



Technical Ammonium Nitrate Plant

Yara Pilbara Nitrates Pty Ltd

Ambient Air Quality Monitoring Report 2023-2024

JBS&G 65496 | 162,544

30 September 2024





We acknowledge the Traditional Custodians of Country throughout Australia and their connections to land, sea and community.

We pay respect to Elders past and present and in the spirit of reconciliation, we commit to working together for our shared future.

Caring for Country The Journey of JBS&G
Artist: Patrick Caruso, Eastern Arrernte



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Appendices

Appendix A	Results from Monitoring of Gases
Appendix B	Results from Monitoring of TSP
Appendix C	Results from Dust Deposition Monitoring

Abbreviations and Definitions

Term	Definition	Description and context for this report
µm	Micrometre	One millionth (0.000001) of a metre
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	Low volume air sampling instrument for sampling of TSP, manufactured by Ecotech
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
OEMP	Operational Environmental Management Plan	Management plan prepared by YPN in accordance with Condition 7 of the EPBC Approval (as varied 24 March 2020)
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 an 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 Murujuga 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 Yara Pilbara Nitrates Pty Ltd.'s (YPN) approval under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) (reference 2008/4546 as varied 24 March 2020) for the Technical Ammonium Nitrate (TAN) Plant requires monitoring of various air quality parameters.

Condition 3 of the approval outlines reporting requirements, including an analysis of monitoring data from the monitoring program carried out under condition 9A. This report is provided in response to Condition 3(a) of the approval for the monitoring period 1 July 2023 to 30 June 2024.

2. Scope of Monitoring Program

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

Condition 9A of the approval 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 (Hearson Cove Road 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:

<i>Element of air quality to be monitored</i>	<i>Specific air quality parameter to be sampled</i>	<i>Minimum frequency of monitoring</i>
<i>Ambient air concentration of gases</i>	<i>NH₃ (ammonia)</i>	<i>Continuous monitoring for at least 14 consecutive days, every month</i>
	<i>NO₂ (nitrogen oxide)</i>	
	<i>SO₂ (sulfur oxide)</i>	
<i>Airborne particulate concentration</i>	<i>Total suspended particulates up to 50 μm (TSP)</i>	<i>Every 6 days</i>
<i>Deposited dust</i>	<i>Total dust deposition per month (Insoluble Fraction)</i>	<i>Quarterly</i>
	<i>Total dust deposition per month (Soluble Fraction)</i>	

Figure 1: Condition 9A of EPBC Approval 2008/4546 (as varied 24 March 2020)

Condition 3(a)i of the EPBC Act approval requires (in part) publication of a report that includes “...an analysis of monitoring data required under Condition 9A...”.

On 24 March 2020, approval was granted to relocate Site 7 (Deep Gorge) to accommodate the development of a boardwalk at the Ngajarli heritage site (formerly known as Deep Gorge) by Murujuga Aboriginal Corporation (MAC). Consequently, Site 7 was relocated to Hearson Cove on 8 April 2020. This site was referenced as ‘Deep Gorge’ in the report for 2020-2021. However, as the site is now closer to Hearson Cove, it is referred to as ‘Hearson Cove’ herein (including in graphs where data prior to April 2020 is from monitoring at the Deep Gorge site).

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

The following reports have been issued as required by the EPBC Act approval:

- October 2018 for the period 2017-2018 (Strategen 2018);
- October 2019 for the period 2018-2019 (Strategen-JBS&G 2019);
- October 2020 for the period 2019-2020 (Strategen-JBS&G 2020);
- October 2021 for the period 2020-2021 (Strategen-JBS&G 2021);
- October 2022 for the period 2021-2022 (Strategen-JBS&G 2022); and
- October 2023 for the period 2023-2024 (JBS&G 2023).

This report presents an analysis of monitoring data obtained for the monitoring period 1 July 2023 to 30 June 2024 (referred to herein as the 2023-2024 monitoring period).

3. TAN Plant Operation

The TAN Plant (including the nitric acid, ammonium nitrate solution and prill plants) was in operation for the following dates during the 2023-2024 monitoring period:

- 18 to 27 July 2023;
- 29 July to 4 August 2023;
- 7 to 20 August 2023;
- 29 August to 27 October 2023;
- 4 November to 16 April 2024;
- 18 April to 14 June 2024;
- 24 June 2024;
- 25 to 28 June 2024; and
- 29 to 30 June 2024 (end of reporting period).

4. Air Quality Monitoring Program

4.1 Gases

4.1.1 Results of Monitoring

Monitoring of ammonia (NH₃), nitrogen dioxide (NO₂), sulfur dioxide (SO₂) and nitric acid (HNO₃) gases using Radiello passive sampling was carried out continuously throughout the 2023-2024 monitoring period at the three specified monitoring sites – Site 5 Burrup Road, Site 6 Water Tanks and Site 7 Hearson Cove.

A total of 24 fortnightly measurements were made of NH₃, NO₂, SO₂ and HNO₃ concentrations at each monitoring site during the 2023-2024 monitoring period. Sampling commenced on 30 June 2023, when samplers deployed for the previous fortnight were replaced, and sampling concluded on 1 July 2024.

Tabulated results of the monitoring are shown in Appendix A. The concentrations for each parameter at the respective sites are illustrated in Figure 2 for NH₃, Figure 3 for NO₂ and Figure 4 for SO₂. The concentrations of HNO₃ are illustrated in Figure 5.

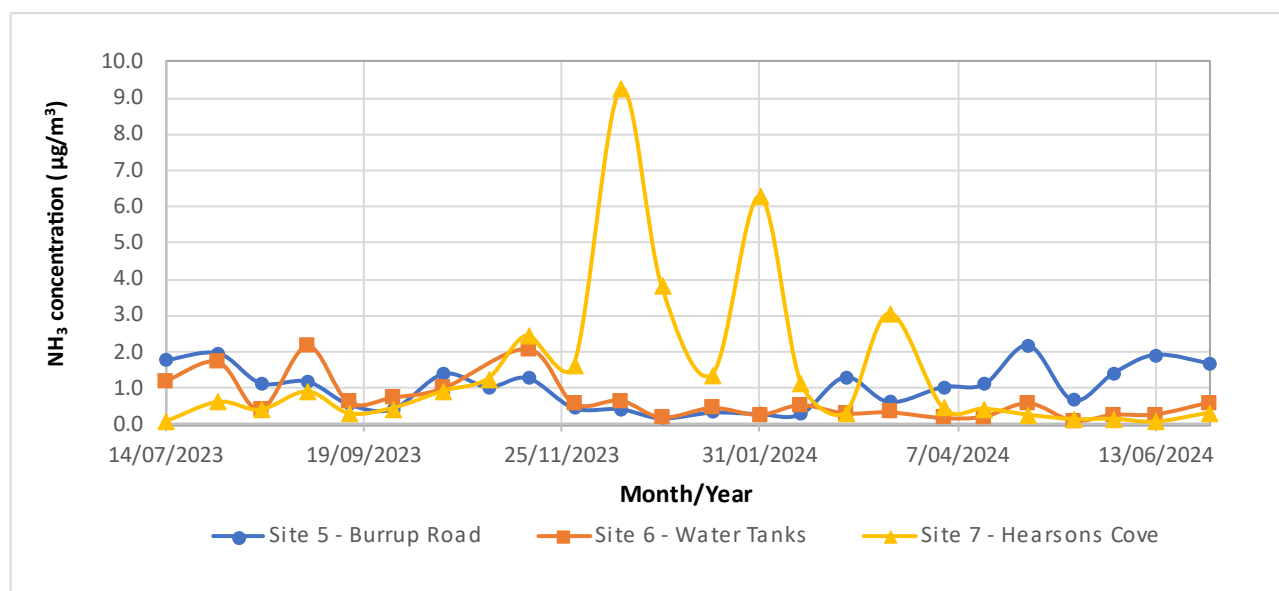


Figure 2: Measured NH₃ concentrations for 1 July 2023 to 30 June 2024

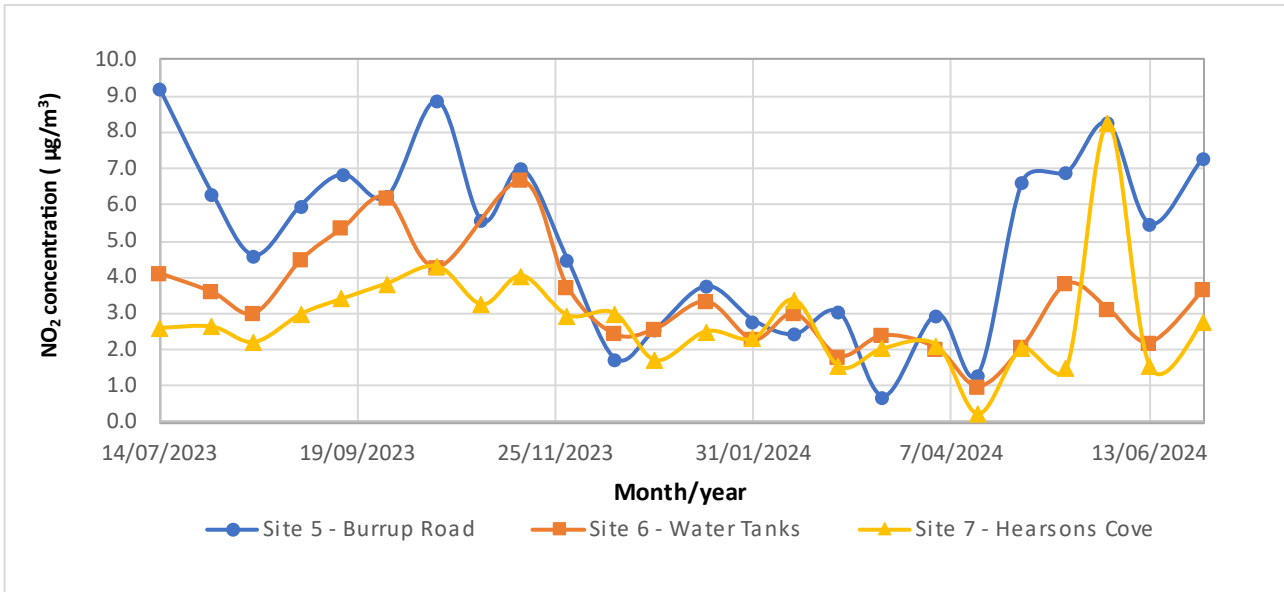


Figure 3: Measured NO₂ concentrations for 1 July 2023 to 30 June 2024

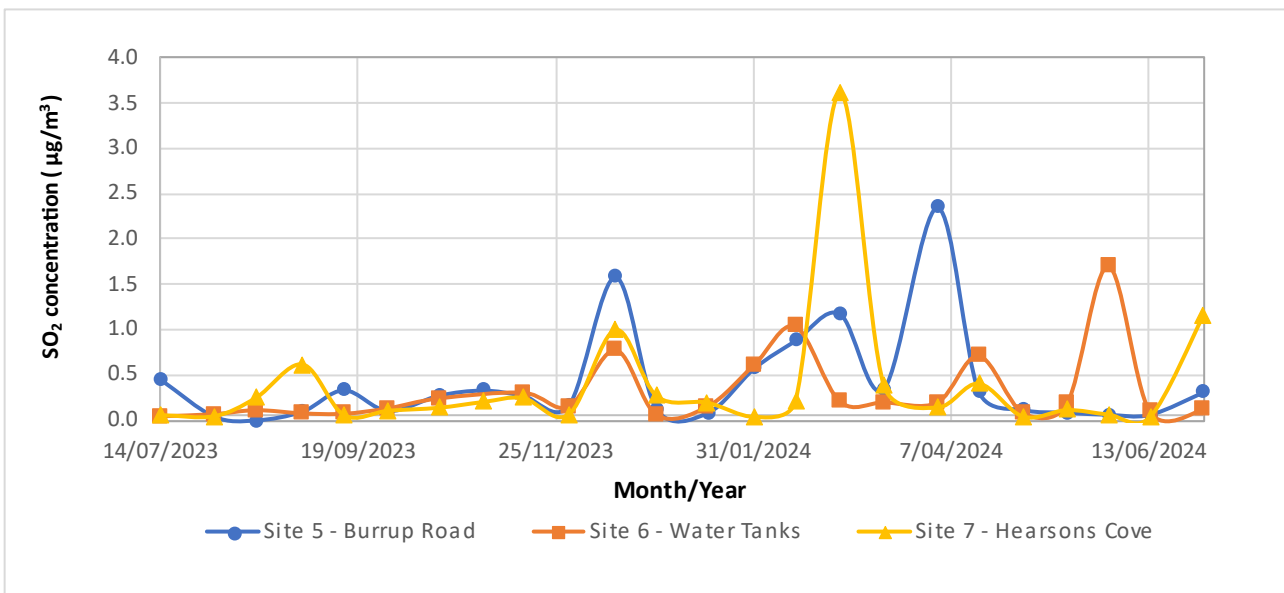


Figure 4: Measured SO₂ concentrations for 1 July 2023 to 30 June 2024

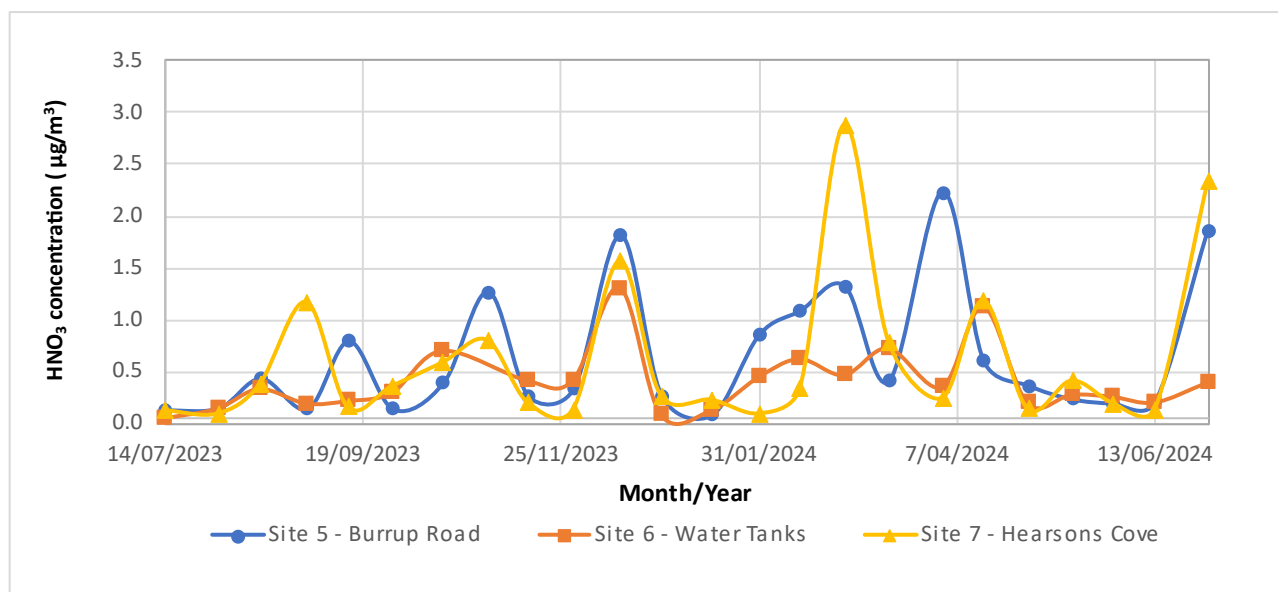


Figure 5: Measured HNO₃ concentrations for 1 July 2023 to 30 June 2024

4.1.2 Analysis of Data

Analysis of measured concentrations involves a comparison of descriptive statistics for the 2023-2024 monitoring period with those from monitoring carried out in the baseline study (YPN 2017). These statistics are shown in Table 1 for concentrations of NH₃, Table 2 for NO₂, Table 3 for SO₂, and Table 4 for HNO₃. Concentrations are calculated for the actual duration of exposure of the samplers, which were nominally 15-days but may vary a day on either side of that duration for logistical reasons.

Table 1: Descriptive statistics for NH₃ concentrations (2023-2024 and baseline)

Ammonia concentration µg/m ³						
Statistic	Site 5 Burrup Road		Site 6 Water Tanks		Site 7 Hearson Cove	
	2023-2024	Baseline	2023-2024	Baseline	2023-2024	Baseline
Minimum	0.19	0	0.11	0	0.06	0
Average	1.03	0.44	0.67	0.93	1.50	0.75
Maximum	2.16	1.2	2.15	3.97	9.24	4.35
Standard deviation	0.59	0.34	0.58	0.76	2.20	0.82

Table 2: Descriptive statistics for NO₂ monitoring (2023-2024 and baseline)

Nitrogen dioxide concentration µg/m ³						
Statistic	Site 5 Burrup Road		Site 6 Water Tanks		Site 6 Water Tanks	
	2023-2024	Baseline	2023-2024	Baseline	2023-2024	Baseline
Minimum	0.71	0.38	0.98	0.31	0.24	0.4
Average	5.04	3.6	3.35	2.56	2.81	2.31
Maximum	9.22	6.53	6.66	5.27	8.24	4.12
Standard deviation	2.44	1.46	1.39	1.04	1.48	0.69

Table 3: Descriptive statistics for SO₂ monitoring (2023-2024 and baseline)

Sulfur dioxide concentration $\mu\text{g}/\text{m}^3$						
Statistic	Site 5 Burrup Road		Site 6 Water Tanks		Site 7 Hearson Cove	
	2023-2024	Baseline	2023-2024	Baseline	2023-2024	Baseline
Minimum	0.00	0.07	0.04	0	0.03	0.13
Average	0.42	1.38	0.32	0.95	0.39	0.82
Maximum	2.35	3.09	1.70	3.5	3.61	2.01
Standard deviation	0.56	0.83	0.40	0.84	0.75	0.53

Table 4: Descriptive statistics for HNO₃ monitoring (2023-2024 and baseline)

Nitric acid concentration $\mu\text{g}/\text{m}^3$						
Statistic	Site 5 Burrup Road		Site 6 Water Tanks		Site 7 Hearson Cove	
	2023-2024	Baseline	2023-2024	Baseline	2023-2024	Baseline
Minimum	0.08	0.00	0.05	0.00	0.09	0.00
Average	0.65	0.58	0.41	0.54	0.62	0.48
Maximum	2.23	1.55	1.31	1.81	2.87	1.42
Standard deviation	0.63	0.45	0.31	0.48	0.73	0.37

The concentrations for each monitoring site from the 2023-2024 monitoring period have been compared with the baseline via statistical analysis (t-test) to determine if differences in the average concentrations are statistically significant (determined by t-test P values <0.05).

The results are summarised in Table 5 and key findings from these data are summarised in Table 6.

Table 5: T-test results for comparison of 2023-2024 and baseline NH₃, NO₂, SO₂ and HNO₃ concentrations

Parameter	Monitoring period	Statistic	Site 5 Burrup Road	Site 6 Water Tanks	Site 7 Hearson Cove
NH ₃	2023-2024	Average	1.03	0.67	1.50
	baseline	Average	0.44	0.93	0.75
		P value	7.04E-05	0.12	0.12
NO ₂	2023-2024	Average	5.04	3.35	2.81
	baseline	Average	3.60	2.56	2.31
		P value	0.01	0.02	0.13
SO ₂	2023-2024	Average	0.42	0.32	0.39
	baseline	Average	1.41	0.95	0.82
		P value	1.21E-06	3.68E-05	1.72E-02
HNO ₃	2023-2024	Average	0.65	0.41	0.62
	baseline	Average	0.58	0.54	0.48
		P value	0.65	0.19	0.40

(1) Red value indicate statistically significant different concentrations from the baseline

Table 6: Analysis of NH₃, NO₂, SO₂ and HNO₃ concentration data

Parameter	Site	Finding
NH ₃	Burrup Road	The (higher) average NH ₃ concentration from 2023-2024 monitoring compared with baseline monitoring at this site is statistically significant.
	Water Tanks	The (lower) average NH ₃ concentration from 2023-2024 monitoring compared with baseline monitoring is not statistically significant
	Hearson Cove	The (higher) average NH ₃ concentration from 2023-2024 monitoring compared with baseline monitoring is not statistically significant
NO ₂	Burrup Road	The (higher) average NO ₂ concentration from 2023-2024 monitoring compared with baseline monitoring at this site is statistically significant.
	Water Tanks	The (higher) average NO ₂ concentration from 2023-2024 monitoring compared with baseline monitoring at this site is statistically significant.
	Hearson Cove	The (higher) average NO ₂ concentration from 2023-2024 monitoring compared with baseline monitoring at this site is not statistically significant.
SO ₂	Burrup Road	The (lower) average SO ₂ concentrations from 2023-2024 monitoring compared with baseline monitoring are statistically significant at all three monitoring sites.
	Water Tanks	
	Hearson Cove	
HNO ₃	Burrup Road	The (higher) average HNO ₃ concentrations from 2023-2024 monitoring compared with baseline monitoring is not statistically significant.
	Water Tanks	The (lower) average HNO ₃ concentrations from 2023-2024 monitoring compared with baseline monitoring is not statistically significant.
	Hearson Cove	The (higher) average HNO ₃ concentrations from 2023-2024 monitoring compared with baseline monitoring is not statistically significant.

The average concentrations of NH₃ detected at the Water Tanks and Hearson Cove sites during the 2023-2024 monitoring period were determined to be statistically insignificant from the baseline dataset. The average NH₃ concentration measured at Burrup Road, however, was determined to be statistically significantly higher than the baseline.

The average concentrations of NO₂ at the Burrup Road and Water tanks sites were determined to be statistically significantly higher than the baseline. The slightly higher average NO₂ concentrations measured at the Burrup Road site, however, was determined not to be significantly different to the baseline.

Continuing from previous years, statistically significant decreases in the SO₂ concentrations recorded during the 2023-2024 monitoring period compared with the baseline study were determined for all three monitoring sites (Table 5). The reasons for the apparent decrease in average SO₂ concentrations since the baseline data were recorded are not known, but may reflect a reduced frequency of flaring at the gas plants on the Burrup Peninsula or the use of lower sulfur fuels in ships that visit the Port of Dampier.

The differences in the HNO₃ concentrations recorded at all monitoring sites during the 2023-2024 monitoring period relative to the baseline study are statistically insignificant.

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. Total annual deposition rates were calculated from the combined rates for NH₃, NO₂, SO₂ and HNO₃. The results for total annual dry deposition are illustrated in Figure 6.

The monitoring periods shown are from the start of July to the end of June in the following year, except for the 2013-2014 monitoring period, which is reported from September 2013 to August 2014 and, therefore, overlaps with the 2014-2015 period to represent an entire 12-month period.

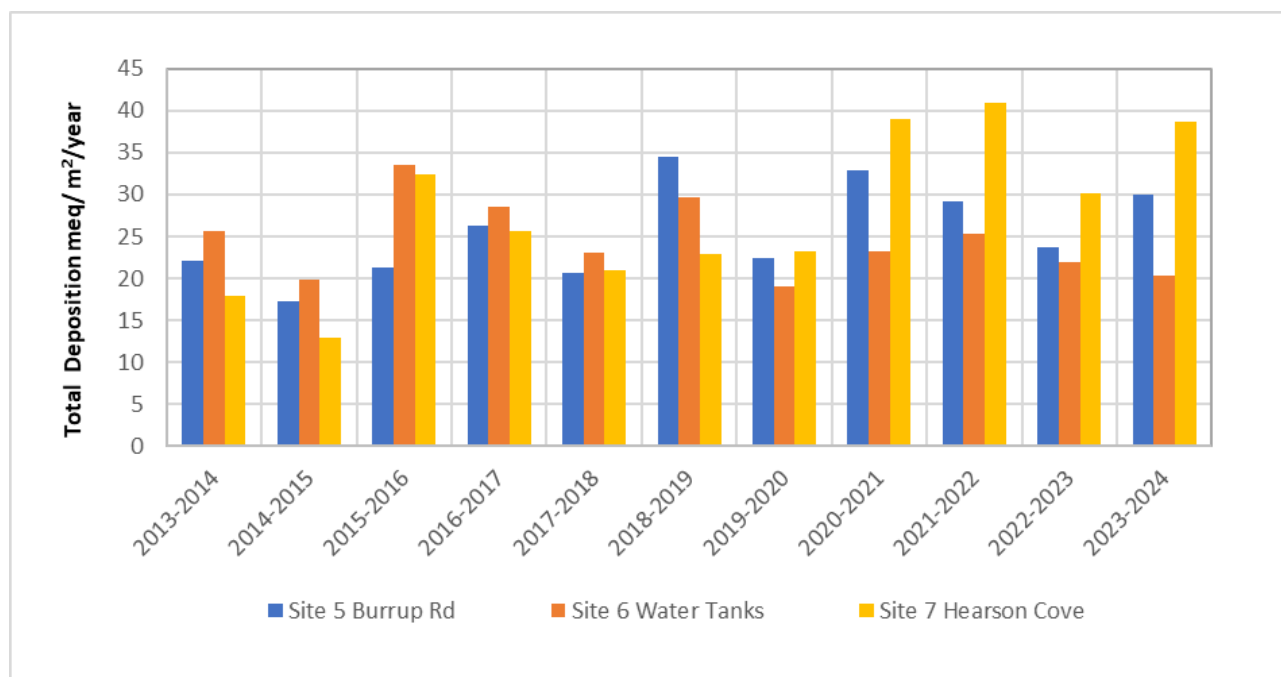


Figure 6: Annual deposition rates from measured gases (2013-2024)

The results of the annual dry deposition monitoring 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/m ² /year)		
	Site 5 Burrup Road	Site 6 Water Tanks	Site 7 Hearson Cove
2013-2014	22.1	25.6	17.9
2014-2015	17.3	19.8	12.9
2015-2016	21.3	33.6	32.4
2016-2017	26.3	28.5	25.6
2017-2018	20.7	23.0	21.0
2018-2019	34.5	29.7	23.0
2019-2020	22.4	19.0	23.2
2020-2021	32.9	23.3	39.1
2021-2022	29.1	25.4	40.9
2022-2023	23.8	22.0	30.1
2023-2024	30.0	20.3	38.7
Investigation level	25.5	42.2	51.8

During the 2023-2024 monitoring period, dry deposition rates of gas species remained within the levels observed in previous years. At Site 7, which was relocated from Deep Gorge to Hearson Cove in April 2020, the results are within the rates previously determined at Hearson Cove. Deposition rates determined at Hearson Cove are elevated compared to previous annual dry deposition results from the Deep Gorge site; possibly due to the change in location to a more exposed position.

The annual dry deposition rate determined for the Burrup Road site was above the investigation level, whereas the rates at the Water Tanks and Hearson Cove sites were below the respective investigation levels.

The composition of the total deposition at each monitoring site is illustrated in Figure 7 to Figure 9.

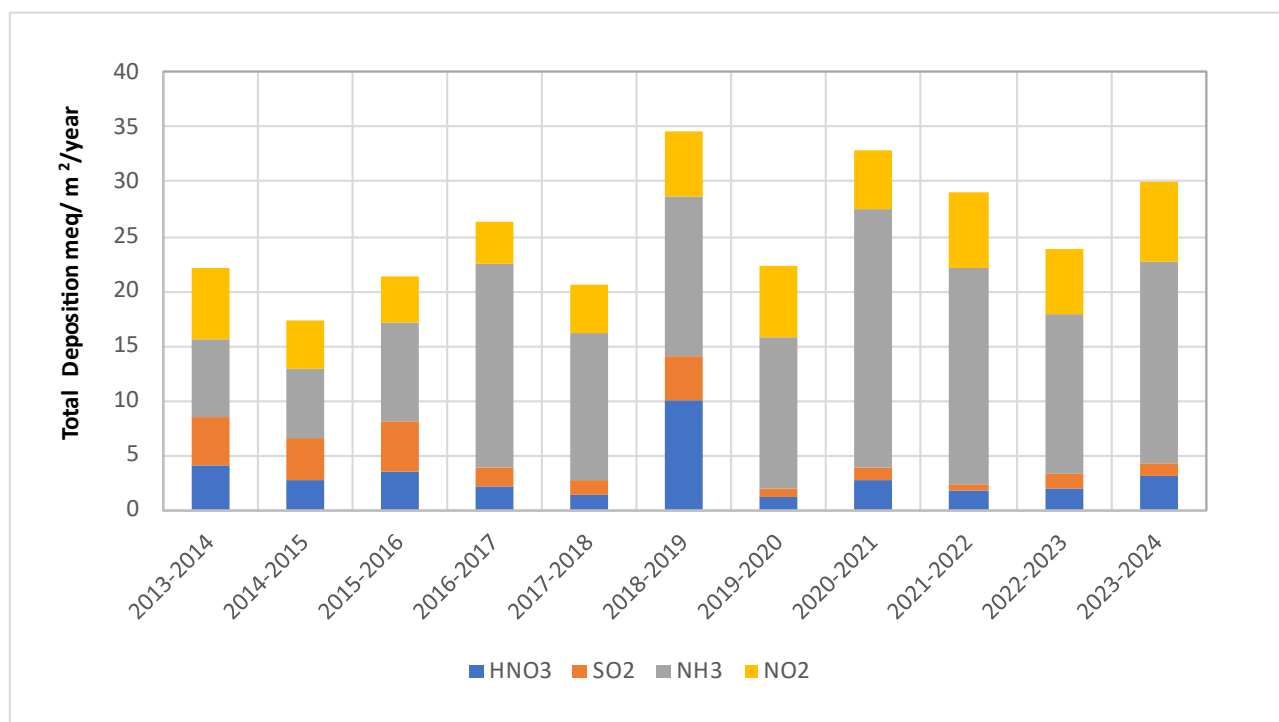


Figure 7: Burrup Road dry deposition composition

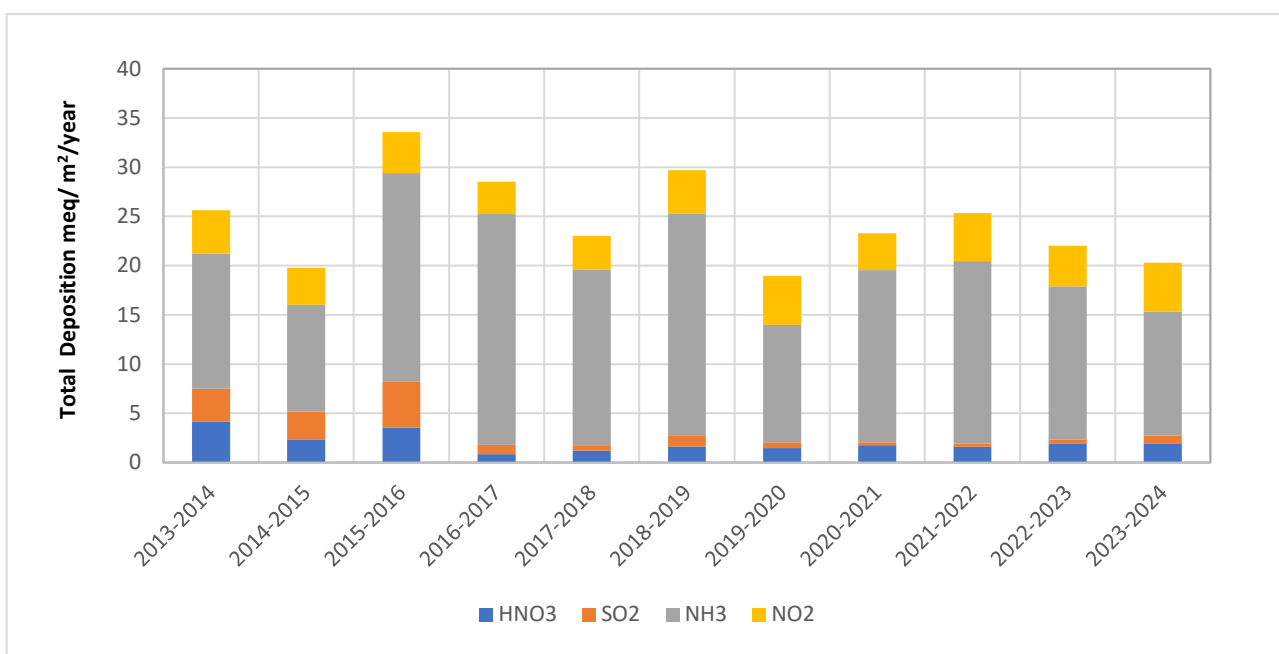


Figure 8: Water Tanks dry deposition rates

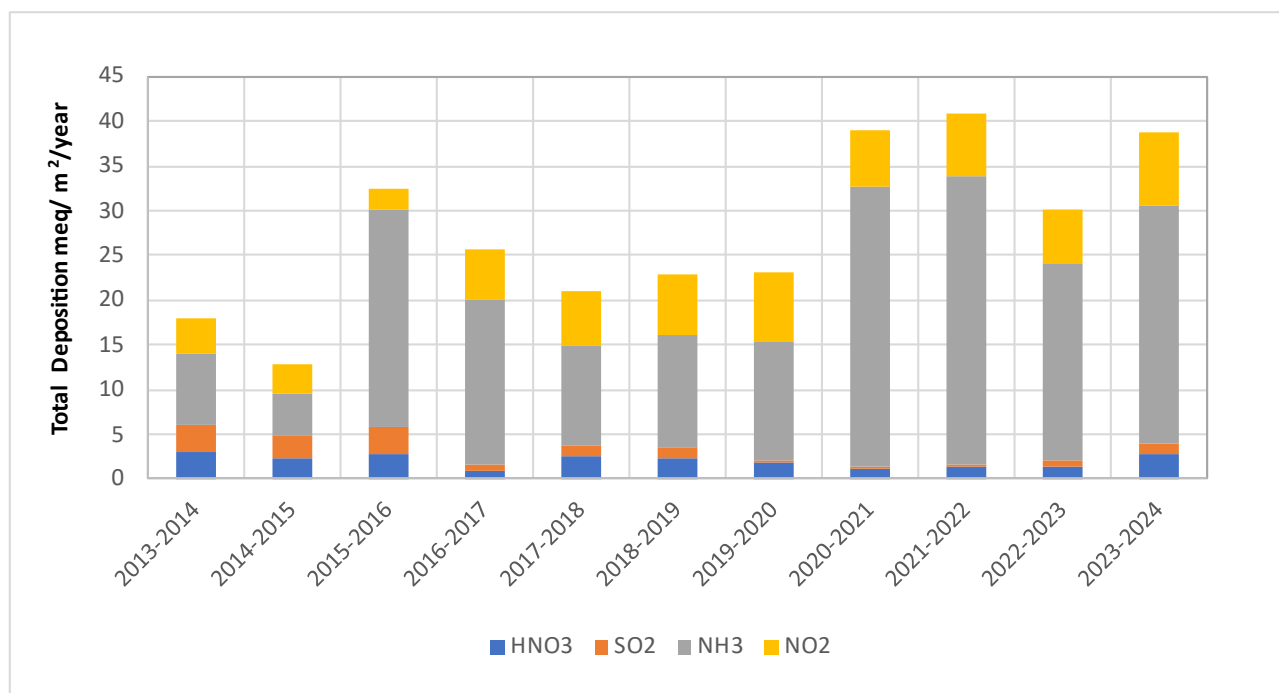


Figure 9: Hearson Cove dry deposition rates

4.2 Total Suspended Particulates

4.2.1 Results of TSP Monitoring

Monitoring for total suspended particulates (TSP) using MicroVol samplers was carried out at the three monitoring sites. Monitoring occurred for 24 hours every six days from the period 5 July 2023 to 29 June 2024. Tabulated results of the monitoring are shown in Appendix B.

Valid data was collected at all monitoring sites throughout the 2023-2024 monitoring period except for two samples collected from the Water Tanks and Hearson Cove sites on 12 April 2024 that appeared contaminated (with a deposit observed on the edge of the filter upon collection) and one sample from 7 March 2024 at the Hearson Cove site when the sampler experienced a run-time error during the collection period.

Similar trends in the concentrations from the three monitoring sites are typically observable across the year (Figure 10). This suggests the monitoring data reflects TSP trends in the local airshed rather than direct impacts from individual local sources.

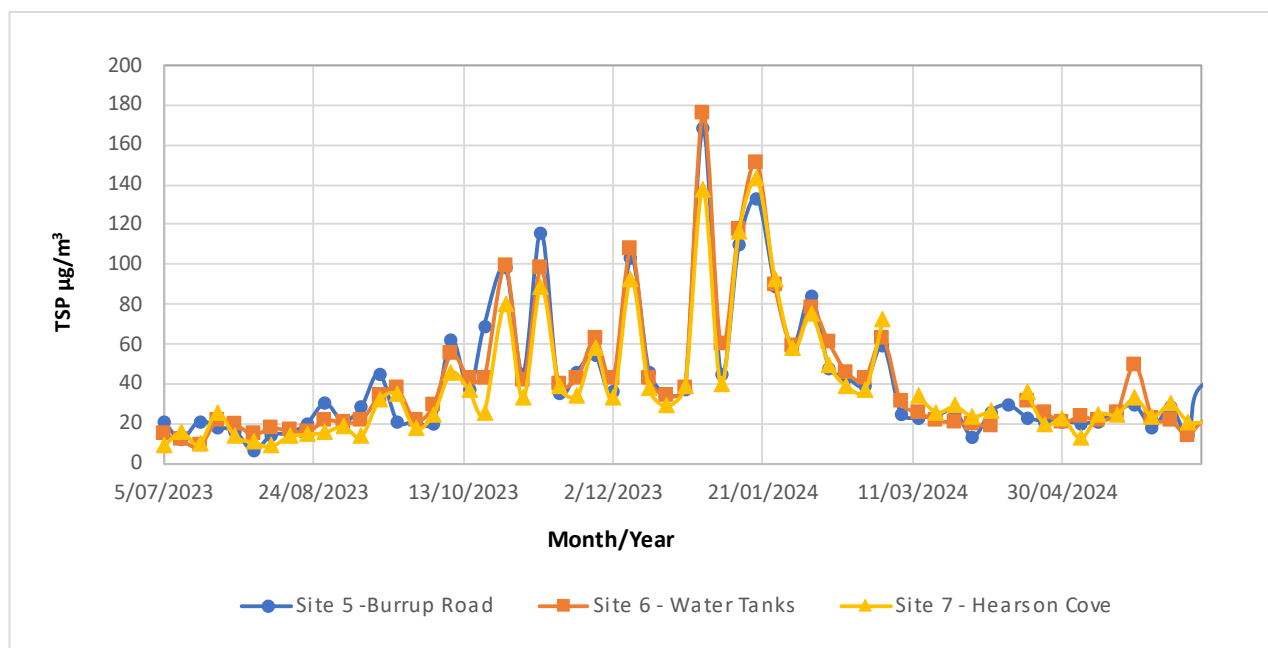


Figure 10: Measured TSP concentrations for 2023-2024

The baseline dataset was derived from direct TSP measurements as well as from estimates calculated from measured PM₁₀ concentrations as described in the baseline report (YPN 2017). Furthermore, the measured baseline dataset for the Water Tanks site was impacted by local activities associated with the construction of the TAN Plant resulting in an over-representation of background levels at that site. The ongoing measured average concentration data are consequently compared to both the measured and calculated datasets for the baseline (Figure 11).

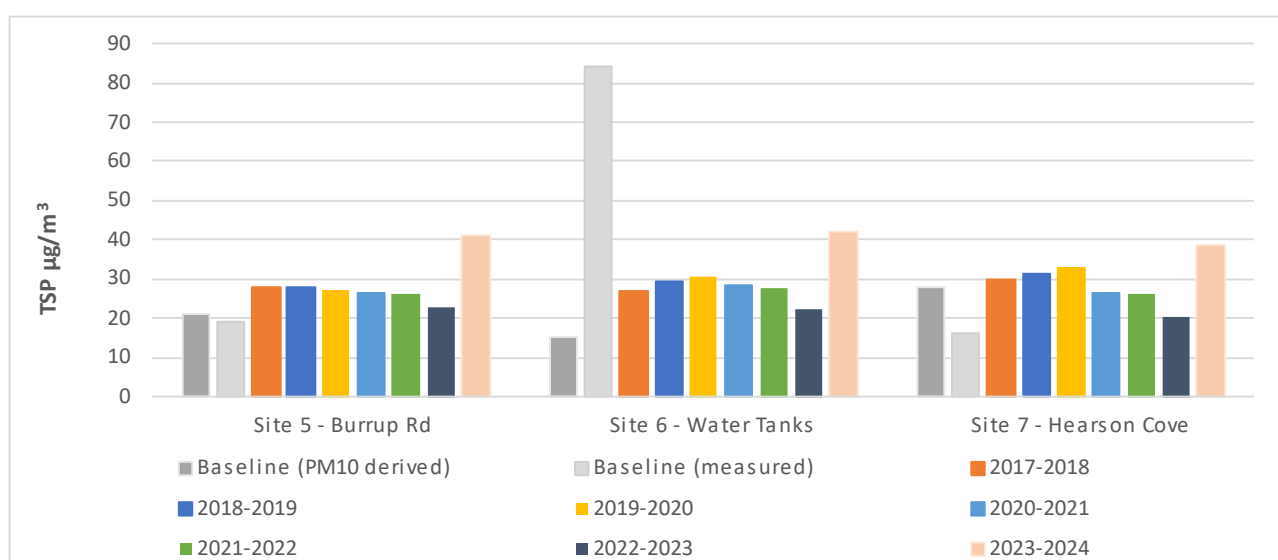


Figure 11: Comparison of average TSP concentrations for 2023-2024 with previous years and baseline data

Descriptive statistics for TSP during the 2023-2024 monitoring period at all three monitoring sites are shown in Table 8 to Table 10 alongside the data for previous years.

Table 8: Descriptive statistics for TSP monitoring 2018 to 2024 – Burrup Road

		TSP concentration $\mu\text{g}/\text{m}^3$					
Statistic	Site 5 Burrup Road						
	2023-2024	2022-2023	2021-2022	2020-2021	2019-2020	2018-2019	2017-2018
Minimum	6	5	8	5	8	2	6
Average	41	23	26	27	27	28	28
Maximum	168	50	76	78	77	66	76
Standard deviation	32	10	13	14	15	14	13

Table 9: Descriptive statistics for TSP monitoring 2018 to 2024 – Water Tanks

		TSP concentration $\mu\text{g}/\text{m}^3$					
Statistic	Site 6 Water Tanks						
	2023-2024	2022-2023	2021-2022	2020-2021	2019-2020	2018-2019	2017-2018
Minimum	9	6	8	5	9	8	6
Average	42	22	28	28	31	29	27
Maximum	176	50	89	79	141	63	76
Standard deviation	34	10	14	15	22	13	12

Table 10: Descriptive statistics for TSP monitoring 2018 to 2024 – Hearson Cove

		TSP concentration $\mu\text{g}/\text{m}^3$					
Statistic	Site 7 Hearson Cove						
	2023-2024	2022-2023	2021-2022	2020-2021	2019-2020	2018-2019	2017-2018
Minimum	9	6	7	7	8	8	11
Average	38	20	26	27	33	32	30
Maximum	143	50	89	67	148	67	79
Standard deviation	30	9	15	14	23	15	15

A comparison of the mean TSP concentrations measured during the six monitoring periods after the baseline study shows the average TSP concentration for the 2023-2024 monitoring period is above that in previous years for all monitoring sites (Figure 11 and Table 8 to Table 10).

The levels monitored at the Water Tanks site since the baseline study have persisted lower than the baseline measured data and are comparable to the levels recorded at other sites. This continues to support the hypothesis that the baseline measurements at the Water Tanks site were affected by construction activities.

The 2023-2024 data were compared to the previously measured datasets to determine if there was any significant change in the recorded ambient TSP levels. The 2023-2024 dataset was determined to be statistically significantly different from previous reporting years at the Water Tanks and Hearson Cove sites. At the Burrup Road site, the 2023-2024 dataset was not statistically significantly different to the 2017-2018, 2018- 2019 and 2019-2020 datasets, but was significantly different to the three most recent datasets.

Elevated TSP is likely due to extensive earthworks occurring in the 2023-2024 monitoring period associated with construction of the Perdaman Urea Project to the west of the TAN plant.

4.3 Dust Deposition

4.3.1 Results from Monitoring Deposited Dust

Results of dust deposition monitoring at the three monitoring sites are shown in Table 11. Values with a less than (<) prefix indicate the measured deposition rates were below the method detection limits, with the value indicating the limit. Tabulated results of the monitoring are shown in Appendix C.

Table 11: Results of dust deposition monitoring 2023-2024

Date deployed	Date collected	Site 5 - Burrup Road		Site 6 - Water Tanks		Site 7 – Hearson Cove	
		Soluble solids	Insoluble solids	Soluble solids	Insoluble solids	Soluble solids	Insoluble solids
		g/m ² /month	g/m ² /month	g/m ² /month	g/m ² /month	g/m ² /month	g/m ² /month
30/06/2023	1/08/2023	0.8	1.1	<0.7	<0.8	<0.7	<0.8
1/08/2023	31/08/2023	<0.7	0.8	<0.7	1.1	<0.7	1.1
31/08/2023	29/09/2023	1	1.9	1	0.9	1.1	1.4
29/09/2023	31/10/2023	1	1.9	0.7	1.8	2.4	2.1
31/10/2023	29/11/2023	0.9	2.2	2	2	<0.7	1.9
29/11/2023	29/12/2023	1	1.7	0.8	1.3	1	2
29/12/2023	31/01/2024	1.2	1.2	1	1.2	0.7	1.8
31/01/2024	29/02/2024	0.9	2.3	1.3	1.6	1.7	2.2
29/02/2024	2/04/2024	<4.3	1.3	<4.3	1.8	<4.0	1.4
2/04/2024	1/05/2024	<2.6	1.4	<3.3	1.6	<2.4	1.4
1/05/2024	30/05/2024	<0.7	<0.8	1.1	<0.8	<0.7	<0.8
30/05/2024	1/07/2024	<2.2	<0.8	<2	<0.8	<2.7	<0.8

4.3.2 Analysis of Dust Deposition Data

A comparison of the dust deposition data from the 2023-2024 monitoring period with the baseline data (insoluble fraction only) is shown in Table 12.

Table 12: Descriptive statistics for dust deposition monitoring 2023-2024 and baseline study

Statistic ⁽¹⁾	Burrup Road (g/m ² /month)			Water Tanks (g/m ² /month)			Hearson Cove (g/m ² /month)		
	2023-2024		Baseline	2023-2024		Baseline	2023-2024		Baseline
	Soluble	Insoluble	Insoluble	Soluble	Insoluble	Insoluble	Soluble	Insoluble	Insoluble
Minimum	0.4	0.4	0.0	0.4	0.4	0.0	0.4	0.4	0.0
Average	1.0	1.4	0.9	1.1	1.2	0.8	1.1	1.4	1.1
95 th percentile	1.7	2.2	1.8	2.1	1.9	1.9	2.2	2.1	2.3
Maximum	2.2	2.3	2.0	2.2	2.0	2.1	2.4	2.2	5.0

(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 higher than baseline across all three monitoring sites (Figure 12). The differences between the baseline and 2023-2024 datasets were not statistically significant at the Hearson Cove and Water Tanks sites (determined by t-test P values >0.05). The average measured insoluble fraction at the Burrup Road and Water Tanks sites are within the range seen in other years, while the average at the Hearson Cove site was above that previously recorded. The Burrup Road site was the exception with a statistically significant difference compared to the baseline; the average deposition rate was slightly lower than the immediately preceding monitoring period.

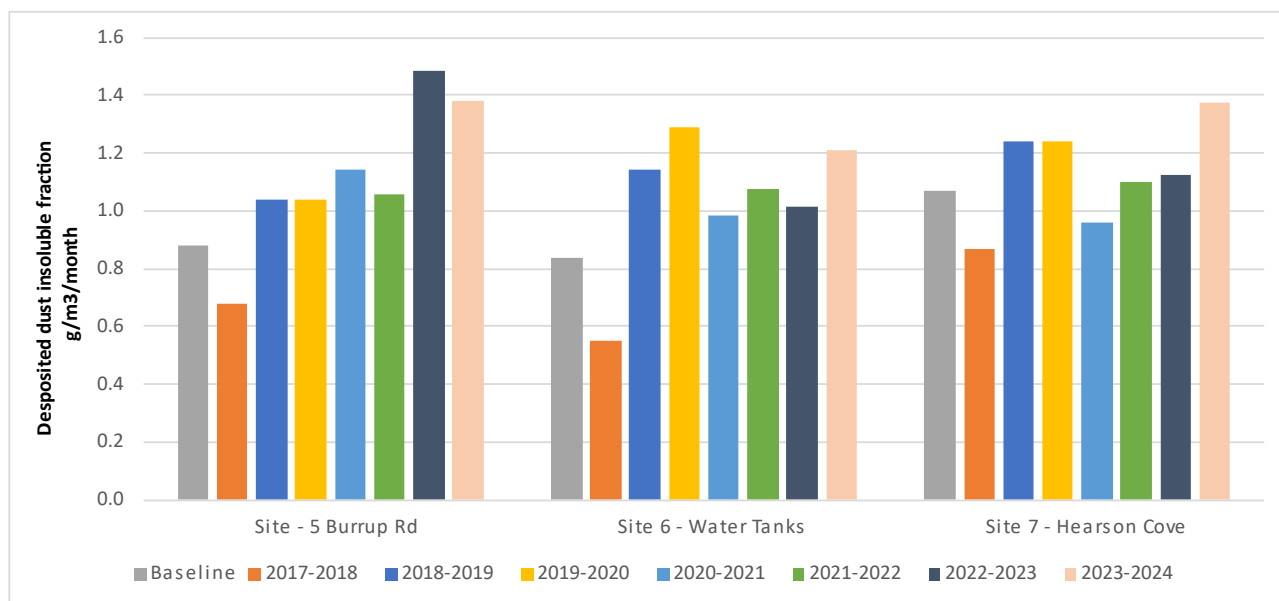


Figure 12: Deposited dust average insoluble fraction baseline to 2023-2024

Similar trends in the insoluble deposition rates were observed at the three monitoring sites across most of the 2023-2024 monitoring period (Figure 13). The deposition of insoluble material at the Hearson Cove site was above the other monitoring sites during January 2024. Note that these comparisons reflect the use of non-detect deposition rates of half the detection limits, including in March 2024 when the highest deposition as shown on Figure 13 was from a non-detect result. The actual deposition rates below detection limits may be lower or higher than the half detection rates.

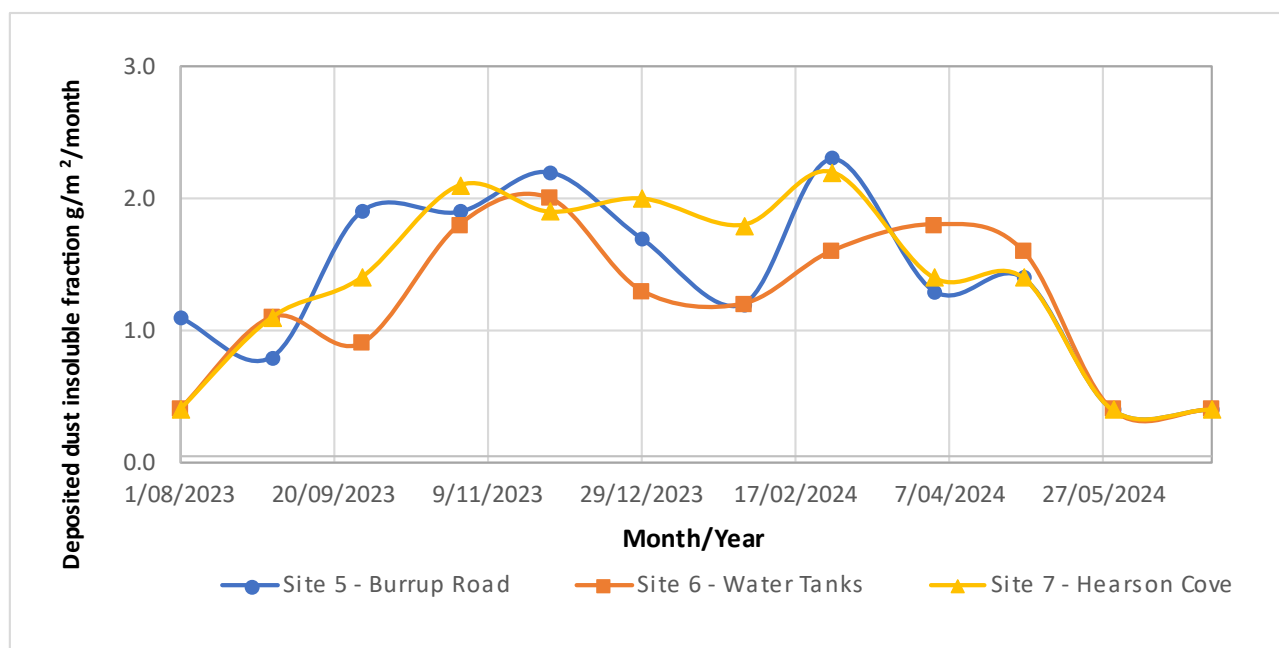


Figure 13: Deposited dust insoluble fraction 2023-2024

The soluble fraction was not determined in samples collected for the baseline study as the EPBC Act approval 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 required both insoluble and soluble fractions of deposited dust to be monitored. In the absence of baseline data, the data for the 2023-2024 soluble fraction is compared to the data collected for the 2018 to 2023 monitoring periods.

The average soluble fraction measured from the deposited dust collected in the 2023-2024 monitoring period is within the range seen from monitoring carried out across previous years at all sites (Figure 14).

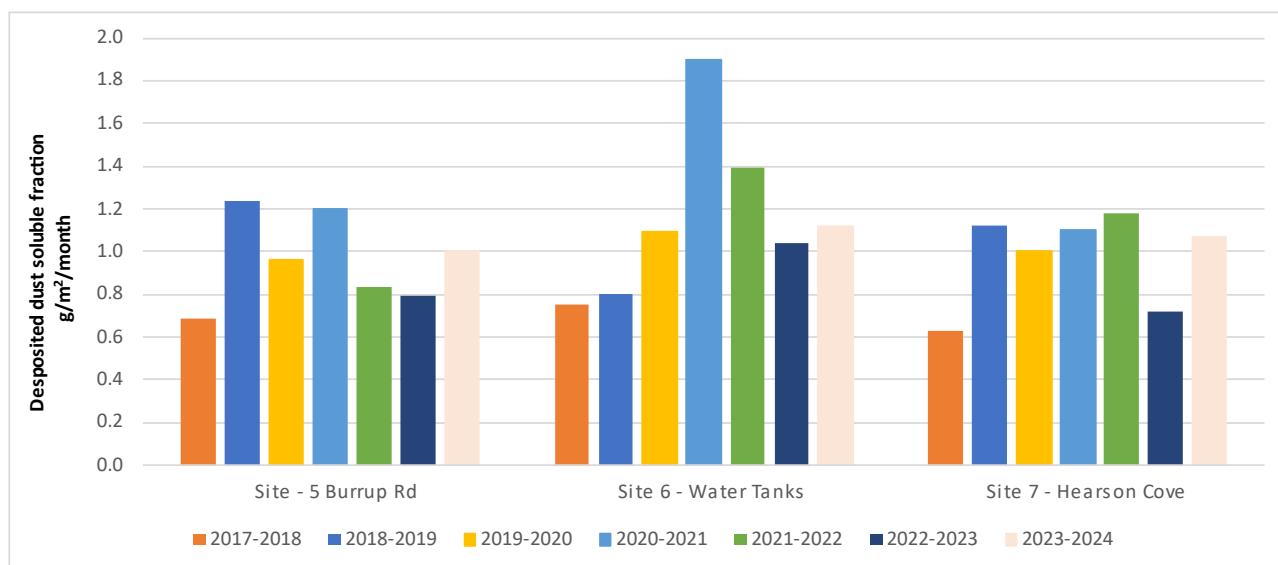


Figure 14: Deposited dust average soluble fraction baseline to 2023-2024

The trends in the soluble deposition rates observed at the three monitoring sites across the 2023-2024 monitoring period are presented in Figure 15. More variability in the monthly data for the soluble fraction of deposited dust across the three monitoring sites during the first half of the 2023-2024 period is evident.

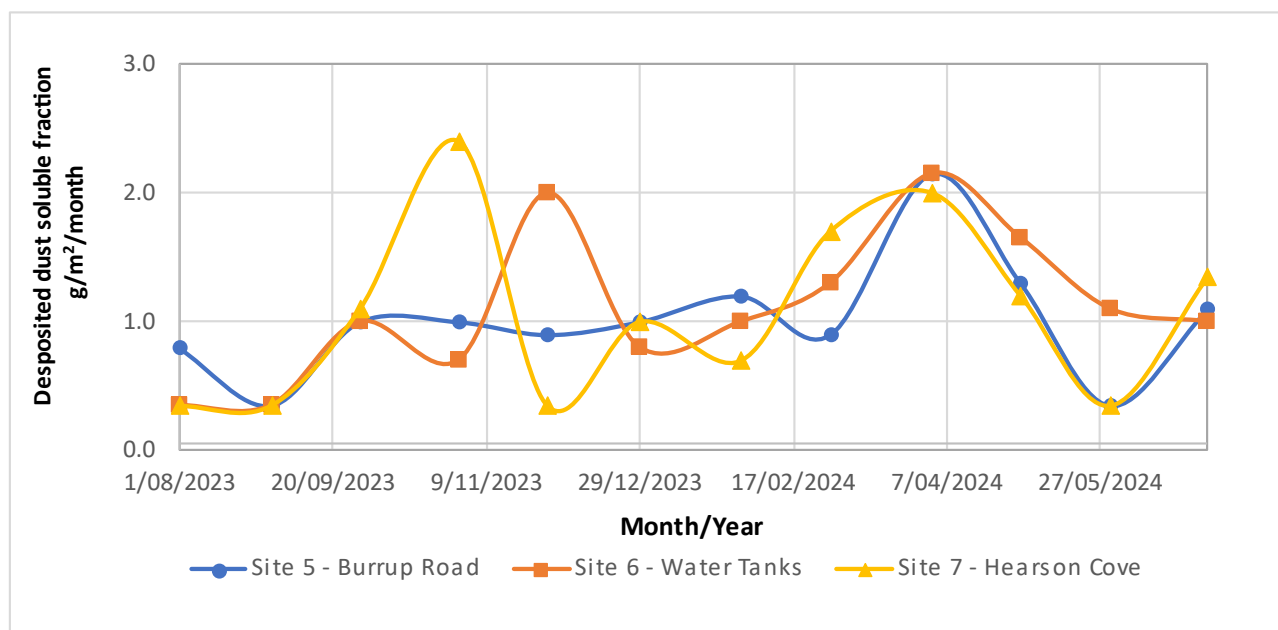


Figure 15: Deposited dust soluble fraction 2023-2024

Most of the soluble dust deposited on Murujuga 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 variable nature of soluble deposition rates from August to December each year may reflect the wind being predominantly from the west. During westerly winds, the landform that air coming from the ocean must pass over could influence the amount of entrained sea salt and, thus, deposition varies at the three monitoring sites, which have varying degrees of shielding to the west.

The results for the last four months of monitoring were below the detection limit reported by the laboratory. Unfortunately, rain affected the analysis of these samples resulting in raised detection limits due to an analytical shortcoming¹. Therefore, the presentation of the data using half the reported detection limit may be an over or underestimate of actual deposition.

Overall, the levels of dust deposited at the three monitoring sites remain largely consistent with those observed from the baseline study and previous monitoring carried out since 2017.

5. Dry Deposition Rate Investigation and Actions

As described in Section 4.1.3, the monitoring carried out in the 2023-2024 monitoring period showed that the annual dry deposition rate exceeded the investigation levels established from the baseline study at the Burrup Road site.

The Burrup Road site rolling annual deposition had a rising trend across the 2023-2024 monitoring period, with the monthly rolling annual deposition exceeding the investigation level (25.5 meq/m²/y) by the end of the first quarter (Figure 16). Peak concentrations were within the range of previous years (Figure 17).

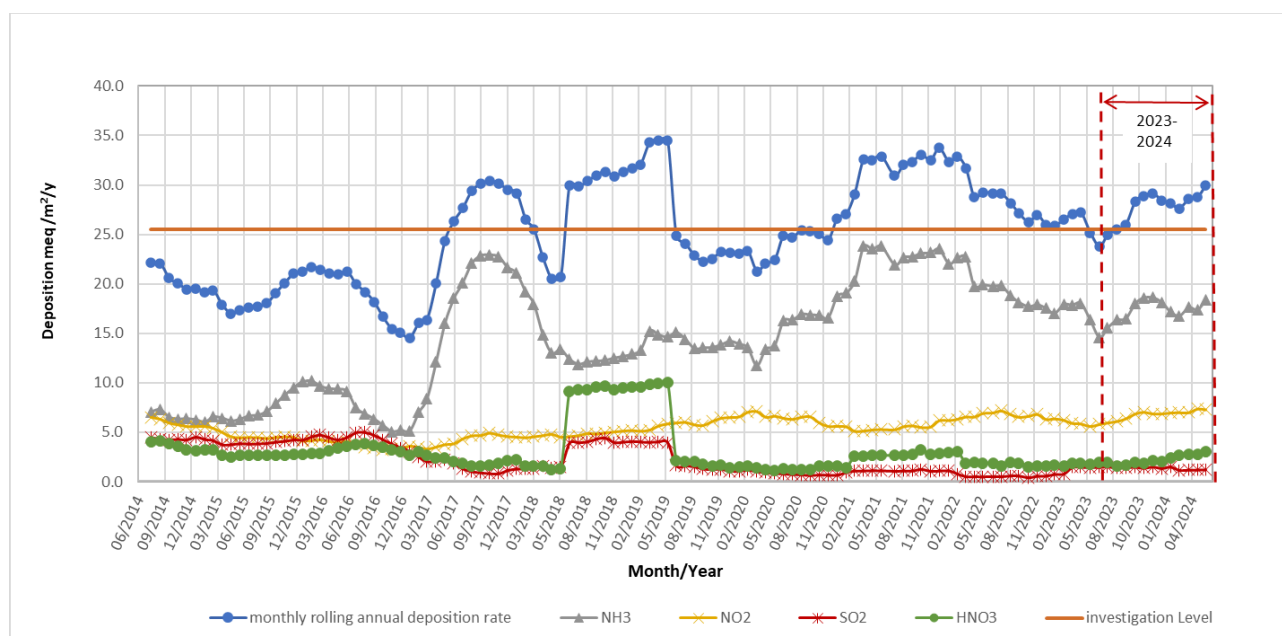


Figure 16: Monthly rolling annual total and individual gas dry deposition rates – Burrup Road

¹ Efforts to address this analytical issue are ongoing.

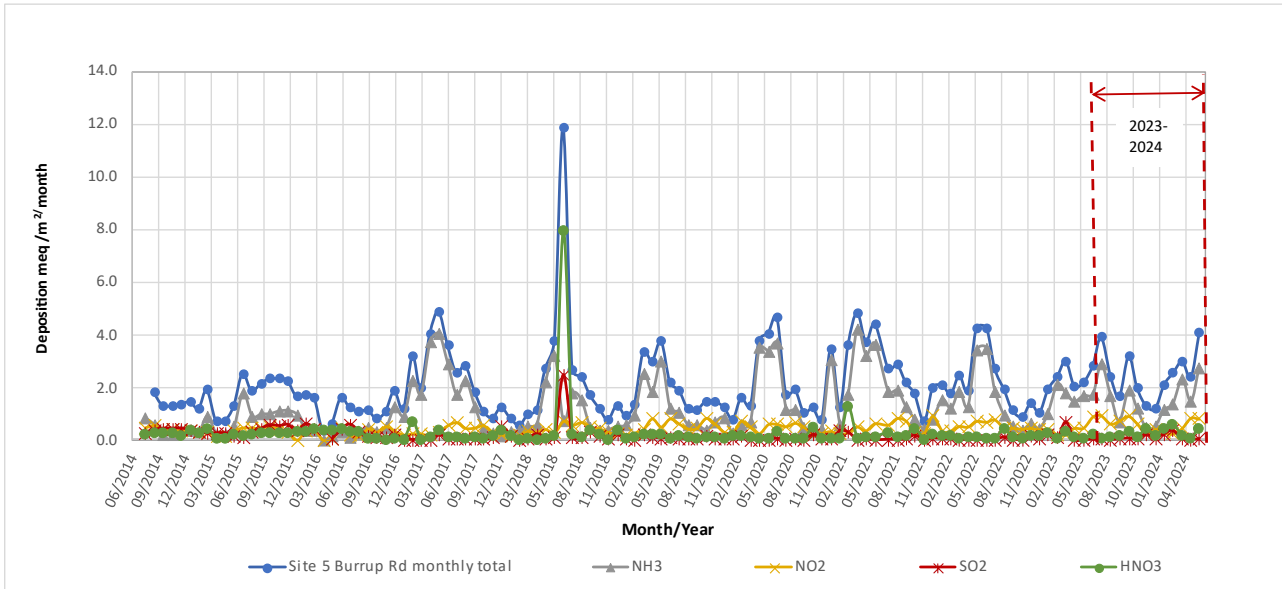


Figure 17: Monthly total and individual gas dry deposition rates – Burrup Road

The monthly rolling annual deposition at the Water Tanks and Hearson Cove sites remained below the investigation level throughout the monitoring period (Figure 18 and Figure 19).

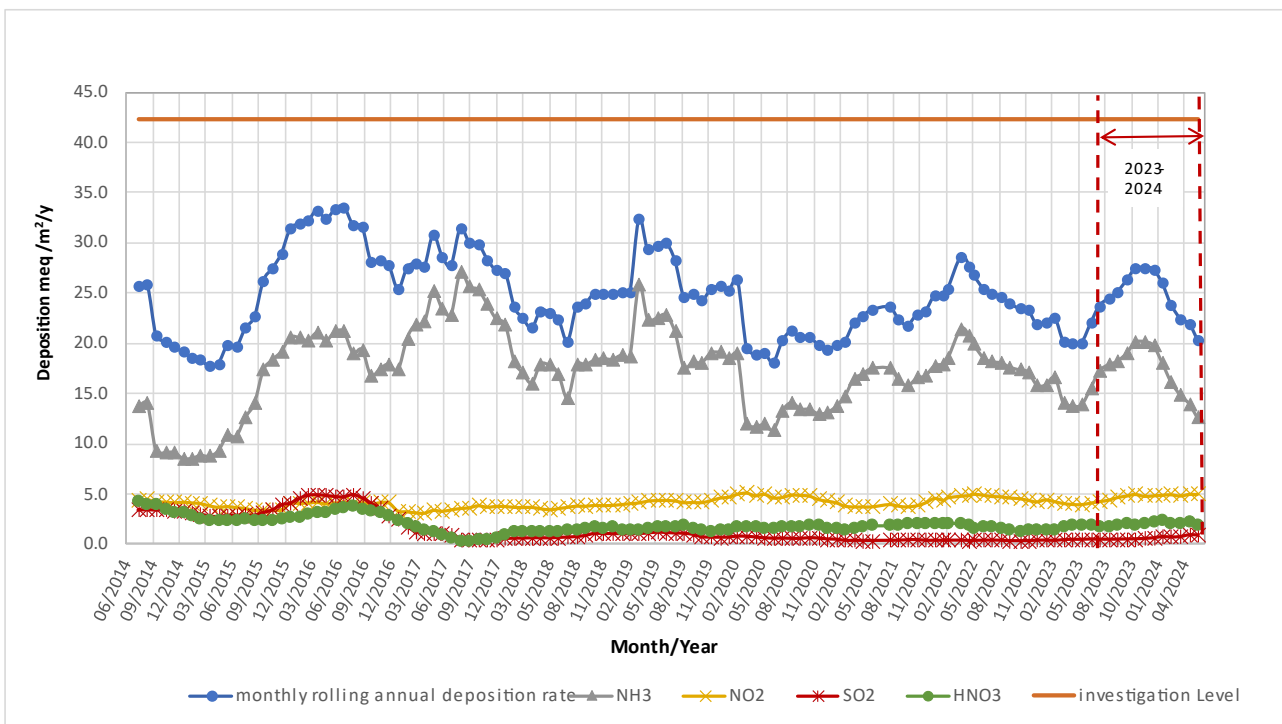


Figure 18: Monthly rolling annual total and individual gas dry deposition rates – Water Tanks

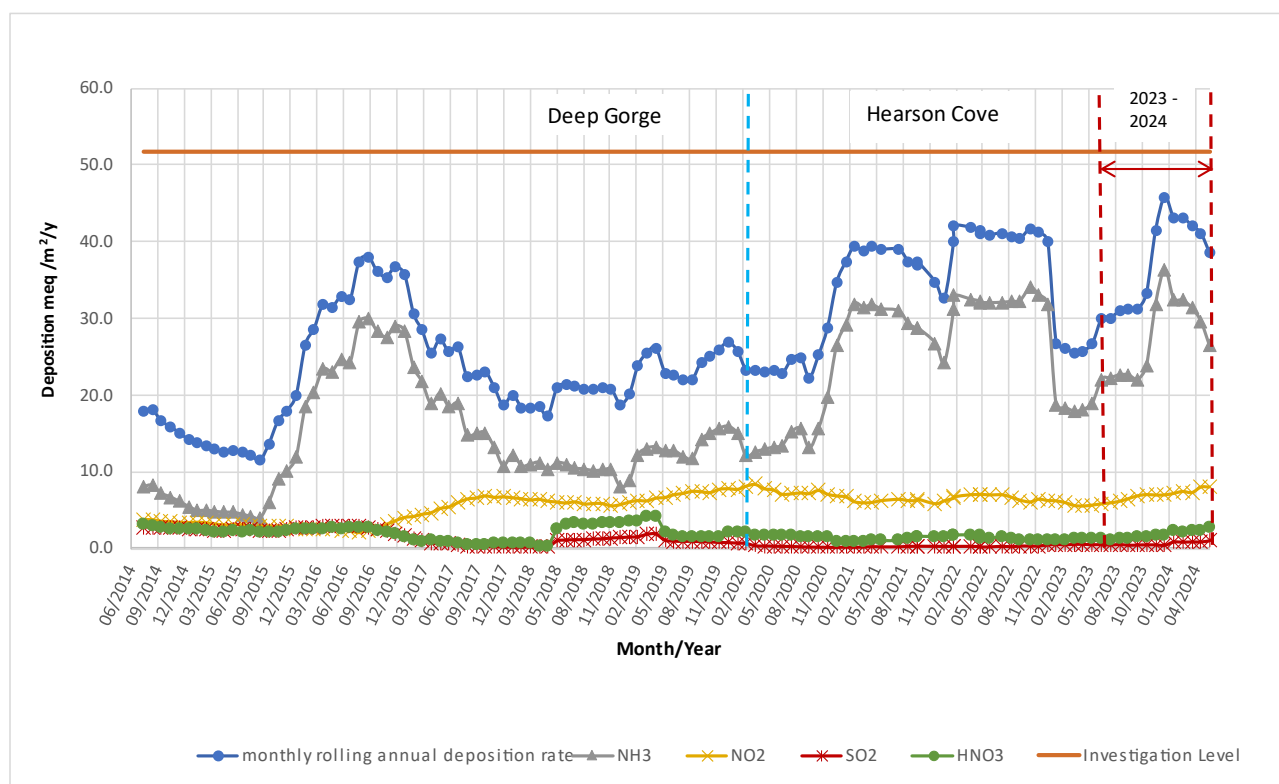


Figure 19: Monthly rolling annual total and individual gas dry deposition rates – Hearson Cove

Key findings from the investigation into the elevated deposition rates exceeding the investigation level at Burrup Road are summarised in Table 13.

Table 13: Findings from investigation into elevated deposition rates

Factor	Investigation	Finding	Comment
Contributions from individual gases	Individual contributions examined to identify gases responsible for increase in deposition rate compared to baseline	Deposition dominated by NH ₃ at all sites. Burrup Road: Highest monthly deposition rates, within range detected in previous monitoring periods, were detected at the start and end of the year (i.e., not driven by a single elevated point or cluster of data), with decreased NH ₃ deposition in the middle of the reporting year (summer months) (see Figure 17).	TAN plant NH ₃ CEMS data (Nitric Acid Plant) did not trend with ambient deposition rates. Note that NH ₃ emissions from the Common Stack are not measured continuously; instead, they are determined from quarterly stack testing. As such, it is not possible to determine any correlation of NH ₃ emissions from that source with the ambient concentrations and deposition rates. NH ₃ emission rates from the Common Stack are typically consistent with those from the Nitric Acid Plant, with some higher rates observed on occasion. The levels of NH ₃ emitted from the TAN Plant sources are considerably lower than those emitted from the Ammonia Plant. This suggests that the variation in NH ₃ deposition, resulting in an increase in annual deposition above the investigation level during the year, may be due to sources other than TAN Plant emissions.

Factor	Investigation	Finding	Comment
TAN Plant operations	TAN plant availability Determine any operating condition that could have led to elevated emissions from the nitric acid plant stack emissions or other sources associated with the TAN plant.	Plant was operating under steady state for the majority (85%) of the monitoring period. There were no adverse plant conditions that led to elevated NH ₃ emissions being recorded by Nitric Acid Plant CEMS. Elevated ambient ammonia levels corresponding with the Ammonia Plant venting in August were not observed.	Preliminary review of available emissions data did not identify a probable cause related to the TAN Plant operations for ammonia deposition above the investigation level.

6. Concluding Remarks

Monitoring data are reported for all parameters specified in EPBC Act approval 2008/4546 (as varied 24 March 2020).

Analysis of data for gases shows the following:

- The average NH₃ concentrations at the Burrup Road site were found to be statistically significantly different (higher) to the baseline;
- The average NH₃ concentrations at the Water Tanks and Hearson Cove sites were lower and higher than baseline, respectively, but the difference was not statistically significant;
- The average NO₂ concentrations were not found to be statistically significant at the Water Tanks and Hearson Cove sites but were significantly higher at the Burrup Road sites; and
- The average SO₂ concentrations at all three monitoring sites were lower than the baseline concentrations, with differences in the averages being statistically significant.

The TAN Plant was operating at steady state for 88% of the 2023-2024 monitoring period. Nine plant start-ups occurred throughout the year during which potentially higher NH₃ emissions may occur; however, these did not correlate with elevated ambient concentrations.

Overall, there is no evidence from the monitoring conducted to show that operation of the TAN Plant has resulted in significant increases in NO₂ and NH₃ levels over the monitoring period.

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

- Dry deposition rates were within the range determined for previous years;
- The annual dry deposition rate for the 2023-2024 monitoring period was below the investigation level derived from baseline measurements for the Water Tanks and Hearson Cove sites;
- The Burrup Road site dry deposition rate was above the investigation level derived from baseline measurements; and
- NH₃ is the dominant contributor to dry deposition at all monitoring sites.

Analysis of the TSP data shows the following:

- Concentrations of TSP measured in the 2023-2024 monitoring period continue to be comparable across the three monitoring sites suggesting reflection of air shed background concentrations as seen in previous reporting periods; and

- Average TSP concentrations at all three monitoring sites were elevated compared to the results from the previous monitoring carried out since 2017.

Elevated TSP concentrations are likely from nearby third-party earthworks in the area and monitoring yields no evidence to show that the operation of the TAN Plant resulted in a significant increase in ambient TSP concentrations in the 2023-2024 monitoring period.

Analysis of dust deposition data shows the following:

- Average insoluble deposition rates within previous levels were observed at the Water Tanks and Burrup Road sites;
- Average insoluble deposition rates at the Hearson Cove site were elevated compared to historical monitoring results;
- Average insoluble deposition at the Burrup Road site was statistically significantly different to those concentrations measured in the baseline study; and
- The soluble fraction of the deposited dust from the 2023-2024 monitoring period was within the range of previous years.

Overall, there is no evidence to suggest that the operation of the TAN Plant has resulted in materially significant increases in insoluble dust deposition rates.

7. References

Strategen (2018). *Yara Pilbara Nitrates, EPBC Approval 2008/4546. Ambient air quality report 2017-2018.* Document 650-200-rep-sec-0004, issued October 2018.

Strategen (2019). *Yara Pilbara Nitrates, EPBC Approval 2008/4546. Ambient air quality report 2018-2019.* Document 650-200-rep-sec-0006, issued October 2019.

Strategen (2020). *Yara Pilbara Nitrates, EPBC Approval 2008/4546. Ambient air quality report 2019-2020.* 650-200-rep-sec-0007, issued October 2020.

Strategen JBS&G (2021). *Yara Pilbara Nitrates, EPBC Approval 2008/4546. Ambient air quality report 2020-2021.* 650-200-rep-sec-0007, issued October 2021.

Strategen JBS&G (2022). *Yara Pilbara Nitrates, EPBC Approval 2008/4546. Ambient air quality report 2020-2021.* 650-200-rep-sec-0007, issued October 2022.

JBS&G (2023). *Yara Pilbara Nitrates, EPBC Approval 2008/4546. Ambient air quality report 2020-2021.* 650-200-rep-sec-0007, issued October 2023.

YPN (2017). *Yara Pilbara Nitrates, EPBC Approval 2008/4546. Baseline Air Quality Monitoring Report.* Document 250-200-rep-ypf-0002, issued 16 June 2017, updated 24 March 2020.

8. Limitations

Scope of services

This report (“the report”) has been prepared by JBS&G in accordance with the scope of services set out in the contract, or as otherwise agreed, between the Client and 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.

Reliance on data

In preparing the report, JBS&G has relied upon data and other information provided by the Client and other individuals and organisations, most of which are referred to in the report (“the data”). Except as otherwise expressly stated in the report, JBS&G has not verified the accuracy or completeness of the data. To the extent that the statements, opinions, facts, information, conclusions and/or recommendations in the report (“conclusions”) are based in whole or part on the data, those conclusions are contingent upon the accuracy and completeness of the data. JBS&G has also not attempted to determine whether any material matter has been omitted from the data. JBS&G will not be liable in relation to incorrect conclusions should any data, information or condition be incorrect or have been concealed, withheld, misrepresented or otherwise not fully disclosed to JBS&G. The making of any assumption does not imply that JBS&G has made any enquiry to verify the correctness of that assumption.

The report is based on conditions encountered and information received at the time of preparation of this report or the time that site investigations were carried out. JBS&G disclaims responsibility for any changes that may have occurred after this time. This report and any legal issues arising from it are governed by and construed in accordance with the law as at the date of this report.

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, including to any third parties, and no liability will be accepted for use or interpretation of this report by any third party.

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

Site	Date on	Date off	NH ₃ µg/m ³	NO ₂ µg/m ³	SO ₂ µg/m ³	HNO ₃ µg/m ³
Site 5 - Burrup Road	30/06/2023	14/07/2023	1.77	9.22	0.45	0.13
Site 5 - Burrup Road	14/07/2023	1/08/2023	1.95	6.30	0.04	0.15
Site 5 - Burrup Road	1/08/2023	15/08/2023	1.15	4.60	0.00	0.43
Site 5 - Burrup Road	15/08/2023	31/08/2023	1.19	5.99	0.10	0.14
Site 5 - Burrup Road	31/08/2023	14/09/2023	0.58	6.83	0.33	0.79
Site 5 - Burrup Road	14/09/2023	29/09/2023	0.44	6.22	0.10	0.14
Site 5 - Burrup Road	29/09/2023	16/10/2023	1.40	8.86	0.27	0.40
Site 5 - Burrup Road	16/10/2023	31/10/2023	1.04	5.55	0.33	1.27
Site 5 - Burrup Road	31/10/2023	14/11/2023	1.28	6.99	0.27	0.27
Site 5 - Burrup Road	14/11/2023	29/11/2023	0.47	4.48	0.16	0.34
Site 5 - Burrup Road	29/11/2023	15/12/2023	0.44	1.76	1.58	1.81
Site 5 - Burrup Road	15/12/2023	29/12/2023	0.19	2.56	0.13	0.27
Site 5 - Burrup Road	29/12/2023	15/01/2024	0.35	3.75	0.08	0.08
Site 5 - Burrup Road	15/01/2024	31/01/2024	0.31	2.80	0.57	0.85
Site 5 - Burrup Road	31/01/2024	14/02/2024	0.30	2.42	0.88	1.09
Site 5 - Burrup Road	14/02/2024	29/02/2024	1.31	3.03	1.18	1.32
Site 5 - Burrup Road	29/02/2024	15/03/2024	0.63	0.71	0.35	0.41
Site 5 - Burrup Road	15/03/2024	2/04/2024	1.04	2.97	2.35	2.23
Site 5 - Burrup Road	2/04/2024	16/04/2024	1.11	1.32	0.32	0.61
Site 5 - Burrup Road	16/04/2024	1/05/2024	2.16	6.64	0.12	0.37
Site 5 - Burrup Road	1/05/2024	16/05/2024	0.69	6.88	0.08	0.24
Site 5 - Burrup Road	16/05/2024	30/05/2024	1.42	8.24	0.06	0.19
Site 5 - Burrup Road	30/05/2024	13/06/2024	1.92	5.47	0.06	0.21
Site 5 - Burrup Road	13/06/2024	1/07/2024	1.68	7.28	0.31	1.86
Site 6 - Water Tanks	30/06/2023	14/07/2023	1.19	4.11	0.04	0.05
Site 6 - Water Tanks	14/07/2023	1/08/2023	1.71	3.58	0.07	0.15
Site 6 - Water Tanks	1/08/2023	15/08/2023	0.40	3.00	0.11	0.34
Site 6 - Water Tanks	15/08/2023	31/08/2023	2.15	4.48	0.07	0.20
Site 6 - Water Tanks	31/08/2023	14/09/2023	0.62	5.35	0.07	0.22
Site 6 - Water Tanks	14/09/2023	29/09/2023	0.74	6.20	0.13	0.30
Site 6 - Water Tanks	29/09/2023	16/10/2023	1.00	4.27	0.24	0.70
Site 6 - Water Tanks	16/10/2023	31/10/2023	-	-	-	-
Site 6 - Water Tanks	31/10/2023	14/11/2023	2.07	6.66	0.30	0.42
Site 6 - Water Tanks	14/11/2023	29/11/2023	0.58	3.72	0.15	0.42
Site 6 - Water Tanks	29/11/2023	15/12/2023	0.66	2.42	0.77	1.31
Site 6 - Water Tanks	15/12/2023	29/12/2023	0.19	2.57	0.06	0.09
Site 6 - Water Tanks	29/12/2023	15/01/2024	0.45	3.32	0.15	0.13
Site 6 - Water Tanks	15/01/2024	31/01/2024	0.26	2.27	0.61	0.45

Site	Date on	Date off	NH ₃ µg/m ³	NO ₂ µg/m ³	SO ₂ µg/m ³	HNO ₃ µg/m ³
Site 6 - Water Tanks	31/01/2024	14/02/2024	0.53	2.99	1.03	0.62
Site 6 - Water Tanks	14/02/2024	29/02/2024	0.30	1.82	0.21	0.47
Site 6 - Water Tanks	29/02/2024	15/03/2024	0.34	2.39	0.19	0.72
Site 6 - Water Tanks	15/03/2024	2/04/2024	0.18	2.03	0.19	0.35
Site 6 - Water Tanks	2/04/2024	16/04/2024	0.22	0.98	0.71	1.12
Site 6 - Water Tanks	16/04/2024	1/05/2024	0.59	2.08	0.08	0.20
Site 6 - Water Tanks	1/05/2024	16/05/2024	0.11	3.81	0.18	0.28
Site 6 - Water Tanks	16/05/2024	30/05/2024	0.27	3.13	1.70	0.26
Site 6 - Water Tanks	30/05/2024	13/06/2024	0.28	2.20	0.09	0.21
Site 6 - Water Tanks	13/06/2024	1/07/2024	0.61	3.63	0.11	0.40
Site 7 - Hearsons Cove	30/06/2023	14/07/2023	0.06	2.61	0.06	0.13
Site 7 - Hearsons Cove	14/07/2023	1/08/2023	0.61	2.65	0.04	0.09
Site 7 - Hearsons Cove	1/08/2023	15/08/2023	0.39	2.22	0.25	0.37
Site 7 - Hearsons Cove	15/08/2023	31/08/2023	0.90	3.00	0.61	1.17
Site 7 - Hearsons Cove	31/08/2023	14/09/2023	0.29	3.42	0.06	0.16
Site 7 - Hearsons Cove	14/09/2023	29/09/2023	0.44	3.84	0.10	0.36
Site 7 - Hearsons Cove	29/09/2023	16/10/2023	0.91	4.31	0.14	0.59
Site 7 - Hearsons Cove	16/10/2023	31/10/2023	1.25	3.26	0.20	0.80
Site 7 - Hearsons Cove	31/10/2023	14/11/2023	2.45	4.06	0.24	0.21
Site 7 - Hearsons Cove	14/11/2023	29/11/2023	1.61	2.97	0.06	0.13
Site 7 - Hearsons Cove	29/11/2023	15/12/2023	9.24	3.02	1.00	1.56
Site 7 - Hearsons Cove	15/12/2023	29/12/2023	3.80	1.72	0.27	0.27
Site 7 - Hearsons Cove	29/12/2023	15/01/2024	1.37	2.52	0.19	0.23
Site 7 - Hearsons Cove	15/01/2024	31/01/2024	6.28	2.32	0.04	0.09
Site 7 - Hearsons Cove	31/01/2024	14/02/2024	1.15	3.39	0.21	0.33
Site 7 - Hearsons Cove	14/02/2024	29/02/2024	0.30	1.55	3.61	2.87
Site 7 - Hearsons Cove	29/02/2024	15/03/2024	3.05	2.05	0.38	0.79
Site 7 - Hearsons Cove	15/03/2024	2/04/2024	0.45	2.14	0.14	0.24
Site 7 - Hearsons Cove	2/04/2024	16/04/2024	0.42	0.24	0.40	1.18
Site 7 - Hearsons Cove	16/04/2024	1/05/2024	0.25	2.08	0.04	0.14
Site 7 - Hearsons Cove	1/05/2024	16/05/2024	0.13	1.50	0.11	0.41
Site 7 - Hearsons Cove	16/05/2024	30/05/2024	0.14	8.24	0.06	0.19
Site 7 - Hearsons Cove	30/05/2024	13/06/2024	0.06	1.55	0.03	0.14
Site 7 - Hearsons Cove	13/06/2024	1/07/2024	0.31	2.77	1.15	2.34

Appendix B Results from Monitoring of TSP

Period start date	Site 5 -Burrup Road TSP $\mu\text{g}/\text{m}^3$	Site 6 - Water Tanks TSP $\mu\text{g}/\text{m}^3$	Site 7 – Hearson Cove TSP $\mu\text{g}/\text{m}^3$
05-Jul-23	21	15	9
11-Jul-23	12	12	16
17-Jul-23	21	9	10
23-Jul-23	18	22	26
29-Jul-23	16	20	14
04-Aug-23	6	15	11
10-Aug-23	14	18	9
16-Aug-23	15	17	14
22-Aug-23	20	16	15
28-Aug-23	30	22	16
03-Sep-23	21	21	19
09-Sep-23	28	22	14
15-Sep-23	45	34	32
21-Sep-23	21	38	35
27-Sep-23	21	22	18
03-Oct-23	20	29	25
09-Oct-23	62	55	46
15-Oct-23	37	43	37
20-Oct-23	69	43	26
27-Oct-23	98	99	80
02-Nov-23	45	42	33
08-Nov-23	116	98	89
14-Nov-23	35	40	39
20-Nov-23	46	43	34
26-Nov-23	54	63	58
02-Dec-23	36	43	33
08-Dec-23	103	108	93
14-Dec-23	46	43	38
20-Dec-23	34	34	29
26-Dec-23	37	38	39
01-Jan-24	168	176	138
07-Jan-24	45	60	40
13-Jan-24	110	118	117
19-Jan-24	133	151	143
25-Jan-24	89	90	93
31-Jan-24	59	59	58
06-Feb-24	84	78	75
12-Feb-24	48	61	50
18-Feb-24	43	46	39

Period start date	Site 5 -Burrup Road TSP $\mu\text{g}/\text{m}^3$	Site 6 - Water Tanks TSP $\mu\text{g}/\text{m}^3$	Site 7 – Hearson Cove TSP $\mu\text{g}/\text{m}^3$
24-Feb-24	39	43	37
01-Mar-24	59	63	73
07-Mar-24	25	31	
13-Mar-24	23	26	34
19-Mar-24	24	22	26
25-Mar-24	26	21	29
31-Mar-24	13	20	24
06-Apr-24	26	19	27
12-Apr-24	29		
18-Apr-24	23	31	36
24-Apr-24	21	26	20
30-Apr-24	21	21	23
06-May-24	20	24	13
12-May-24	21	22	25
18-May-24	26	26	25
24-May-24	29	50	33
30-May-24	18	23	24
05-Jun-24	28	22	30
11-Jun-24	14	14	21
17-Jun-24	40	22	21
23-Jul-24	32	25	19
29-Jun-24	23	26	20

Appendix C Results from Dust Deposition Monitoring

Date collected	Site 5 - Burrup Road		Site 6 - Water Tanks		Site 7 – Hearson Cove	
	Soluble solids	Insoluble solids	Soluble solids	Insoluble solids	Soluble solids	Insoluble solids
	g/m ² /month	g/m ² /month	g/m ² /month	g/m ² /month	g/m ² /month	g/m ² /month
30/06/2023	1/08/2023	0.8	1.1	<0.7	<0.8	<0.7
01/08/2023	31/08/2023	<0.7	0.8	<0.7	1.1	<0.7
31/08/2023	29/09/2023	1	1.9	1	0.9	1.1
29/09/2023	31/10/2023	1	1.9	0.7	1.8	2.4
31/10/2023	29/11/2023	0.9	2.2	2	2	<0.7
29/11/2023	29/12/2023	1	1.7	0.8	1.3	1
29/12/2023	31/01/2024	1.2	1.2	1	1.2	0.7
31/01/2024	29/02/2024	0.9	2.3	1.3	1.6	1.7
29/02/2024	2/04/2024	<4.3	1.3	<4.3	1.8	<4.0
02/04/2024	1/05/2024	<2.6	1.4	<3.3	1.6	<2.4
01/05/2024	30/05/2024	<0.7	<0.8	1.1	<0.8	<0.7
30/05/2024	1/07/2024	<2.2	<0.8	<2	<0.8	<2.7


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