monthly rolling annual total and individual gas dry deposition rates – Water Tanks

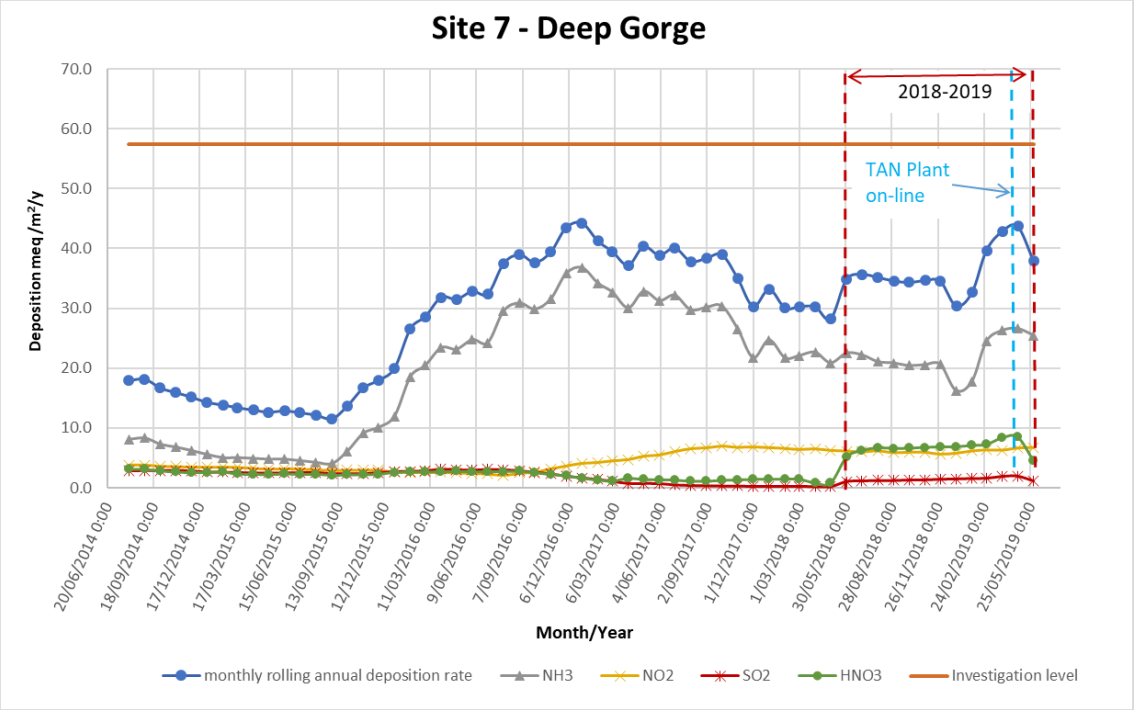

Figure 17: Monthly rolling annual total and individual gas dry deposition rates – Deep Gorge

Ammonia is the dominant contributor to dry deposition at the Water Tanks and Deep Gorge sites; less so at Burrup Road where NO_2 and HNO_3 tend to dominate.

Burrup Road deposition levels increased in the 2018-2019 period with the contribution of HNO_3 being much higher than previous years monitored.

Key findings from the investigation into the elevated deposition rates are summarised in Table 11.

Table 11: Findings from investigation into elevated deposition rates

Factor	Investigation	Finding	Comment
Contributions from individual gases	Examine individual contributions to identify gases reasonable for increase in deposition rate	Burrup Road (see Figure 15): significant increase in HNO_3 deposition rate is primary reason for exceedance of investigation level. NO_2 and SO_2 rates have also increased.	Increase driven by relatively high HNO_3 concentration (38.2 µg/m³) observed for July 2018 sample. TAN Plant was shut-down at that time. Spike in HNO_3 concentration must have been caused by emissions from other sources (see Section 4.1.2). Increase in NO_2 and SO_2 also due to sources other than the TAN Plant
		Water Tanks (see Figure 16): higher NH_3 deposition rates are the primary cause of exceedance of investigation level, some contribution from increased NO_2 rates.	The exceedance of the monthly rolling annual average investigation levels was observed from receipt of October 2018 results. The TAN Plant was shut-down at that time and for the previous 3 months of that reporting year. The spike in deposition rate observed in April 2019 predated re-start of the TAN Plant and therefore must be due to emissions from other sources.
		Deep Gorge (see Figure 17): investigation level not exceeded; however, higher total deposition rates largely due to increase in NH_3 levels.	As described for Water Tanks, the increase in emissions was not due to the TAN Plant since the increased deposition rate predated restart of the plant in May 2019

Factor	Investigation	Finding	Comment
TAN Plant availability	Plant availability was limited due to the extended shutdown that occurred in 2018-2019	TAN Plant was operating from 12 May to 30 June 2019	As discussed, the relatively short duration of operations indicates that the TAN Plant is not a significant continuous source of emissions that contributed to increased ambient concentrations
TAN Plant stack emissions performance	Stack emissions data were examined to identify emission rates outside approved limits	Nitric acid plant (NAP) stack and Common stack emissions were within regulatory limits	This includes NAP stack emissions during May 2019 plant start-up

Overall, the relatively short duration of operation of the TAN Plant in 2018-2019, the trends in ambient concentrations and frequency of prevailing winds during plant operations indicate that the TAN Plant was not a significant contributor to increases in ambient concentrations which have given rise to exceedances of dry deposition investigation levels.

6. Concluding remarks

Monitoring data are reported for all parameters specified in EPBC Approval 2008/4546 of 12 September 2017.

Analysis of data for gases shows the following:

- the average NH_3 concentration at Burrup Road was higher than baseline, and the difference was determined to be statistically significant
- the average NH_3 concentrations at Water Tanks and Deep Gorge, while higher than baseline, were not found to be statistically significantly different
- the average NO_2 concentrations at all three monitoring locations in 2018-2019 are higher than the baseline concentrations; however, the differences were not found to be statistically significant
- the average SO_2 concentrations at all three monitoring locations in 2018-2019 are lower than the baseline concentrations, with differences in the averages being statistically significant.

The TAN Plant was shut down for the majority of the 2018-2019 reporting period and only operated for 1.5 months from mid-May to end June 2019. Overall there is no evidence to show that operation of the TAN Plant has resulted in significant increases in the NO_2 and SO_2 levels over the 12-month monitoring period. A statistically significant increase of NH_3 concentration at Burrup Road, not observed at the other two sites, suggests this site may have been subject to local impacts from the TAN Plant while an increase in airshed concentration was not apparent.

Analysis of annual dry deposition rates of gas species show the following:

- dry deposition rates have increased at all sites in 2018-2019 compared to baseline
- Burrup Road and Water Tanks dry deposition rates are above investigation levels derived from baseline measurements
- NH_3 is the dominant contributor to dry deposition at Water Tanks and Deep Gorge sites
- HNO_3 has become a larger contributor to dry deposition at the Burrup Road site in 2018-2019 than other years.

The exceedance of investigation levels has triggered an investigation as per the requirements of the OEMP. That investigation did not support a hypothesis that the emissions from TAN Plant operations in May-June 2019 were responsible for exceedances of the investigation levels.

Analysis of the TSP data shows the following:

- concentrations of TSP measured in 2018-2019 were reasonably consistent across the three sites suggesting reflection of air shed background concentrations
- average and maximum TSP concentrations at all three monitoring sites are very similar to the 2017-2018 dataset.

Overall there is no evidence to show operation of the TAN plant has resulted in significant increase in ambient TSP concentrations in 2018-2019.

Analysis of dust deposition data shows the following:

- similar average insoluble deposition rates were observed at all three sites
- average insoluble deposition at all sites are not statistically significantly different to those concentrations measured in the baseline study
- the soluble fraction of the deposited dust from 2018-2019 was higher at Burrup Road and Deep Gorge than the 2017-2018 dataset
- the soluble fraction of the deposited dust at Water Tanks was similar between 2017-2018 and 2018-2019 data sets
- the soluble deposition rates were found to vary across the three sites.

Overall there is no evidence to suggest the operation of the TAN plant has resulted in materially significant increases in insoluble dust deposition rates. Influences on soluble deposition rates at Water Tanks appear to differ from the other two sites; however, those influences cannot be identified at this time.

7. References

Strategen (2018). *Yara Pilbara Nitrates, EPBC Approval 2008/4546.* Ambient air quality report 2017-2018. Document 250-200-EP-PN-0002, issued October 2018.

YPN (2017). *Yara Pilbara Nitrates, EPBC Approval 2008/4546. Baseline Air Quality Monitoring Report*. Document 250-200-EP-PN-0002, issued 16 June 2017.

Limitations

Scope of services

This report ("the report") has been prepared by Strategen-JBS&G in accordance with the scope of services set out in the contract, or as otherwise agreed, between the Client and Strategen-JBS&G. In some circumstances, a range of factors such as time, budget, access and/or site disturbance constraints may have limited the scope of services. This report is strictly limited to the matters stated in it and is not to be read as extending, by implication, to any other matter in connection with the matters addressed in it.

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Environmental conclusions

Within the limitations imposed by the scope of services, the preparation of this report has been undertaken and performed in a professional manner, in accordance with generally accepted environmental consulting practices. No other warranty, whether express or implied, is made.

The advice herein relates only to this project and all results conclusions and recommendations made should be reviewed by a competent person with experience in environmental investigations, before being used for any other purpose.

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Appendix A Results from monitoring of gases for 2018-2019

Site	Date on	Date off	NH_3 µg/m³	NO_2 µg/m³	SO_2 µg/m³	HNO_3 µg/m³
Site 5 - Burrup Road	29/06/2018	16/07/2018	0.60	6.25	19.07	38.24
Site 6 - Water Tanks	29/06/2018	16/07/2018	1.12	4.18	0.38	0.35
Site 7 - Deep Gorge	29/06/2018	16/07/2018	0.24	1.51	0.68	2.45
Site 5 - Burrup Road	16/07/2018	31/07/2018	0.32	5.42	0.45	0.10
Site 6 - Water Tanks	16/07/2018	31/07/2018	0.34	5.01	0.30	0.03
Site 7 - Deep Gorge	16/07/2018	31/07/2018	0.23	3.05	0.48	0.60
Site 5 - Burrup Road	31/07/2018	15/08/2018	1.90	3.55	0.07	0.03
Site 6 - Water Tanks	31/07/2018	15/08/2018	2.00	3.42	0.09	0.03
Site 7 - Deep Gorge	31/07/2018	15/08/2018	0.64	2.03	0.09	0.24
Site 5 - Burrup Road	15/08/2018	31/08/2018	0.55	5.99	0.77	1.02
Site 6 - Water Tanks	15/08/2018	31/08/2018	1.00	4.61	0.45	0.35
Site 7 - Deep Gorge	15/08/2018	31/08/2018	0.77	3.54	0.40	0.95
Site 5 - Burrup Road	31/08/2018	14/09/2018	0.70	5.58	0.68	0.13
Site 6 - Water Tanks	31/08/2018	14/09/2018	5.54	4.42	0.26	0.13
Site 7 - Deep Gorge	31/08/2018	14/09/2018	0.70	3.18	0.35	0.13
Site 5 - Burrup Road	14/09/2018	28/09/2018	1.54	7.00	0.49	0.44
Site 6 - Water Tanks	14/09/2018	28/09/2018	1.10	5.38	0.38	0.03
Site 7 - Deep Gorge	14/09/2018	28/09/2018	0.71	0.71	0.04	0.00
Site 5 - Burrup Road	28/09/2018	15/10/2018	0.30	3.91	0.78	1.49
Site 6 - Water Tanks	28/09/2018	15/10/2018	0.32	3.20	0.37	0.11
Site 7 - Deep Gorge	28/09/2018	15/10/2018	0.24	2.83	0.35	0.11
Site 5 - Burrup Road	15/10/2018	31/10/2018	0.31	4.18	1.88	0.35
Site 6 - Water Tanks	15/10/2018	31/10/2018	0.49	3.34	0.73	1.01
Site 7 - Deep Gorge	15/10/2018	31/10/2018	0.40	3.24	0.43	0.39
Site 5 - Burrup Road	31/10/2018	15/11/2018	0.25	4.73	1.41	0.80
Site 6 - Water Tanks	31/10/2018	15/11/2018	0.27	3.86	2.26	1.22
Site 7 - Deep Gorge	31/10/2018	15/11/2018	0.30	3.48	0.30	0.23
Site 5 - Burrup Road	15/11/2018	29/11/2018	0.27	3.12	0.27	0.45
Site 6 - Water Tanks	15/11/2018	29/11/2018	0.97	3.23	0.18	0.47
Site 7 - Deep Gorge	15/11/2018	29/11/2018	0.56	1.61	0.21	0.38
Site 5 - Burrup Road	29/11/2018	13/12/2018	0.22	3.38	0.34	0.03
Site 6 - Water Tanks	29/11/2018	13/12/2018	0.22	3.06	0.46	0.52
Site 7 - Deep Gorge	29/11/2018	13/12/2018	0.22	2.31	0.18	0.09
Site 5 - Burrup Road	13/12/2018	31/12/2018	0.29	1.76	0.16	0.07
Site 6 - Water Tanks	13/12/2018	31/12/2018	0.25	2.33	0.25	0.03
Site 7 - Deep Gorge	13/12/2018	31/12/2018	0.37	1.55	0.70	0.25
Site 5 - Burrup Road	31/12/2018	14/01/2019	0.27	2.58	1.85	1.67
Site 6 - Water Tanks	31/12/2018	14/01/2019	0.32	1.67	0.51	0.23
Site 7 - Deep Gorge	31/12/2018	14/01/2019	0.52	3.06	0.40	0.23
Site 5 - Burrup Road	14/01/2019	31/01/2019	0.42	1.70	0.24	0.29
Site 6 - Water Tanks	14/01/2019	31/01/2019	0.48	1.75	0.54	1.30
Site 7 - Deep Gorge	14/01/2019	31/01/2019	0.65	1.05	0.15	0.15
Site 5 - Burrup Road	31/01/2019	14/02/2019	0.44	1.22	0.10	0.01
Site 6 - Water Tanks	31/01/2019	14/02/2019	0.57	1.41	0.10	0.18
Site 7 - Deep Gorge	31/01/2019	14/02/2019	1.03	1.46	0.07	0.01
Site 5 - Burrup Road	14/02/2019	28/02/2019	0.40	3.16	0.65	0.22
Site 6 - Water Tanks	14/02/2019	28/02/2019	0.83	2.71	0.25	0.24
Site 7 - Deep Gorge	14/02/2019	28/02/2019	1.18	4.45	0.79	0.65
Site 5 - Burrup Road	28/02/2019	14/03/2019	0.24	3.16	0.17	0.16
Site 6 - Water Tanks	28/02/2019	14/03/2019	0.36	2.92	0.21	0.21
Site 7 - Deep Gorge	28/02/2019	14/03/2019	0.96	3.23	0.31	0.32
Site 5 - Burrup Road	14/03/2019	22/03/2019	2.04	3.50	0.19	0.57
Site 6 - Water Tanks	14/03/2019	22/03/2019	0.56	4.07	0.19	0.28
Site 7 - Deep Gorge	14/03/2019	22/03/2019	8.42	3.28	0.39	0.38

Site	Date on	Date off	NH_3 µg/m³	NO_2 µg/m³	SO_2 µg/m³	HNO_3 µg/m³
Site 5 - Burrup Road	28/03/2019	16/04/2019	2.03	2.48	1.19	0.95
Site 6 - Water Tanks	28/03/2019	16/04/2019	4.68	2.25	0.29	0.13
Site 7 - Deep Gorge	28/03/2019	16/04/2019	1.13	1.00	2.24	1.77
Site 5 - Burrup Road	16/04/2019	30/04/2019	0.92	4.35	0.16	0.06
Site 6 - Water Tanks	16/04/2019	30/04/2019	5.50	2.07	0.15	0.00
Site 7 - Deep Gorge	16/04/2019	30/04/2019	0.62	2.37	0.16	0.69
Site 5 - Burrup Road	30/04/2019	16/05/2019	0.84	5.91	0.49	0.22
Site 6 - Water Tanks	30/04/2019	16/05/2019	0.46	2.30	0.16	0.87
Site 7 - Deep Gorge	30/04/2019	16/05/2019	0.24	2.26	0.17	0.00
Site 5 - Burrup Road	16/05/2019	30/05/2019	1.77	8.50	0.59	0.99
Site 6 - Water Tanks	16/05/2019	30/05/2019	1.96	4.41	0.58	0.09
Site 7 - Deep Gorge	16/05/2019	30/05/2019	0.71	3.75	0.42	0.56
Site 5 - Burrup Road	30/05/2019	13/06/2019	2.44	4.26	0.53	1.05
Site 6 - Water Tanks	30/05/2019	13/06/2019	0.86	1.13	0.47	0.38
Site 7 - Deep Gorge	30/05/2019	13/06/2019	0.32	0.96	0.28	0.56
Site 5 - Burrup Road	13/06/2019	1/07/2019	1.53	3.85	0.10	0.08
Site 6 - Water Tanks	13/06/2019	1/07/2019	0.55	1.95	0.32	0.48
Site 7 - Deep Gorge	13/06/2019	1/07/2019	0.27	2.13	0.20	0.51
Site 5 - Burrup Road	1/07/2019	15/07/2019	1.04	7.23	0.26	0.17
Site 6 - Water Tanks	1/07/2019	15/07/2019	0.62	4.48	0.14	0.30
Site 7 - Deep Gorge	1/07/2019	15/07/2019	0.40	3.91	0.10	0.17
Site 5 - Burrup Road	15/07/2019	31/07/2019	0.65	6.96	0.77	0.21
Site 6 - Water Tanks	15/07/2019	31/07/2019	1.38	5.49	0.28	0.18
Site 7 - Deep Gorge	15/07/2019	31/07/2019	0.22	3.93	0.11	0.15
Site 5 - Burrup Road	31/07/2019	15/08/2019	0.55	5.99	0.60	0.46
Site 6 - Water Tanks	31/07/2019	15/08/2019	0.38	3.71	0.08	0.15
Site 7 - Deep Gorge	31/07/2019	15/08/2019	0.06	3.80	0.14	0.15

Appendix B Results from monitoring of TSP for 2018-2019

Period start date	Site 5 -Burrup Road TSP µg/m³	Site 6 - Water Tanks TSP µg/m³	Site 7 - Deep Gorge TSP µg/m³
01-Jul-18	9	12	18
07-Jul-18	16	11	22
13-Jul-18	17	19	22
19-Jul-18	27	22	19
25-Jul-18	16	24	18
31-Jul-18	17	12	15
06-Aug-18	22	17	16
12-Aug-18	21	35	37
18-Aug-18	17	13	15
24-Aug-18	21	18	15
30-Aug-18	20	23	22
05-Sep-18	20	21	18
11-Sep-18	20	19	28
17-Sep-18	38	40	41
23-Sep-18	31	22	18
29-Sep-18	32	34	38
05-Oct-18	34	32	21
11-Oct-18	11	27	27
17-Oct-18	2	29	30
23-Oct-18	32	27	31
29-Oct-18	41	35	51
04-Nov-18	32	36	39
10-Nov-18	30	38	39
16-Nov-18	38	27	27
22-Nov-18	32	36	42
28-Nov-18	31	37	48
04-Dec-18	26	31	38
10-Dec-18	66	63	63
16-Dec-18	34	46	67
22-Dec-18	51	37	51
28-Dec-18	55	59	55
03-Jan-19	39	39	39
09-Jan-19	43	49	47
15-Jan-19	44	43	46
21-Jan-19	33	38	42
27-Jan-19	23	27	33
02-Feb-19	57	56	57
08-Feb-19	46	51	47
14-Feb-19	34	39	43
20-Feb-19	49	-	48
22-Feb-19	-	34	-
26-Feb-19	38	39	41
04-Mar-19	16	20	19
10-Mar-19	43	42	39
16-Mar-19	35	33	28
22-Mar-19	27	35	33
28-Mar-19	31	30	43
03-Apr-19	26	27	27
09-Apr-19	18	20	26
15-Apr-19	12	10	12
21-Apr-19	18	28	24
27-Apr-19	19	19	23
03-May-19	20	17	20
09-May-19	58	49	58
15-May-19	14	12	13

Period start date	Site 5 -Burrup Road TSP µg/m³	Site 6 - Water Tanks TSP µg/m³	Site 7 - Deep Gorge TSP µg/m³
21-May-19	13	16	12
27-May-19	14	16	18
02-Jun-19	26	32	33
08-Jun-19	24	30	32
14-Jun-19	9	8	8
20-Jun-19	14	13	15
26-Jun-19	12	13	9

Appendix C Results from dust deposition monitoring 2018-2019

	Site 5 - Burrup Road		Site 6 - Water Tanks		Site 7 - Deep Gorge	
Date collected	Soluble solids	Insoluble solids	Soluble solids	Insoluble solids	Soluble solids	Insoluble solids
	g/m²/month	g/m²/month	g/m²/month	g/m²/month	g/m²/month	g/m²/month
31/07/2018	0.8	<0.8	<0.7	<0.8	<2	<0.8
31/08/2018	1.8	<0.8	<0.7	1.1	1.9	0.8
28/09/2018	<0.7	<0.8	<0.7	0.8	0.7	0.9
31/10/2018	1	<0.8	<0.7	<0.8	0.8	1.1
29/11/2018	0.9	1.9	0.9	2.3	<0.7	2.4
31/12/2018	1.9	1.9	<0.7	1.7	1.2	1.6
31/01/2019	2.4	1.7	<0.7	1.2	1.9	1.5
28/02/2019	<0.7	1.5	0.9	1.8	1.2	2
1/04/2019	1.7	1.8	1.2	1.3	1.7	1.4
30/04/2019	1.4	1.3	1.6	1.1	1.3	1.5
30/05/2019	0.8	<0.8	1.1	1.2	<0.7	<0.8
1/07/2019	1.4	<0.8	1.8	<0.8	1.1	0.9

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