Air Quality Monitoring - Tank Filling Event

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Executive summary

Jacobs Group (Australia) Pty Ltd (Jacobs) was engaged by Crowley Australia (Crowley) to undertake the air quality monitoring for the worst-case air emissions scenario for the Project Caymus Bulk Fuel Storage Facility as a condition of the Environmental Approval (EP2021/008-002).

Jet A-1 (Tank 9)

The calculated emission rates for the floating-roof tanks were significantly lower than those calculated for the worst-case air emissions scenario (filling of the fixed-roof tanks). The AQIA determined that even at the modelled worst-case emissions scenario, there was a low risk of air quality impact anywhere in the Darwin region due to operation of the site. As such it is concluded that emission rates associated with the Jet A-1 tanks present a low risk.

No substance exceeded the adopted 24-hour assessment criteria during the filling of the Jet A-1 tanks. Benzene, cumene, hexane and Total volatile organic compounds (TVOC) showed slightly elevated concentrations when compared to baseline conditions. The AQIA predicted benzene and cumene to report concentrations the closest to their guideline values, with hexane the next closest (the AQIA did not model TVOC concentrations as there is no assessment criteria for TVOC). All the maximum results from the Radiello sampling showed values above the baseline averages, however they were all either below the baseline maximum or within an order of magnitude except for Cumene and TVOC.

JP-5 (Tank 3)

The measured emission rates during filling of the JP-5 fixed-roof tank represent the worst-case operational scenario assessed in the AQIA. Monitoring results demonstrate that actual emission rates for all measured compounds were substantially lower than the conservative fixed-roof emission assumptions adopted in the AQIA. The majority of compounds measured emission rates at least an order of magnitude below the AQIA fixed-roof emissions estimates. Toluene, Ethylbenzene and Xylenes recorded the highest emission; however they were all less than 40% of the estimated fixed-roof emission rates. This confirms that the worst-case modelling assumptions were conservative and that emissions during the JP-5 tank filling event were well within the envelope assessed for regulatory compliance.

No monitored substance exceeded the adopted 24-hour assessment criteria during the JP-5 tank filling event. Concentrations of benzene, toluene, ethylbenzene, xylenes, cumene, cyclohexane, hexane and TVOC were all substantially below the relevant EPA Victoria and NEPM guideline values where applicable. Several compounds, including toluene, ethylbenzene, xylenes, cumene, hexane and TVOC, exhibited concentrations above baseline average levels during the monitoring period, which is consistent with the occurrence of an active tank filling event.

Overall, the JP-5 monitoring results confirm that emissions generated during the fixed-roof tank filling event (the predicted worst-case emissions scenario) do not result in unacceptable air quality impacts and that the AQIA findings remain valid and conservative for assessing impacts associated with worst-case site operations.

Summary

In summary, the monitoring undertaken during filling events in September 2025 and February 2026 to meet Condition 11 of EP2021/008-002 determined that total and speciated VOC emission concentrations and rates were below the most conservative values adopted in the 'Level 1' (screening level) air quality impact assessment (Jacobs, 2022). Based on this outcome, an updated validated air dispersion model report was not identified as being required.

Contents

Executive summary i

1. Introduction 1

1.1 Background 2

1.2 Purpose of this report 2

1.3 Air Quality Impact Assessment 3

1.3.1 Modelled Emission Rates 3

1.3.2 Modelled Ground Level Concentrations (GLCs) 4

2. Methodology 5

2.1 Monitoring Locations 5

2.2 Frequency and Timing 7

2.3 Pollutants 7

2.4 Assessment Criteria 7

2.4.1 Emission Rates 7

2.4.2 Concentrations 7

2.4.3 Assumptions for Assessment Criteria 9

3. Air Quality Monitoring Summary 10

3.1 Meteorological Data Source 10

3.2 Jet A-1 (Tank 9) 10

3.2.1 Wind Data 11

3.2.2 Emission Rates 13

3.2.3 Benzene 14

3.2.4 Toluene 15

3.2.5 Ethylbenzene 16

3.2.6 Xylenes 17

3.2.7 Cumene (Isopropylbenzene) 18

3.2.8 Cyclohexane 19

3.2.9 Hexane 20

3.2.10 Total Volatile Organic Compounds (TVOC) 21

3.3 JP-5 (Tank 3) 22

3.3.1 Wind Data 22

3.3.2 Emission Rates 25

3.3.3 Benzene 26

3.3.4 Toluene 26

3.3.5 Ethylbenzene 27

3.3.6 Xylenes 28

3.3.7 Cumene (Isopropylbenzene) 29

3.3.8 Cyclohexane 30

3.3.9 Hexane 31
3.3.10 Total Volatile Organic Compounds (TVOC) 32
4. Measurement Results summary 34
4.1 Jet A-1 (Tank 8) 34
4.2 JP-5 (Tank 3) 34
5. References 35

Appendices

Appendix A. Baseline Results Table 36
Appendix B. Laboratory Results 39
Appendix C. Air Quality Impact Assessment 40

Tables

Table 1-1 Speciation of TVOC emissions results 3
Table 2-1 Sampling Locations 5
Table 3-1 Emission Rate Calculation 13
Table 3-2 Benzene Results Summary 14
Table 3-3 Toluene Results Summary 15
Table 3-4 Ethylbenzene Results Summary 16
Table 3-5 Xylenes Results Summary 17
Table 3-6 Cumene Results Summary 18
Table 3-7 Cyclohexane Results Summary 19
Table 3-8 Hexane Results Summary 20
Table 3-9 TVOC Results Summary 21
Table 3-10. Emission Rate Calculation at JP-5 25
Table 3-11. Benzene Results Summary 26
Table 3-12. Toluene Results Summary 27
Table 3-13. Ethylbenzene Results Summary 27
Table 3-14. Xylenes Results Summary 28
Table 3-15. Cumene Results Summary 29
Table 3-16. Cyclohexane Results Summary 30
Table 3-17. Hexane Results Summary 31
Table 3-18. TVOC Results Summary 32
Table A- 1 Baseline Ambient Air Quality Data 37

Figures

Figure 2-1 Sampling Locations 6

Figure 3-1 Windrose – SUMMA Canister in September 2025 11
Figure 3-2 Windrose – Radiello Tube in September 2025 12
Figure 3-3 Benzene Baseline Data 15
Figure 3-4 Toluene Baseline Data 16
Figure 3-5 Ethylbenzene Baseline Data 17
Figure 3-6 Xylenes Baseline Data 18
Figure 3-7 Cumene Baseline Data 19
Figure 3-8 Cyclohexane Baseline Data 20
Figure 3-9 Hexane Baseline Data 21
Figure 3-10 TVOC Baseline Data 22
Figure 3-11. Windrose - SUMMA Canister 23
Figure 3-12. Windrose – Radiello Tube 24
Figure 3-13. Benzene Baseline Data 26
Figure 3-14. Toluene Baseline Data 27
Figure 3-15. Ethylbenzene Baseline Data 28
Figure 3-16. Xylenes Baseline Data 29
Figure 3-17. Cumene Baseline Data 30
Figure 3-18. Cyclohexane Baseline Data 31
Figure 3-19. Hexane Baseline Data 32
Figure 3-20. VOC Baseline Data 33

1. Introduction

Crowley Australia (Crowley) as proponent for the Project Caymus Bulk Fuel Storage Facility was issued with an Environmental Approval under the *Environment Protection Act 2019* (EP Act) (EP2021/008-001) on 29 November 2021. The Approval was subsequently amended by variations to conditions 6(d), 11(i), 11(j) made pursuant to Section 65 of the EP Act. The Environmental Approval (EP2021/008-002) includes the following conditions related to air quality monitoring:

Condition 11. Air Quality (air monitoring)

The approval holder must ensure there are no attributable impacts from the action on the following environmental outcome:

> *Protect air quality and minimise emissions and their impacts on the Darwin airshed so that environmental values are maintained.*

To demonstrate that the outcome in condition 11 is met, the approval holder must:

- h) *Within the period of the first turnover and during a period in which the action is operating under predicted maximum emission levels (i.e. during tank filling), undertake a sampling program to confirm the air emission performance of the premises. The sampling program must measure as a minimum*
  - a. *organic vapours concentration at point source discharge points/s such as tank vents or vapour recovery systems using the appropriate test method/s*
- i) *Within six weeks of sampling referred to in condition 11h (unless otherwise agreed by the CEO), provide a written verification report to the CEO. The report will include:*
  - a. *all analytical results of sampling required for all discharge points (any external report must be reproduced in full);*
  - b. *all relevant Australian Standard (AS) information in relation to establishing, siting, operating and maintaining meteorological monitoring equipment i.e. the latest versions of:*
    - a. *AM-1 Guide for the siting of sampling units (AS/NZS 3580.1.1)*
    - b. *AM-2 Guide for measurement of horizontal wind for air quality applications (AS 3580.14)*
    - c. *AM-4 Meteorological monitoring guidance for regulatory modelling applications (AS 3580.14 or USEPA 454/R-99-005).*

    Also, the meteorological stations will use an anemometer with a stall speed of 0.5 m/s or less;
  - c. *A description of operational parameters during sampling relevant for air emissions estimates: and*
  - d. *A comparison of analytical results from sampling against final design emission specifications and modelled emission parameters in the AQIA required under conditions 11c and 11d.*
- j) *Ensure that where any comparison under condition 11i identifies measured emission concentrations or rates that are more than 15% greater than the emissions characteristics used in the AQIA or are greater than the Protection of the Environment Operations (Clean Air) Regulation 2021 standards of concentration:*
  - a. *Provide an updated validated air dispersion model report to confirm compliance with the impact assessment criteria contained in the Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales (EPA 2016) or the latest version: and*

b. *If requested by the CEO, identify and record as part of the EMS, measures to be implemented to reduce emissions of air pollutants so that they comply with the relevant NSW Clean Air Regulation standard and assessment criteria in the Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales (EPA 2016) or the latest version.*

1.1 Background

Project Caymus Bulk Fuel Storage Facility (referred to hereinafter as "the site") is located on Lot 5720 west of the Railway Terminal on East Arm District, Northern Territory. The Environmental Approval covers the development and operation of a bulk aviation turbine (jet) fuel storage facility. Fuels permitted to be stored onsite include:

- JP-8 (Jet Propellant 8) - to meet the requirements of US Military Specification MIL-T- 83188D - North Atlantic Treaty Organisation (NATO) Code F34 (referred to as Jet A-1)
- JP-5 (Jet Propellant 5) - to meet the requirements of US Military Specification MIL-PRF- 5624S Grade JP-5 - NATO Code F44.

The Environmental Approval allowed for:

- Construction of an access road.
- Extension of an existing pipeline rack and pipeline.
- Placement of 11 tanks in a tank farm, with a total storage capacity of 330 ML as follows:
  - 4 x 30 ML tanks storing up to 111 megalitre (ML) of Jet A-1 (lower flash point (38°C) kerosene-based jet fuel).
  - 7 x 30 ML tanks storing up to 190 ML of JP-5 (high flash point (>60°C) kerosene-based jet fuel).
- Construction of a bunded area for the tank farm with concrete retaining walls and flooring designed to contain spills.
- Unsealed paved areas outside of the tank farm to allow emergency and crane access.
- Construction and operation of a common user facility incorporating:
  - a tanker loading gantry.
  - park-up area for triple road tankers.
  - warehouse and administration building.
  - firewater system including tanks and pumps.
  - oily-water separation unit for treatment of collected stormwater.

Fuel is received and issued from ships berthed at East Arm Wharf via an extension to an existing pipeline rack and pipeline, and from triple road trains via a Site gantry. **Figure 2-1** displays the arrangement of the site and sampling locations.

1.2 Purpose of this report

The purpose of the monitoring outlined in this report is to test the findings presented in the Level 1 Air Quality Impact Assessment (Jacobs, 2022) and to demonstrate the site is operating in line with the relevant conditions in EP2021/008-002 as outlined in **Section 1.**

1.3 Air Quality Impact Assessment

Crowley engaged Jacobs to undertake a 'Level 1' (screening level) air quality impact assessment for the site as a condition of the Northern Territory Government Environmental Approval Number EP2021/008–002 (NTG, 2021). The relevant Environmental Conditions were (quote):

11.c Within 20 business days after the commencement of construction of the action, complete:

(i) a Level 1 air quality impact assessment (AQIA) of the operational design of the action; and

(ii) if required following completion of the Level 1 assessment, a Level 2 (refined dispersion modelling) AQIA for operation of the action.

The NSW Environment Protection Authorities *'Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales',* (NSW EPA, 2022a) sets out two levels of AQIA: Level 1 is a screening-level dispersion modelling technique using worst-case input data including the use of synthetic meteorological data covering a wide range of hypothetical meteorological conditions.

1.3.1 Modelled Emission Rates

The worst-case site operations scenario was determined by 'TANKS' modelling of air emissions of hydrocarbon vapours, (Volatile Organic Compounds or 'VOCs'), due to fuel-loading of four floating-roof Jet A-1 tanks and seven fixed-roof JP-5 tanks. The worst-case air emissions scenario was determined to be loading the fixed-roof JP-5 tanks at the maximum fuel-loading rate.

The Total VOC (TVOC) emission rate from the fixed-roof tank was estimated to be 3000 times higher than from the floating-roof tanks, with speciated hydrocarbons similarly estimated to be orders of magnitude higher from the fixed-roof tank. The air quality impact assessment therefore assessed the fixed-roof tank filling event as the worst-case scenario as discussed in **Section 1.3.2**.

The speciation of the TVOC emissions estimates used the NPI (2012)[1] emissions factors for jet kerosene. The speciation results and calculated species emission rates are provided in **Table 1-1** by emission rate (g/s).

Table 1-1 Speciation of TVOC Emissions Results (Jacobs, 2022)

VOC	Emission rate, floating roof tank (g/s)	Emission rate, fixed-roof tank (g/s)
Benzene	3.0×10^{-6}	0.019
Cumene	12×10^{-6}	0.008
Cyclohexane	9.7×10^{-6}	0.065
Ethylbenzene	2.3×10^{-6}	0.003
n-Hexane	4.8×10^{-5}	0.390
Toluene	9.6×10^{-7}	0.003
Xylenes	8.3×10^{-6}	0.009
TVOC	8.8×10^{-4}	2.64

[1] National Pollutants Inventory – Emission Estimation Technique Manual for Fuel and Organic Liquid Storage – May 2012

1.3.2 Modelled Ground Level Concentrations (GLCs)

Ausplume was selected for the Project Caymus Level 1 'screening level' assessment; the model is specified for use in NSW (NSW EPA,2022a). Ausplume modelling was completed for 10,201 grid receptors with horizontal resolution 100 metres giving a study grid area of 14 km east-west by 10 km north-south, centred on the site location in East Arm District to calculate maximum 1-hour average GLC (μg/m^3), for comparisons with the impact assessment criteria (IAC)(further defined in **Section 2.4.2**).

VOC emissions for the Jet A-1 fuel-loading scenario for the floating-roof tanks were found to be insignificant, with no predicted 'working losses' (during fuel-loading), and the 'standing losses' (annual venting) were insignificant due to the fuel being well-covered by the floating roofs at all times.

VOC emissions for the JP-5 fuel-loading scenario for the fixed-roof tanks were found to be significant during the loading period (working losses only). The standing losses were insignificant over the loading period, which was estimated to be just a few days. Hence the worst-case operating scenario for assessment was filling the seven Fixed-Roof tanks over the fuel-loading period. Ausplume results are provided for the worst-case VOC emissions scenario, i.e., filling of the seven fixed-roof tanks with JP-5 fuel over a period of days. As a conservative step in the assessment, the volume source was assumed to be in the position of the fixed-roof tank closest to the nearest sensitive receptor (Darwin Railway Terminal). Any VOC emissions that may occur from the floating-roof tanks during the same period would be negligible.

The maximum results for all receptors are compared with relevant Level 1 impact assessment criteria in **Table 1-2.** All the results are less than 7% of the IAC, and there were no predicted exceedances of criteria.

Table 1-2 Modelled VOC GLC (hourly maximum)(Jacobs, 2022)

VOC	Max. 1h GLC (μg/m^3)	IAC (μg/m^3)	Result as fraction of IAC (%)
Benzene	1.9	29	6.5%
Cumene	0.6	21	2.7%
Cyclohexane	6.3	19000	0.0%
Ethylbenzene	0.3	8000	0.0%
n-Hexane	38.0	3200	1.2%
Toluene	0.2	360	0.1%
Xylenes	0.6	190	0.3%

2. Methodology

The Air Quality Monitoring Plan – Tank Filling Event (Jacobs, 2025a) outlines the methodology selection process in relation to the conditions in the Environmental Approval. The below briefly outlines the methodology followed.

The samples were collected using the SUMMA canister method, where a laboratory supplied evacuated canister fitted with a flow controller was used to collect a whole air sample for laboratory analysis by GC-MS (gas chromatography - mass spectrometry). A total of three SUMMA canisters were deployed for each of the two monitoring events. The samplers were active for 10 hours and 14 minutes during the September 2025 sampling event (Jet A-1), and 11 hours and 25 minutes during the March 2026 sampling event (JP-5).

In addition to the tank vent sampling, three Radiello diffusive samplers were set up at locations around the site boundary (seen in **Figure 2-1**) for each filling event. These samplers were deployed for the entirety of the tank filling process.

2.1 Monitoring Locations

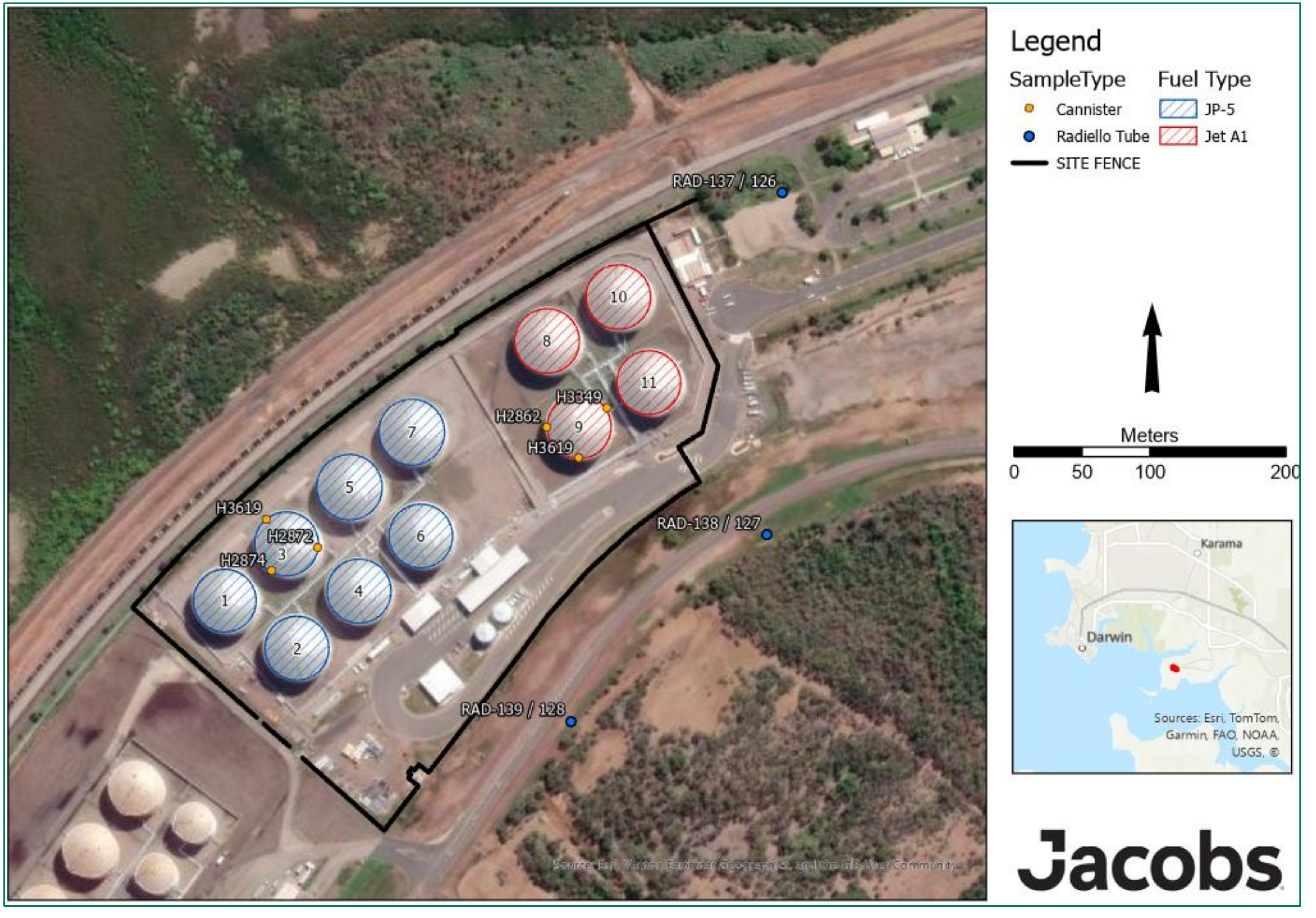
The SUMMA cannisters were deployed evenly around the rim of Tank 8 to provide spatial coverage depending on wind direction. The Radiello diffusive samplers were deployed at locations around the boundary of the site (seen in **Figure 2-1** and **Table 2-1**).

Table 2-1 Sampling Locations

Location ID	Co-ordinates (UTM 52L)	Description
SUMMA Cannister		
H3349	706726, 8620212	Spread evenly around the rim of Tank 9.
H3619	706705, 8620176	
H2862	706682, 8620198	
H3619*	706481 8620135	Spread evenly around the rim of Tank 3
H2874	706484 8620097	
H2872	706518 8620114	
Radiello Tube		
RAD-137/126	706854, 8620364	Between site and closest sensitive receptor (Darwin Passenger Rail terminal).
RAD-138/127	706840, 8620120	Southeast of Tank 9.
RAD-139/128	706699, 8619988	South of Tank 9.

Note: H3619* refers to the SUMMA canister sampling location associated with the JP-5 filling event at Tank 5. This sampling point is distinct from the location also labelled H3619 at Tank 9. These locations share the same reference ID for consistency with historical naming but represent separate physical sampling points. Refer to the following **Figure 2-1** for location differentiation

Figure 2-1 Sampling Locations



2.2 Frequency and Timing

Jet A-1

The tank filling process was conducted in two phases. Stage 1 included filling Tank 8 at a low flow to a level in which the internal roof was completely floated, before switching to Tank 9 and completing the same process. Stage 2 involved switching back to Tank 8 and finishing the filling of the tank at a standard flow rate, before repeating for Tank 9.

It was determined that the *predicted maximum emission levels* would be recorded during Stage 2 of the filling process. As such the SUMMA cannisters were activated when Stage 2 commenced at Tank 9 (1:54am - 26/09/2025) and were de-activated when the tank was full (12:08pm - 26/09/2025). The Radiello tubes were set up prior to the initiation of Stage 1 (22/09/25) and were collected after the filling process was completed (29/09/25).

JP-5

The tank filling process was conducted in two phases. Stage 1 included filling Tank 3 at a low flow rate, before switching to the Tank 4. Stage 2 involved switching back to Tank 3 and finishing the filling to the tank at a standard flow rate.

The SUMMA canisters were activated at 4:45 pm - 25/02/2026 when the filling process commenced under standard operating conditions (Stage 2) and were deactivated at 4:00 am - 26/02/2026 upon completion of the filling event. The Radiello tubes were deployed prior to commencement of the JP-5 filling on 12:00 am - 19/02/2026 and were retrieved after the filling activities were completed on 3:00 pm - 27/02/2026.

2.3 Pollutants

The identification of air pollutants was determined by the Jacobs (2022) air quality impact assessment. These pollutants were included in the monitoring plan with monitoring methodology selected to ensure all identified pollutants could be measured with appropriate analytical sensitivities, and with reference to the ' Approved Methods for the Sampling and Analysis of Air Pollutants in New South Wales' (NSW EPA, 2022b).

The following pollutants were identified for inclusion in the air quality monitoring program:

- Total volatile organic compounds (TVOC)
- Benzene, toluene, ethylbenzene, and xylenes (BTEX)
- Cumene
- Cyclohexane
- n-hexane.

2.4 Assessment Criteria

2.4.1 Emission Rates

Emission rates were calculated using the data from the SUMMA canister sampling and compared against the predicted rates outlined in the AQIA (2022, Jacobs), reproduced in **Table 1-1.**

2.4.2 Concentrations

The NSW EPA 'Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales' (NSW EPA, 2022a)[2], provides Impact Assessment Criteria (IAC) adopted for this assessment (Jacobs, 2022). NSW EPA (2022a) clearly states, "*Assessment criteria must not be used as limit conditions in environment protection licences. Compliance with assessment criteria (i.e. in the ambient air at the boundary of the*

[2] In March 2026 the NSW EPA have released an updated *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW – Draft for consultation*. The proposed updated IAC values have been adopted for this assessment.

premises or nearest sensitive receptor) cannot be readily determined for regulatory purposes. For point sources, a site-specific stack emission limit can be calculated (see Sections 10 and 11.1) so that the assessment criteria will not be exceeded at and beyond the boundary of a premises because of emissions from those sources".

The phrase, "*Compliance with assessment criteria (i.e. in the ambient air at the boundary of the premises or nearest sensitive receptor) cannot be readily determined for regulatory purposes*", acknowledges the difficulty in monitoring individual pollutants at the analytical sensitivity necessary and at the temporal resolution adopted in modelling assessments. Therefore, alternative assessment criteria have been identified and adopted to better align with the temporal resolution of monitoring results.

The Radiello monitoring results are reported as a 7-day average concentration, which means there are limited assessment criteria to directly compare against. As such they will be compared against the baseline data collected onsite (Jacobs, 2025b). Also, comparisons will be made against 24-hour assessment criteria, with reasonable assumptions as outlined in **Section 2.4.3**. it is noted that annual air quality monitoring was put on hold on19 February 2025 after the completion of two years of baseline monitoring. The monitoring was resumed when the first shipment of fuel was delivered to site.

Sources of assessment criteria for interpretation of monitoring results have been summarised in **Table 2-2**. There are three sources referred in the table, the *National Environment Protection (Air Toxics) Measure* (Air Toxics NEPM) (NEPC, 2011) is a national regulatory document and has been adopted as the primary reference for assessing monitoring results. For compounds which are not included in the NEPM or for alternative averaging times, the EPA Victoria 'Guideline for Assessing and Minimising Air Pollution in Victoria' (EPA Vic, 2025), has been used. The IAC adopted in the impact assessment (Jacobs, 2022) have been included for completeness – noting these are hourly criteria and not to be used for regulatory purposes.

The Air Toxics NEPM (NEPC, 2011) sets national environment protection goal and monitoring investigation levels for benzene, toluene and xylenes that are applicable to States and Territories. Whilst the air toxics NEPM is not directly applicable to State or Territory air quality assessments, the monitoring investigation levels are routinely referenced when interpreting air quality monitoring data in jurisdictions where there are no established air quality standards applicable to monitoring data. Examples where NEPM air toxics monitoring investigation levels have been applied in such circumstances include: INPEX Annual Environmental Monitoring Report 2019-2020 (INPEX, 2020), EPA Victoria Tullamarine Landfill VOC monitoring study (EPC VIC, 2012), and West Gate Tunnel Project (Golder, 2022).

Relevant air quality objectives for monitored pollutants sourced from the Air Toxics NEPM, are presented in **Table 2-2**. Since the Air Toxics NEPM criteria limits are presented in units of ppm and the diffusion tubes results are reported as a mass concentration, converted criteria limits have also been presented so that both are presente din the same units of measurement.

The EPA Victoria Guideline for Assessing and Minimising Air Pollution in Victoria (EPA Vic, 2025) published air pollution assessment criteria (APAC) and are intended to "*enable an understanding of the current condition of the environment and a basis for assessing actual and potential risks to environmental values*". APACs with averaging times of 24 hours of more are included in **Table 2-2.** The NSW criteria adopted by the impact assessment are included. However, they are not intended for regulatory purposes and are included here for completeness only.

Table 2-2 Air Monitoring Assessment Criteria

VOC	Averaging period	NEPM Investigation Level		EPA Victoria APAC		NSW EPA IAC
		PPM	µg/m³ (25ºC, 1 atm)	PPM	µg/m³ (25ºC, 1 atm)	µg/m³ (25ºC, 1 atm)
Benzene	1 hour	-	-	0.18	580	29
	24 hours	-	-	0.009	29	-
Toluene	1 hour	-	-	2	7,600	360*
	24 hours	1	3767	-	-	-
	7 days	-	-	0.07	260	-
Ethylbenzene	1 hour	-	-	20	86,000	21,700
	24 hours	-	-	5	21,712	-
Xylenes (as total of ortho, meta and para isomers)	1 hour	-	-	5	22,000	190*
	24 hours	0.25	1085	2	8,685	-
Cumene	1 hour	-	-	-	-	21*
Cyclohexane	1 hour	-	-	-	-	3,400
n-hexane	1 hour	-	-	5.4	19,000	21,000

* Odour based IAC

IAC values published in the NSW guidance (NSW EPA, 2022a) are sourced from EPA Victoria 'State Environment Protection Policy (Air Quality Management)' (SEPP(AQM)) (Victoria Government, 2001), which is no longer enforced in Victoria, having been replaced by an Environmental Reference Standard and supporting documentation including EPA VIC (2025), from which the APAC listed in **Table 2-2** are sourced. The odour-based IAC, (based on the SEPP AQM), adopted in the impact assessment are no longer included in any regulatory documentation in Victoria, with all current APAC based on health-based criteria only. Odour assessments in Victoria are now assessed by other methods and no longer include concentration-based criteria for assessment of individual odorous compounds.

2.4.3 Assumptions for Assessment Criteria

Laboratory results are reported as an average over the sampler exposure duration, nominally 7-days for the Radiello samples. When comparing to the project assessment criteria, there is a discrepancy between the sampling time and averaging period for the assessment criteria. For the assessment criteria less than 7-days, a conservative assumption has been made.

The maximum results for the Radiello tubes sampling were interpreted as 24-hour or 7-day samples; i.e., the calculations assumed the total VOCs masses collected over 7-days were collected over a shorter period of 24 hours. This is an overly conservative method of interpretation, however for monitoring results which are low, it provides a simple and conservative interpretation method.

The SUMMA cannister results are used to validate the emissions assumptions adopted in the AQIA (2022, Jacobs) and ensure compliance with condition 11 j) of the license i.e. confirm that *emission concentrations or rates are not more than 15% greater than the emissions characteristics used in the AQIA and that they are not greater than the Protection of the Environment Operations (Clean Air) Regulation 2021 standards of concentration.*

3. Air Quality Monitoring Summary

Analysis of monitoring results for BTEX, cumene, cyclohexane, hexane and TVOC are presented in the following subsections. The monitoring data is reported against the air quality standards, AQIA results and baseline data.

The average of the results from the three SUMMA canisters has been used to compare against the emission rates assumed in the AQIA, by averaging the three results, this accounts for the potential differences in concentrations around the tank due to changes in wind direction.

The maximum radiello results have also been compared against the baseline monitoring conducted onsite between February 2023 and March 2025 (Jacobs, 2025b)[3]. The baseline data is presented as the average over the baseline period and is compared against the maximum reported values from the Radiello sampling for this monitoring event.

For VOCs results below the limits of detection reported by the laboratory, the limit of detection was used as a conservative (high) estimate of the pollutant concentrations.

3.1 Meteorological Data Source

Meteorological data used to support the assessment were obtained from the Palmerston Air Quality Monitoring Station, operated by the Northern Territory Environment Protection Authority (NT EPA). The station was established in September 2010 as part of the NT Government's ambient air quality monitoring network and is located at approximately latitude -12.50779, longitude 130.94853, with a station elevation of about 30 m AHD.

The Palmerston monitoring station is located approximately south-south-east of the East Arm project area, at around 6–8 km and is the closest NT EPA station that provides continuous measurements of wind speed and wind direction relevant to the site. The surrounding environment is influenced by similar coastal and regional meteorological conditions to those affecting East Arm, and the station is considered representative of the broader airshed rather than being subject to highly localised residential or site-specific obstructions.

In accordance with the AAQ NEPM, the Palmerston station houses Australian-Standard-compliant instruments for the measurement of key ambient air pollutants. Meteorological parameters, including wind speed and wind direction, are collected on-site to assist in the interpretation of air quality data.

Wind speed and wind direction data are recorded at 5-minute intervals, and these data were used to characterise prevailing wind conditions during the monitoring period for this assessment. Meteorological data were obtained directly from the NT EPA air monitoring network. It is noted that, at the time of access, the data may not have undergone full validation; however, validated historical datasets are available through NT EPA reporting systems.

3.2 Jet A-1 (Tank 9)

The following displays the results for the Jet A-1 Tank filling event conducted. Laboratory documents be found in **Appendix B.**

[3] Annual air quality monitoring was put on hold on19 February 2025 after the completion of two years of baseline monitoring. The monitoring was resumed when the first shipment of fuel was delivered to site.

3.2.1 Wind Data

Meteorological data has been acquired from the NT EPA website and has been converted into the Windrose plots seen below **Figure 3-1** displays wind data from when the SUMMA canisters were activated (01:50 am - 26/09/25 to 12:10 pm - 26/09/25). **Figure 3-2** displays wind data from when the Radiello tubes were deployed (10:15 am - 22/9/2025 to 2:10 pm - 29/09/2025).

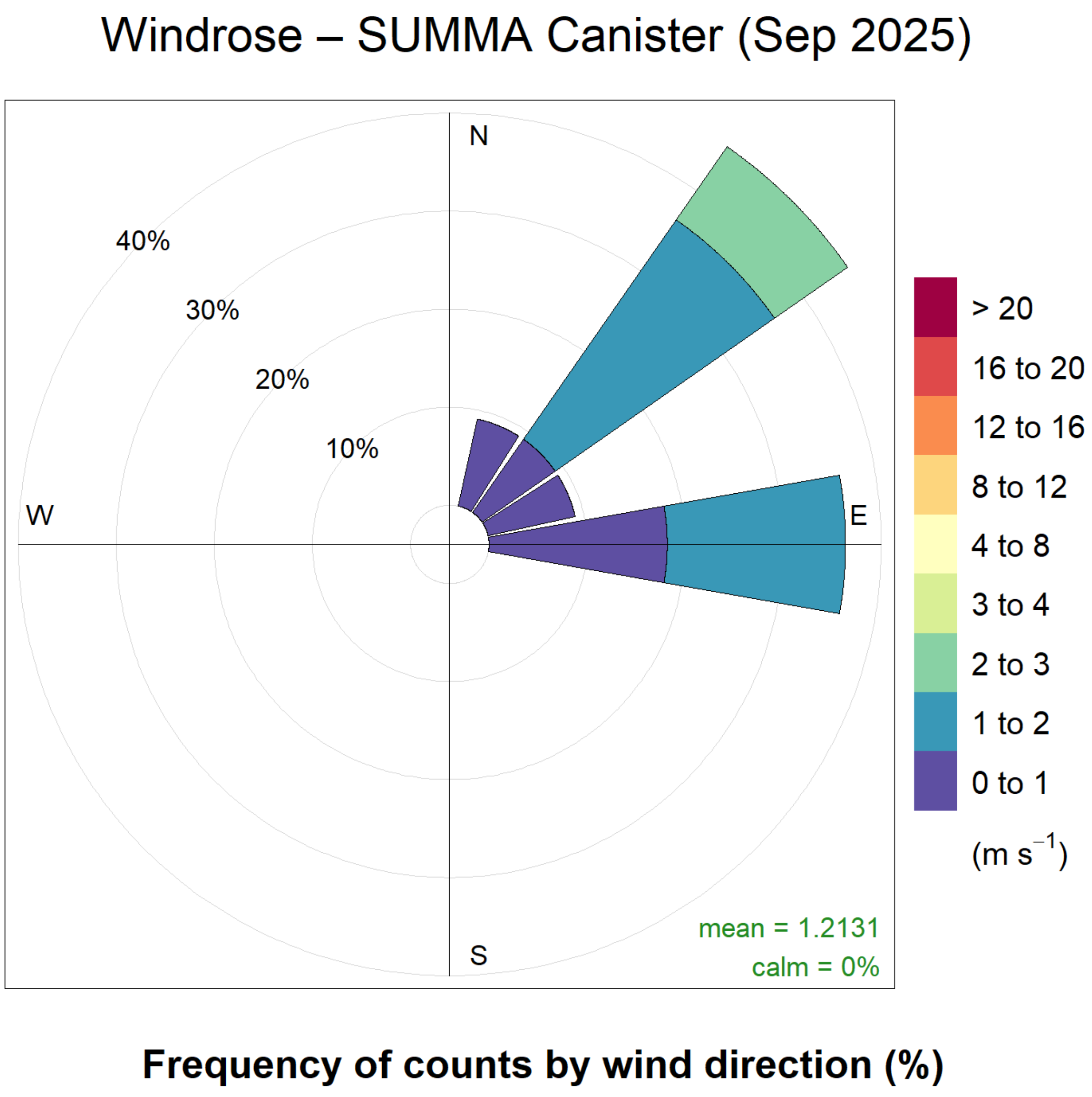


Figure 3-1 Windrose – SUMMA Canister in September 2025

During the SUMMA canister sampling the wind predominantly blew from the east to east-north-east, accounting for approximately 45% of the monitoring period, with the majority of wind speeds being relatively low and generally below 3 m/s. A smaller proportion of winds, approximately 25%, were recorded from the north-east to north-north-east sector, also largely at low wind speeds. The concentrations recorded by the SUMMA canisters were relatively similar, with slightly elevated concentrations in H2862 located on the west side of the tank and H3619 located on the south side of the tank; this distribution is consistent with the prevailing easterly to north-easterly wind conditions observed during the sampling period.

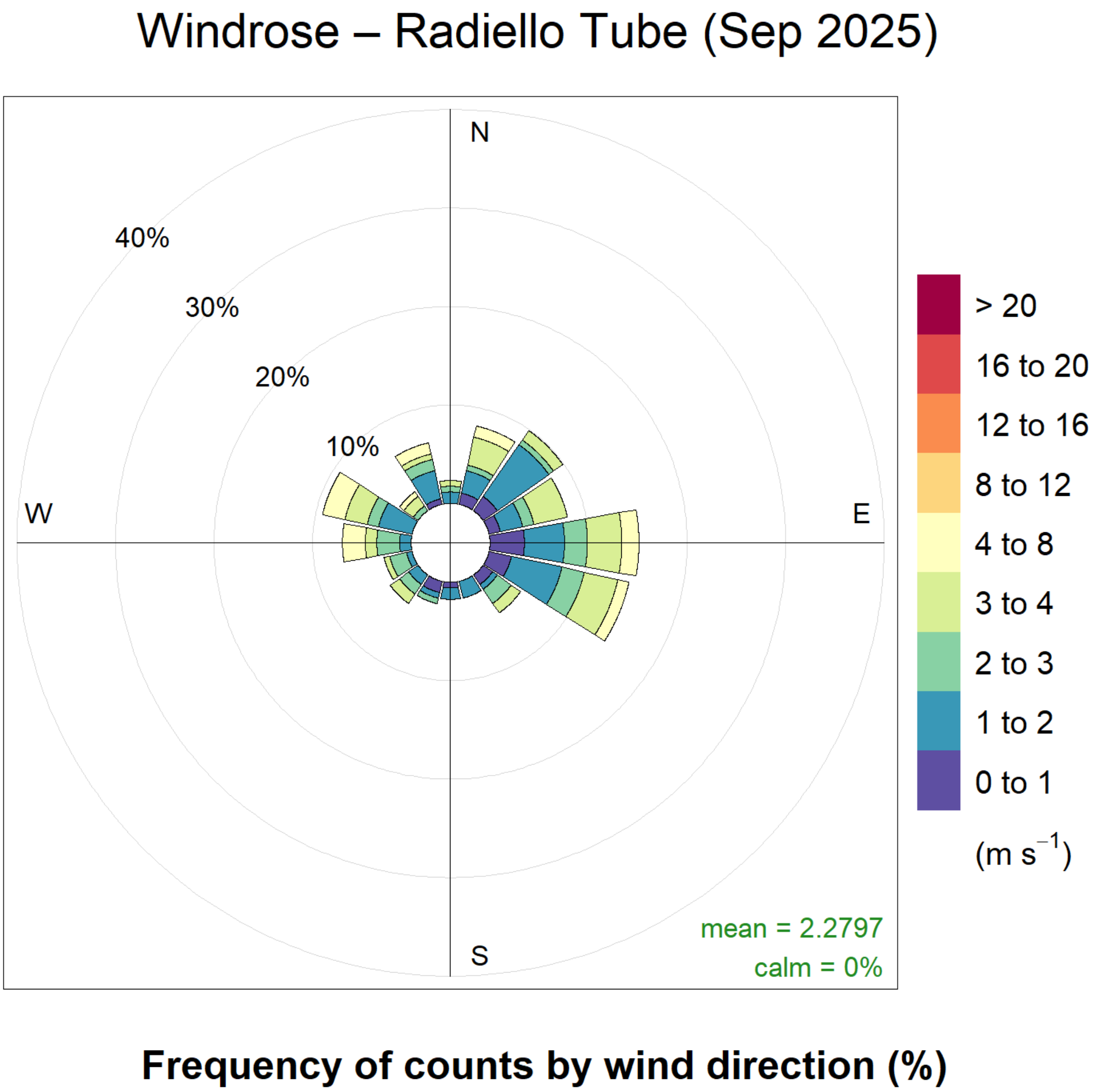


Figure 3-2 Windrose – Radiello Tube in September 2025

During the Radiello tube sampling the wind most frequently blew from the north to north-north-east, accounting for approximately 15% of the monitoring period, with the majority of wind speeds being low and generally below 4 m/s. Winds were otherwise distributed across a range of directions, including easterly sectors.

3.2.2 Emission Rates

Using the average concentration from the SUMMA cannister sampling results and the volume of fuel loaded, emission rates for the different compounds monitored were calculated. To calculate the emission rates the following information was also used:

- Sampling Period: 10.24 Hours
- Volume of fuel loaded (during the sampling period): 10,041KL (representing the volume of emissions from the tank).

The calculated actual emission rates have been compared against the AQIA modelled emissions rates in the below **Table 3-1.**

Table 3-1 Emission Rate Calculation

VOC	Average Conc. (µg/m^3)	Max Conc. (µg/m^3)	Emission Rate (g/s)	AQIA Emissions Estimates		Actual Emission Rate vs AQIA Floating-roof	Actual Emission Rate vs AQIA Fixed-roof
				Floating-roof tank (g/s)	Fixed-roof tank (g/s)		
Cumene	20.0	20	0.0000058	0.000012	0.008	48%	0.1%
Hexane	163	190	0.0000549	0.000048	0.009	114%	0.0%
Benzene	26.7	30	0.00000867	0.000003	0.019	289%	0.0%
Cyclohexane	45.7	53	0.0000153	0.0000097	0.065	158%	0.0%
Toluene	150	170	0.000049	0.00000096	0.003	5119%	1.6%
Ethylbenzene	110	120	0.000035	0.0000023	0.003	1508%	1.2%
Xylenes	274	310	0.000090	0.0000083	0.009	1080%	1.0%
TVOC	12633	15400	0.00445	0.00088	2.64	506%	0.2%

Actual emission rates depicted in **Table 3-1** show higher than estimated rates for the floating roof tanks for all compounds with the exception of Cumene. The largest difference between actual and estimated emission rate is seen in Toluene, which has an actual emission rate approximately 51 times that of what was estimated by the assessment.

However, the AQIA assumed the worst-case emissions in the modelling assessment i.e., those from the fixed-roof tanks. When comparing actual emission rate against the assumed emission rate in the modelling assessment (AQIA emission estimates for fixed-roof tank), it is significantly below the modelled emissions. This is the same case with all the compounds, with ethylbenzene's emission rate being the closest to the predicted worst-case air emissions rate at approximately 85 times less than modelled. As such the higher emission rates measured from the floating roof tank are not expected to result in change in outcomes compared with the assessment. This supported by the off-site concentration values presented in the following subsections.

3.2.3 Benzene

The adopted assessment criteria for benzene are the EPA Victoria 24-hour APAC. The statistical analysis of the measured benzene results are summarised in **Table 3-2**.

Table 3-2 Benzene Results Summary

Statistic	Assessment Criteria		Sampling Period	February 2023 to March 2025 Baseline Concentration (µg/m^3)	Concentration (µg/m^3)
	Source	Value (µg/m^3)			
Max 7-day	NA		~7 Days	0.21	0.30
Max 14-day			~14 Days	0.10	
Max 24-hour	EPA Vic	29	~ 24 hours	1.66	2.1

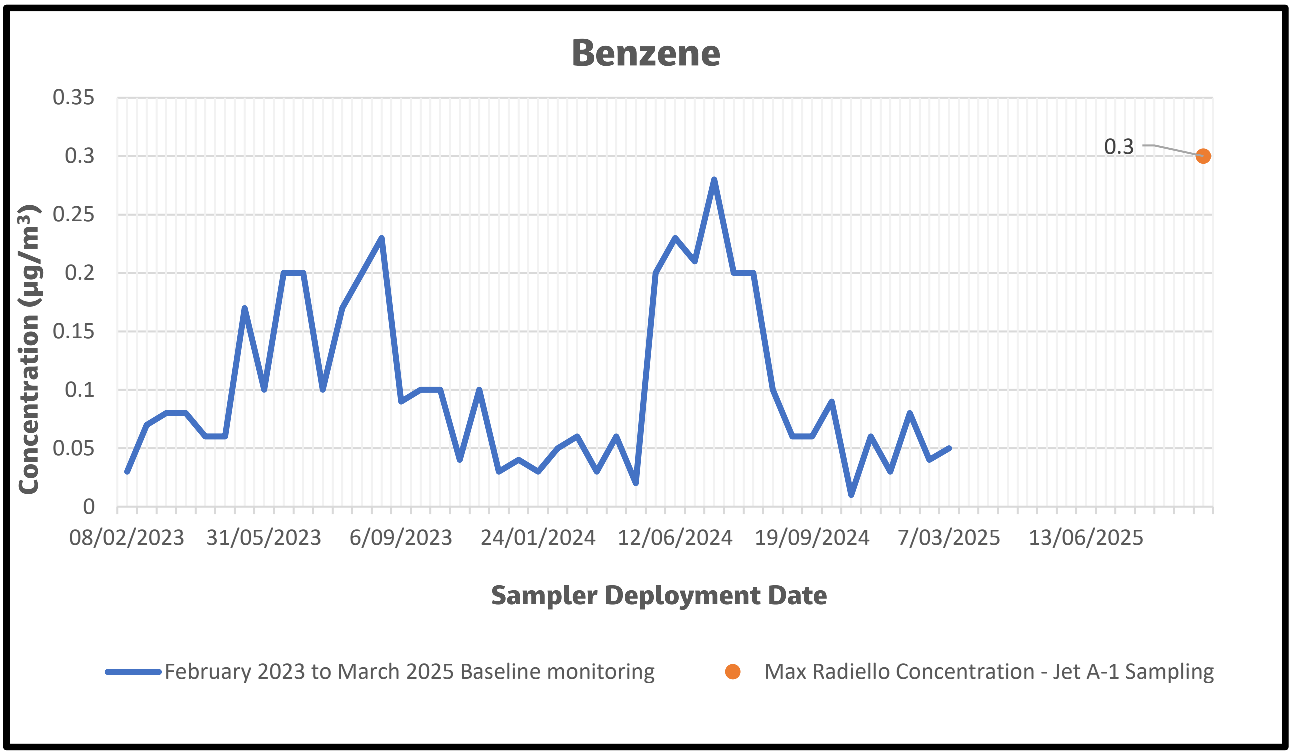


Figure 3-3 Benzene Baseline Data

The benzene concentrations are slightly above the baseline concentrations, however the 24-hour result is still below the adopted EPA Victoria guideline value.

3.2.4 Toluene

The adopted assessment criteria for toluene are the NEPM 24-hour average investigation levels and the EPA Victoria APAC 7-day average. The statistical analysis of the measured toluene results are summarised in **Table 3-3**.

Table 3-3 Toluene Results Summary

Statistic	Assessment Criteria		Averaging Period	February 2023 to March 2025 Baseline Concentration (µg/m³)	Concentration (µg/m³)
	Source	Value (µg/m³)			
Max 7-day	EPA Vic	260	~7 Days	0.84	0.87
Max 14-day	NA		~14 Days	0.42	
Max 24-hour	NEPM	3,767	24 hours	5.89	6.09

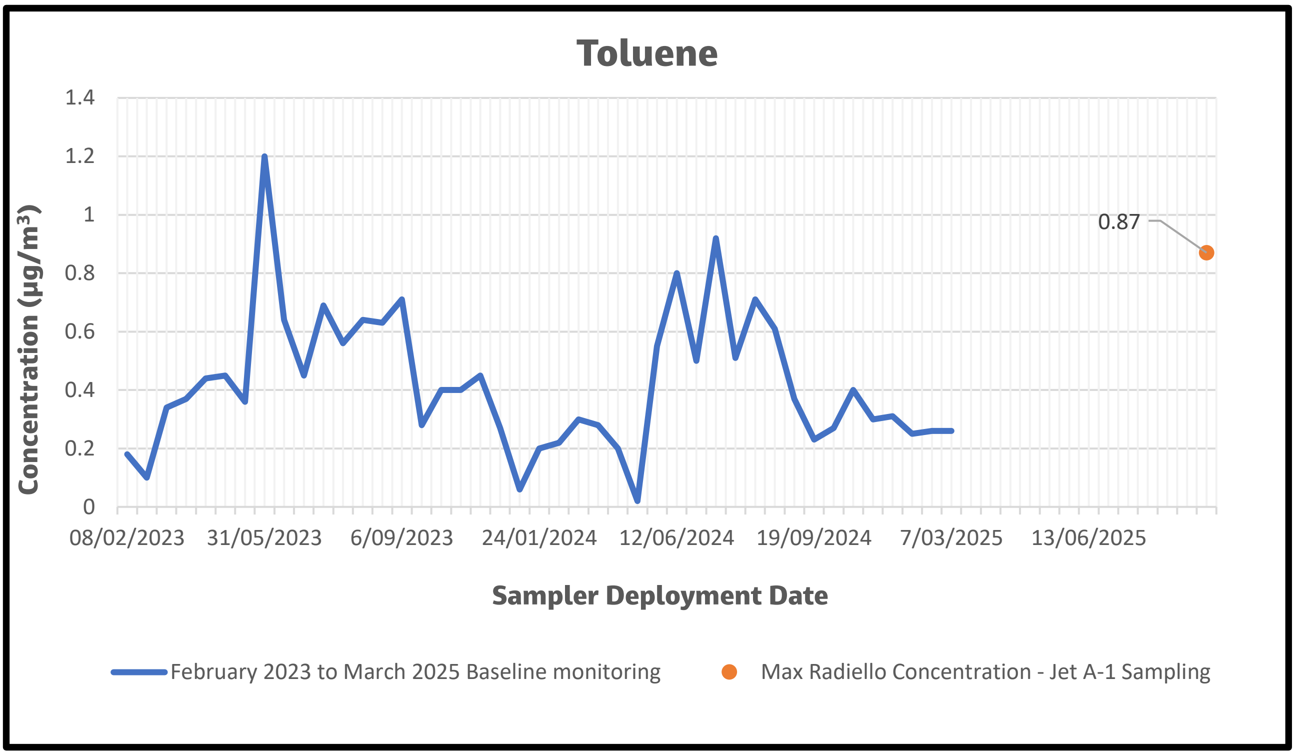


Figure 3-4 Toluene Baseline Data

The toluene 24-hour and 7-day results are significantly lower than the respective EPA Victoria and NEPM guideline values. The toluene results are slightly above the baseline averages, but below the maximum baseline results.

3.2.5 Ethylbenzene

The adopted assessment criteria for ethylbenzene are the EPA Victoria 24-hour APAC. The statistical analysis of the measured ethylbenzene results are summarised in **Table 3-4**.

Table 3-4 Ethylbenzene Results Summary

Statistic	Assessment Criteria		Sampling Period	Baseline Concentration (µg/m³)	Concentration (µg/m³)
	Source	Value (µg/m³)			
Max 7-day	NA		~7 Days	0.25	0.30
Max 14-day			~14 Days	0.12	
Max 24-hour	EPA Vic	21,712	24 hours	1.74	2.1

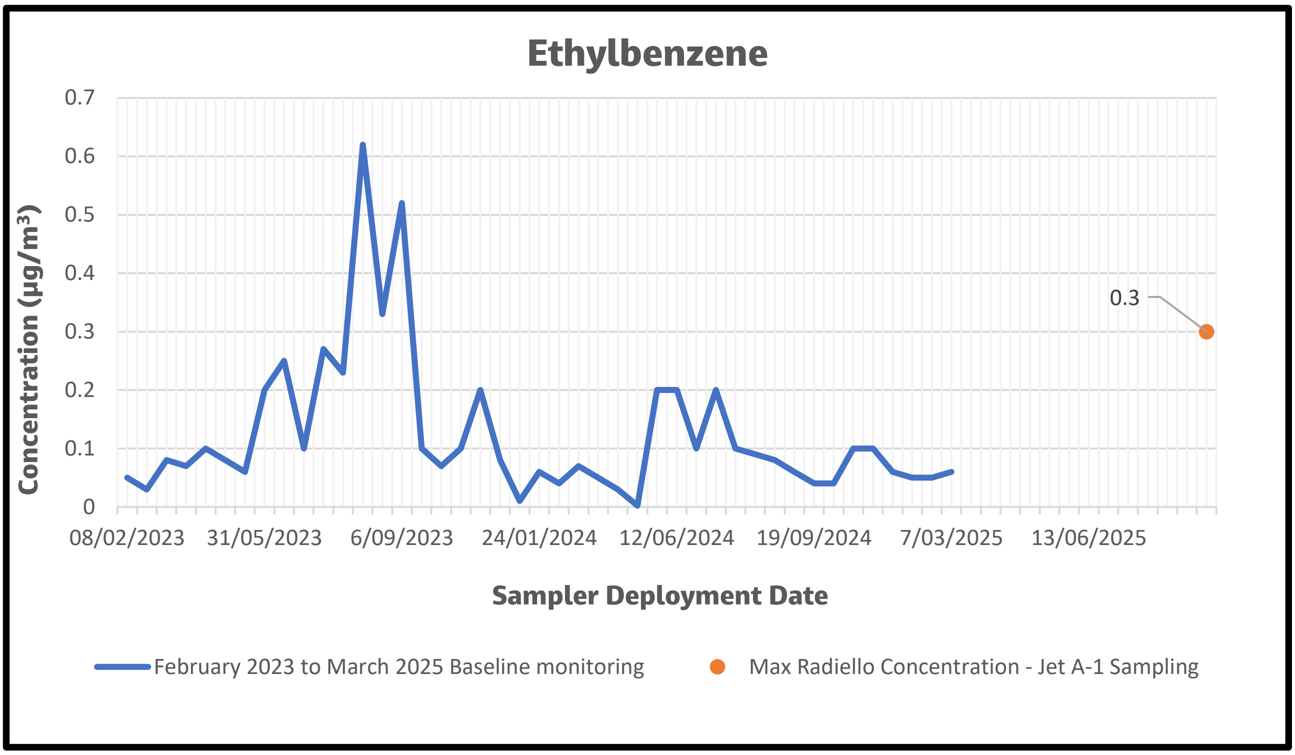


Figure 3-5 Ethylbenzene Baseline Data

The ethylbenzene 24-hour result is significantly lower than the adopted EPA Victoria guideline value. The ethylbenzene results are slightly above the baseline averages, but below the maximum baseline results.

3.2.6 Xylenes

The adopted assessment criteria for Xylenes are the NEPM 24-hour average investigation levels. The statistical analysis of the measured xylenes results are summarised in **Table 3-5**.

Table 3-5 Xylenes Results Summary

Statistic	Assessment Criteria		Sampling Period	Baseline Concentration (µg/m³)	Concentration (µg/m³)
	Source	Value (µg/m³)			
Max 7-day	NA		~7 Days	0.69	0.60
Max 14-day			~14 Days	0.34	
Max 24-hour	NEPM	1085	24 hours	4.79	4.2

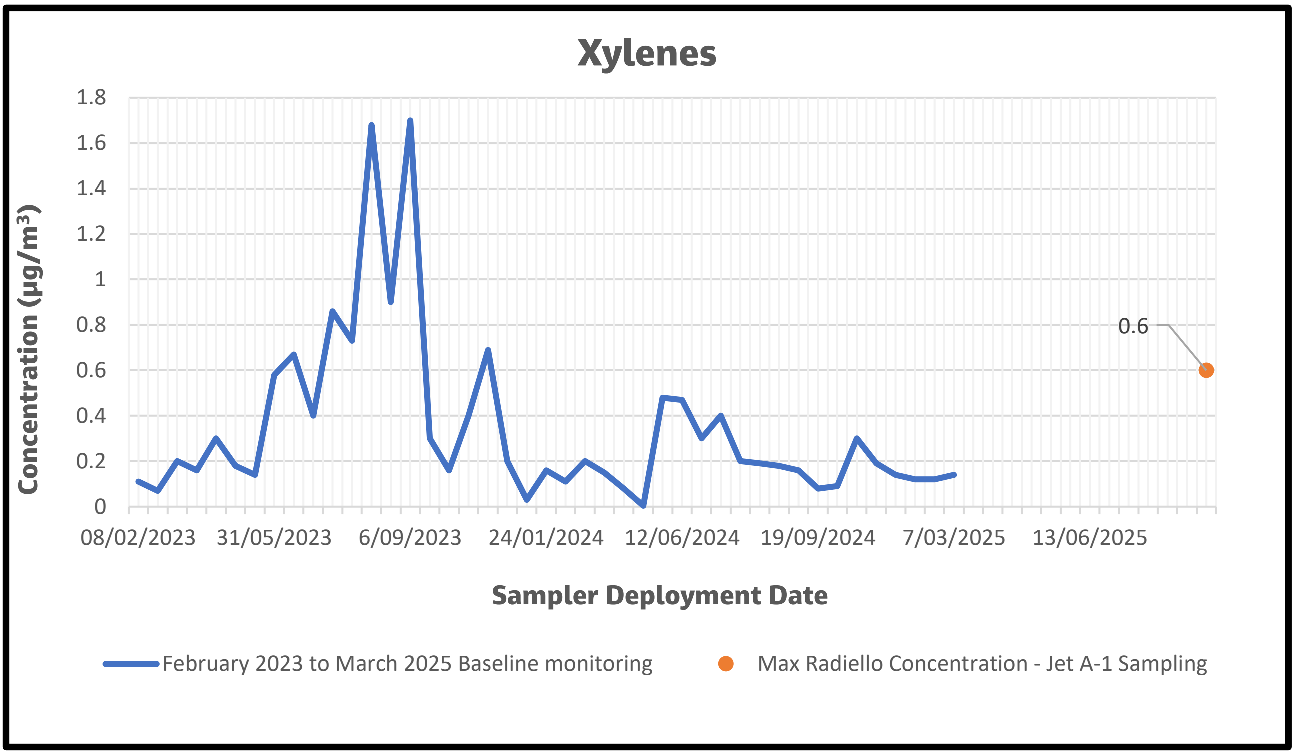


Figure 3-6 Xylenes Baseline Data

The xylenes 24-hour result is significantly lower than the adopted NEPM guideline value. The xylenes result is slightly above the 7-day baseline average (below the 14-day average), but below the maximum baseline result.

3.2.7 Cumene (Isopropylbenzene)

There is no 24-hour guideline value for Cumene. The statistical analysis of the measured cumene results are summarised in **Table 3-6**.

Table 3-6 Cumene Results Summary

Statistic	Assessment Criteria		Sampling Period	Baseline Concentration (µg/m³)	Concentration (µg/m³)
	Source	Value (µg/m³)			
Max 7-day	NA		~7 Days	0.007	0.02
Max 14-day			~14 Days	0.003	
Max 24-hour	NA		24 hours	0.047	0.14

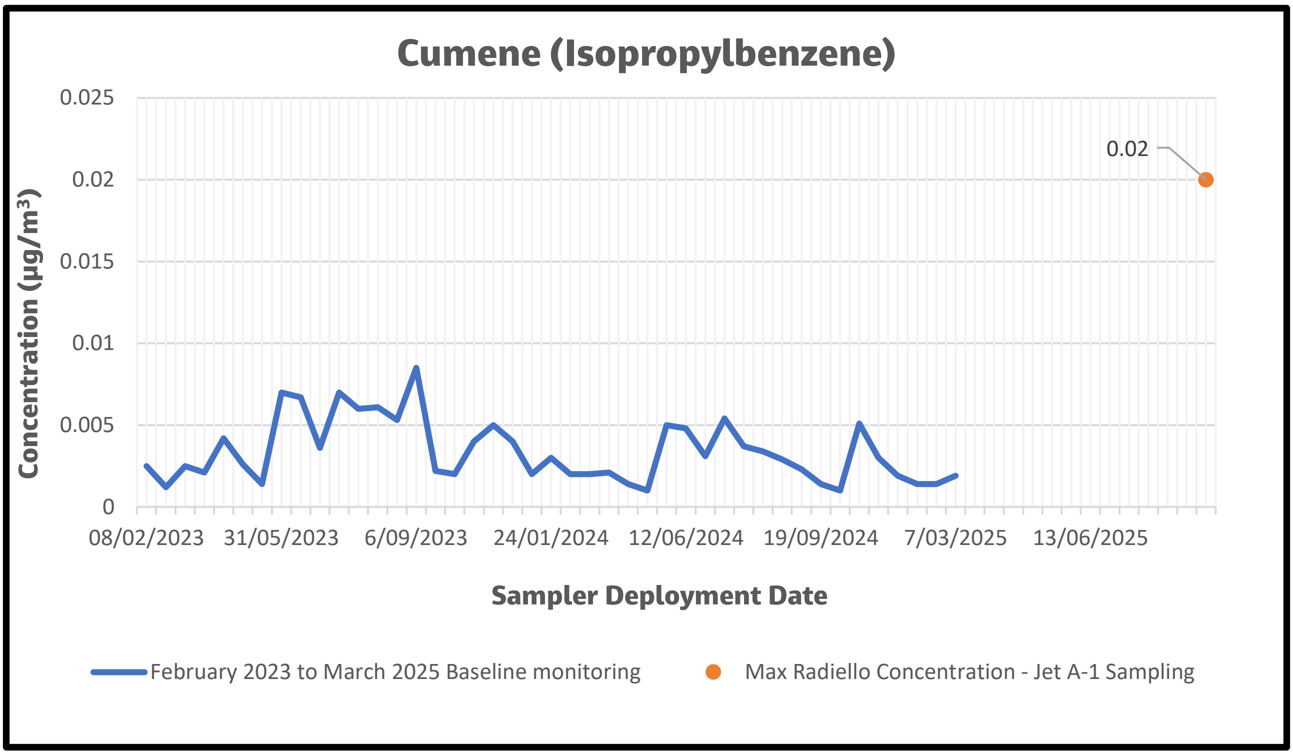


Figure 3-7 Cumene Baseline Data

The cumene result is above the baseline averages. There is no 24-hour guideline for cumene, however the result is significantly below the 1-hour NSW IAC guideline (21 µg/m^3).

3.2.8 Cyclohexane

There is no 24-hour guideline value for cyclohexane. The statistical analysis of the measured cyclohexane results are summarised in **Table 3-7**.

Table 3-7 Cyclohexane Results Summary

Statistic	Assessment Criteria		Sampling Period	Baseline Concentration (µg/m^3)	Concentration (µg/m^3)
	Source	Value (µg/m^3)			
Max 7-day	NA		~7 Days	0.004	0.004
Max 14-day			~14 Days	0.002	
Max 24-hour	NA		24 hours	0.030	0.028

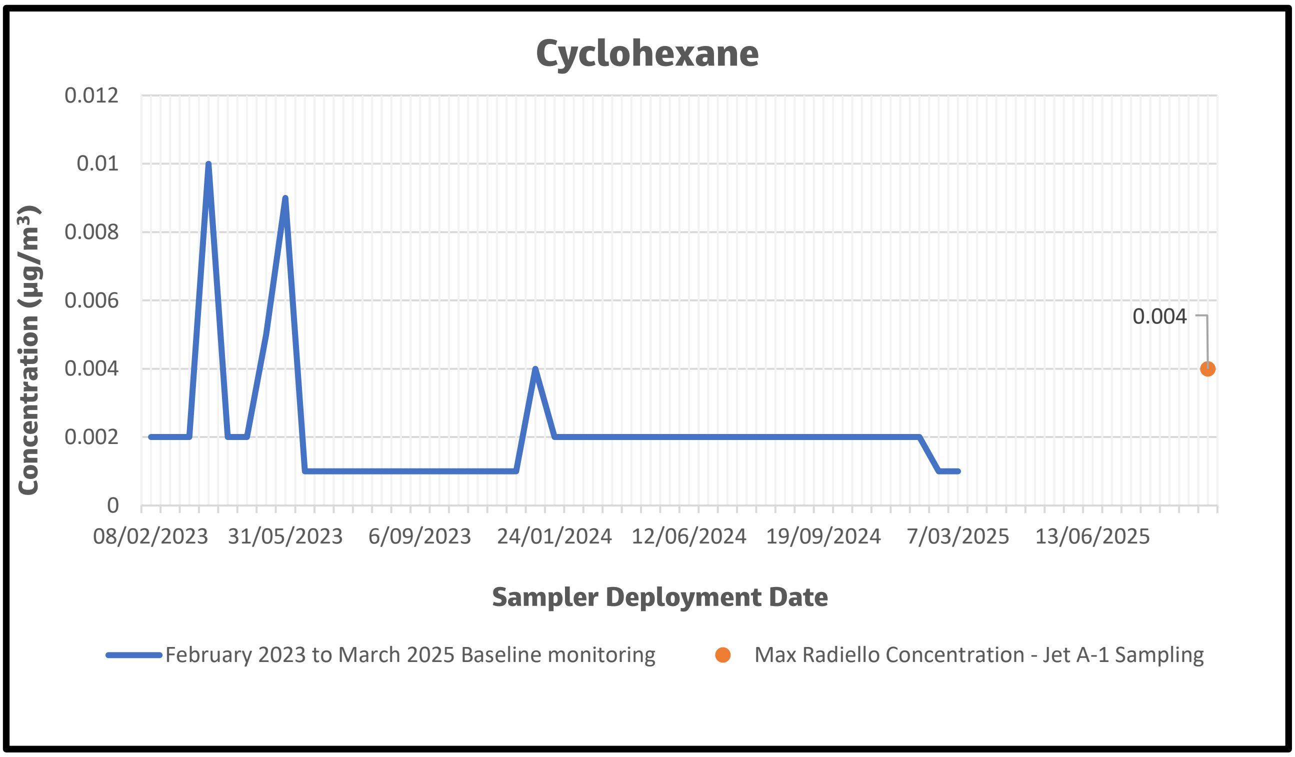


Figure 3-8 Cyclohexane Baseline Data

There is no 24-hour guideline for cyclohexane, however the result is below the 1-hour NSW IAC guideline (1,900 µg/m³). The cyclohexane results are slightly above the baseline averages, but below the 14-day baseline maximum.

3.2.9 Hexane

There is no 24-hour guideline value for hexane. The statistical analysis of the measured hexane results are summarised in **Table 3-8**.

Table 3-8 Hexane Results Summary

Statistic	Assessment Criteria		Sampling Period	Baseline Concentration (µg/m³)	Concentration (µg/m³)
	Source	Value (µg/m³)			
Max 7-day	NA		~7 Days	0.24	0.76
Max 14-day			~14 Days	0.12	
Max 24-hour	NA		24 hours	1.66	5.32

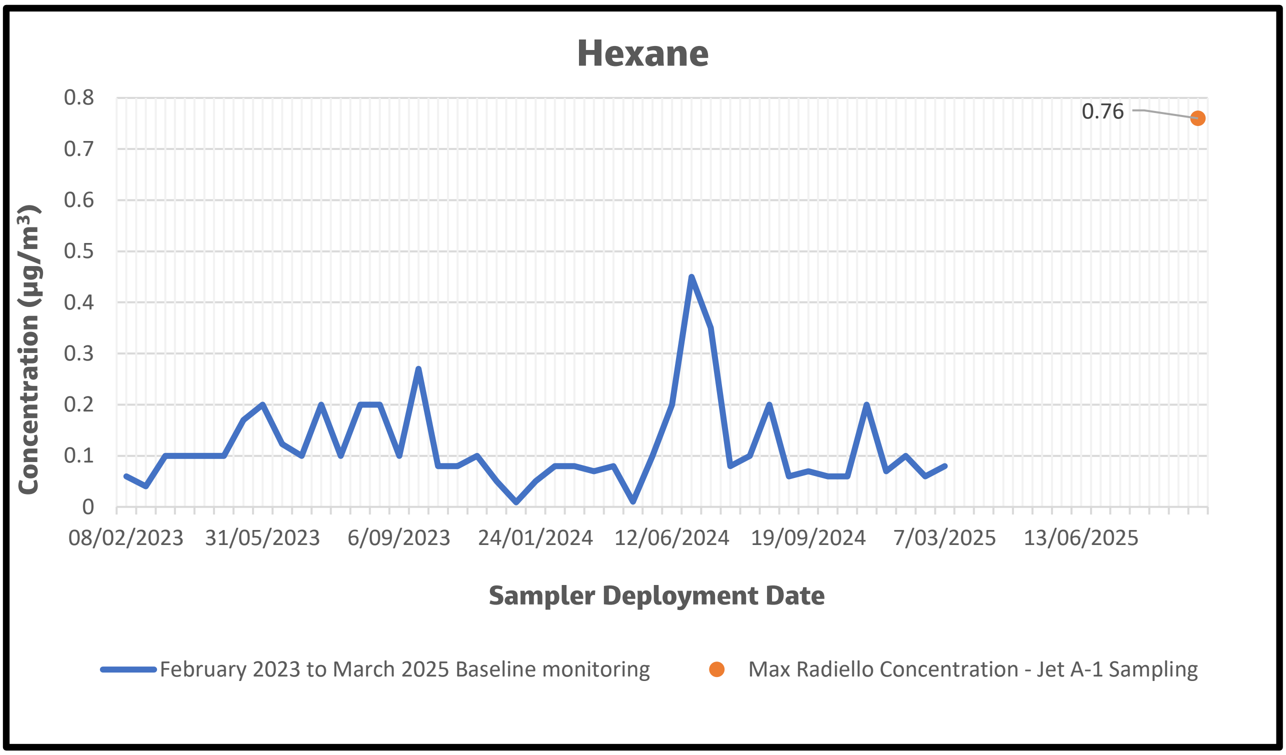


Figure 3-9 Hexane Baseline Data

There is no 24-hour guideline for hexane, however the result is below the 1-hour NSW IAC guideline (3,200µg/m^3). The hexane results are above the baseline averages, but within an order of magnitude.

3.2.10 Total Volatile Organic Compounds (TVOC)

There is no 24-hour guideline value for TVOC. The statistical analysis of the measured TVOC results are summarised in **Table 3-9**.

Table 3-9 TVOC Results Summary

Statistic	Assessment Criteria		Sampling Period	Baseline Concentration (µg/m^3)	Concentration (µg/m^3)
	Source	Value (µg/m^3)			
Max 7-day	NA		~7 Days	9.25	20
Max 14-day			~14 Days	4.63	
Max 24-hour	NA		24 hours	64.8	140

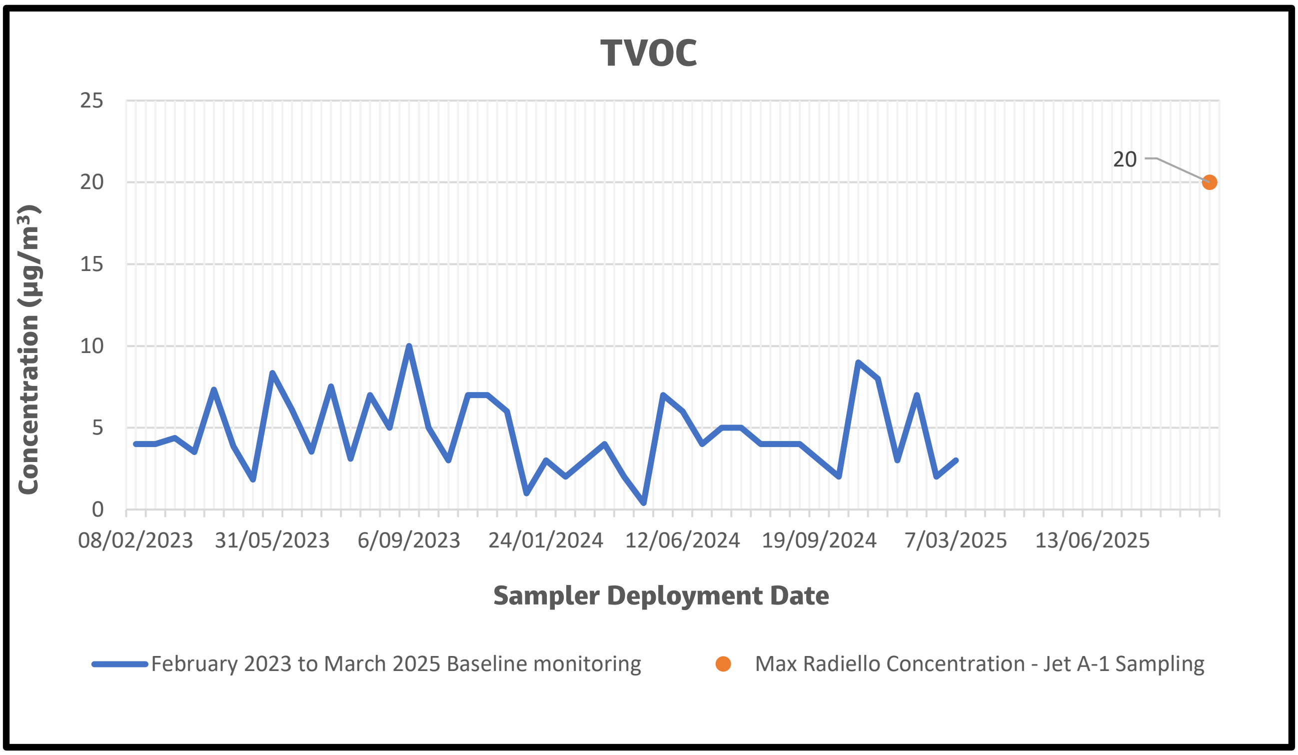


Figure 3-10 TVOC Baseline Data

There is no 24-hour guideline for TVOC. The TVOC results are above the average baseline results.

3.3 JP-5 (Tank 3)

The following displays the results for the JP-5 Tank filling event conducted. Laboratory documents be found in **Appendix B.**

3.3.1 Wind Data

Meteorological data has been acquired from the NT EPA website and has been converted into the Windrose plots seen below. **Figure 3-11** displays wind data from when the SUMMA canisters were activated(4:45 pm - 25/02/26 to 4:00 am - 26/02/26). **Figure 3-12** displays wind data from when the Radiello tubes were deployed (12:00 am - 19/02/2026 12:00 to 3:00 pm - 27/02/2026).

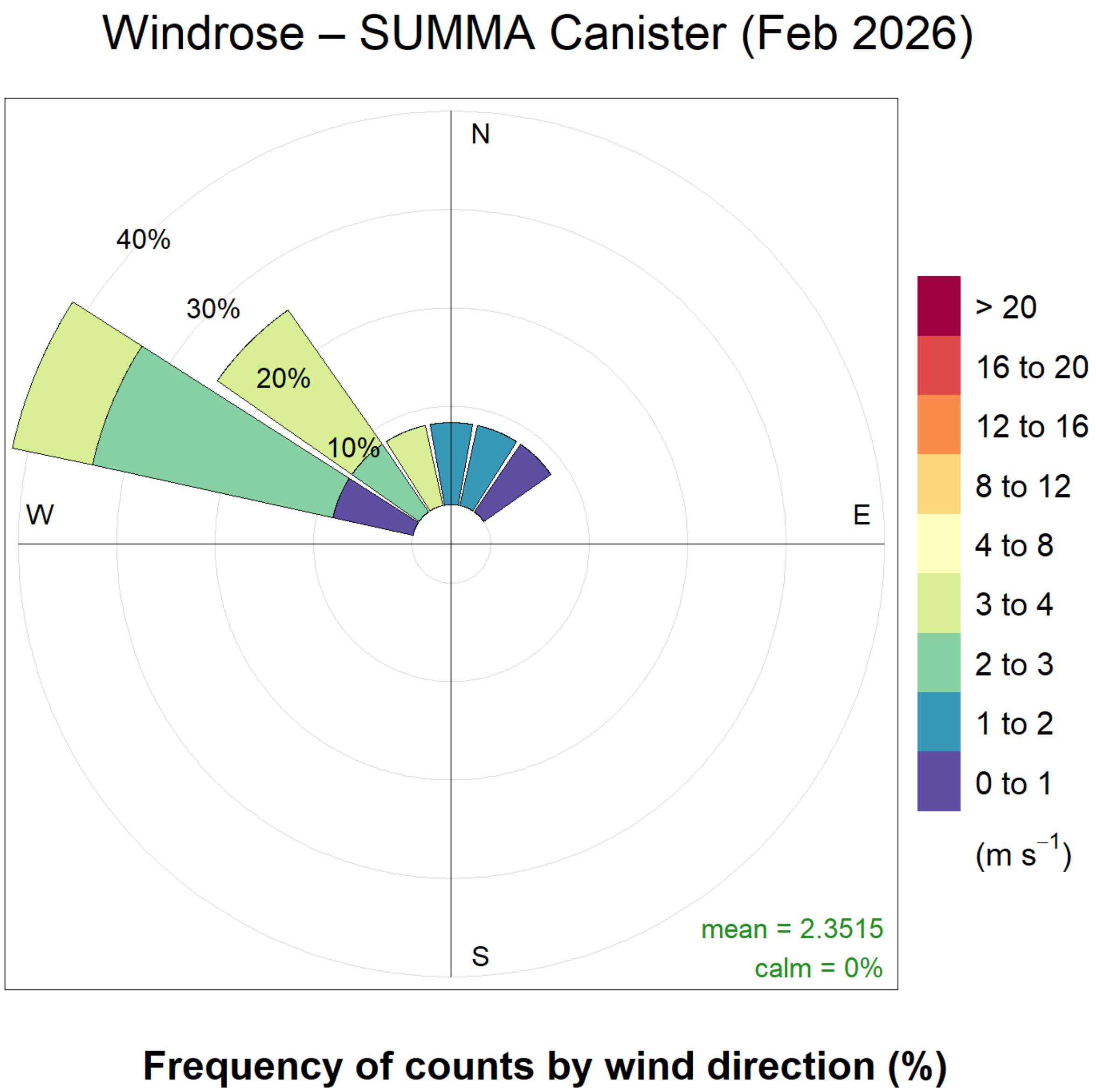


Figure 3-11. Windrose - SUMMA Canister

During the SUMMA canister sampling, winds predominantly blew from the west to north-west sector, accounting for approximately 70% of the monitoring period, with wind speeds generally below 4 m/s. Limited wind occurrences were recorded from the east and north-north-east sectors. Consistent with these prevailing conditions, the highest concentrations were observed at monitoring location H2862, which is situated downwind of the primary emission sources under the dominant wind direction. In contrast, H3619, located to the north of the tank cluster, generally remained upwind during the sampling period and recorded comparatively lower concentrations.

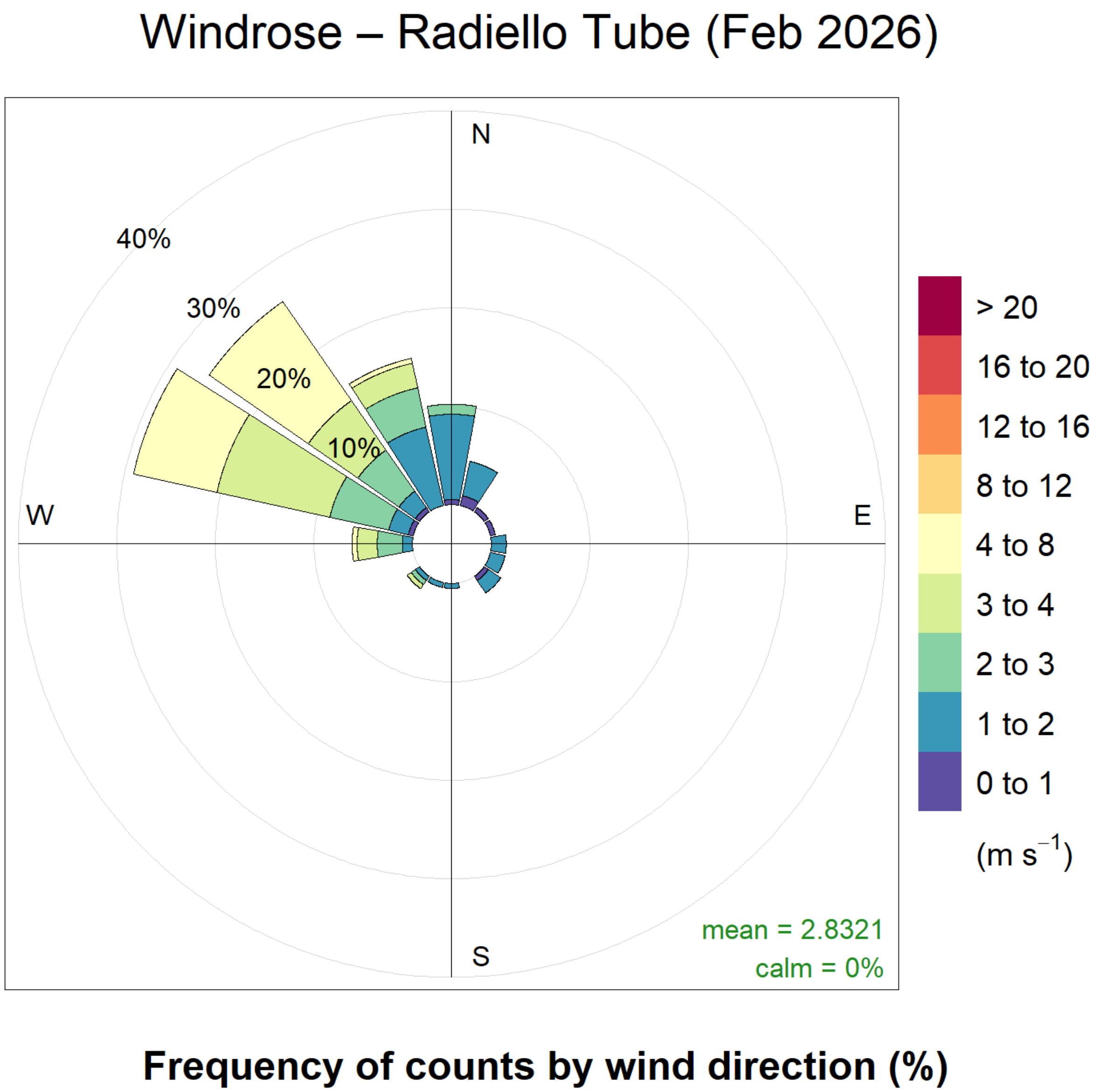


Figure 3-12. Windrose – Radiello Tube

The windrose indicates that winds predominantly originated from the west to north-west sectors, accounting for approximately 55% of occurrences, with wind speeds generally in the low to moderate range and predominantly below 8 m/s. The average wind speed during the monitoring period was approximately 2.8 m/s. This wind regime would favour the dispersion of emissions towards the east to south-eastern sectors. Consistent with this pattern, RAD-128, located to the south of the tank cluster, generally exhibited elevated concentrations and recorded the highest values for most analytes. RAD-127 recorded intermediate concentrations, while lower concentrations were generally observed at RAD-126, which is located to the north of the site and is typically upwind under prevailing conditions.

Overall, the observed spatial distribution of concentrations is broadly consistent with the prevailing wind regime.

3.3.2 Emission Rates

Using the average concentration from the SUMMA cannister sampling results and the volume of fuel loaded, emission rates for the different compounds monitored were calculated. To calculate the emission rates the following information was also used:

- Sampling Period: 11.25 Hours
- Volume of fuel loaded (during the sampling period): 11,896 KL (representing the volume of emissions from the tank).

The calculated actual emission rates have been compared against the AQIA modelled emissions rates in the below **Table 3-10**.

Table 3-10. Emission Rate Calculation at JP-5

VOC	Average Conc. (µg/m^3)	Max Conc. (µg/m^3)	Actual Emission Rate (g/s)	AQIA Emissions Estimates	Actual Emission Rate vs AQIA Fixed-roof (JP-5)
				Fixed-roof tank (g/s)	
Cumene	733	990	0.0002154	0.008	2.7%
Hexane	863	1200	0.0002536	0.009	0.1%
Benzene	336	490	0.00009889	0.019	0.5%
Cyclohexane	963	1400	0.0002830	0.065	0.4%
Toluene	3033	4100	0.000891	0.003	29.7%
Ethylbenzene	2533	3200	0.000744	0.003	24.8%
Xylenes	12066	14200	0.003544	0.009	39.4%
TVOC	477333	704000	0.14021	2.64	5.3%

Actual emission rates depicted in **Table 3-10** are all below then those estimated for the fixed-roof tanks in the AQIA. All results are less than 40% of the modelled emission rates, with Xylenes being the closest to the modelled rate. As predicted TVOC has the greatest emission rate. These results confirm that the fixed-roof emission assumptions adopted in the AQIA were conservative and that emissions measured during the JP-5 tank filling event remain well within the envelope assessed for regulatory compliance.

3.3.3 Benzene

The adopted assessment criteria for benzene are the EPA Victoria 24-hour APAC. The statistical analysis of the measured benzene results are summarised in **Table 3-11.**

Table 3-11. Benzene Results Summary

Statistic	Assessment Criteria		Sampling Period	Baseline Concentration (µg/m3)	Concentration (µg/m3)
	Source	Value (µg/m³)			
Max 7-day	NA		~7 Days	0.21	0.2
Max 14-day			~14 Days	0.10	
Max 24-hour	EPA Vic	29	~ 24 hours	1.66	1.4

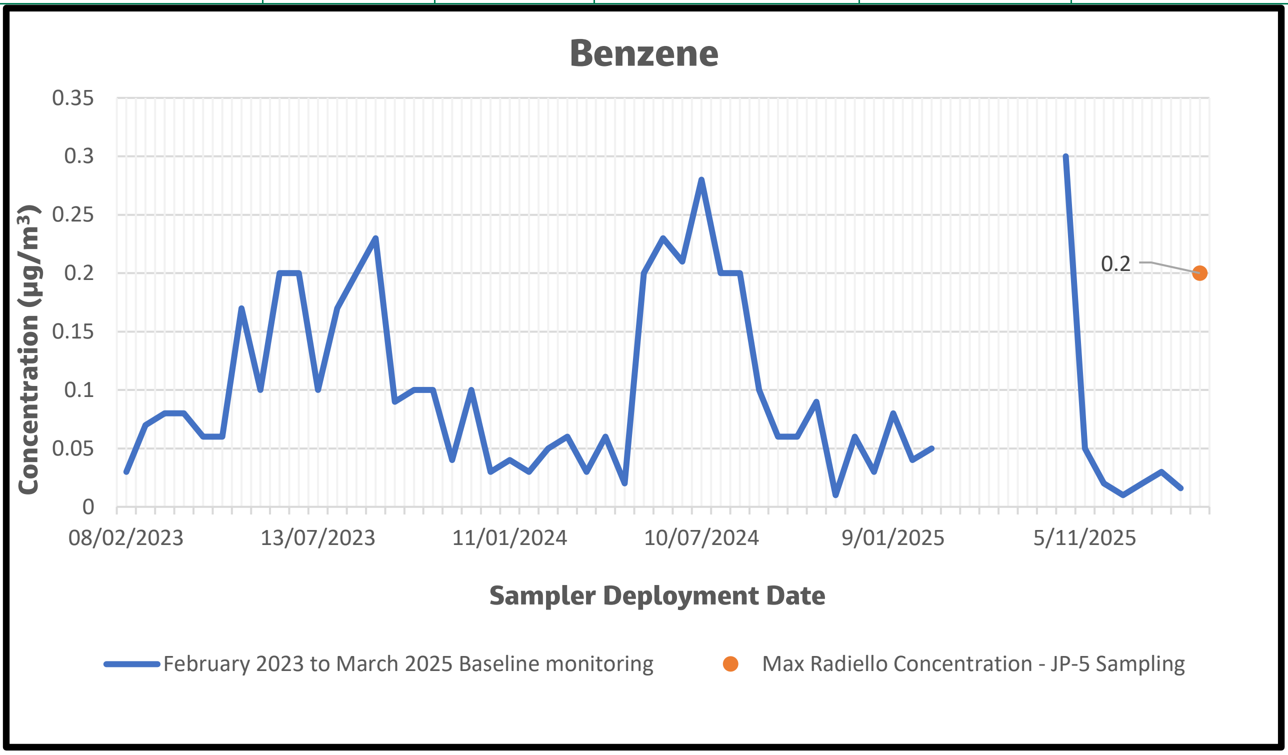


Figure 3-13. Benzene Baseline Data

The measured benzene concentrations are consistent with but below the 2023 to 2025 baseline concentrations, as well as the adopted 24-hour EPA Victoria guideline value.

3.3.4 Toluene

The adopted assessment criteria for toluene are the NEPM 24-hour average investigation levels and the EPA Victoria APAC 7-day average. The statistical analysis of the measured toluene results are summarised in **Table 3-12.**

Table 3-12. Toluene Results Summary

Statistic	Assessment Criteria		Averaging Period	Baseline Concentration (µg/m3)	Concentration (µg/m3)
	Source	Value (µg/m3)			
Max 7-day	EPA Vic	260	~7 Days	0.84	1.3
Max 14-day	NA		~14 Days	0.42	
Max 24-hour	NEPM	3,767	24 hours	5.89	9.1

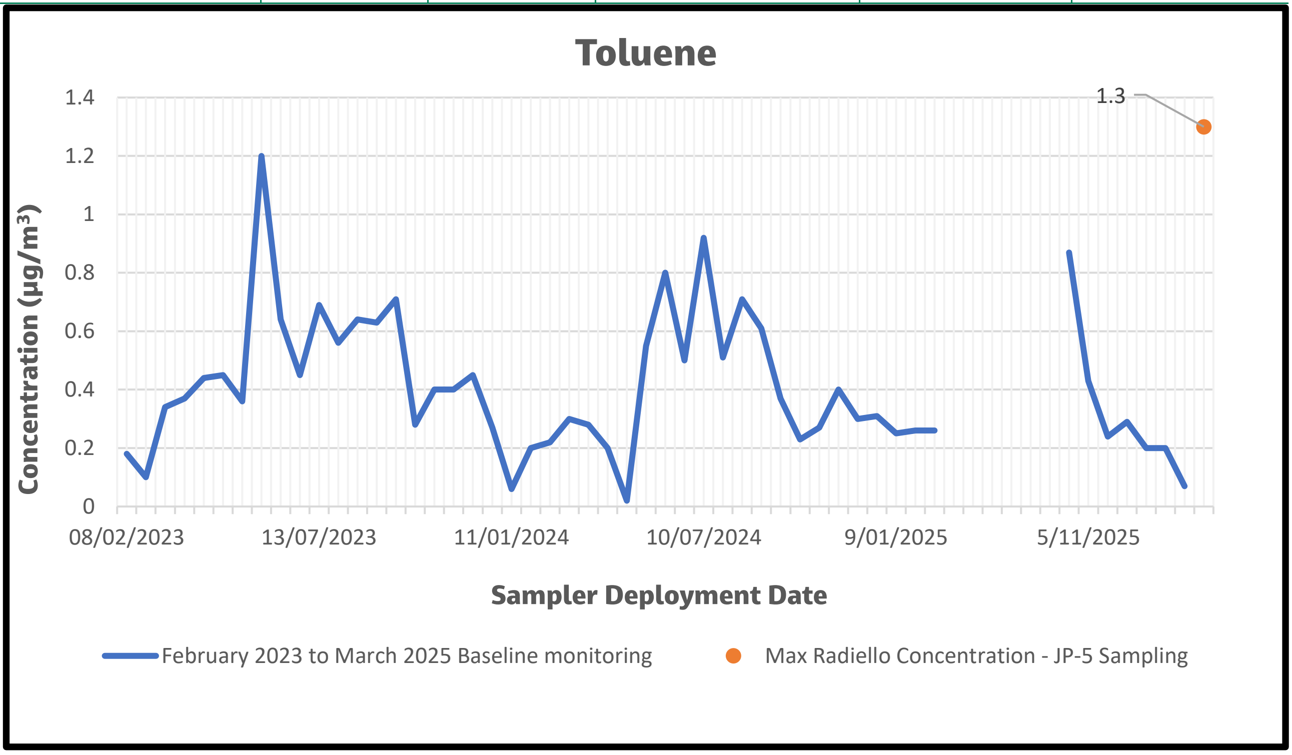


Figure 3-14. Toluene Baseline Data

The toluene 24-hour and 7-day concentrations are substantially below the adopted NEPM and EPA Victoria guideline values. Measured toluene concentrations are slightly above baseline concentrations for the corresponding averaging periods.

3.3.5 Ethylbenzene

The adopted assessment criteria for ethylbenzene are the EPA Victoria 24-hour APAC. The statistical analysis of the measured ethylbenzene results are summarised in **Table 3-13.**

Table 3-13. Ethylbenzene Results Summary

Statistic	Assessment Criteria		Sampling Period	Baseline Concentration (µg/m3)	Concentration (µg/m3)
	Source	Value (µg/m3)			
Max 7-day	NA		~7 Days	0.25	0.6
Max 14-day			~14 Days	0.12	
Max 24-hour	EPA VIC	21,712	24 hours	1.74	4.2

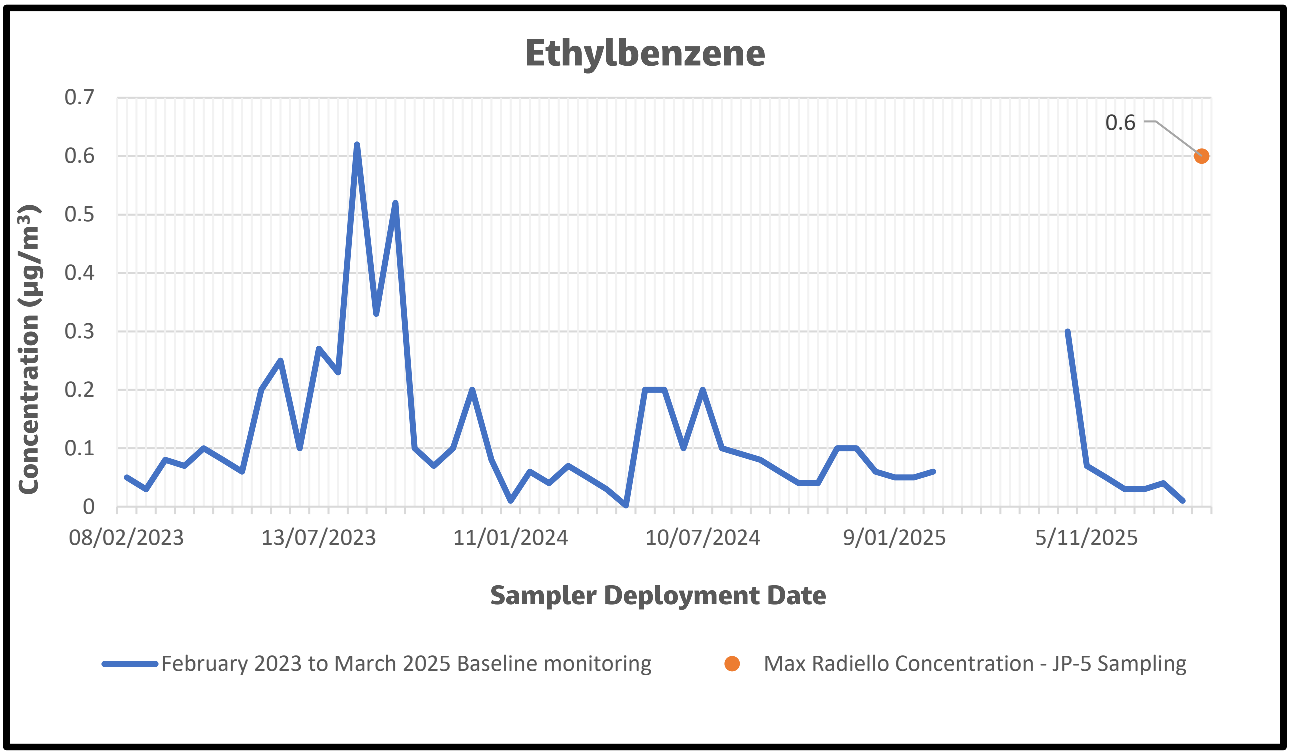


Figure 3-15. Ethylbenzene Baseline Data

The ethylbenzene 24-hour result is significantly lower than the adopted EPA Victoria guideline value. The ethylbenzene results are slightly above the baseline averages and maximum baseline results.

3.3.6 Xylenes

The adopted assessment criteria for Xylenes are the NEPM 24-hour average investigation levels. The statistical analysis of the measured xylenes results are summarised in **Table 3-14.**

Table 3-14. Xylenes Results Summary

Statistic	Assessment Criteria		Sampling Period	Baseline Concentration (µg/m3)	Concentration (µg/m3)
	Source	Value (µg/m3)			
Max 7-day	NA		~7 Days	0.69	1.8
Max 14-day			~14 Days	0.34	
Max 24-hour	NEPM	1085	24 hours	4.79	12.6

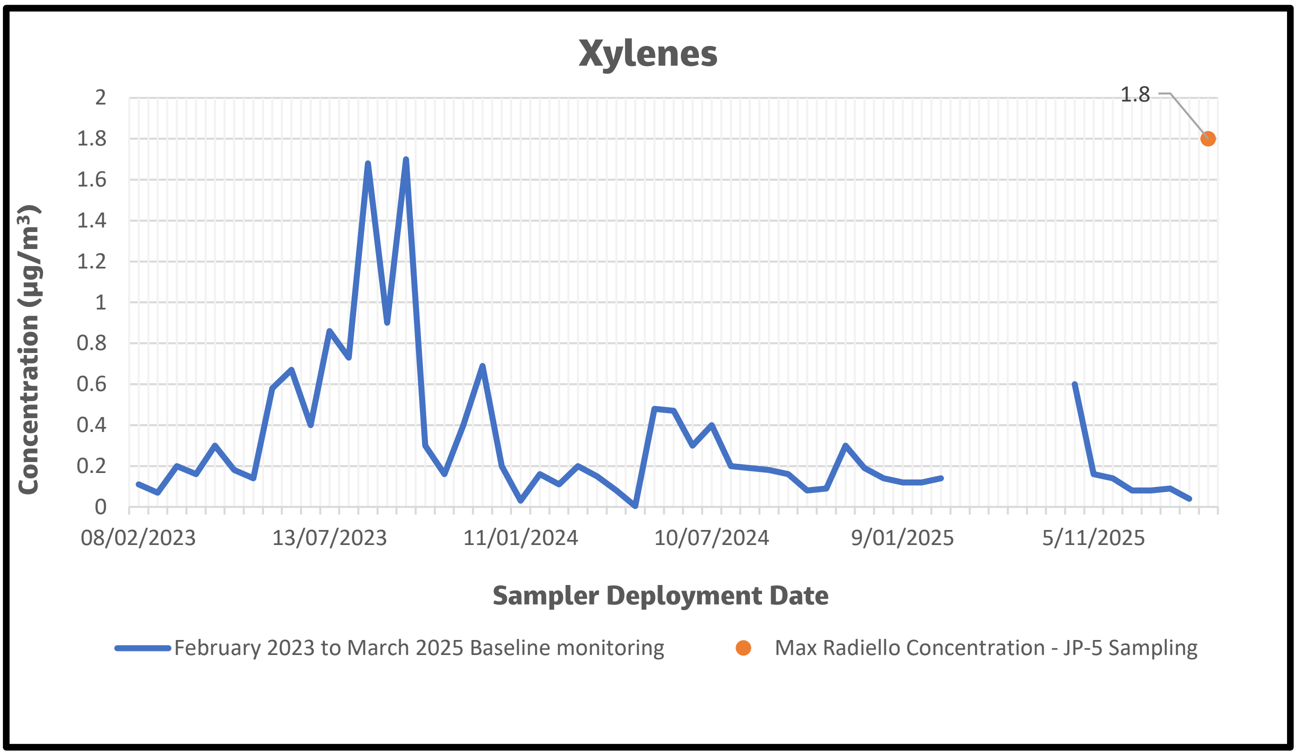


Figure 3-16. Xylenes Baseline Data

The xylenes 24-hour result is significantly lower than the adopted NEPM guideline value. The xylenes result are slightly above the maximum baseline results.

3.3.7 Cumene (Isopropylbenzene)

There is no 24-hour guideline value for Cumene. The statistical analysis of the measured cumene results are summarised in **Table 3-15.**

Table 3-15. Cumene Results Summary

Statistic	Assessment Criteria		Sampling Period	Baseline Concentration (µg/m3)	Concentration (µg/m3)
	Source	Value (µg/m3)			
Max 7-day	NA		~7 Days	0.007	0.08
Max 14-day			~14 Days	0.003	
Max 24-hour	NA		24 hours	0.047	0.56

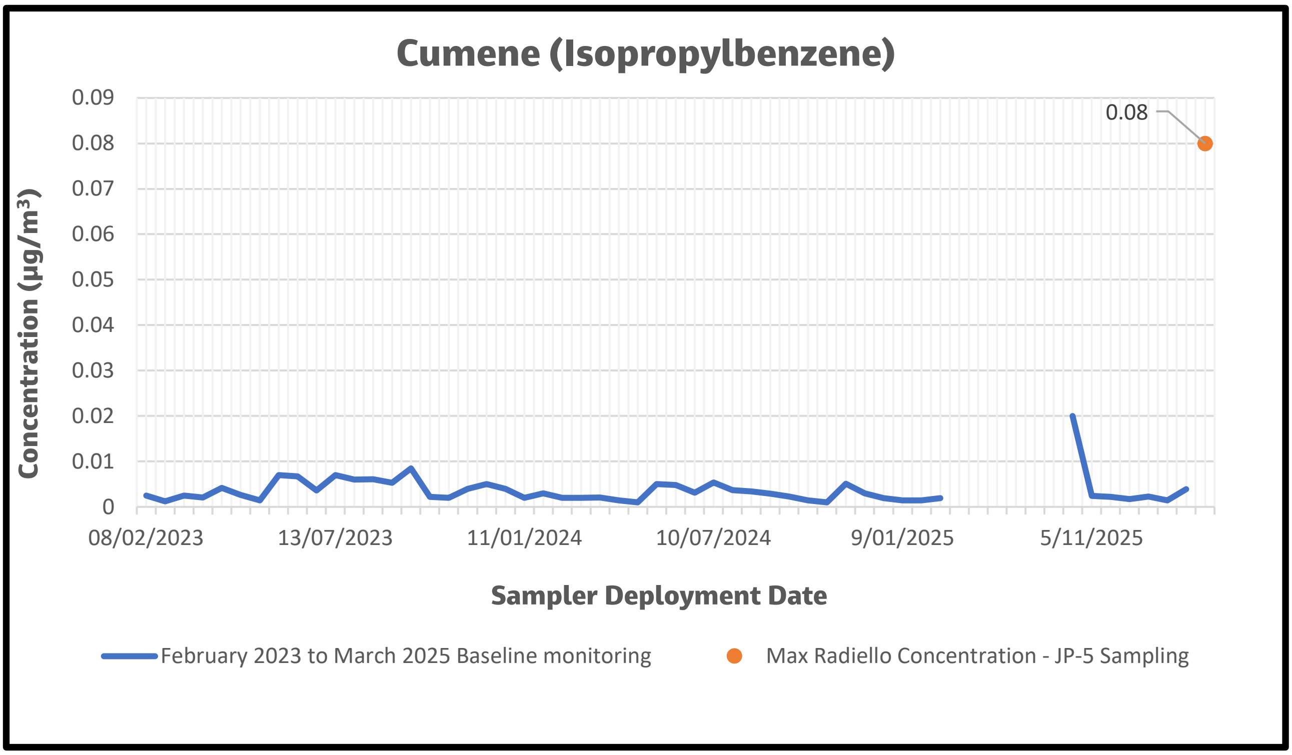


Figure 3-17. Cumene Baseline Data

The cumene results is above the baseline maximum. There is no 24-hour guideline for cumene, however the result is below the 1-hour NSW EPA IAC guideline (21 µg/m3).

3.3.8 Cyclohexane

There is no 24-hour guideline value for cyclohexane. The statistical analysis of the measured cyclohexane results are summarised in **Table 3-16.**

Table 3-16. Cyclohexane Results Summary

Statistic	Assessment Criteria		Sampling Period	Baseline Concentration (µg/m3)	Concentration (µg/m3)
	Source	Value (µg/m3)			
Max 7-day	NA		~7 Days	0.004	0.1
Max 14-day			~14 Days	0.002	
Max 24-hour	NA		24 hours	0.030	0.7

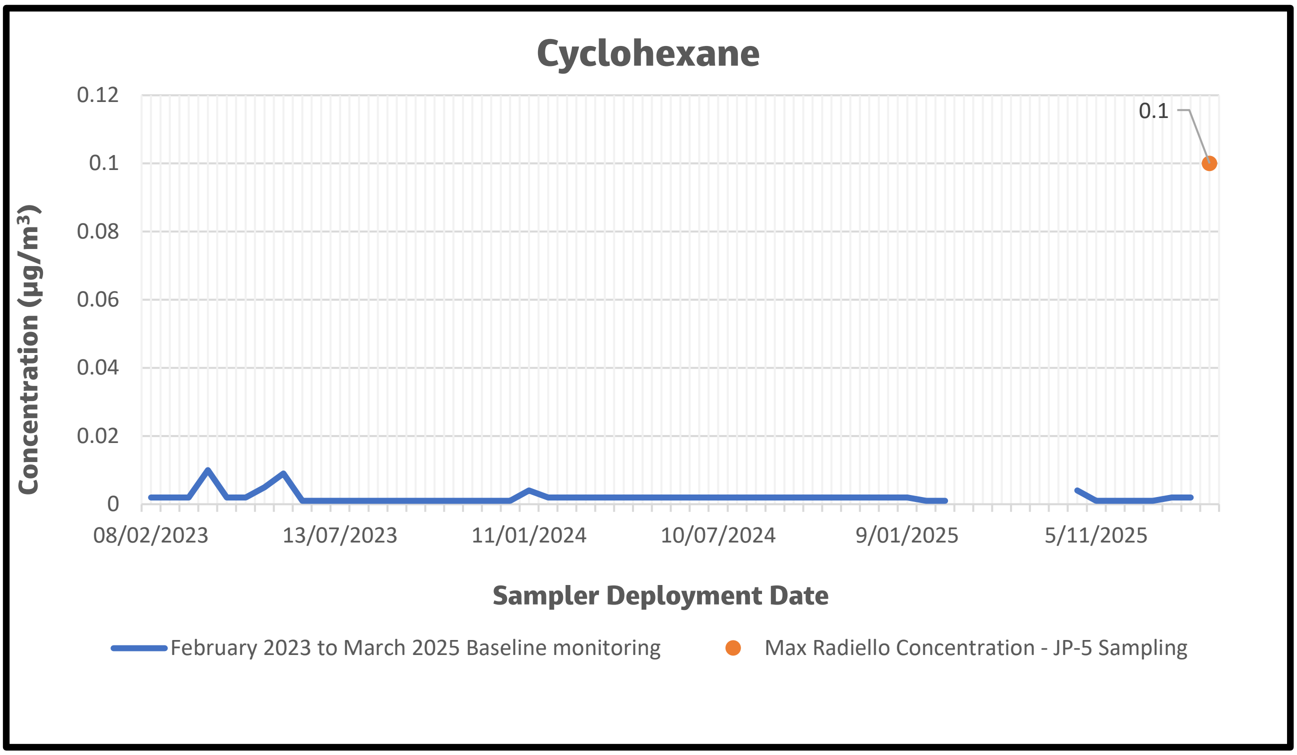


Figure 3-18. Cyclohexane Baseline Data

The cyclohexane results are above the baseline maximum. There is no 24-hour guideline for cyclohexane, however the result is significantly below the 1-hour NSW EPA IAC (1,900 µg/m3).

3.3.9 Hexane

There is no 24-hour guideline value for hexane. The statistical analysis of the measured hexane results are summarised in **Table 3-17.**

Table 3-17. Hexane Results Summary

Statistic	Assessment Criteria		Sampling Period	Baseline Concentration (µg/m3)	Concentration (µg/m3)
	Source	Value (µg/m3)			
Max 7-day	NA		~7 Days	0.24	0.58
Max 14-day			~14 Days	0.12	
Max 24-hour	NA		24 hours	1.66	4.06

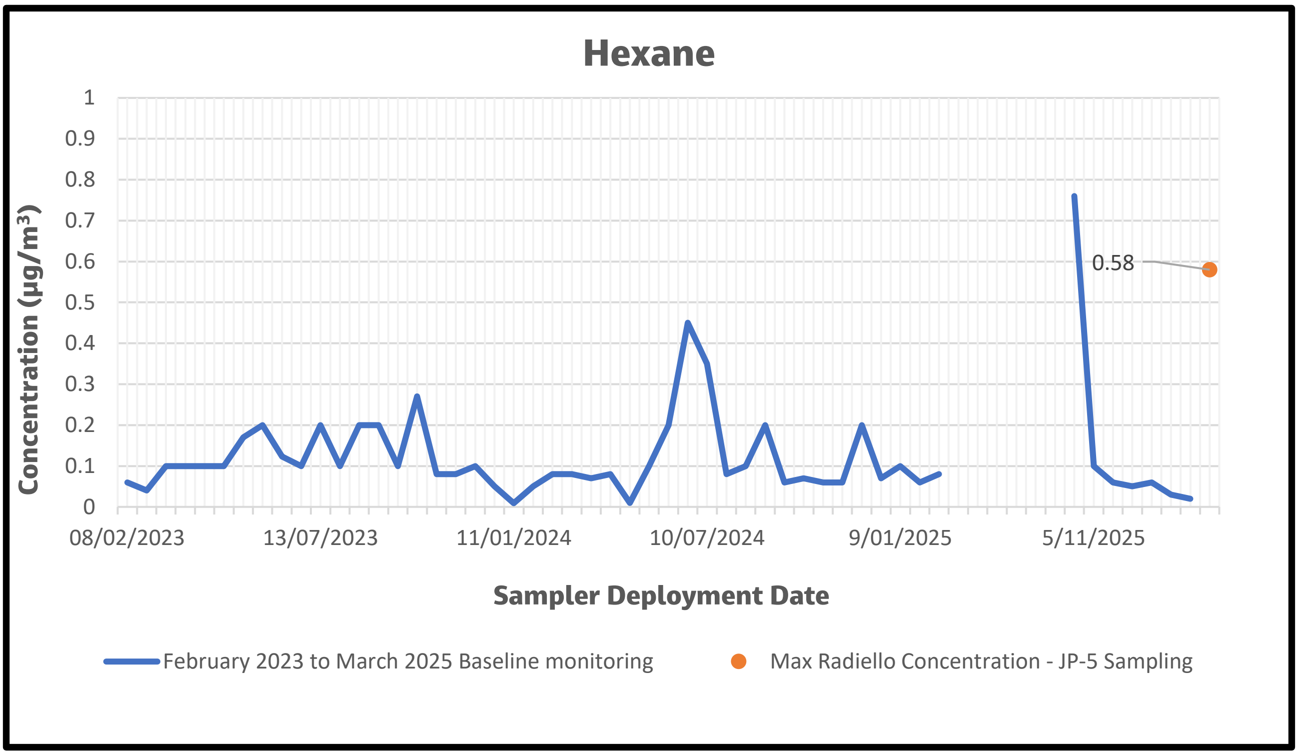


Figure 3-19. Hexane Baseline Data

There is no 24-hour guideline for hexane, however the result is below the 1-hour NSW IAC guideline (3,200µg/m3). The hexane results are within an order of magnitude of the baseline average.

3.3.10 Total Volatile Organic Compounds (TVOC)

There is no 24-hour guideline value for TVOC. The statistical analysis of the measured TVOC results are summarised in

Table 3-18. TVOC Results Summary

Statistic	Assessment Criteria		Sampling Period	Baseline Concentration (µg/m3)	Concentration (µg/m3)
	Source	Value (µg/m3)			
Max 7-day	NA		~7 Days	9.25	56.1
Max 14-day			~14 Days	4.63	
Max 24-hour	NA		24 hours	64.8	392.7

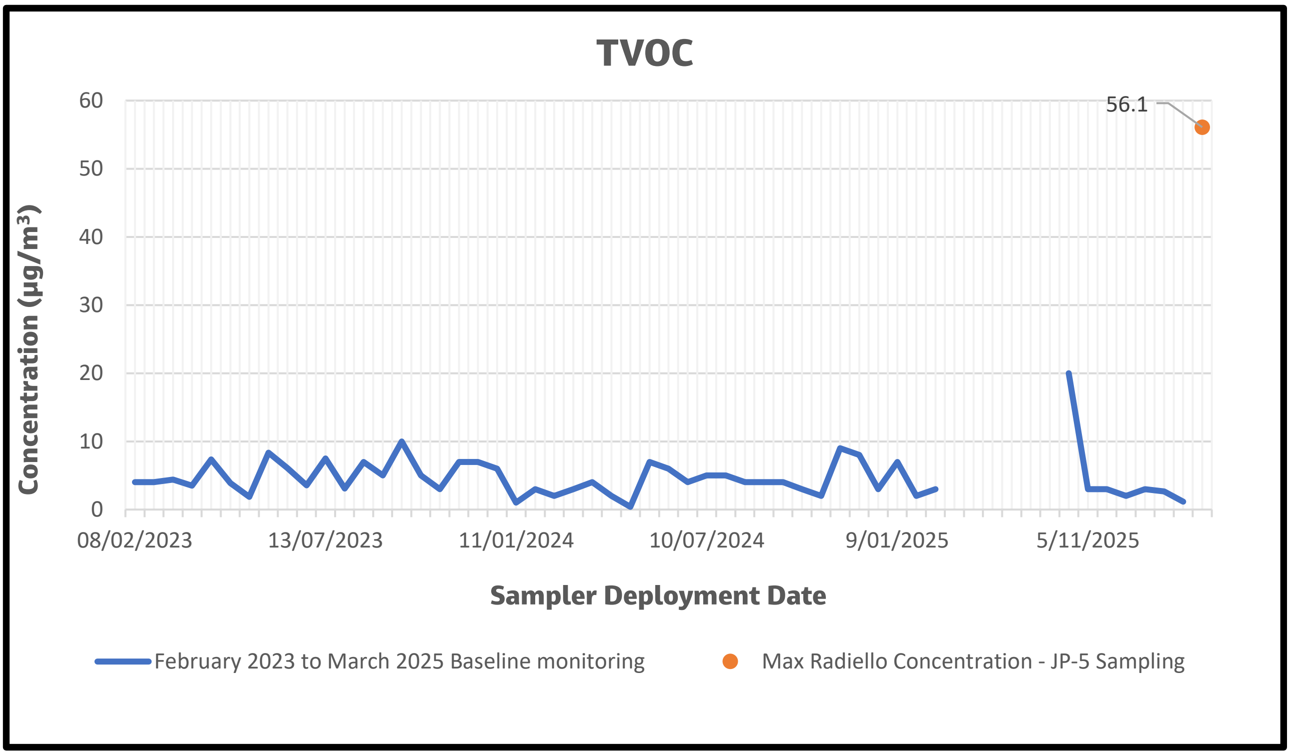


Figure 3-20. TVOC Baseline Data

There is no 24-hour guideline for TVOC. The TVOC results are above the baseline maximum.

4. Measurement Results summary

4.1 Jet A-1 (Tank 8)

The calculated emission rates for the floating-roof tanks were significantly lower than those calculated for the worst-case air emissions scenario (filling of the fixed-roof tanks). The AQIA determined that even at the modelled worst-case emissions scenario there was a low risk of air quality impact anywhere in the Darwin region due to operation of the site. As such it is concluded that emission rates associated with the Jet A-1 tanks present a low risk.

No substance exceeded the adopted 24-hour assessment criteria during the filling of the Jet A-1 tanks. Benzene, cumene, hexane and TVOC showed slightly elevated concentrations when compared to baseline conditions. The AQIA predicted benzene and cumene to report concentrations the closest to their guideline values, with hexane the next closest (the AQIA did not model TVOC concentrations). All the maximum results from the Radiello sampling showed values above the baseline averages, however they were all either below the baseline maximum or within an order of magnitude except for Cumene and TVOC.

4.2 JP-5 (Tank 3)

The measured emission rates during filling of the JP-5 fixed-roof tank represent the worst-case operational scenario assessed in the AQIA. Monitoring results demonstrate that actual emission rates for all measured compounds were substantially lower than the conservative fixed-roof emission assumptions adopted in the AQIA. The majority of compounds measured emission rates at least an order of magnitude below the AQIA fixed-roof emissions estimates. Toluene, Ethylbenzene and Xylenes recorded the highest emission; however they were all were less than 40% of the estimated fixed-roof emission rates. This confirms that the worst-case modelling assumptions were conservative and that emissions during the JP-5 tank filling event were well within the envelope assessed for regulatory compliance.

No monitored substance exceeded the adopted 24-hour assessment criteria during the JP-5 tank filling event. Concentrations of benzene, toluene, ethylbenzene, xylenes, cumene, cyclohexane, hexane and TVOC were all substantially below the relevant EPA Victoria and NEPM guideline values where applicable. Several compounds, including toluene, ethylbenzene, xylenes, cumene, hexane and TVOC, exhibited concentrations above baseline average levels during the monitoring period, which is consistent with the occurrence of an active tank filling event.

Overall, the JP-5 monitoring results confirm that emissions generated during the fixed-roof tank filling event do not result in unacceptable air quality impacts and that the AQIA findings remain valid and conservative for assessing impacts associated with worst-case site operations.

5. References

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Appendix A. Baseline Results Table

The below

Table A- 1 depicts the annual ambient air quality data from the ongoing air quality monitoring at the site.

Table A- 1 Baseline Ambient Air Quality Data

Date Diffusive Sampler Deployed	Hexane	Benzene	Cyclohexane	Toluene	Ethylbenzene	Xylenes (m+p+o)	Cumene (Isopropylbenzene)	TVOC
	µg/m3	µg/m3	µg/m3	µg/m3	µg/m3	µg/m3	µg/m3	µg/m3
NEPM Air Quality Criteria		10.5		411.0		947.0		
Practical Quantitation Limit (PQL)	0.002	0.002	0.002	0.002	0.002	0.002	1.000	0.008
08/02/2023	0.06	0.030	0.002	0.18	0.050	0.110	0.0025	4.000
22/02/2023	0.04	0.070	0.002	0.1	0.030	0.070	0.0012	4.000
8/03/2023	0.10	0.080	0.002	0.340	0.080	0.200	0.003	4.380
23/03/2023	0.10	0.080	0.010	0.370	0.070	0.160	0.002	3.520
5/04/2023	0.10	0.060	0.002	0.440	0.100	0.300	0.004	7.340
19/04/2023	0.10	0.060	0.002	0.450	0.080	0.180	0.003	3.870
3/05/2023	0.17	0.170	0.005	0.360	0.060	0.140	0.001	1.840
31/05/2023	0.20	0.100	0.009	1.200	0.200	0.580	0.007	8.340
14/06/2023	0.12	0.200	0.001	0.640	0.250	0.670	0.007	6.100
28/06/2023	0.10	0.200	0.001	0.450	0.100	0.400	0.004	3.540
13/07/2023	0.20	0.100	0.001	0.690	0.270	0.860	0.007	7.520
26/07/2023	0.10	0.170	0.001	0.560	0.230	0.730	0.006	3.100
10/08/2023	0.20	0.200	0.001	0.640	0.620	1.680	0.006	7.000
23/08/2023	0.20	0.230	0.001	0.630	0.330	0.900	0.005	5.000
6/09/2023	0.10	0.090	0.001	0.710	0.520	1.700	0.009	10.000
20/09/2023	0.27	0.100	0.001	0.280	0.100	0.300	0.002	5.000
1/11/2023	0.08	0.100	0.001	0.400	0.070	0.160	0.002	3.000
15/11/2023	0.08	0.040	0.001	0.400	0.100	0.400	0.004	7.000
29/11/2023	0.10	0.100	0.001	0.450	0.200	0.690	0.005	7.000
13/12/2023	0.05	0.030	0.001	0.270	0.080	0.200	0.004	6.000
11/01/2024	0.01	0.040	0.004	0.060	0.010	0.030	0.002	1.000
24/01/2024	0.05	0.030	0.002	0.200	0.060	0.160	0.003	3.000
8/02/2024	0.08	0.050	0.002	0.220	0.040	0.110	0.002	2.000
21/02/2024	0.08	0.060	0.002	0.300	0.070	0.200	0.002	3.000
6/03/2024	0.07	0.030	0.002	0.280	0.050	0.150	0.002	4.000
20/03/2024	0.08	0.060	0.002	0.200	0.030	0.080	0.001	2.000
3/04/2024	0.01	0.020	0.002	0.020	0.002	0.004	0.001	0.400
31/05/2024	0.10	0.200	0.002	0.550	0.200	0.480	0.005	7.000
12/06/2024	0.20	0.230	0.002	0.800	0.200	0.470	0.005	6.000
26/06/2024	0.45	0.210	0.002	0.500	0.100	0.300	0.003	4.000
10/07/2024	0.35	0.280	0.002	0.920	0.200	0.400	0.005	5.000
24/07/2024	0.08	0.200	0.002	0.510	0.100	0.200	0.004	5.000
8/08/2024	0.10	0.200	0.002	0.710	0.090	0.190	0.003	4.000
22/08/2024	0.20	0.100	0.002	0.610	0.080	0.180	0.003	4.000
4/09/2024	0.06	0.060	0.002	0.370	0.060	0.160	0.002	4.000
19/09/2024	0.07	0.060	0.002	0.230	0.040	0.080	0.001	3.000
4/10/2024	0.06	0.090	0.002	0.270	0.040	0.090	0.001	2.000
13/11/2024	0.06	0.010	0.002	0.400	0.100	0.300	0.005	9.000
2/12/2024	0.20	0.060	0.002	0.300	0.100	0.190	0.003	8.000

Date Diffusive Sampler Deployed	Hexane	Benzene	Cyclohexane	Toluene	Ethylbenzene	Xylenes (m+p+o)	Cumene (Isopropylbenzene)	TVOC
	µg/m3	µg/m3	µg/m3	µg/m3	µg/m3	µg/m3	µg/m3	µg/m3
NEPM Air Quality Criteria		10.5		411.0		947.0		
Practical Quantitation Limit (PQL)	0.002	0.002	0.002	0.002	0.002	0.002	1.000	0.008
13/12/2024	0.07	0.030	0.002	0.310	0.060	0.140	0.002	3.000
9/01/2025	0.10	0.080	0.002	0.250	0.050	0.120	0.001	7.000
19/02/2025	0.06	0.040	0.001	0.260	0.050	0.120	0.001	2.000
7/03/2025	0.08	0.050	0.001	0.260	0.060	0.140	0.002	3.000
22/09/2025	0.76	0.300	0.004	0.870	0.300	0.600	0.020	20.00
5/11/2025	0.10	0.050	0.001	0.430	0.070	0.160	0.002	3.000
19/11/2025	0.06	0.020	0.001	0.240	0.050	0.140	0.002	3.000
10/12/2025	0.05	0.010	0.001	0.290	0.030	0.080	0.002	2.000
5/01/2026	0.06	0.020	0.001	0.200	0.030	0.080	0.002	3.000
21/02/2026	0.03	0.030	0.002	0.200	0.040	0.090	0.001	2.680
6/02/2026	0.03	0.016	0.002	0.070	0.020	0.040	0.004	1.160

Appendix B. Laboratory Results

ENVIROLAB ENVIROLAB mpl

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CHAIN OF CUSTODY - CANISTERS / BAGS / TD TUBES

See reverse side for TERMS AND CONDITIONS FOR PROVISION OF SAMPLING EQUIPMENT

ENVIROLAB GROUP

National phone number 1300 424 344

Sydney Lab - Envirolab Services
12 Ashley St, Chatswood, NSW 2067
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07 3266 9532 | brisbane@envirolab.com.au

Darwin Office - Envirolab Services
Unit 20/119 Reichardt Road, Winnellie, NT 0820

Client: Jacobs
Contact Person: Daniel Coffey / Greg Simes
Project Mgr: Daniel Coffey
Sampler: D. Coffey / G. Simes
Address: 10/25 Parap Rd, Parap
Phone: 0421 403574 Mob:
Email: daniel.coffey@jacobs.com greg-simes@jacobs.com

Client Project Name / Number / Site etc. (i.e. report title): Project Caymus
PO No.: 8400022 86
Envirolab Quote No.: 25NT 108
Date results required:
Or choose: standard / same day / 1 day / 2 day / 3 day
Note: Inform lab in advance if urgent turnaround is required - surcharges apply
Additional report format: esdat / equis /
Lab Comments:

Sample Information												Tests Required								Comments
Envirolab Sample ID	Client Sample ID (Field Location)	Canister / TD Tube #	Soil Gas Train / Mass Flow Controller #	Leak Test Passed (Y/N)	PID Reading (ppmv)	Date of Collection	Collection Time: Time On	Collection Time: Time Off	Canister Vacuum (Hg"): Initial	Canister Vacuum (Hg"): Final	Flow Rate (Bags/TD Tubes only)	TO-15 (Cans/Bags) / TO-17 (Tubes)	TPH	5 Sulphides (Cans/Bags only)	Ozone Precursors	General Gases* (Cans/Bags only)	RGA Full List (Cans/Bags only)			
	1	Rad-133				22/9/25-24/9/25	1018	1400				X								
	2	Rad-138				22/9/25-24/9	1025	1350				X								
	3	Rad-139				22/9/25-24/9	1028	1355				X								
	4	42863				26/09/25	0154	1208	-29.6	-9		X								BTEX N-Hexane, Cyclohexane, Cumene & TVOC
	5	43349				26/09/25	0154	1208	-29.6	-10		X								
	6	43619				26/09/25	0154	1208	-29.6	-9		X								

* General Gases - Please tick one:

☐ 1) Methane, Oxygen, Carbon dioxide, Carbon monoxide, Nitrogen

☐ 2) Methane, Oxygen, Carbon dioxide, Carbon monoxide, Helium, Hydrogen

☐ 3) Specify analytes (NB: If both Nitrogen and Helium/Hydrogen are require, please contact the laboratory

Relinquished by (Company): Jacobs	Received by (Company): ELS Darwin	ELS DPOLP	Lab Use Only:
Print Name: Daniel Coffey	Print Name: Gwenda Hayes		Job Number: 39978
Date & Time: 30/9/25 08:53	Date & Time: 30/9/25 8.55	01/10/25 11:10	Security seal: Intact / Broken / None
Signature:	Signature:		TAT Req - SAME day / 1 / 2 / 3 / 4 / STD

TERMS AND CONDITIONS FOR PROVISION OF SAMPLING EQUIPMENT

Envirolab Services Pty Ltd
ABN 37 112 535 645
12 Ashley St Chatswood NSW 2067
ph 02 9910 6200 fax 02 9910 6201
customerservice@envirolab.com.au
www.envirolab.com.au

CERTIFICATE OF ANALYSIS 391978

Client Details

Client	Jacobs Group (Australia) Pty Ltd (Darwin)
Attention	Daniel Coffey
Address	34 McLachlan St, Darwin, NT, 0800

Sample Details

Your Reference	**Project Caymus**
Number of Samples	6 Air
Date samples received	01/10/2025
Date completed instructions received	01/10/2025

Analysis Details

Please refer to the following pages for results, methodology summary and quality control data.

Samples were analysed as received from the client unless as indicated below in the method summaries. Results relate specifically to the samples as received.

Results are reported on a dry weight basis for solids and on an as received basis for other matrices.

Please refer to the last page of this report for any comments relating to the results.

Report Details

Date results requested by	09/10/2025
Date of Issue	09/10/2025

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Accredited for compliance with ISO/IEC 17025 - Testing. **Tests not covered by NATA are denoted with ***

Results Approved By
Jue Wang, Chemist (FAS)

Authorised By
Nancy Zhang, Laboratory Manager

TO17 in TD tubes				
Our Reference		391978-1	391978-2	391978-3
Your Reference	UNITS	RAD-137	RAD-138	RAD-139
Date Sampled		22/09/2025	22/09/2025	22/09/2025
Type of sample		Air	Air	Air
Air Kit Security No.		RAD-137	RAD-138	RAD-139
Date prepared	-	03/10/2025	03/10/2025	03/10/2025
Date analysed	-	03/10/2025	03/10/2025	03/10/2025
Hexane	ng/tube	55	86	200^
Benzene	ng/tube	40	50	70
Cyclohexane	ng/tube	<1	<1	<1
Toluene	ng/tube	120^	160^	270^
Ethylbenzene	ng/tube	40	47	89
m-& p-Xylene	ng/tube	63	80	180
o-Xylene	ng/tube	20	28	71
Naphthalene	ng/tube	9	4	11
Isopropylbenzene	ng/tube	4	5	14
TVOC's as Toluene*	ng/tube	2,000	2,300	4,900
Surrogate-Bromochloromethane	% rec	83	102	102
Surrogate -1,4-Difluorobenzene	% rec	70	98	96
Surrogate-Chlorobenzene-D5	% rec	78	100	99

TO17 in Radiello TDTs µg/m3				
Our Reference		391978-1	391978-2	391978-3
Your Reference	UNITS	RAD-137	RAD-138	RAD-139
Date Sampled		22/09/2025	22/09/2025	22/09/2025
Type of sample		Air	Air	Air
Air Kit Security No.		RAD-137	RAD-138	RAD-139
Date prepared	-	03/10/2025	03/10/2025	03/10/2025
Date analysed	-	03/10/2025	03/10/2025	03/10/2025
Hexane	µg/m³	0.2	0.3	0.76^
Benzene	µg/m³	0.1	0.2	0.3
Cyclohexane	µg/m³	<0.004	<0.004	<0.004
Toluene	µg/m³	0.39^	0.52^	0.87^
Ethylbenzene	µg/m³	0.2	0.2	0.3
m-& p-Xylene	µg/m³	0.1	0.1	0.3
o-Xylene	µg/m³	0.08	0.1	0.3
Naphthalene	µg/m³	0.04	0.02	0.05
Isopropylbenzene	µg/m³	0.007	0.009	0.02
TVOC's as Toluene*	µg/m3	6	7	20
Surrogate-Bromochloromethane	% rec	83	102	102
Surrogate -1,4-Difluorobenzene	% rec	70	98	96
Surrogate-Chlorobenzene-D5	% rec	78	100	99

BTEX in Canisters/Bags				
Our Reference		391978-4	391978-5	391978-6
Your Reference	UNITS	H2862	H3349	H3619
Date Sampled		26/09/2025	26/09/2025	26/09/2025
Type of sample		Air	Air	Air
Air Kit Security No.		H2862	H3349	H3619
Vacuum before Shipment	Hg"	-30	-30	-30
Vacuum before Analysis	Hg"	-9	-11	-3
Date prepared	-	01/10/2025	01/10/2025	01/10/2025
Date analysed	-	01/10/2025	01/10/2025	01/10/2025
Hexane	ppbv	54	32	53
Benzene	ppbv	9.1	6.6	9.4
Cyclohexane	ppbv	15	9.2	15
Toluene	ppbv	42	31	45
Ethylbenzene	ppbv	27	20	28
m-& p-Xylene	ppbv	42	35	47
o-Xylene	ppbv	24	19	26
Naphthalene	ppbv	0.5	0.5	0.6
Isopropylbenzene	ppbv	4	3	5
TVOC's as Toluene*	ng/tube	3,200	2,700	4,100
Surrogate-Bromochloromethane	% rec	88	106	115
Surrogate -1,4-Difluorobenzene	% rec	93	112	122
Surrogate-Chlorobenzene-D5	% rec	102	118	129

BTEX in Canisters µg/m3				
Our Reference		391978-4	391978-5	391978-6
Your Reference	UNITS	H2862	H3349	H3619
Date Sampled		26/09/2025	26/09/2025	26/09/2025
Type of sample		Air	Air	Air
Air Kit Security No.		H2862	H3349	H3619
Date prepared	-	01/10/2025	01/10/2025	01/10/2025
Date analysed	-	01/10/2025	01/10/2025	01/10/2025
Vacuum before Shipment	Hg"	-30	-30	-30
Vacuum before Analysis	Hg"	-9	-11	-3
Hexane	µg/m^3	190	110	190
Benzene	µg/m^3	29	21	30
Cyclohexane	µg/m^3	52	32	53
Toluene	µg/m^3	160	120	170
Ethylbenzene	µg/m^3	120	89	120
m-& p-Xylene	µg/m^3	180	150	200
o-Xylene	µg/m^3	100	82	110
Naphthalene	µg/m^3	3	3	3
Isopropylbenzene	µg/m^3	20	20	20
TVOC's as toluene*	ug/m3	12,200	10,300	15,400
Surrogate-Bromochloromethane	% rec	88	106	115
Surrogate -1,4-Difluorobenzene	% rec	93	112	122
Surrogate-Chlorobenzene-D5	% rec	102	118	129

Method ID	Methodology Summary
TO15	USEPA TO15 - Analysis of VOC's in air using USEPA TO15 and in house method AT-002. Note, longer term stability of some oxygenated compounds is questionable where significant humidity is present.
TO17	USEPA TO17 - Analysis of VOC's in air using USEPA TO17 and in house method AT-001

QUALITY CONTROL: TO17 in TD tubes					Duplicate					Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
Date prepared	-			03/10/2025	[NT]	[NT]	[NT]	[NT]	03/10/2025	[NT]
Date analysed	-			03/10/2025	[NT]	[NT]	[NT]	[NT]	03/10/2025	[NT]
Hexane	ng/tube	1	TO17	<1	[NT]	[NT]	[NT]	[NT]	105	[NT]
Benzene	ng/tube	10	TO17	<10	[NT]	[NT]	[NT]	[NT]	97	[NT]
Cyclohexane	ng/tube	1	TO17	<1	[NT]	[NT]	[NT]	[NT]	107	[NT]
Toluene	ng/tube	10	TO17	<10	[NT]	[NT]	[NT]	[NT]	95	[NT]
Ethylbenzene	ng/tube	1	TO17	<1	[NT]	[NT]	[NT]	[NT]	95	[NT]
m-& p-Xylene	ng/tube	2	TO17	<2	[NT]	[NT]	[NT]	[NT]	89	[NT]
o-Xylene	ng/tube	1	TO17	<1	[NT]	[NT]	[NT]	[NT]	82	[NT]
Naphthalene	ng/tube	1	TO17	<1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Isopropylbenzene	ng/tube	1	TO17	<1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
TVOC's as Toluene*	ng/tube	50	TO17	<50	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Surrogate-Bromochloromethane	% rec		TO17	104	[NT]	[NT]	[NT]	[NT]	98	[NT]
Surrogate -1,4-Difluorobenzene	% rec		TO17	107	[NT]	[NT]	[NT]	[NT]	96	[NT]
Surrogate-Chlorobenzene-D5	% rec		TO17	99	[NT]	[NT]	[NT]	[NT]	94	[NT]

QUALITY CONTROL: TO17 in Radiello TDTs µg/m3					Duplicate				Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	[NT]	[NT]
Date prepared	-			03/10/2025	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Date analysed	-			03/10/2025	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Hexane	µg/m³	0.004	TO17	<0.004	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Benzene	µg/m³	0.035	TO17	<0.035	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Cyclohexane	µg/m³	0.004	TO17	<0.004	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Toluene	µg/m³	0.032	TO17	<0.032	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Ethylbenzene	µg/m³	0.004	TO17	<0.004	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
m-& p-Xylene	µg/m³	0.004	TO17	<0.004	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
o-Xylene	µg/m³	0.004	TO17	<0.004	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Naphthalene	µg/m³	0.004	TO17	<0.004	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Isopropylbenzene	µg/m³	0.0017	TO15	<0.0017	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
TVOC's as Toluene*	µg/m3	0.162	TO17	<0.162	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Surrogate-Bromochloromethane	% rec		TO17	104	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Surrogate -1,4-Difluorobenzene	% rec		TO17	107	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Surrogate-Chlorobenzene-D5	% rec		TO17	99	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]

QUALITY CONTROL: BTEX in Canisters/Bags						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
Vacuum before Shipment	Hg"			[NT]	4	-30	-30	0	[NT]	[NT]
Vacuum before Analysis	Hg"			[NT]	4	-9	-9	0	[NT]	[NT]
Date prepared	-			01/10/2025	4	01/10/2025	01/10/2025		01/10/2025	[NT]
Date analysed	-			01/10/2025	4	01/10/2025	01/10/2025		01/10/2025	[NT]
Hexane	ppbv	0.5	TO15	<0.5	4	54	54	0	96	[NT]
Benzene	ppbv	0.5	TO15	<0.5	4	9.1	9.1	0	98	[NT]
Cyclohexane	ppbv	0.5	TO15	<0.5	4	15	15	0	93	[NT]
Toluene	ppbv	0.5	TO15	<0.5	4	42	42	0	93	[NT]
Ethylbenzene	ppbv	0.5	TO15	<0.5	4	27	27	0	91	[NT]
m-& p-Xylene	ppbv	1	TO15	<1	4	42	43	2	90	[NT]
o-Xylene	ppbv	0.5	TO15	<0.5	4	24	24	0	88	[NT]
Naphthalene	ppbv	0.5	TO15	<0.5	4	0.5	0.5	0	[NT]	[NT]
Isopropylbenzene	ppbv	0.5	TO15	<0.5	4	4	5	22	[NT]	[NT]
TVOC's as Toluene*	ng/tube	50	TO17	<50	4	3200	3500	9	[NT]	[NT]
Surrogate-Bromochloromethane	% rec		TO15	95	4	88	99	12	105	[NT]
Surrogate -1,4-Difluorobenzene	% rec		TO15	97	4	93	105	12	105	[NT]
Surrogate-Chlorobenzene-D5	% rec		TO15	89	4	102	110	8	103	[NT]

QUALITY CONTROL: BTEX in Canisters µg/m3						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	[NT]	[NT]
Date prepared	-			01/10/2025	4	01/10/2025	01/10/2025		[NT]	[NT]
Date analysed	-			01/10/2025	4	01/10/2025	01/10/2025		[NT]	[NT]
Vacuum before Shipment	Hg"			[NT]	4	-30	-30	0	[NT]	[NT]
Vacuum before Analysis	Hg"			[NT]	4	-9	-9	0	[NT]	[NT]
Hexane	µg/m^3	1.8	TO15	<1.8	4	190	190	0	[NT]	[NT]
Benzene	µg/m^3	1.6	TO15	<1.6	4	29	29	0	[NT]	[NT]
Cyclohexane	µg/m^3	1.7	TO15	<1.7	4	52	53	2	[NT]	[NT]
Toluene	µg/m^3	1.9	TO15	<1.9	4	160	160	0	[NT]	[NT]
Ethylbenzene	µg/m^3	2.2	TO15	<2.2	4	120	120	0	[NT]	[NT]
m-& p-Xylene	µg/m^3	4.3	TO15	<4.3	4	180	190	5	[NT]	[NT]
o-Xylene	µg/m^3	2.2	TO15	<2.2	4	100	110	10	[NT]	[NT]
Naphthalene	µg/m^3	2.6	TO15	<2.6	4	3	3	0	[NT]	[NT]
Isopropylbenzene	µg/m^3	2.5	TO15	<2.5	4	20	20	0	[NT]	[NT]
TVOC's as toluene*	ug/m3	190	TO15	<190	4	12200	13300	9	[NT]	[NT]
Surrogate-Bromochloromethane	% rec		TO15	95	4	88	99	12	[NT]	[NT]
Surrogate -1,4-Difluorobenzene	% rec		TO15	97	4	93	105	12	[NT]	[NT]
Surrogate-Chlorobenzene-D5	% rec		TO15	89	4	102	110	8	[NT]	[NT]

Result Definitions

NT	Not tested
NA	Test not required
INS	Insufficient sample for this test
PQL	Practical Quantitation Limit
<	Less than
>	Greater than
RPD	Relative Percent Difference
LCS	Laboratory Control Sample
NS	Not specified
NEPM	National Environmental Protection Measure
NR	Not Reported

Quality Control Definitions

Blank	This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, can be determined by processing solvents and reagents in exactly the same manner as for samples.
Duplicate	This is the complete duplicate analysis of a sample from the process batch. If possible, the sample selected should be one where the analyte concentration is easily measurable.
Matrix Spike	A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist.
LCS (Laboratory Control Sample)	This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample.
Surrogate Spike	Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples.

Laboratory Acceptance Criteria

Duplicate sample and matrix spike recoveries may not be reported on smaller jobs, however, were analysed at a frequency to meet or exceed NEPM requirements. All samples are tested in batches of 20. The duplicate sample RPD and matrix spike recoveries for the batch were within the laboratory acceptance criteria.

Filters, swabs, wipes, tubes and badges will not have duplicate data as the whole sample is generally extracted during sample extraction.

Spikes for Physical and Aggregate Tests are not applicable.

For VOCs in water samples, three vials are required for duplicate or spike analysis.

Duplicates: >10xPQL - RPD acceptance criteria will vary depending on the analytes and the analytical techniques but is typically in the range 20%-50% – see ELN-P05 QA/QC tables for details; <10xPQL - RPD are higher as the results approach PQL and the estimated measurement uncertainty will statistically increase.

Air volumes are typically provided by customers (often as flow rate(s) and sampling time(s) and/or simply volumes) sampled or exposure times (determines 'volume' passive badges are exposed to)). Hence in such circumstances the volume measurement is inevitably not covered by Envirolab's NATA accreditation. An exception may occur where Envirolab Newcastle does the sampling where accreditation exists for certain types of sampling and hence volume determination(s). Note air volumes are often used to determine concentrations for dust and/or analyses on filters, sorbents and in impingers. For canister sampling, the air volume is covered by Envirolab's NATA accreditation.

Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals (not SPOCAS); 60-140% for organics/SPOCAS (+/-50% surrogates) and 10-140% for labile SVOCs (including labile surrogates), ultra trace organics and speciated phenols is acceptable.

In circumstances where no duplicate and/or sample spike has been reported at 1 in 10 and/or 1 in 20 samples respectively, the sample volume submitted was insufficient in order to satisfy laboratory QA/QC protocols.

When samples are received where certain analytes are outside of recommended technical holding times (THTs), the analysis has proceeded. Where analytes are on the verge of breaching THTs, every effort will be made to analyse within the THT or as soon as practicable.

Where sampling dates are not provided, Envirolab are not in a position to comment on the validity of the analysis where recommended technical holding times may have been breached.

Measurement Uncertainty estimates are available for most tests upon request.

Analysis of aqueous samples typically involves the extraction/digestion and/or analysis of the liquid phase only (i.e. NOT any settled sediment phase but inclusive of suspended particles if present), unless stipulated on the Envirolab COC and/or by correspondence. Notable exceptions include certain Physical Tests (pH/EC/BOD/COD/Apparent Colour etc.), Solids testing, total recoverable metals and PFAS where solids are included by default.

For Dust Deposit Gauge (DDG) analysis the sampling, sampling period and funnel exposure area do not fall under Envirolab's NATA accreditation (unless the Newcastle laboratory where responsible for the sampling), hence the annotation on the DDG units of reporting.

Urine Analysis - The BEI values listed are taken from the 2022 edition of "TLVs and BEIs Threshold Limits" by ACGIH.

Report Comments

AIR_TO17

^ the result is an estimated value: the analyte was detected at a level above the linear calibration range for said analyte(s).

Note, not all analytes have a currently available uptake rate and therefore conversion ng/tube to ug/m3 may not be feasible (an alternative compound with an uptake rate has been used but this will limit the accuracy of the data to semi-quantitative - see below):

The following uptake rates have been used for the calculation of ug/m3:

NAPHTHALENE: using 1,2,4-trimethylbenzene uptake rate

TVOC as Toluene* for Radiello tubes has been reported from the retention time of n-Hexane (n-C6) to the retention time of Naphthalene.

AIR_TO15

TVOC in canister is reported as C3-Naphthalene (propylene to naphthalene)

CHAIN OF CUSTODY - CANISTERS / BAGS / TD TUBES

ENVIROLAB GROUP / ENVIROLAB SERVICES / mpl

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See reverse side for TERMS AND CONDITIONS FOR PROVISION OF SAMPLING EQUIPMENT

ENVIROLAB GROUP
National phone number 1300 424 344
Sydney Lab - Envirolab Services, 12 Ashley St, Chatswood, NSW 2067, 02 9910 6200 | sydney@envirolab.com.au
Perth Lab - MPL Laboratories, 7-11 Catalano Rd, Canning Vale, WA 6155, 08 9317 2505 | lab@mpl.com.au
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Darwin Lab - Envirolab Services, 55 Export Drive, East Arm, NT 0822, 08 8967 1201 | darwin@envirolab.com.au
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Client:
Contact Person: Daniel Coffey
Project Mgr: " "
Sampler: " "
Address:
Phone: 0421 403 579 Mob:
Email Results to: daniel.coffey@jacobs.com
Email Invoice to: AUAPInvoices@jacobs.com

Client Project Name / Number / Site etc. (i.e. report title): Project Caymus
PO No.: 540007286
Envirolab Quote No. :- ~~NA~~ 25NT108
Date results required:
Or choose: standard / same day / 1 day / 2 day / 3 day
Note: Inform lab in advance if urgent turnaround is required - surcharges apply
Additional report format: esdat / equis / datanest
Lab Comments:

Sample Information / **Tests Required** / **Comments**

Envirolab Sample ID	Client Sample ID (Field Location)	Canister / TD Tube #	Soil Gas Train / Mass Flow Controller #	Leak Test Passed (Y/N)	PID Reading (ppmv)	Date Sampled	Collection Time: Time On	Collection Time: Time Off	Canister Vacuum (Hg"): Initial	Canister Vacuum (Hg"): Final	Flow Rate (Bags/TD Tubes only)	TPH NEPM	General Gases* (Cans/Bags only)	VOC - Full suite	BTEXN & IPA	CHCs & IPA	BTEXN, CHCs & IPA	Sulfur Speciation (Cans/Bags only)	Ozone Precursors				Comments
1		H3619	1776				16:45 - 25/2/26	0400 26/2/25	-29.7	-4													Cumene, TVOC, BTEX, N-Hexane, Cyclohexane
2		H2874	2196				↓	↓	-29.7	-1													↓
3		H2872	2193				↓	↓	-29.7	-20													↓
4		Rad-126				12:00 - 14/2/26		27/2/26															↓
5		Rad-127				↓		↓															↓
6		Rad-128				↓		↓															↓

* General Gases - Please tick one:
- ☐ 1) Methane, Oxygen, Carbon dioxide, Carbon monoxide, Nitrogen
- ☐ 2) Methane, Oxygen, Carbon dioxide, Carbon monoxide, Helium, Hydrogen
- ☐ 3) Fixed Gases Full Suite
- ☐ 4) Specify analytes (NB: If both Nitrogen and Helium/Hydrogen are require, please contact the laboratory

Relinquished by (Company):	Received by (Company): ~~Hans~~ ELS Darwin / ELS	*Lab Use Only:*
Print Name: D. Coffey	Print Name: Hans Alw / DFORD	Job Number: 403294
Date & Time: 27/2/26 4:10	Date & Time: 27/2/26 4.10 pm / 03/03/26	Security seal: Intact / Broken / None
Signature:	Signature: DF	TAT Req - SAME day / 1 / 2 / 3 / 4 / STD

Envirolab Services Pty Ltd
ABN 37 112 535 645
12 Ashley St Chatswood NSW 2067
ph 02 9910 6200 fax 02 9910 6201
customerservice@envirolab.com.au
www.envirolab.com.au

CERTIFICATE OF ANALYSIS 403294

Client Details

Client	Jacobs Group (Australia) Pty Ltd (Darwin)
Attention	Daniel Coffey
Address	34 McLachlan St, Darwin, NT, 0800

Sample Details

Your Reference	**Project Caymus**
Number of Samples	6 Air
Date samples received	03/03/2026
Date completed instructions received	03/03/2026

Analysis Details

Please refer to the following pages for results, methodology summary and quality control data.

Samples were analysed as received from the client unless as indicated below in the method summaries. Results relate specifically to the samples as received.

Results are reported on a dry weight basis for solids and on an as received basis for other matrices.

Please refer to the last page of this report for any comments relating to the results.

Report Details

Date results requested by	10/03/2026
Date of Issue	10/03/2026
NATA Accreditation Number 2901. This document shall not be reproduced except in full.	
Accredited for compliance with ISO/IEC 17025 - Testing. **Tests not covered by NATA are denoted with ***	

Results Approved By
Jue Wang, Chemist (FAS)

Authorised By
Nancy Zhang, Laboratory Manager

TO15 in Canisters/Bags				
Our Reference		403294-1	403294-2	403294-3
Your Reference	UNITS	H3619	H2874	H2872
Date Sampled		25/02/2026	25/02/2026	25/02/2026
Type of sample		Air	Air	Air
Air Kit Security No.		H3619	H2874	H2872
Vacuum before Shipment	Hg"	-30	-30	-30
Vacuum before Analysis	Hg"	-4	-0.98	-19
Date prepared	-	04/03/2026	04/03/2026	04/03/2026
Date analysed	-	04/03/2026	04/03/2026	04/03/2026
Hexane	ppbv	170	220	350
Benzene	ppbv	69	93	150
Cyclohexane	ppbv	180	260	420
Toluene	ppbv	630	700	1,100
Ethylbenzene	ppbv	470	550	740
m-& p-Xylene	ppbv	1,500	1,800	2,600
o-Xylene	ppbv	840	960	1,400
Naphthalene	ppbv	28	41	28
TVOC's as toluene*	ppbv	83,000	110,000	190,000
Surrogate-Bromochloromethane	% rec	89	101	110
Surrogate -1,4-Difluorobenzene	% rec	87	118	130
Surrogate-Chlorobenzene-D5	% rec	81	100	118

TO15 in Canisters µg/m3				
Our Reference		403294-1	403294-2	403294-3
Your Reference	UNITS	H3619	H2874	H2872
Date Sampled		25/02/2026	25/02/2026	25/02/2026
Type of sample		Air	Air	Air
Air Kit Security No.		H3619	H2874	H2872
Vacuum before Shipment	Hg"	-30	-30	-30
Vacuum before Analysis	Hg"	-4	-0.98	-19
Date prepared	-	04/03/2026	04/03/2026	04/03/2026
Date analysed	-	04/03/2026	04/03/2026	04/03/2026
Hexane	µg/m^3	600	790	1,200
Benzene	µg/m^3	220	300	490
Cyclohexane	µg/m^3	610	880	1,400
Toluene	µg/m^3	2,400	2,600	4,100
Ethylbenzene	µg/m^3	2,000	2,400	3,200
m-& p-Xylene	µg/m^3	6,500	7,700	11,000
o-Xylene	µg/m^3	3,600	4,200	6,200
Naphthalene	µg/m^3	150	220	150
TVOC's as toluene*	ug/m3	312,000	416,000	704,000
Surrogate-Bromochloromethane	% rec	89	101	110
Surrogate -1,4-Difluorobenzene	% rec	87	118	130
Surrogate-Chlorobenzene-D5	% rec	81	100	118

Extended TO15 in Cans				
Our Reference		403294-1	403294-2	403294-3
Your Reference	UNITS	H3619	H2874	H2872
Date Sampled		25/02/2026	25/02/2026	25/02/2026
Type of sample		Air	Air	Air
Air Kit Security No.		H3619	H2874	H2872
Vacuum before Shipment	Hg"	-30	-30	-30
Vacuum before Analysis	Hg"	-4	-0.98	-19
Date prepared	-	04/03/2026	04/03/2026	04/03/2026
Date analysed	-	04/03/2026	04/03/2026	04/03/2026
Isopropylbenzene	ppbv	110	130	200
Surrogate-Bromochloromethane	% rec	89	101	110
Surrogate -1,4-Difluorobenzene	% rec	87	118	130
Surrogate-Chlorobenzene-D5	% rec	81	100	118

Extented TO15 in Cans µg/m3				
Our Reference		403294-1	403294-2	403294-3
Your Reference	UNITS	H3619	H2874	H2872
Date Sampled		25/02/2026	25/02/2026	25/02/2026
Type of sample		Air	Air	Air
Air Kit Security No.		H3619	H2874	H2872
Vacuum before Shipment	Hg"	-30	-30	-30
Vacuum before Analysis	Hg"	-4	-0.98	-19
Date prepared	-	04/03/2026	04/03/2026	04/03/2026
Date analysed	-	04/03/2026	04/03/2026	04/03/2026
Isopropylbenzene	µg/m^3	560	650	990
Surrogate-Bromochloromethane	% rec	89	101	110
Surrogate -1,4-Difluorobenzene	% rec	87	118	130
Surrogate-Chlorobenzene-D5	% rec	81	100	118

TO17 in TD tubes				
Our Reference		403294-4	403294-5	403294-6
Your Reference	UNITS	RAD-126	RAD-127	RAD-128
Date Sampled		27/02/2026	27/02/2026	27/02/2026
Type of sample		Air	Air	Air
Air Kit Security No.		RAD-126	RAD-127	RAD-128
Date prepared	-	05/03/2026	05/03/2026	05/03/2026
Date analysed	-	05/03/2026	05/03/2026	05/03/2026
Hexane	ng/tube	10	76	170^
Benzene	ng/tube	20	30	60
Cyclohexane	ng/tube	<1	15	40
Toluene	ng/tube	70	360^	460^
Ethylbenzene	ng/tube	18	160^	190^
m-& p-Xylene	ng/tube	47	490^	570^
o-Xylene	ng/tube	19	230^	250^
Naphthalene	ng/tube	2	12	13
TVOC's as Toluene*	ng/tube	810	10,000	19,000
Surrogate-Bromochloromethane	% rec	96	104	95
Surrogate -1,4-Difluorobenzene	% rec	81	98	91
Surrogate-Chlorobenzene-D5	% rec	88	110	97

TO17 in TD tubes in µg/m3				
Our Reference		403294-4	403294-5	403294-6
Your Reference	UNITS	RAD-126	RAD-127	RAD-128
Date Sampled		27/02/2026	27/02/2026	27/02/2026
Type of sample		Air	Air	Air
Air Kit Security No.		RAD-126	RAD-127	RAD-128
Date prepared	-	05/03/2026	05/03/2026	05/03/2026
Date analysed	-	05/03/2026	05/03/2026	05/03/2026
Hexane	µg/m^3	0.03	0.3	0.58^
Benzene	µg/m^3	0.07	0.1	0.2
Cyclohexane	µg/m^3	<0.003	0.05	0.1
Toluene	µg/m^3	0.2	1^	1.3^
Ethylbenzene	µg/m^3	0.06	0.5^	0.6^
m-& p-Xylene	µg/m^3	0.08	0.8^	0.9^
o-Xylene	µg/m^3	0.07	0.8^	0.9^
Naphthalene	µg/m^3	0.008	0.05	0.05
TVOC's as Toluene*	µg/m3	2.3	29.2	56.1
Surrogate-Bromochloromethane	% rec	96	104	95
Surrogate -1,4-Difluorobenzene	% rec	81	98	91
Surrogate-Chlorobenzene-D5	% rec	88	110	97

TO17 in TD tubes				
Our Reference		403294-4	403294-5	403294-6
Your Reference	UNITS	RAD-126	RAD-127	RAD-128
Date Sampled		27/02/2026	27/02/2026	27/02/2026
Type of sample		Air	Air	Air
Air Kit Security No.		RAD-126	RAD-127	RAD-128
Date prepared	-	05/03/2026	05/03/2026	05/03/2026
Date analysed	-	05/03/2026	05/03/2026	05/03/2026
Isopropylbenzene	ng/tube	3	39	52
Surrogate-Bromochloromethane	% rec	96	104	95
Surrogate -1,4-Difluorobenzene	% rec	81	98	91
Surrogate-Chlorobenzene-D5	% rec	88	110	97

TO17 in TD tubes in µg/m3				
Our Reference		403294-4	403294-5	403294-6
Your Reference	UNITS	RAD-126	RAD-127	RAD-128
Date Sampled		27/02/2026	27/02/2026	27/02/2026
Type of sample		Air	Air	Air
Air Kit Security No.		RAD-126	RAD-127	RAD-128
Date prepared	-	05/03/2026	05/03/2026	05/03/2026
Date analysed	-	05/03/2026	05/03/2026	05/03/2026
Isopropylbenzene	µg/m^3	0.004	0.06	0.08
Surrogate-Bromochloromethane	% rec	96	104	95
Surrogate -1,4-Difluorobenzene	% rec	81	98	91
Surrogate-Chlorobenzene-D5	% rec	88	110	97

Method ID	Methodology Summary
TO15	USEPA TO15 - Analysis of VOC's in air using USEPA TO15 and in house method AT-002. Note, longer term stability of some oxygenated compounds is questionable where significant humidity is present.
TO17	USEPA TO17 - Analysis of VOC's in air using USEPA TO17 and in house method AT-001

QUALITY CONTROL: TO15 in Canisters/Bags					Duplicate				Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
Date prepared	-			04/03/2026	[NT]	[NT]	[NT]	[NT]	04/03/2026	[NT]
Date analysed	-			04/03/2026	[NT]	[NT]	[NT]	[NT]	04/03/2026	[NT]
Hexane	ppbv	0.5	TO15	<0.5	[NT]	[NT]	[NT]	[NT]	111	[NT]
Benzene	ppbv	0.5	TO15	<0.5	[NT]	[NT]	[NT]	[NT]	110	[NT]
Cyclohexane	ppbv	0.5	TO15	<0.5	[NT]	[NT]	[NT]	[NT]	100	[NT]
Toluene	ppbv	0.5	TO15	<0.5	[NT]	[NT]	[NT]	[NT]	104	[NT]
Ethylbenzene	ppbv	0.5	TO15	<0.5	[NT]	[NT]	[NT]	[NT]	106	[NT]
m-& p-Xylene	ppbv	1	TO15	<1	[NT]	[NT]	[NT]	[NT]	103	[NT]
o-Xylene	ppbv	0.5	TO15	<0.5	[NT]	[NT]	[NT]	[NT]	115	[NT]
Naphthalene	ppbv	0.5	TO15	<0.5	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
TVOC's as toluene*	ppbv	50	TO15	<50	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Surrogate-Bromochloromethane	% rec		TO15	102	[NT]	[NT]	[NT]	[NT]	108	[NT]
Surrogate -1,4-Difluorobenzene	% rec		TO15	100	[NT]	[NT]	[NT]	[NT]	112	[NT]
Surrogate-Chlorobenzene-D5	% rec		TO15	101	[NT]	[NT]	[NT]	[NT]	107	[NT]

QUALITY CONTROL: TO15 in Canisters µg/m3					Duplicate				Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	[NT]	[NT]
Date prepared	-			04/03/2026	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Date analysed	-			04/03/2026	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Hexane	µg/m³	1.8	TO15	<1.8	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Benzene	µg/m³	1.6	TO15	<1.6	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Cyclohexane	µg/m³	1.7	TO15	<1.7	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Toluene	µg/m³	1.9	TO15	<1.9	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Ethylbenzene	µg/m³	2.2	TO15	<2.2	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
m-& p-Xylene	µg/m³	4.3	TO15	<4.3	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
o-Xylene	µg/m³	2.2	TO15	<2.2	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Naphthalene	µg/m³	2.6	TO15	<2.6	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
TVOC's as toluene*	ug/m3	190	TO15	<190	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Surrogate-Bromochloromethane	% rec		TO15	102	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Surrogate -1,4-Difluorobenzene	% rec		TO15	100	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Surrogate-Chlorobenzene-D5	% rec		TO15	101	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]

QUALITY CONTROL: Extended TO15 in Cans					Duplicate				Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
Date prepared	-			04/03/2026	[NT]	[NT]	[NT]	[NT]	04/03/2026	[NT]
Date analysed	-			04/03/2026	[NT]	[NT]	[NT]	[NT]	04/03/2026	[NT]
Isopropylbenzene	ppbv	0.5	TO15	<0.5	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Surrogate-Bromochloromethane	% rec		TO15	102	[NT]	[NT]	[NT]	[NT]	108	[NT]
Surrogate -1,4-Difluorobenzene	% rec		TO15	100	[NT]	[NT]	[NT]	[NT]	112	[NT]
Surrogate-Chlorobenzene-D5	% rec		TO15	101	[NT]	[NT]	[NT]	[NT]	107	[NT]

QUALITY CONTROL: Extented TO15 in Cans µg/m3					Duplicate				Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	[NT]	[NT]
Date prepared	-			04/03/2026	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Date analysed	-			04/03/2026	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Isopropylbenzene	µg/m^3	2.5	TO15	<2.5	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Surrogate-Bromochloromethane	% rec		TO15	102	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Surrogate -1,4-Difluorobenzene	% rec		TO15	100	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Surrogate-Chlorobenzene-D5	% rec		TO15	101	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]

QUALITY CONTROL: TO17 in TD tubes					Duplicate				Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
Date prepared	-			05/03/2026	[NT]	[NT]	[NT]	[NT]	05/03/2026	[NT]
Date analysed	-			05/03/2026	[NT]	[NT]	[NT]	[NT]	05/03/2026	[NT]
Hexane	ng/tube	1	TO17	<1	[NT]	[NT]	[NT]	[NT]	102	[NT]
Benzene	ng/tube	10	TO17	<10	[NT]	[NT]	[NT]	[NT]	97	[NT]
Cyclohexane	ng/tube	1	TO17	<1	[NT]	[NT]	[NT]	[NT]	95	[NT]
Toluene	ng/tube	10	TO17	<10	[NT]	[NT]	[NT]	[NT]	100	[NT]
Ethylbenzene	ng/tube	1	TO17	<1	[NT]	[NT]	[NT]	[NT]	87	[NT]
m-& p-Xylene	ng/tube	2	TO17	<2	[NT]	[NT]	[NT]	[NT]	85	[NT]
o-Xylene	ng/tube	1	TO17	<1	[NT]	[NT]	[NT]	[NT]	87	[NT]
Naphthalene	ng/tube	1	TO17	<1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
TVOC's as Toluene*	ng/tube	50	TO17	<50	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Surrogate-Bromochloromethane	% rec		TO17	104	[NT]	[NT]	[NT]	[NT]	108	[NT]
Surrogate -1,4-Difluorobenzene	% rec		TO17	99	[NT]	[NT]	[NT]	[NT]	100	[NT]
Surrogate-Chlorobenzene-D5	% rec		TO17	92	[NT]	[NT]	[NT]	[NT]	102	[NT]

QUALITY CONTROL: TO17 in TD tubes in µg/m3					Duplicate				Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	[NT]	[NT]
Date prepared	-			05/03/2026	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Date analysed	-			05/03/2026	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Hexane	µg/m³	0.003	TO17	<0.003	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Benzene	µg/m³	0.031	TO17	<0.031	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Cyclohexane	µg/m³	0.003	TO17	<0.003	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Toluene	µg/m³	0.029	TO17	<0.029	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Ethylbenzene	µg/m³	0.003	TO17	<0.003	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
m-& p-Xylene	µg/m³	0.003	TO17	<0.003	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
o-Xylene	µg/m³	0.004	TO17	<0.004	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Naphthalene	µg/m³	0.004	TO17	<0.004	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
TVOC's as Toluene*	µg/m3	0.145	TO17	<0.145	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Surrogate-Bromochloromethane	% rec		TO17	104	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Surrogate -1,4-Difluorobenzene	% rec		TO17	99	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Surrogate-Chlorobenzene-D5	% rec		TO17	92	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]

QUALITY CONTROL: TO17 in TD tubes					Duplicate				Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	[NT]	[NT]
Date prepared	-			05/03/2026	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Date analysed	-			05/03/2026	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Isopropylbenzene	ng/tube	1	TO17	<1	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Surrogate-Bromochloromethane	% rec		TO17	104	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Surrogate -1,4-Difluorobenzene	% rec		TO17	99	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Surrogate-Chlorobenzene-D5	% rec		TO17	92	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]

QUALITY CONTROL: TO17 in TD tubes in µg/m3						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	[NT]	[NT]
Date prepared	-			05/03/2026	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Date analysed	-			05/03/2026	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Isopropylbenzene	µg/m³	0.0015	TO15	<0.0015	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Surrogate-Bromochloromethane	% rec		TO17	104	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Surrogate -1,4-Difluorobenzene	% rec		TO17	99	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]
Surrogate-Chlorobenzene-D5	% rec		TO17	92	[NT]	[NT]	[NT]	[NT]	[NT]	[NT]

Result Definitions

NT	Not tested
NA	Test not required
INS	Insufficient sample for this test
PQL	Practical Quantitation Limit
<	Less than
>	Greater than
RPD	Relative Percent Difference
LCS	Laboratory Control Sample
NS	Not specified
NEPM	National Environmental Protection Measure
NR	Not Reported

Quality Control Definitions

Blank	This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, can be determined by processing solvents and reagents in exactly the same manner as for samples.
Duplicate	This is the complete duplicate analysis of a sample from the process batch. If possible, the sample selected should be one where the analyte concentration is easily measurable.
Matrix Spike	A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist.
LCS (Laboratory Control Sample)	This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample.
Surrogate Spike	Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples.

Laboratory Acceptance Criteria

Duplicate sample and matrix spike recoveries may not be reported on smaller jobs, however, were analysed at a frequency to meet or exceed NEPM requirements. All samples are tested in batches of 20. The duplicate sample RPD and matrix spike recoveries for the batch were within the laboratory acceptance criteria.

Filters, swabs, wipes, tubes and badges will not have duplicate data as the whole sample is generally extracted during sample extraction.

Spikes for Physical and Aggregate Tests are not applicable.

For VOCs in water samples, three vials are required for duplicate or spike analysis.

Duplicates: >10xPQL - RPD acceptance criteria will vary depending on the analytes and the analytical techniques but is typically in the range 20%-50% – see ELN-P05 QA/QC tables for details; <10xPQL - RPD are higher as the results approach PQL and the estimated measurement uncertainty will statistically increase.

Air volumes are typically provided by customers (often as flow rate(s) and sampling time(s) and/or simply volumes) sampled or exposure times (determines 'volume' passive badges are exposed to)). Hence in such circumstances the volume measurement is inevitably not covered by Envirolab's NATA accreditation. An exception may occur where Envirolab Newcastle does the sampling where accreditation exists for certain types of sampling and hence volume determination(s). Note air volumes are often used to determine concentrations for dust and/or analyses on filters, sorbents and in impingers. For canister sampling, the air volume is covered by Envirolab's NATA accreditation.

Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals (not SPOCAS); 60-140% for organics/SPOCAS (+/-50% surrogates) and 10-140% for labile SVOCs (including labile surrogates), ultra trace organics and speciated phenols is acceptable.

In circumstances where no duplicate and/or sample spike has been reported at 1 in 10 and/or 1 in 20 samples respectively, the sample volume submitted was insufficient in order to satisfy laboratory QA/QC protocols.

When samples are received where certain analytes are outside of recommended technical holding times (THTs), the analysis has proceeded. Where analytes are on the verge of breaching THTs, every effort will be made to analyse within the THT or as soon as practicable.

Where sampling dates are not provided, Envirolab are not in a position to comment on the validity of the analysis where recommended technical holding times may have been breached.

Measurement Uncertainty estimates can be downloaded from the Envirolab Resources website or obtained directly by contacting the laboratory.

Analysis of aqueous samples typically involves the extraction/digestion and/or analysis of the liquid phase only (i.e. NOT any settled sediment phase but inclusive of suspended particles if present), unless stipulated on the Envirolab COC and/or by correspondence. Notable exceptions include certain Physical Tests (pH/EC/BOD/COD/Apparent Colour etc.), Solids testing, total recoverable metals and PFAS where solids are included by default.

For Dust Deposit Gauge (DDG) analysis the sampling, sampling period and funnel exposure area do not fall under Envirolab's NATA accreditation (unless the Newcastle laboratory where responsible for the sampling), hence the annotation on the DDG units of reporting.

Urine Analysis - The BEI values listed are taken from the 2022 edition of "TLVs and BEIs Threshold Limits" by ACGIH.

Report Comments

AIR_TO17

^ the result is an estimated value: the analyte was detected at a level above the linear calibration range for said analyte(s).

TVOC as Toluene* has been reported from the retention time of n-Hexane (n-C6) to the retention time of Naphthalene.

AIR_TO15

TVOC as Toluene* has been reported from the retention time of Propylene to the retention time of Naphthalene.

Appendix C. Air Quality Impact Assessment

Level 1 Air Quality Impact Assessment

Document no: IW272400-1-NN-RPT-001
Revision no: 2

Crowley Engineering Pty Ltd
PO22-00125

Project Caymus Bulk Fuel Storage Facility
11 August 2022

Level 1 Air Quality Impact Assessment

Client name:	Crowley Engineering Pty Ltd		
Project name:	Project Caymus		
Client reference:	PO22-00125	**Project no:**	IW272400
Document no:	IW272400-1-NN-RPT-001	**Project manager:**	Darren Skuse
Revision no:	2	**Prepared by:**	Matthew Pickett
Date:	11 August 2022	**File name:**	IW272400-1-NN-RPT-001 Caymus AQIA_REV2
Doc status:	Final report		

Document history and status

Rev.	Date	Description	Author	Checked	Reviewed	Approved
0	25/3/22	Draft report	M Pickett		G Simes	D.Skuse
1	.30/3/22	Draft report	M Pickett		G Simes	D.Skuse
2.1	29/7/22	Final report	M Pickett	AV, SP, TF (Jacobs)	T Freeman	A Beraldo
2.2	5/8/22	Final report	M Pickett	LN (Crowley)	D.Skuse	D.Skuse
2.3	11/8/22	Final report	M Pickett	LN	D.Skuse	D.Skuse

Distribution of copies

Revision	Issue approved	Date issued	Issued to	Comments
1	30/3/22	30/3/22	L Noland	Final draft Rev 1
2.1	5/8/22	5/8/22	L Noland	Client review
2.2	5/8/22	5/8/22	L Noland	Client review
2.3	11/8/22	11/8/22	L Noland	Final report

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Executive summary

Crowley engaged Jacobs to undertake a ‘Level 1’ (screening level) air quality impact assessment for the Project Caymus Bulk Fuel Storage Facility (BFSF) as a condition of the Northern Territory Government Environmental Approval Number EP2021/008–001 (NTG, 2021). The relevant Environmental Conditions were (quote):*11.c Within 20 business days after the commencement of construction of the action, complete:*

> *(i) a Level 1 air quality impact assessment (AQIA) of the operational design of the action; and*
>
> *(ii) if required following completion of the Level 1 assessment, a Level 2 (refined dispersion modelling) AQIA for operation of the action.*

The NSW Environment Protection Authority *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (NSW 2016) sets out two levels of AQIA: Level 1 is a screening-level dispersion modelling technique using worst-case input data including the use of synthetic meteorological data covering a wide range of hypothetical meteorological conditions. The AQIA was undertaken in accordance with NSW (2016); a compliance checklist is provided in Appendix D.

The worst-case BFSF operation was determined by ‘TANKS’ modelling of air emissions of hydrocarbon vapours, (Volatile Organic Compounds or ‘VOCs’), due to fuel-loading of four floating-roof F-35 (AVTUR) tanks and seven fixed-roof F-44 (AVCAT) tanks. The worst-case air emissions scenario was determined to be loading the fixed-roof tanks at the maximum fuel-loading rate, an equipment limitation on East Arm Wharf.

A synthetic meteorological data file was created in accordance with the Level 1 assessment requirements of NSW (2016) and used for this assessment. Additionally, sensitivity tests were conducted with other meteorological datasets; e.g., (1) an annual dataset based on hourly average meteorological observations at Darwin Airport; and (2) Ausplume’s own screening-test meteorological file (‘met-sample’). The Ausplume results were very similar regardless of the meteorological data used.

Ausplume was selected for the Project Caymus Level 1 ‘screening level’ assessment; the model is specified for use in NSW (2016). Ausplume modelling was completed for 10,201 grid receptors with horizontal resolution 100 metres giving a study grid area of 14 km east-west by 10 km north-south, centred on the Project Caymus site location in East Arm District.

The NSW (2016) VOCs were assessed by comparisons of the Ausplume-predicted maximum Ground Level Concentrations (GLC) of individual toxic VOCs with relevant NSW (2016) Impact Assessment Criteria (IAC) applied at and beyond site boundaries; i.e., at all 10,201 grid receptor locations. The results for the highest maximum 1-hour average GLC for the toxic VOCs was benzene:

- benzene 1.9 $\mu g/m^3$ (6.5% of IAC - 29 $\mu g/m^3$)

The NSW (2016) odorous VOCs were assessed by comparisons of the Ausplume-predicted maximum GLCs with IAC applied at existing or future sensitive receptor locations – ten discrete (sensitive) receptor locations. The results for the highest maximum 1-hour average GLCs for the odorous VOCs was for cumene:

- cumene 0.6 $\mu g/m^3$ (2.7% of IAC - 21 $\mu g/m^3$)

All the Ausplume results were less than 7% of their IAC – none of the thousands of Ausplume results obtained for Project Caymus operations exceeded NSW impact assessment criteria.

In conclusion, the results indicate there is a low risk of air quality impact on and around East Arm Wharf and anywhere else in the Darwin region due to operations by Project Caymus.

It is not recommended to proceed to a Level 2 assessment as prescribed in NSW (2016) for these reasons:

- NSW EPA (2016) Section 2.1 states – ”*It is not intended that an assessment should routinely progress through the two levels… if a Level 1 assessment conclusively demonstrates that adverse impacts will not occur, there is no need to progress to Level 2*”. There were no Ausplume-predicted exceedences of NSW impact assessment criteria at any receptor. Further, all the Ausplume results were less than 7% of IAC.
- Further, the BFSF loading operation will be a unique event, occurring once to fill the fuel farm. Essentially the fuel farm will serve as a storage facility.

Important note about your report

The sole purpose of this report and the associated services performed by Jacobs was to provide an air quality assessment for Crowley in accordance with the scope of services set out in the contract between Jacobs and the Client. That scope of services, as described in this report, was developed with the Client.

In preparing this report, Jacobs has relied upon, and presumed accurate, any information (or confirmation of the absence thereof) provided by the Client and/or from other sources. Except as otherwise stated in the report, Jacobs has not attempted to verify the accuracy or completeness of any such information. If the information is subsequently determined to be false, inaccurate or incomplete then it is possible that our observations and conclusions as expressed in this report may change.

Jacobs derived the data in this report from information sourced from the Client (if any) and/or available in the public domain at the time or times outlined in this report. The passage of time, manifestation of latent conditions or impacts of future events may require further examination of the project and subsequent data analysis, and re-evaluation of the data, findings, observations and conclusions expressed in this report.

Jacobs has prepared this report in accordance with the usual care and thoroughness of the consulting profession for the sole purpose described above and by reference to applicable standards, guidelines, procedures and practices at the date of issue of this report. For the reasons outlined above, however, no other warranty or guarantee, whether expressed or implied, is made as to the data, observations and findings expressed in this report, to the extent permitted by law.

This report should be read in full and no excerpts are to be taken as representative of the findings. No responsibility is accepted by Jacobs for use of any part of this report in any other context.

This report has been prepared on behalf of, and for the exclusive use of, Jacobs's Client, and is subject to, and issued in accordance with, the provisions of the contract between Jacobs and the Client. Jacobs accepts no liability or responsibility whatsoever for, or in respect of, any use of, or reliance upon, this report by any third party.

Contents

Executive summary....i
Acronyms and abbreviations....iv
1. Introduction....1
  1.1 Background....1
  1.2 Project Caymus and air quality assessment....1
  1.3 Scope of AQIA....1
2. Project Description....3
  2.1 Overview....3
  2.2 Site Plan....3
  2.3 Site Activities....3
  2.4 Air Emissions Inventory....4
  2.5 Sensitive Receptors....7
3. Local Air Environment....8
  3.1 Overview....8
  3.2 Darwin Climatology....8
  3.3 Meteorological Data for Assessment....8
  3.4 Background VOC levels....9
4. Modelling Methodology....10
  4.1 Overview....10
  4.2 Tank venting: source type....10
  4.3 Worst Case Air Emissions Scenario....10
  4.4 NSW (2016) Level 1 AQIA requirements....10
  4.5 Ausplume inputs....12
  4.6 Geographical parameters....13
5. Ausplume results....14
  5.1 Overview....14
  5.2 Summary of Key Ausplume Results....14
  5.3 Electronic files....15
6. Conclusion....16
7. References....17

Appendices

Appendix A. Darwin Air Quality Study Area....18
Appendix B. Project Caymus Site Plan and Elevation....19
Appendix C. Wind Roses – Darwin Airport....20
  C.1 Annual wind roses 2014-2018....20
  C.2 Seasonal wind roses 2014-2018....21
Appendix D. Compliance with EPA (2016)....22

Acronyms and abbreviations

AG	Australian Government
AQIA	Air Quality Impact Assessment
BBL	Barrel – oil volume unit equivalent to 42 USG (‘BBL’ origin is ‘blue barrel’)
BFSF	Bulk Fuel Storage Facility
Crowley	Crowley Australia Pty Ltd
EPA Victoria	Environment Protection Authority Victoria
FSII	Fuel System Icing Inhibitor
GLC	Ground Level Concentration (from model results, for comparison with IAC)
IAC	Impact Assessment Criteria (NSW EPA)
kL	kiloLitre
MGA2020	Map Grid of Australia 2020 (Geoscience Australia)
ML	MegaLitre
NEPC	National Environment Protection Council
NPI	National Pollutant Inventory
NSW EPA	New South Wales Environment Protection Authority
NT EPA	Northern Territory Environment Protection Authority
t	tonne (metric; 1000 kg)
USG	U.S. Gallon
U.S.	United States of America
VOC	Volatile Organic Compound – for the purpose of this report the Australian Government NPI definition is adopted; i.e., *any chemical compound based on carbon chains or rings with a vapour pressure greater than 0.01 kiloPascal at 293.15 K (25 degrees Celsius) that participate in chemical reactions; exclusions include carbon monoxide and methane; see AG* (2009).

1. Introduction

1.1 Background

A U.S. Defence Bulk Fuel Storage Facility (BFSF) is to be located on Lot 5720 west of the Railway Terminal on East Arm District, Northern Territory, near Darwin. The jet fuel storage facility functional requirements were identified as having a minimum storage of 300 MegaLitre (ML) jet fuel comprising the capacities:

- 700,000 barrels (111.3 ML) of F-35 or 'AVTUR' jet fuel (military kerosene type) aviation turbine fuel with Fuel System Icing Inhibitor (FSII) used by land-based military gas turbine engine aircraft; and
- 1,200,000 barrels (190.8 ML) F-44 or 'AVCAT' combustible jet fuel (military high flash-point kerosene type) aviation turbine fuel with FSII used by ship borne military gas turbine engine aircraft.

1.2 Project Caymus and air quality assessment

Crowley Australia Pty Ltd (Crowley) is pursing development of the new BFSF (Project Caymus). The 300 ML-capacity BFSF will comprise eleven fuel tanks: four vertical floating-roof tanks for F-35; and seven vertical fixed-roof tanks for F-44. Crowley engaged Tetra Tech Proteus partnering with Pritchard Francis to undertake the Phase I Project Definition and Conceptual Design for the BFSF, and Pritchard Francis engaged CDM Smith to undertake the environmental approvals.

On 29th November 2021 the Northern Territory Government approved construction and operation of the BFSF and ancillary infrastructure for the transfer and storage of jet fuel – Environmental Approval Number EP2021/008 – 001.

Environmental condition 11 of the Approval is the 'approval holder must ensure there are no attributable impacts from the (BFSF) on the following environmental outcome:

- *Protect air quality and minimise emissions and their impacts on the Darwin airshed so that environmental values are maintained.*'

The NT Government Minister for Environment determined that due to the estimated emissions of Volatile Organic Compounds (VOCs) from the planned BFSF, including cumulative impacts to the regional airshed; i.e., the wider Darwin region, that there is potential for Darwin's air quality to be impacted. Accordingly, the NT EPA required Crowley conduct an air quality impact assessment (AQIA) to demonstrate the project will not have a significant air quality impact. This report describes the AQIA undertaken and results.

1.3 Scope of AQIA

Crowley requested Jacobs perform the AQIA of the operational design of the Caymus BFSF as required by the Northern Territory Environment Protection Authority (NT EPA), described in the Environmental Approval Number EP2021/008 – 001; specifically Conditions 11.c. and 11.d (Northern Territory Government, 29 November 2021):

The preceding Notice of Decision and Statement of Reasons includes these conditions (NT EPA, 14 October 2021):

- *Condition 11.c. Within 20 business days after the commencement of construction of the action, complete:*
    - *Level 1 AQIA of the operational design of the action; and*
    - *If required following completion of the Level 1 assessment, a Level 2 (refined dispersion modelling) AQIA for operation of the action.*
- *Condition 11.d. Undertake the AQIA in accordance with the Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales (State of NSW and Environment Protection Authority [EPA] 2016 or latest version), to the satisfaction of the CEO. An AQIA report must be provided to the CEO within 20 business days of completing the AQIA.*

Exclusions from the scope of work are described in the following points:

- The assessment was based on air dispersion modelling of BFSF emissions in accordance with the NSW Environment Protection Authority *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (NSW, 2016), for the VOCs of interest. The inclusion of background VOC concentrations was outside the scope of the NSW (2016) Level 1 assessment.
- It was assumed NT EPA's intention was to focus the assessment on VOCs; i.e., to assess air quality impact due to emissions of VOCs; i.e., the assessment of emissions of 'criteria pollutants' such as nitrogen dioxide and particulate matter was outside the scope of this assessment.
- If accidental, (relatively small), leaks and spills occur their VOC emissions are expected to have a negligible effect on ambient air quality. The spills would occur over relatively short timeframes, and they are expected to be cleaned up quickly.
- An assessment for the wider Darwin region ('airshed'), was outside the scope of this assessment.

In summary this NSW (2016) Level 1 AQIA assessed the VOC emissions expected from sources associated with filling the BFSF; i.e., filling of floating-roof tanks with F-35 ('AVTUR'), and the filling of fixed-roof tanks with F-44 ('AVCAT'), with the focus on the worst-case air emissions scenario, filling the fixed-roof tanks.

The report also provides recommendations on whether a Level 2 AQIA may be required, as per the second point of Condition 11.c, with the ultimate conclusion that a Level 2 AQIA is not necessary.

2. Project Description

2.1 Overview

The air quality study area for the Level 1 AQIA for Project Caymus is shown in Figure 2-1 (see also Appendix A). The study area was designed to capture the key discrete (sensitive) receptors for the modelling study and other industrial sources of air pollution considered in the cumulative impact assessment.

Figure 2-1 Project Caymus air quality study area

- Base map aligned to grid north (base map image: Google Earth).
- Co-ordinate system Map Grid of Australia 2020; co-ordinates labelled in metres.
- Plotted points: Discrete (sensitive) receptor locations (blue); to decode abbreviations see Section 2.5. Industrial facilities (yellow) with abbreviations: ‘PC’ =Project Caymus; ‘VT’ = Vopak Terminal; ‘DLNG’ = Darwin LNG (plant). INPEX plant location also plotted.

Details about the Ausplume model study grid are provided in Section 0.

2.2 Site Plan

A Project Caymus site plan and elevation are provided in Appendix B. The site is located on East Arm District shown by ‘PC’ in the centre of Figure 2-1, between the existing Vopak Terminal (VT) and Darwin Rail Terminal (DRT).

2.3 Site Activities

There will be very little site activity most of the time. Fuel ships will be unloaded at Wharf 4 at the East Arm port facility approximately four times per year. Fuel will be delivered via ship to the BFSF along a pre-existing pipeline rack and easement. Fuel will be delivered via shore pumps located at the storage facility (CDM

Smith, 2021). After the initial terminal fill, the expectation is that the terminal will receive about 120 ML/annum (4 ships).

The maximum BFSF fuel loading rate will be 1,400 m^3/hr, which was a key input for this AQIA; i.e., part of the assessment of the worst-case operating scenario. Other site activities such as tank truck on/off loading were considered to be minor relative to the main activity for assessment which is high-rate fuel loading to the BFSF.

2.4 Air Emissions Inventory

2.4.1 Overview

The purpose of this section is to set out the air (VOC) emissions estimates used as input to the AQIA for the Caymus Project. Other significant sources of VOC emissions in the study area were identified.

2.4.2 Fuel tank air emissions

A fuel tank fitted with a vent, usually on top-centre, will emit fuel vapours (VOCs) as it is being filled with fuel, as the air space within decreases. The vented emissions occur at ambient temperature, and relatively slowly, so the buoyancy of the emissions is expected to be zero. A diagram of a Crowley fixed-roof tank vent is provided in Figure 2-2.

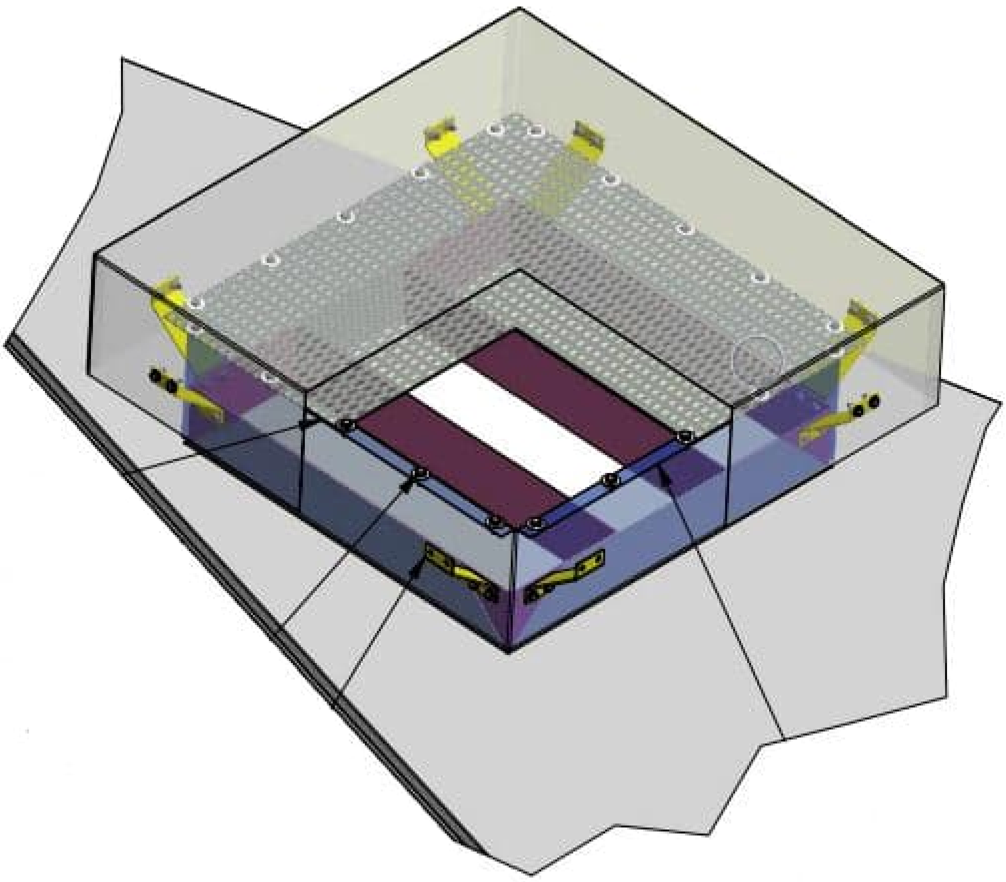

Figure 2-2 Project Caymus vertical fixed-roof tank – single roof vent with cover

In Australia, the rate of VOCs released may be calculated using National Pollutant Inventory (NPI) methods. However, for this assessment, more accurate modelling was completed using the U.S. EPA 'TANKS' model. The Australian Government (AG) NPI Emissions Estimation Technique Manual for Fuel and Organic Liquid Storage (AG, 2012), was used to speciate the TANKS results into individual species, such as benzene. The speciation compared well with the speciation calculated directly from TANKS.

The seven vertical fixed-roof F-44 tanks of Project Caymus are geodesic dome rooves with VOCs vented from the top vents and the rims, the latter comprising intersections of roof joints and shells. The four floating-roof F-35 tanks are equipped with full contact floating rooves with no fuel surface areas venting to internal tank spaces.

2.4.3 Air emissions scenarios and estimates

Analysis of the NSW (2016) impact assessment criteria, the TANKS model outputs, and the proposed Caymus fuel loading operations, led to use of the maximum BFSF fuel-loading rate in the Ausplume model to determine maximum 1-hour average VOC Ground Level Concentrations (GLCs) for assessment. The maximum fuel loading rate was a limitation of the East Arm wharf facilities, not a Caymus limitation.

Air emissions parameters and estimates for the BFSF Floating-Roof tank fuel-loading scenario are provided in Table 2-1, and similarly for the Fixed-Roof tank fuel-loading scenario in Table 2-2.

Table 2-1 BFSF maximum F-35 fuel-loading scenario: four Floating-Roof tanks

Assessment parameter	Value	Notes
Turnover (conservative, high)	Single turnover	Single filling event
Working volume per tank (input to TANKS program)	7,386,300 27,960	USG per tank, or kL per tank[1.]
No. of floating-roof tanks	4	
Fuel farm "working capacity", and conservative (high) fuel movement for assessment	29,545,200 111,840 703,457	USG, or kL[1.], or BBL[2.]
Floating-roof tank scenario, annual venting		
Standing loss time (no working losses by TANKS)	8760	hours of emissions (hours in one year)
Fuel density	0.837	t/kL
TANKS model result: standing (and total) losses	27.65	kg TVOC per annum
Calculated TVOC emission rate	0.0032	kg/h
Calculated TVOC emission rate	0.001	g/s – annual average emission rate
Conclusion:	Negligible TVOC emission rate for assessment	

1. Conversion factor 3.785412 L/USG
2. Conversion factor 42 USG/BBL

Table 2-2 BFSF maximum F-44 fuel-loading scenario: seven Fixed-Roof tanks

Assessment parameter	Value	Notes
Turnover (conservative, high)	Single turnover	Single filling event
Working volume per tank (input to TANKS program)	7,386,300 27,960	USG per tank, or kL per tank[1.]

Assessment parameter	Value	Notes
No. of fixed-roof tanks	7	
Fuel farm "working capacity", and conservative (high) fuel movement for assessment	51,704,100 195,721 1,231,050	USG, or kL[1.], or BBL[2.]
Floating-roof tank scenario, East Arm Wharf maximum fuel loading rate 1,400 kL/h		
Time to load AVCAT tanks	139.8	hours to load
Fuel density	0.837	t/kL
Fuel loading rate (t/h)	1,172	t/h
Total working losses (calculated by TANKS model)	1,330	kg TVOC
Calculated TVOC emission rate (worst-case VOC emissions scenario for input to Ausplume)	9.51 2.64	kg/h, or g/s

3. Conversion factor 3.785412 L/USG
4. Conversion factor 42 USG/BBL

The speciation of the TVOC emissions estimates into benzene etc. used the NEPC (2012) emissions factors for jet kerosene, but equivalently could have been done using the TANKS outputs directly (data comparisons confirmed this). The speciation results and calculated species emission rates are provided in Table 2-3, by emission rate (g/s).

Table 2-3 Speciation of TVOC emissions results

VOC species	Emission rate, floating roof tank (g/s)	Emission rate, fixed-roof tank (g/s)
Benzene	3.0×10^{-6}	0.019
Cumene	12×10^{-6}	0.008
Cyclohexane	9.7×10^{-6}	0.065
Ethylbenzene	2.3×10^{-6}	0.003
n-Hexane	48×10^{-6}	0.390
Toluene	0.96×10^{-6}	0.003
Xylenes	8.3×10^{-6}	0.009
TVOC	880×10^{-6}	2.64

2.4.4 Other VOC sources

Existing sources of hydrocarbon (VOC) emissions were determined by an analysis of the National Pollutant Inventory (NPI). Road vehicle traffic emissions in the larger urban centres such as Darwin and Palmerston, are widespread over a large area. The main industrial sources of VOCs are listed in Table 2-4; inspection of their distances from the BFSF shows that only the Vopak Terminal, which is a petroleum products and sulfuric acid import and distribution terminal, has some potential to add detectable amounts of VOCs to those of Project Caymus. However, it is unlikely both facilities would be filled (therefore emitting), at the same time and therefore there is a low risk of potential cumulative effects.

Table 2-4 Other main VOC sources in Darwin region in relation to Project Caymus

Industrial VOC source	Approximate vector from Project Caymus BFSF
Vopak Terminal	400 metres SW
INPEX Ichthys plant	5.2 km SSE
INPEX, 2 tanks	7.0 km SSE
Darwin LNG plant	6.5 km SW
Channel Island Power Station (CIPS) 279MW	9.7 km SSW
Weddell Power Station (WPS) 129 MW	12.4 km SSE

2.5 Sensitive Receptors

The sensitive ('discrete') receptors located closest to the proposal site were identified in the study area by inspection of vertical imagery; these are listed in Table 2-5. Some of the points are representative of sensitive areas; e.g., urban areas, and are approximately the closest urban points to the BFSF.

Table 2-5 Project Caymus nearest sensitive receptors (air quality impact assessment)

Easting (m)	Northing (m)	Sensitive receptor	Labels used this report
707516	8623398	Hidden Valley (racecourse)	Hidden Valley
713400	8620800	Durack (north)	Durack N
701000	8620700	Darwin Waterfront Lagoon	Darwin Waterfront Lagoon
708555	8620655	Arnhem Land Progress Aboriginal (ALPA) Corporation & car park	ALPA
708350	8620350	Northline & car park	NL
706950	8620350	Darwin Rail Terminal & car park	DRT
707770	8619180	East Arm Boat Ramp & car park	EABR
713400	8619180	Elrundie	Elrundie
712250	8617600	Marlow Lagoon, Bridle Rd.	Marlow Lagoon
706933	8621191	Bleesers Creek (nominal boat location)	Bleesers Ck

3. Local Air Environment

3.1 Overview

Meteorological data are important for air quality impact assessment; parameters important for predicting the dispersion of air pollutants towards sensitive receptors include: wind speed and direction, temperature, humidity, and rainfall. This section provides a brief description of Darwin's climatological data as it pertains to this assessment, and details about the meteorological data used as input to Ausplume.

3.2 Darwin Climatology

Hourly average meteorological observations were obtained from the Bureau of Meteorology (BoM) Darwin Airport monitoring station #014015, for a five-year period (2014-2018). This station is located 5.65 km north-northwest of the Project Caymus site. The observations were considered representative of East Arm District for the purpose of this assessment.

Darwin has a tropical climate that can be divided into a warmer wet season from November to March inclusive, and a cooler dry season from April to October. Temperature varies little over the course of a year, typically ranging between 31ºC and 33ºC. Typically, humidity varies between 70-80% during the wet season. Monthly rainfall totals vary between more than approximately 400 mm in January, to almost none over June-August.

Wind roses were created from the hourly average wind speed and wind direction observations from BoM Darwin Airport. Annual wind roses for 2014-2018 are provided in Appendix C.1, and seasonal wind roses for the same years in Appendix C.2. The wind rose 'spokes' show wind direction 'blowing from'. Inspection of these wind roses shows (using the traditional southern seasons as divisions):

- Summer winds are dominated by W to WNW winds.
- Autumn winds are dominated by easterly winds.
- Winter winds are dominated by winds in the SE sector.
- Spring winds are dominated by winds in the NW sector.

3.3 Meteorological Data for Assessment

This NSW (2016) Level 1 air quality impact assessment was conducted using synthetic worst-case meteorological data. NSW (2016) provides instructions for the data file construction including combinations of wind speed and stability class, temperature, and mixing layer height; further details are provided in Appendix D.

Darwin's ambient temperature varies only a little by season, and ambient temperature variations are relatively unimportant for volume sources. Wind speed was varied incrementally between the minimum wind speed for Ausplume, 0.5 m/s, and 20 m/s. Wind direction was cycled around the points of the compass in increments of 5 degrees.

Atmospheric stability parameter was varied throughout the range from most unstable ('A' class stability), to most stable ('F' class stability). Mixing layer heights for a rural location were calculated in accordance with the NSW (2016) procedures and set in the input file, ranging from 61 metres up to 5000 metres in height (capped). The completed Level 1 screening meteorological file contained a total of 4,752 hourly records.

Also, an annual meteorological dataset of meteorological parameters was created from BoM observations at Darwin Airport (Jacobs, 2022). This file contained 8,760 records of hourly average meteorological data. The use of this more detailed meteorological file was outside the scope of the Level 1 assessment specified for Project Caymus; the data were used for additional sensitivity testing and for quality control purposes.

3.4 Background VOC levels

The *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales*, (NSW 2016), does not require background levels of individual VOCs to be included as part of a Level 1 (screening) air quality impact assessment. However, in general, background levels of VOCs are low, and they are expected to be reasonably low for sensitive receptors surrounding East Arm Wharf for most of the time. For example, in rural areas, generally VOCs may be detectable at levels of a fraction of 1 part per billion by volume (ppb) (NEPC, 2021).

For Darwin, NEPC (2021) stated that a 9-month monitoring program was completed in February 2006 as part of a program to establish baseline conditions for Darwin. These results showed that concentrations of benzene, toluene and xylenes, were well below NEPM investigation levels. No further (monitoring) activities were conducted in 2018-2019.

New information about VOC levels is expected to become available soon; NEPC (2021) stated that a “number of companies have indicated that they will be undertaking air toxics monitoring at the NT EPA air quality monitoring stations as part of their environment protection licence requirements.”

4. Modelling Methodology

4.1 Overview

A NSW (2016) Level 1 air quality impact assessment was undertaken in accordance with NT Government instructions (Section 1.3). The Ausplume model was selected for use for this Level 1 'screening level' assessment. This section sets out the NSW (2016) Level 1 AQIA requirements, and the Ausplume methodology and parameters used.

4.2 Tank venting: source type

Tank fuel must be protected from evaporation and water ingress, so the vents are capped or covered. For Project Caymus, the fixed-roof tanks have one vent approximately centrally located on each tank roof (Figure 2-2); also, venting can occur around the rims of the tanks. When air emissions occur from these vents they are not vertically upwards, but directed outwards and downwards from the roof and rim. These emissions occur at near-ambient temperatures. As such, fuel tank venting was modelled as a 'volume source'. The dimensions of the tank, or tanks, are used to estimate the initial mixing of the VOCs into the building wake-affected air passing over the tank(s).

It is noted 'point source' air dispersion algorithms were developed based on plume behaviour from stacks usually involving hot (buoyant), plumes injected vertically into the atmosphere. This is a different physical situation from the downwards and sideways venting of hydrocarbon vapours from a fuel tank, which occur at near-ambient temperatures (Section 2.4.2).

As the BFSF fuel tanks were modelled as volume sources, building wake effects algorithms were not included in the calculations. Instead, wake effects were included implicitly due to the modelled emissions from a volume source being spread out in a similar way to a building wake. This meant the modelled emissions were drawn immediately down to ground-level in the modelling – a conservative step in the assessment.

For these reasons the Crowley fuel tank vent releases were modelled as volume sources – tank vents cannot, (and should not), be modelled as point sources.

4.3 Worst Case Air Emissions Scenario

The worst-case fuel-loading operation was assessed; i.e., loading of the BFSF from a ship. Of the two tank types, modelling with 'TANKS' software showed that emissions from filling a fixed-roof tank (F-35 fuel) would be significantly higher than filling a floating-roof tank (F-44 fuel). Hence the worst-case scenario was filling a fixed-roof tank with F-44 fuel at the maximum rate, which was included in the assessment. During this operation, fuel vapours would be emitted from the BFSF tanks as they are filled, while insignificant vapour emissions would occur at the ship with ambient air being drawn into the ship's fuel tanks as their levels decrease. This strengthens the worst-case emissions case because the source of the emitted vapours; i.e. the fuel tank being filled, is closest to the nearest sensitive receptors in the East Arm District.

4.4 NSW (2016) Level 1 AQIA requirements

This section sets out the NSW (2016) Level 1 assessment requirements in relation to Condition 11.d of the Environmental Approval (preceding section). NSW (2016) sets out two levels of impact assessment: Level 1 is a screening-level dispersion modelling technique using worst-case input data. The requirement for Level 1 assessments is to use synthetic, worst-case meteorological data.

The main input parameters were hourly average wind speed and direction, and temperature. Other required hourly parameters calculated from this dataset were atmospheric stability class and mixing layer height (hourly); see Section 3.3.

Ausplume was selected for this Level 1 'screening level' assessment given the model is specified for use in NSW (2016). While improved Gaussian models such as Aermod are now available, Ausplume has been used successfully for detailed air quality assessment for many sites in Australia for over two decades and is suitable for a Level 1 (screening) assessment of the BFSF VOC 'volume' source.

The NSW (2016) air quality impact assessment criteria used for assessment are applied to model results at different receptor locations depending on whether they are toxic pollutants (risk of human health impact), or odorous (risk of amenity impact):

- NSW (2016) Table 7.2a lists Principal Toxic air pollutants and Table 7.2b lists Individual Toxic air pollutants.
  - The relevant Project Caymus substances for assessment are benzene, cyclohexane, ethylbenzene and n-hexane.
  - The Impact Assessment Criteria (IAC) for these pollutants are applied as follows:
    - at and beyond (site) boundaries,
    - incremental (not cumulative) calculated concentrations are assessed, and
    - the modelled GLC maxima results are assessed by comparisons with the corresponding IAC.
- NSW (2016) Table 7.4a lists Individual Odorous air pollutants.
  - The relevant Project Caymus substances for assessment: cumene, toluene and xylenes.
  - The Impact Assessment Criteria (IAC) for these pollutants are applied as follows:
    - at existing or future sensitive receptors,
    - incremental (not cumulative) calculated concentrations are assessed, and
    - the modelled GLC maxima results are assessed by comparisons with the corresponding IAC.

The NSW (2016) IAC identified for assessment of Project Caymus operations are detailed in Table 4-1.

Table 4-1 NSW (2016) impact assessment criteria for assessment

NSW (2016) Table	Substance	Receptor type for assessment	IAC ($\mu g/m^3$)
7.2a	Benzene	Grid	29
7.4a	Cumene	Discrete (sensitive)	21
7.2b	Cyclohexane	Grid	19000
7.2b	Ethylbenzene	Grid	8000
7.2b	n-Hexane	Grid	3200
7.4a	Toluene	Discrete (sensitive)	360
7.4a	Xylenes	Discrete (sensitive)	190

It is noted the NSW (2016) criterion for benzene (29 $\mu g/m^3$, a maximum 1-hour average), is very similar to the Victoria Government's *State Environment Protection Policy (Air Quality Management) 2001* design criterion (53 $\mu g/m^3$, a 99.9th percentile 3-minute average). However, EPA Victoria updated its assessment criteria for VOCs in February of this year – the new benzene criterion is 580 $\mu g/m^3$ (a maximum 1-hour average). This indicates the risk of human health impact due to airborne benzene is lower than indicated by the Victorian 2001 policy, and the NSW (2016) criterion.

4.5 Ausplume inputs

The Ausplume input parameters and settings are detailed in Table 4-2. The 10,201 grid receptors with 100-metre horizontal resolution are plotted on the base map in Figure 4-1 (grid receptors plotted as white points).

Table 4-2 Ausplume input parameters and settings

Parameter	Settings / details
Input meteorological data file	Screening test meteorological file created in accordance with NSW (2016) methods; for more details see Appendix D.
Met. obs. site parameters	Surface roughness 0.1 metres (m); anemometer mast height 10 m.
Surface roughness, study area	0.4 m to reflect turbulence effects by buildings in East Arm District. This is considered to be a conservative (low) estimate for surface roughness, because a less conservative 'industrial' surface roughness (0.8m) could be justified for this site.
Source location	E. 706,600 m; N. 8,620,200 m – the northern-most fixed-roof tank nearest to the closest sensitive receptor (Darwin Rail Terminal); this was a conservative step in the assessment.
Source characteristics	'Volume' source: horizontal spread 10 m (25% of tank width) and vertical spread 10 m (25% of tank heights) representing emissions from a fixed-roof tank dispersing north-east prior to reaching the nearest sensitive receptor (Darwin Railway Terminal), located approximately 380 m ENE of the northernmost fixed-roof tank. Use of a smaller initial horizontal spread (10 metres) was considered to be conservative, reflecting the spread for one fuel tank only i.e., the fixed-roof fuel tank closest to Darwin Railway Terminal. Source height 40 m above ground level; i.e., tank vent height, but use of the volume source spread the emissions down to ground-level at the source.
Cartesian study area and grid receptors	101 grid points (east-west) x 101 grid points (north-south). Horizontal resolution 100m; total 10,201 grid points (Figure 4-1). Grid receptor heights 1.5m above ground level.
Discrete receptors	10 discrete receptors at 2.0m above ground level (for details see Section 2.5).
Horizontal & vertical dispersion curves for sources <100m high	Pasquill Gifford curves – adjusted for roughness: horizontal & vertical.
Temperature gradients	Ausplume defaults for wind speed category vs. stability category
Upper bounds for wind speed categories	Ausplume defaults: 1.54, 3.09, 5.14, 8.23, 10.80, >10.80 m/s
Wind profile exponents	Irwin rural exponent scheme
Miscellaneous parameters	Default decay coefficient (0.0); sigma theta (wind direction) averaging period 60 min., no stability class adjustments.

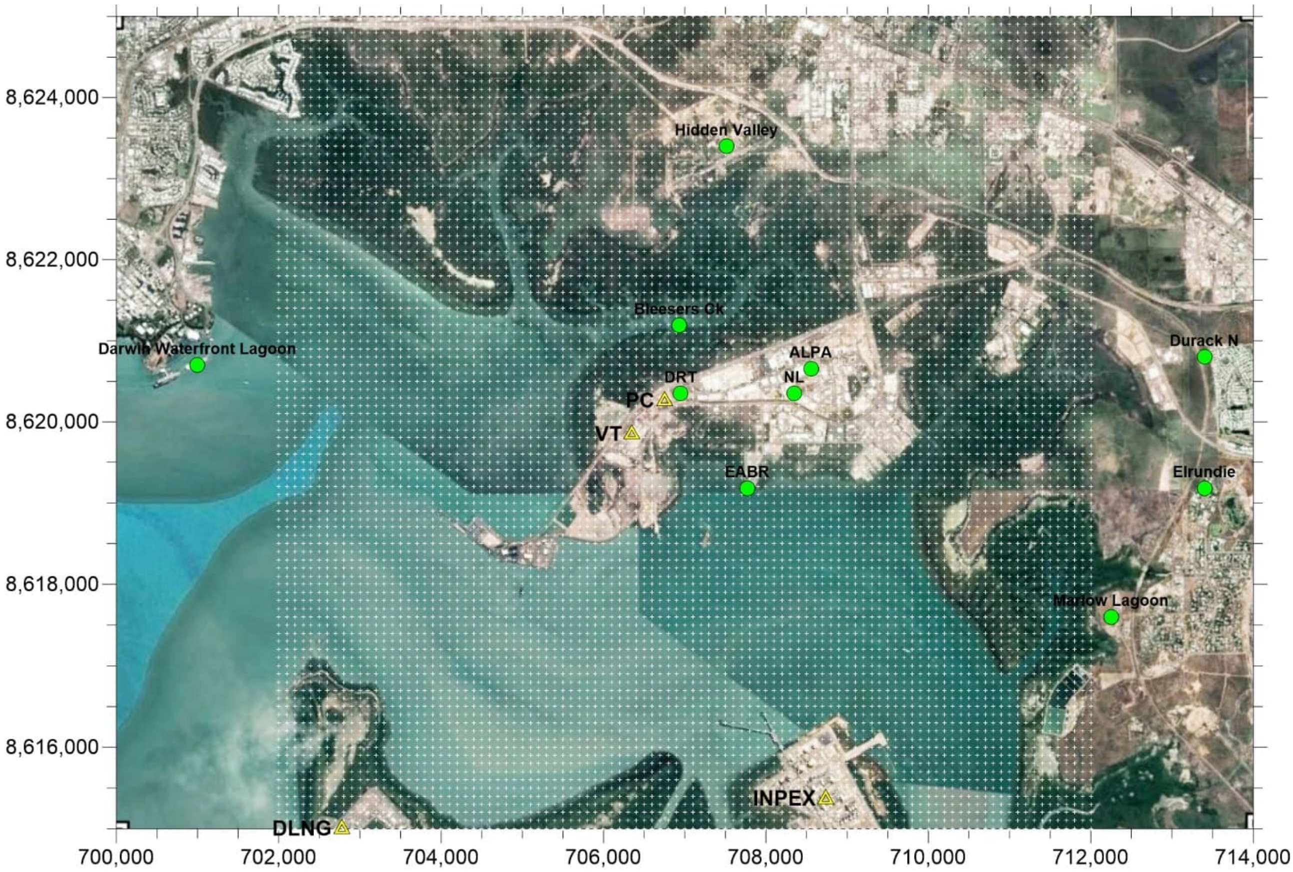

Figure 4-1 Project Caymus air quality study area with 10,201 grid receptors (white points)

4.6 Geographical parameters

The AQIA study area centred on East Arm District is relatively flat, so no topographical data (land elevations) were included in the assessment. Surface roughness selected in Ausplume for the study area was 0.4 metres, which equates to a land type of 'residential' or 'rolling rural'. This was considered to be a conservative step in the assessment; i.e., model results will be overestimated slightly, because the fuel farm and other infrastructure on East Arm would cause turbulence near ground level with a surface roughness probably closer to 0.8 metres (land type 'commercial' or 'industrial').

5. Ausplume results

5.1 Overview

This section provides the key Ausplume results enabling completion of the Level 1 assessment in accordance with NSW (2016). The NSW (2016) IAC are variously applied depending on the type of pollutant and IAC; i.e., toxic or odorous; see Section 4.4. Toxicity-based IAC are relevant for GLC results for the grid receptors anywhere on the study grid, and odour-based IAC are relevant only for the discrete receptors representing sensitive receptor locations.

5.2 Summary of Key Ausplume Results

This section provides the key Ausplume results for GLCs for the 10,201 grid receptors and 10 discrete (sensitive) receptors, for maximum 1-hour average GLC ($\mu g/m^3$), for comparisons with the impact assessment criteria.

VOC emissions for the F-35 fuel-loading scenario for the Floating-Roof tanks were found to be insignificant, with no predicted 'working losses' (during fuel-loading), and the 'standing losses' (annual venting) were insignificant due to the fuel being well-covered by the floating rooves at all times (Table 2-3).

VOC emissions for the F-44 fuel-loading scenario for the Fixed-Roof tanks were found to be significant during the loading period (working losses only; see Table 2-3). The standing losses were insignificant over the loading period, which was estimated to be just a few days. Hence the worst-case operating scenario for assessment was filling the seven Fixed-Roof tanks over the fuel-loading period. Ausplume results are provided for the worst-case VOC emissions scenario; i.e., filling of the seven fixed-roof tanks with F-44 fuel over a period of days. As a conservative step in the assessment, the volume source was assumed to be in the position of the fixed-roof tank closest to the nearest sensitive receptor (Darwin Railway Terminal). Any VOC emissions that may occur from the floating-roof tanks during the same period would be negligible.

The maximum results for all receptors are compared with relevant Level 1 impact assessment criteria in Table 5-1. All the results are less than 7% of the IAC, and (obviously) there were no predicted exceedences of criteria.

Table 5-1 Summary of maximum receptor results – maximum 1-hour average GLCs

VOC	MER (g/s)	Receptor for assessment	Max. 1h GLC ($\mu g/m^3$)	IAC ($\mu g/m^3$)	Result as fraction of IAC
Benzene	0.019	Grid	1.9	29	6.5%
Cumene	0.008	Discrete	0.6	21	2.7%
Cyclohexane	0.065	Grid	6.3	19000	0.0%
Ethylbenzene	0.003	Grid	0.3	8000	0.0%
n-Hexane	0.390	Grid	38.0	3200	1.2%
Toluene	0.003	Discrete	0.2	360	0.1%
Xylenes	0.009	Discrete	0.6	190	0.3%

Additionally, sensitivity tests were conducted with other meteorological datasets; e.g., (1) an annual dataset based on hourly average meteorological observations at Darwin Airport (8,760 hourly records); and (2) Ausplume's own screening-test meteorological file ('met-sample'). The Ausplume results were very similar regardless of the meteorological data used.

5.3 Electronic files

The Ausplume input and output files, and the processed results, include various statistical results for thousands of receptors covering the study area. The Ausplume input files and the results as electronic files will be delivered with this report; these comprise: Ausplume input files with the input unitary VOC emission rate (1 g/s), a spreadsheet showing the conversion of the model results for each substance, and Ausplume output files (all text files).

6. Conclusion

Crowley engaged Jacobs to undertake a Level 1 AQIA of the Project Caymus BFSF as a condition of the Environmental Approval Number EP2021/008 – 001.

The AQIA was undertaken in accordance with NSW (2016); a compliance checklist is provided in Appendix D.

The focus of the AQIA was the worst-case BFSF air emissions scenario, which was identified by a repeat of the TANKS modelling; i.e., loading by ship of the fixed-roof F-44 fuel tanks using the wharf's maximum fuel-loading rate. During this operation, fuel vapours will be emitted from the BFSF tanks as they are filled, while insignificant vapour emissions would occur at the ship with ambient air being drawn into the ship's fuel tanks, as their levels decrease.

The assessment was undertaken in accordance with the Level 1 assessment methodology set out in NSW (2016). Level 1 is a screening-level dispersion modelling technique using worst-case input data, and synthetic worst-case meteorological data. The main meteorological input parameters were hourly average wind speed and direction, atmospheric stability class, and mixing layer height. A number of meteorological datasets were used as input – the use of different data had only small effects on the results. The use of another meteorological dataset would not have changed the outcome of the assessment.

The NSW (2016) VOCs were assessed by comparisons of the maximum GLCs predicted by Ausplume with IAC for toxic air pollutants applied at and beyond site boundaries; i.e., at all 10,201 grid receptor locations.

All the Ausplume results were less than 7% of their IAC – none of the thousands of Ausplume results obtained for Project Caymus operations exceeded NSW impact assessment criteria.

In conclusion the results indicate there is a low risk of air quality impact anywhere in the Darwin region due to operations by Project Caymus.

It is not recommended to proceed to a more detailed (Level 2) assessment for these reasons:

- NSW EPA (2016) Section 2.1 states – "*It is not intended that an assessment should routinely progress through the two levels… if a Level 1 assessment conclusively demonstrates that adverse impacts will not occur, there is no need to progress to Level 2*". There were no Ausplume-predicted exceedences of NSW impact assessment criteria at any receptor including no exceedences at the nearest sensitive receptor, Darwin Rail Terminal.
- Further, the BFSF loading operation will be a unique event, occurring once to fill the fuel farm. Essentially the fuel farm will serve as a storage facility.

7. References

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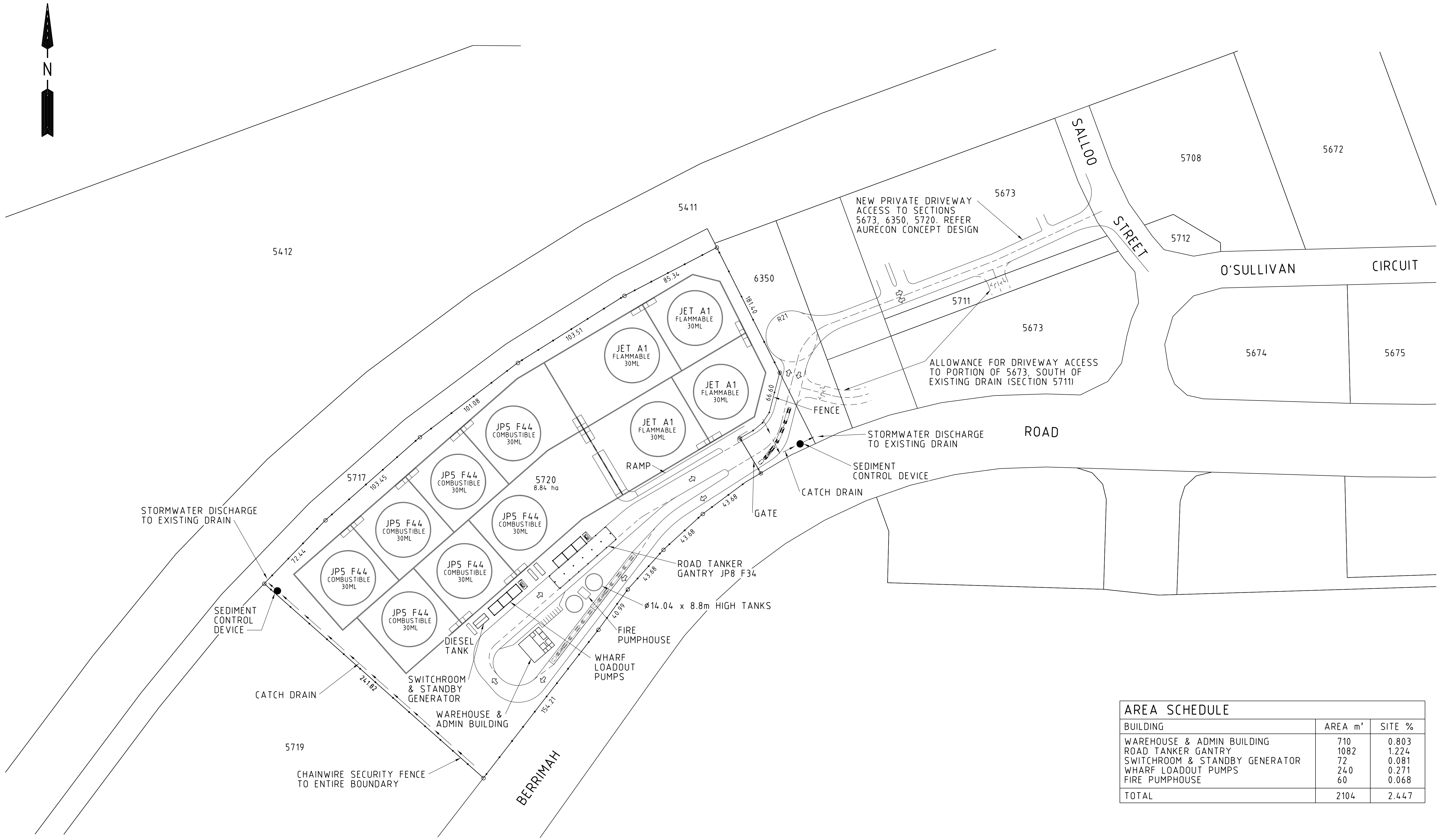
Appendix A. Darwin Air Quality Study Area

8,624,000
8,622,000
8,620,000
8,618,000
8,616,000
700,000
702,000
704,000
706,000
708,000
710,000
712,000
714,000
Hidden Valley
Bleesers Ck
Darwin Waterfront Lagoon
Durack N
ALPA
DRT
NL
PC
VT
EABR
Elrundie
Marlow Lagoon
INPEX
DLNG

Appendix B. Project Caymus Site Plan and Elevation



AREA SCHEDULE

BUILDING	AREA m²	SITE %
WAREHOUSE & ADMIN BUILDING	710	0.803
ROAD TANKER GANTRY	1082	1.224
SWITCHROOM & STANDBY GENERATOR	72	0.081
WHARF LOADOUT PUMPS	240	0.271
FIRE PUMPHOUSE	60	0.068
TOTAL	2104	2.447

PRELIMINARY UNCHECKED

INFORMATION ONLY

TT - PROTEUS DRG No. 267440-XA-006

No	REF. DRG. No.	TITLE	REV	DRN	DATE	DESCRIPTION	DCHK	DESN
			B	TML	05.10.21	ISSUED FOR INFORMATION		
			A	TML	30.09.21	ISSUED FOR INFORMATION		

CLIENT

CROWLEY
People Who Know

TETRA TECH PROTEUS

pritchard francis

	BY	DATE
DRN	T. LEE	30.09.21
DCHK		
DESN		
ECHK		
APP		

TITLE
CROWLEY GOVERNMENT SERVICES
PROJECT CAYMUS
JET FUEL
ALTERNATE OVERALL SITE PLAN

SCALE 1:1500 | A1 | DRG. No. 2129-7000-ARC-SKT-0006 | REV. B

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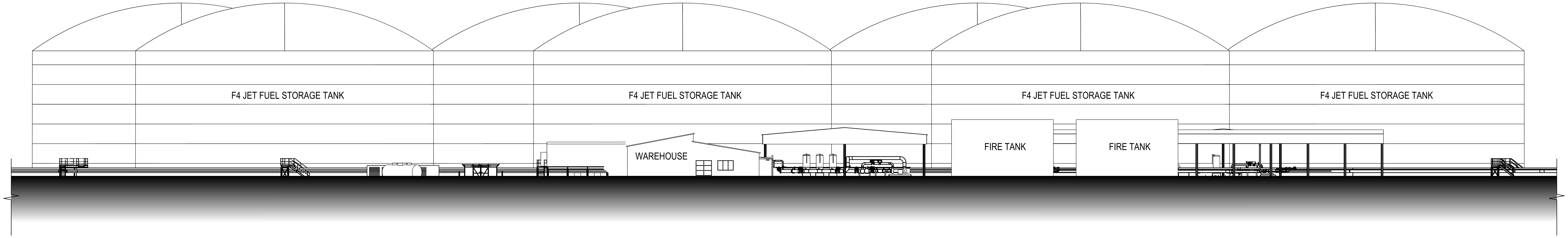
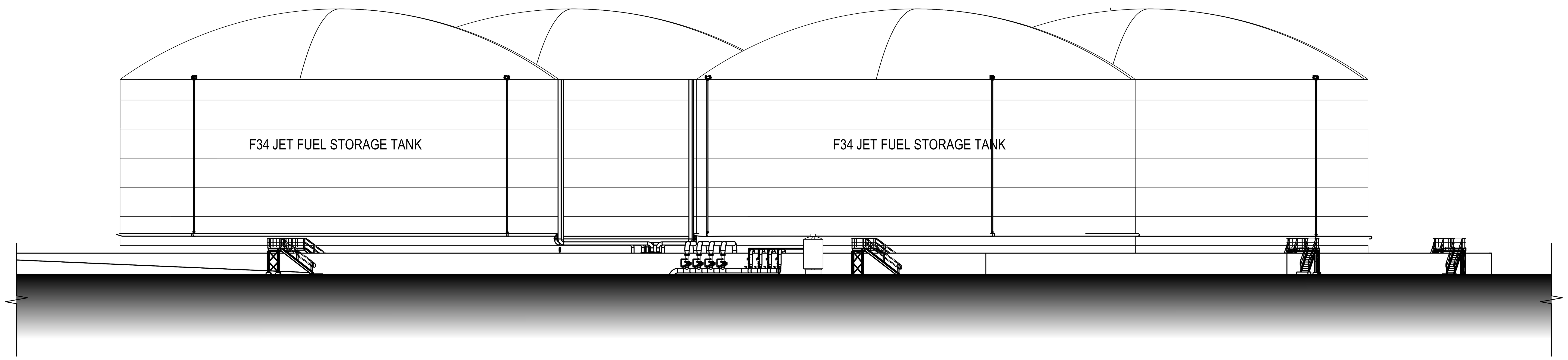
5:06:49 PM 5/10/2021



SITE ELEVATION



SITE ELEVATION

TETRA TECH PROTEUS CLIENT REVIEW

CONCEPT ONLY

SIGN: DATE

TTP DOCUMENT CODE: 267440-DA-004

No	REF. DRG. No.	TITLE	REV	DRN	DATE	DESCRIPTION	DCHK	DESN
			A	KGN	10.12.21	ISSUED FOR CLIENT REVIEW		ZG

CLIENT

CROWLEY
People Who Know

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pritchard francis

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Coffey Services Australia Pty Ltd ABN 55 139 460 521 trading as TETRA TECH PROTEUS

	BY	DATE
DRN	C.HEALY	06.12.21
DCHK		
DESN	Z.GONG	10.12.21
ECHK		
APP		

TITLE

CROWLEY GOVERNMENT SERVICES
PROJECT CAYMUS
JET FUEL
SITE SECTION

SCALE		DRG. No.	REV.
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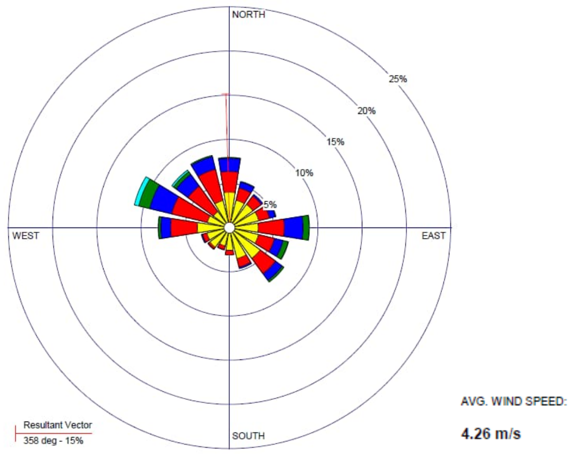
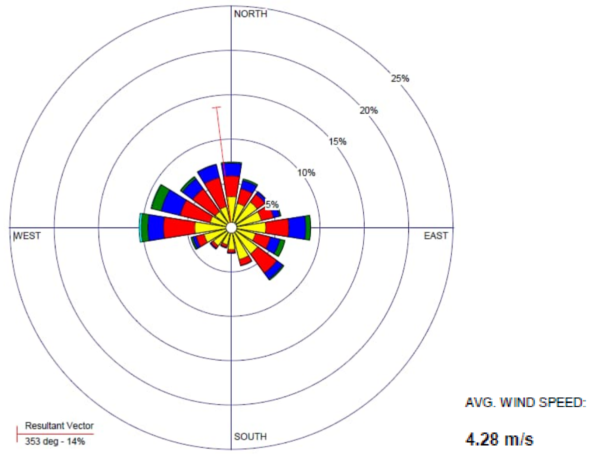
Appendix C. Wind Roses – Darwin Airport

C.1 Annual wind roses 2014-2018

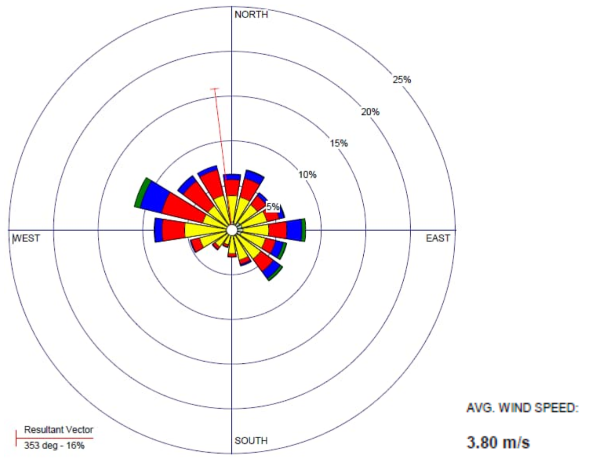
2014



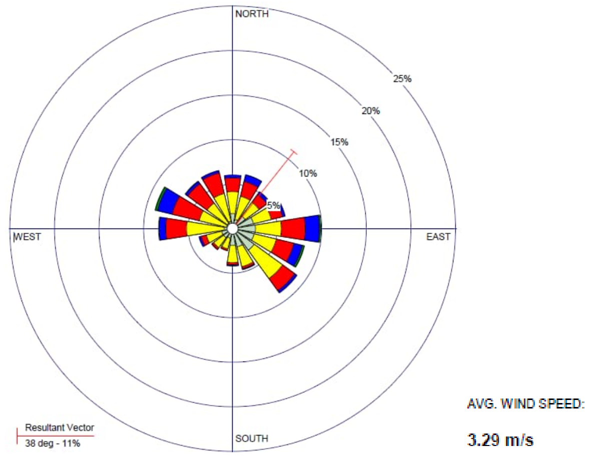
2015



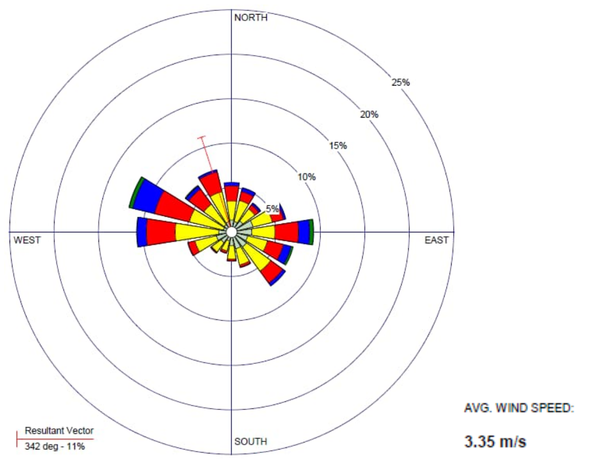
2016



2017



2018

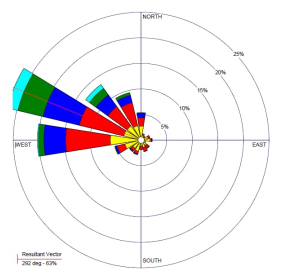
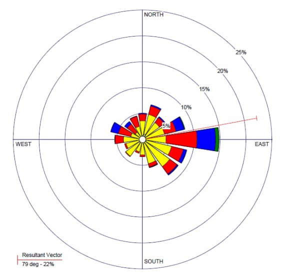
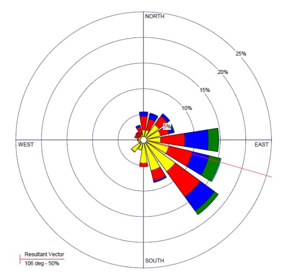
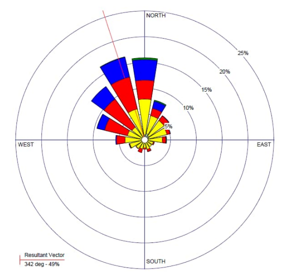
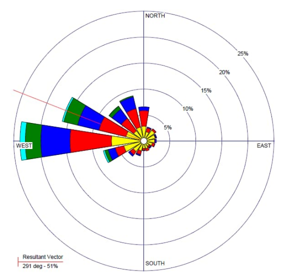
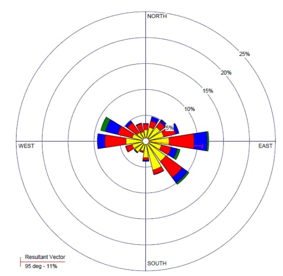
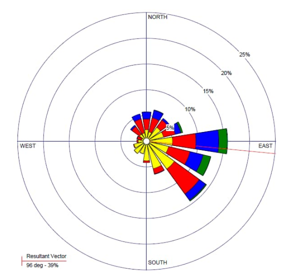
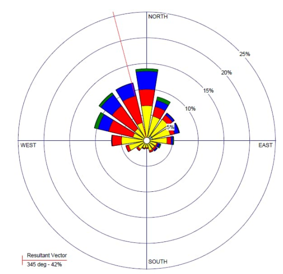
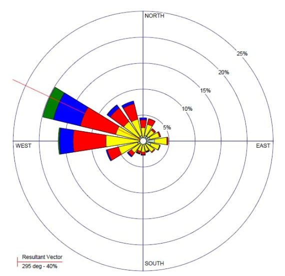
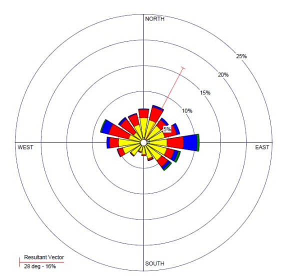
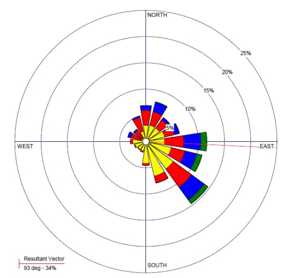
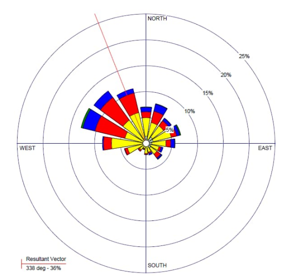
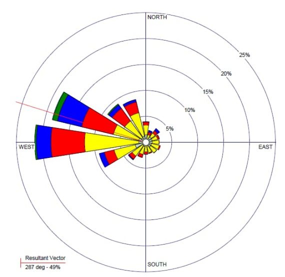
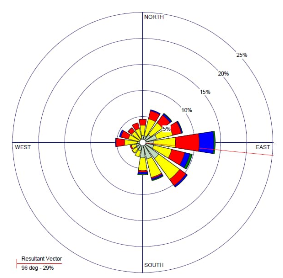
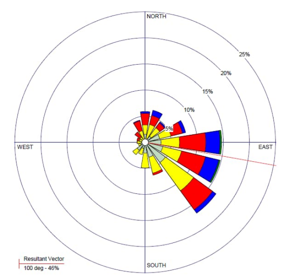
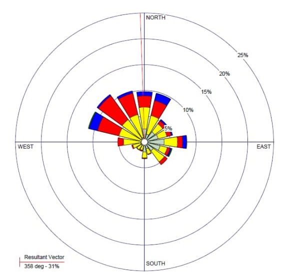
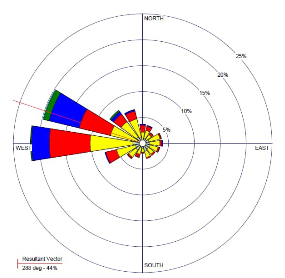
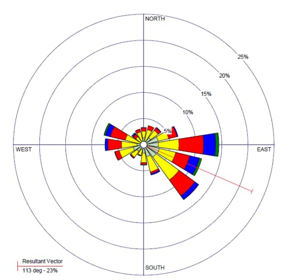
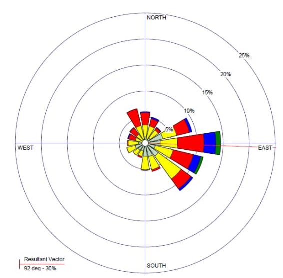
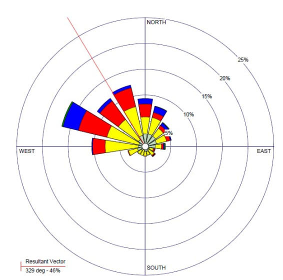


Legend:

WIND SPEED (m/s)

- >= 10.00
- 8.00 - 10.00
- 6.00 - 8.00
- 4.00 - 6.00
- 2.00 - 4.00
- 0.10 - 2.00

C.2 Seasonal wind roses 2014-2018

	Summer	Autumn	Winter	Spring
2014				
2015				
2016				
2017				
2018				

Appendix D. Compliance with EPA (2016)

This Appendix provides a checklist confirming the AQIA Level 1 assessment was undertaken in accordance with NSW (2016).

Table D-1 EPA (2016) Compliance Check

Item #	NSW 2016 Section	NSW (2016) Requirement	Compliance? (Y/N)	Notes
1	4.1	*4.1 Minimum data requirements. The meteorological data used in the dispersion modelling is one factor that determines the level of assessment. Level 1 impact assessments are conducted using 'synthetic' worst-case meteorological data. Table 4.1 lists the wind speed and stability class combinations that need to be included in the synthetic worst-case meteorological data file.*	Y	A synthetic worst-case meteorological data file was used. The meteorological data file used for the final round of modelling was compliant with the requirements for wind-speed and stability class set out in Table 4.1, and used the EPA's sub-sections for calculating Mixing Layer Height (MLH).
2	4.3.1	*Table 4.1 lists the minimum wind speed and stability class combinations that must be included in a Level 1 meteorological data file.*	Y	Exceeded requirement – the combination of F-Class Stability and wind speed =3.5 m/s was included in the meteorological data file, but not a requirement.
3	4.3.2	*For Level 1 impact assessments, the maximum and minimum ambient temperatures that are representative of the site must be included in the Level 1 meteorological data file to account for the range in possible plume rise. Higher ambient temperatures will result in the lowest plume rise and hence the largest impacts.*	N/A	Plume rise is only relevant for stacks and chimneys (point sources), not emissions from fuel tanks (volume sources), which emit at or near ambient temperature. To confirm this, Ausplume modelling sensitivity tests were undertaken using meteorological data files using two different ambient temperatures: 15 ºC and 25 ºC – the results were equivalent (ambient temperature had no effect on the volume source results).
4	4.3.3 Mixing height, and 4.3.4 Monin-Obukhov length	*For Level 1 impact assessments, the mixing height for neutral and unstable conditions (classes A–D) can be calculated using an estimate of the mechanically driven mixing height. The mechanical mixing height, h, can be calculated as follows:* *Equation 4.1: Mechanical mixing height for stability classes A–D* *Equation 4.2: Mechanical mixing height for stability classes E and F*	Y	These procedures were followed to create the meteorological file for use in Ausplume for the Caymus AQIA.

Item #	NSW 2016 Section	NSW (2016) Requirement	Compliance? (Y/N)	Notes
		Equation 4.3: Monin–Obukhov length		
5	4.3.5, Surface friction velocity	*The surface friction velocity, u*, is a measure of mechanical turbulence and is directly related to the surface roughness. The parameter, u*, can be calculated using the procedure presented below (Businger and Fleagle 1980; McRae 1981).* *Condition 1: Wind speed = 0* *Condition 2: Unstable conditions* *Condition 3: Neutral conditions* *Condition 4: Stable conditions*	Y	These procedures were followed to create the meteorological file for use in Ausplume for the Caymus AQIA.
6	4.3.6 Coriolis parameter	*The coriolis parameter accounts for variation in wind direction with height (wind shear) at different latitudes and can be calculated in accordance with well-established techniques.*	Y	The Coriolis parameter was calculated using a latitude for the East Arm Wharf site: 12.474 decimal degrees.
7	5.1.1 Accounting for background concentrations	*For impact assessments of sulfur dioxide (SO_2), nitrogen dioxide (NO_2), ozone (O_3), $PM_{2.5}$, PM_{10}, total suspended particulates (TSP), deposited dust, lead (Pb), carbon monoxide (CO) and hydrogen fluoride (HF), the existing background concentrations of the pollutants in the vicinity of the proposal should be included in the assessment…*	Y	The estimates for background are only to be included for the criteria and other pollutants listed. In any case background levels of the hydrocarbon (VOC) substances assessed for Project Caymus are expected to be very low most of the time; e.g., <10 parts per billion (<10 ppb) is typical for background VOC concentrations (NEPC, 2021).
8	6.2 Approved dispersion models	*AUSPLUME v. 6.0 or later is the approved dispersion model for use in most simple, near-field applications in NSW, where coastal effects and complex terrain are of no concern.*	Y	While Ausplume would not be used for a Level 2 assessment where coastal effects are of concern, the model was considered to be more than adequate for use as a Level 1 (screening test) model for the Project Caymus volume sources (downwards and side-ways emissions from tanks). Coastal effects such as sea breezes and modification of the mixing layer vertical structure along the coastline would be insignificant for these tank emissions – noting that the purpose of the screening-level

Item #	NSW 2016 Section	NSW (2016) Requirement	Compliance? (Y/N)	Notes
				meteorological data file was to test all worst-case meteorological conditions near ground-level.
9	7.2.2 Application of impact assessment criteria	*The impact assessment criteria for individual toxic air pollutants in Tables 7.2a and 7.2b must be applied as follows:* *1. At and beyond the boundary of the facility.* *2. The incremental impact (predicted impacts due to the pollutant source alone) for each pollutant must be reported in concentration units consistent with the criteria (mg/m^3 or ppm), for an averaging period of 1 hour and as the: a. 100th percentile of dispersion model predictions for Level 1 impact assessments…*	Y	Ausplume-predicted maximum 1-hour average GLC (µg/m^3) for individual toxic air pollutants were determined for all grid and discrete (sensitive) receptor locations and assessed by comparisons with their criteria.
10	7.4.2 Application of impact assessment criteria	*The impact assessment criteria for individual odorous air pollutants in Tables 7.4a and 7.4b must be applied as follows:* *1. At the nearest existing or likely future off-site sensitive receptor.* *2. The incremental impact must be reported in concentration units consistent with the impact assessment criteria (µg/m^3) for an averaging period of 1 hour… and as the… 100th percentile of dispersion model predictions for Level 1 impact assessments…*	Y	Ausplume-predicted maximum 1-hour average GLC (µg/m^3) for individual odorous air pollutants were determined for all discrete (sensitive) receptor locations and assessed by comparisons with their criteria.
11	9 Impact assessment report	*An air quality impact assessment report must clearly document the methodology and result of the assessment. The EPA's minimum requirements regarding the information contained within an impact assessment report…*	Y	This impact assessment report complies with section 9 clearly documenting the methodology and results of the assessment.
12	9.4.1 Level 1 meteorological data	*A description of the techniques used to prepare the meteorological data in a format for use in the dispersion modelling.* *The meteorological data used in the dispersion modelling supplied in a Microsoft Windows-compatible format*	Y	Descriptions of techniques provided in preceding rows of this table and in the main text. The meteorological data file used as input to the dispersion modelling supplied as a text file able to be read by Microsoft Windows-compatible software.