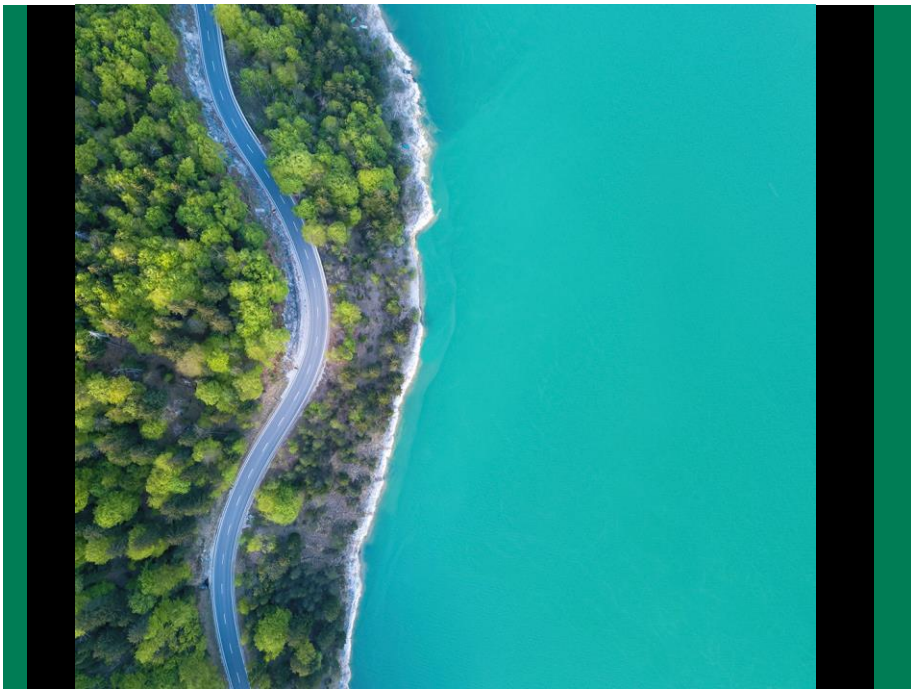
Air Quality Monitoring Plan

Document no: IW272400-MON-NN-PLN-0001
Revision no: 0

Crowley Australia Pty Ltd
[Client reference]

Project Caymus Air Quality Monitoring
28 November 2022



Air Quality Monitoring Plan

Client name:	Crowley Australia Pty Ltd		
Project name:	Project Caymus Air Quality Monitoring		
Client reference:	*[Client reference]*	**Project no:**	IW272400
Document no:	IW272400-MON-NN-PLN-0001	**Project manager:**	Darren Skuse
Revision no:	0	**Prepared by:**	Samuel Putland / Greg SImes
Date:	28 November 2022	**File name:**	IW272400-MON-NN-PLN-0001 Annual Air Quality Monitoring Plan

Document history and status

Revision	Date	Description	Author	Checked	Reviewed	Approved
0	02/12/22	Draft for client review	SP	GS	GS	DS

Distribution of copies

Revision	Issue approved	Date issued	Issued to	Comments
0	DS	7/12/2022	A.Watson, R. McAlister	

Jacobs Group (Australia) Pty Limited

Level 2, Unit 10
25 Parap Road
Parap, NT 0820
PO Box 2145
Parap, NT 0804
Australia

T +61 8 8982 4800
F +61 8 8982 4840
www.jacobs.com

Contents

1. Background **4**
2. Air quality monitoring requirements **5**
3. Monitoring plan **6**
3.1 Methodology 6
3.1.1 Pollutants 6
3.1.2 Monitoring location 6
3.1.3 Frequency and timing 7
3.1.4 Sampling considerations 8
3.2 Reporting 8

Appendices

Appendix A. Monitoring method justification **9**
A.1 Annual Air Quality Monitoring 9
Summary 12

Tables

Table 1 Air Toxics NEPM criteria 6
Table 2 Key Condition Requirements and Approach for Annual Monitoring 9
Table 3 Modelled VOC GLC (hourly maximum) 11
Table 4 Summary of VOC sampling methods. 11
Table 5 Typical laboratory practical quantitation limit (PQL) – canister method vs diffusion tube with thermal desorption 11

Figures

Figure 1 Crowley BFSF under construction at East Arm Wharf (Crowley) 4
Figure 2: Diffuse sampler monitoring location (UTM Zone 52S, metres) 7

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) aviation jet fuel comprising:

- 700,000 barrels (111.3 ML) of F-35 with Fuel System Icing Inhibitor (FSII).
- 1,200,000 barrels (190.8 ML) of F-44 with FSII.

Project Caymus is currently under construction by Crowley Australia Pty Ltd (Crowley) and their contractor Saunders International. 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. 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. Crowley images showing the fuel farm under construction at East Arm Wharf are provided in Figure 1.

Figure 1 Crowley BFSF under construction at East Arm Wharf (Crowley)

2. Air quality monitoring requirements

Air quality monitoring is required as part of Northern Territory Government (NTG) Environmental Approval EP2021/008 – 001 under Section 65 of the Environment Protection Act 2019 (NTG, 2021). The relevant sections from NTG (2021) related to air quality monitoring are reproduced below:

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:

g) *Undertake annual monitoring for total volatile organic compounds and BTEX at the boundary of the operating premises in accordance with approved air emission monitoring techniques in the Approved Methods for the Sampling and Analysis of Air Pollutants in New South Wales (EPA 2016), or latest version to the satisfaction of the CEO. The results from the annual monitoring must be evaluated as part of the Compliance Assessment Reporting process under condition 6.*

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*

   (i) *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 must:*

   (i) *Include all analytical results of sampling required for all discharge points (any external report must be reproduced in full);*

   (ii) *Include all the information listed in section 4 (meteorological data) of the Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales (EPA 2016) or latest version;*

   (iii) *Describe all the operational parameters during sampling;*

   (iv) *Compare 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 above the emissions characteristics in the revised AQIA or the Protection of the Environment Operations (Clean Air) Regulation 2021 standards of concentration:*

   (i) *Re-assess and evaluate both the emission concentrations against the relevant NSW Clean Air Regulation standards of concentrations and the impacts against the relevant impact assessment criteria in the Approved Methods for the Modelling and Assessment of Air Pollutants in NSW (EPA 2016), or the latest version; and/or*

   (ii) *Identify and record as part of the EMS measures to be implemented to reduce emissions of air pollutants to no greater than those predicted in the AQIA (required under condition 11c and 11d).*

Commented [SD1]: Is there a newer version of this document now? I remember Matt saying one of the jurisdictions had recently re published

Commented [SG2R1]: Discussed in the appendix. Yes there is, it has no information on ambient air monitoring in it. See table 2

Commented [SD3R1]: ack

3. Monitoring plan

The following sections outline the air quality monitoring plan, to satisfy the requirement of "Condition 11 g)", as per **Section 2**.

3.1 Methodology

The overall methodology for the completion of air quality monitoring has been developed through an analysis of requirements of "Condition 11 g)", with justification of the methodology proposed detailed in **Appendix A**. Radiello diffusive samplers for volatile organic compound (VOC) with analysis by thermal desorption and GC-MS was the method selected for annual VOC monitoring.

This methodology was selected on the basis of the practicalities, financial considerations, and technical outcomes expected from air quality monitoring completed.

3.1.1 Pollutants

The following pollutants have been selected for inclusion in the air quality monitoring plan:

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

The relevant air quality objectives for monitored pollutants have been sourced from the National *Environment Protection (Air Toxics) Measure (2011)* 'Air Toxics NEPM' and are presented below in Table 1. The Air Toxics NEPM criteria limits are presented in units of ppm; however, as diffusion tubes results are reported as a mass concentration, converted criteria limits have also been presented.

Table 1 Air Toxics NEPM criteria

Pollutant	Averaging period	NEPM Air Quality Criteria	
		ppm	mg/m3 (at 0°C and 1 atm)
Benzene	Annual average	0.003	0.01
Toluene	24 hours	1	4.11
	Annual average	0.1	0.41
Xylenes (as total of ortho, meta and para isomers)	24 hours	0.25	1.18
	Annual average	0.2	0.95

Although the NEPM criteria are not intended to be used in the assessment and compliance of single entities, they are used to inform the air quality objectives that are set by Australian states and territories to manage air quality. As such, there inclusion is for comparative purposes only and not to determine compliance.

3.1.2 Monitoring location

The Radiello diffuse sampler will be located at a single position at the facility boundary or between the facility boundary and the nearest sensitive receptor and mounted at approximately 2-3m above ground level on an existing pole or similar. The sampling location should be situated as to not be significantly affected by other sources, e.g., smoking areas, or passenger pick-up and drop-off locations.

A preferred sampling location has been identified based on a preliminary site visit and review of the satellite imagery. Figure 2 below presents the preferred monitoring location for VOC sampling. The location is approximately 80m from the site boundary, 130m from the nearest tank and 45m from the Darwin Passenger Rail terminal, the nearest sensitive receptor for the Project.

This site has been selected for the following reasons

- Existing light pole will provide a discrete location to mount the sampler and the sampler can be mounted out of reach to avoid tampering. (A short step ladder will be used for sample deployment and collection).
- The location is easily accessible for sample deployment and collection.
- The location is located between the nearest sensitive receptor and the pollutant source.
- The location is far enough distant from the emission source that the sampling location should be representative of the nearest sensitive receptor location conditions i.e. vertical dispersion of tank roof vent emissions should result in similar exposures at both the monitoring location and the nearest sensitive receptor. (A sample location too close to the tank may result in emissions being missed given the height of the tank vents)

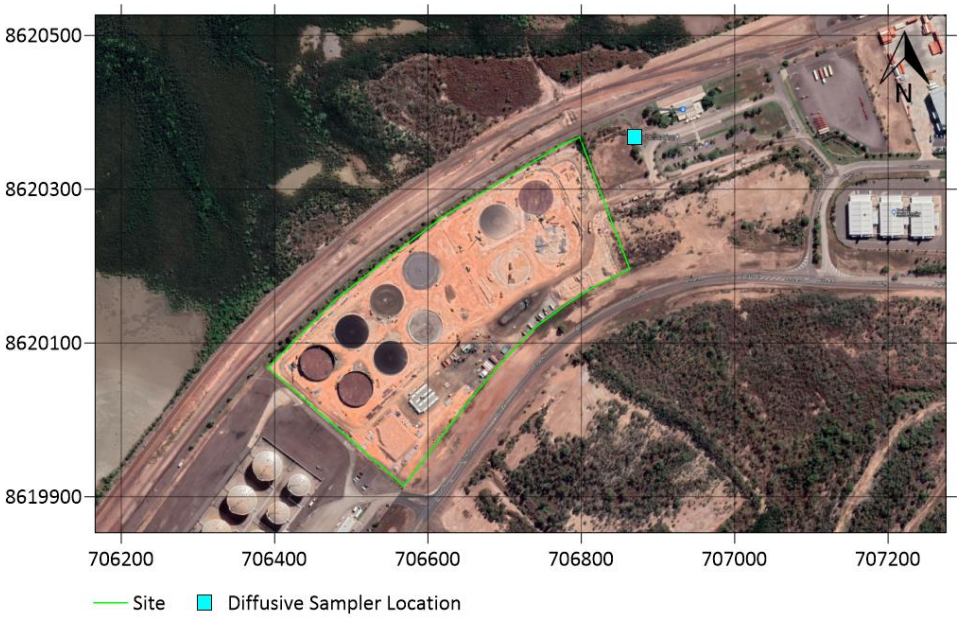


Figure 2: Diffuse sampler monitoring location (UTM Zone 52S, metres)

3.1.3 Frequency and timing

Samplers shall be deployed for 2-week periods at a single location (as per **Figure 2**) with samplers exchanged each 2-weeks. Monitoring will run for at least 12-months providing full coverage over a year, with results of monitoring to be used to calculate annual averages for pollutants monitored.

A total of 26 samples over 12 months will be collected. The annual monitoring is anticipated to run through construction and into operation phase of the Project, and at least for the duration of the current Environmental Approval which expires on the 29th November 2023.

3.1.4 Sampling considerations

The following considerations should be taken when completing the Radiello diffusive sampling at the monitoring location:

- Recording of diffusive sampler tube ID numbers and do not use marking pens to write on the sampler labels, as they can contain solvents that can contaminate the samples.
- Minimise contact with the diffusive sampler body by holding the sampler by the edges.
- Do not smoke or use solvents near the samples as this may contaminate the samples.
- Sample tubes before and after completion of sampling should be stored under refrigeration.
- Samples should be routinely (i.e., monthly) sent to the lab for analysis, to ensure sample degradation is minimised.
- Field notes should be taken for each site visit, detailing any tampering of the sampler or any other relevant site activity.

3.2 Reporting

Reporting of air quality monitoring completed will include the following items:

- Monthly factual report demonstrating summary of results from annual monitoring (Radiello sampler with 2-week exposures)
- Content for inclusion in the compliance assessment report required under condition 6 of the licence.
- Final report comprising annual and campaign monitoring (not included as part of this air quality monitoring plan) results at completion of project.

Appendix A. Monitoring method justification

The requirements specified in the approval EP2021/008 – 001 are interpreted and discussed below, with justification for the methodologies proposed.

A.1 Annual Air Quality Monitoring

Section 11 g) of the approval specifies the requirements for annual air quality monitoring as in in Key condition requirements, context and our approach are outline in Table 2.

Table 2 Key Condition Requirements and Approach for Annual Monitoring

Condition Key Requirements	Context & Approach
Monitoring is be undertaken for total volatile organic compounds and BTEX.	Monitoring will be undertaken for total volatile organic compounds (TVOC), and the TVOC components: benzene, toluene, ethylbenzene and xylenes (BTEX), plus other individual volatile organic compounds (VOC) identified for assessment in the AQIA, namely cumene, cyclohexane and n-hexane
Monitoring is to be undertaken at the boundary of the operating premises.	Depending on site access and logistics, samplers will be deployed on the site boundary, or alternatively (if site boundary is unsuitable for any reason), between the site boundary and the nearest sensitive receptor.
Monitoring is to be conducted in accordance with approved air emission monitoring techniques in the Approved Methods for the Sampling and Analysis of Air Pollutants in New South Wales (EPA 2016), or latest version, to the satisfaction of the CEO.	Approved Methods for the Sampling and Analysis of Air Pollutants in New South Wales (EPA 2016) has been superseded by a January 2022 publication (EPA 2022a). EPA 2022a does not contain any methods for ambient air monitoring, however ambient monitoring is discussed in the Ambient Air Monitoring Guidance Note (EPA 2022b). Key points include: ▪ Previous methods AM-1 to AM-22 are to be used where an AM-coded method is listed in a condition. Otherwise there no specific methods applicable, and; ▪ Monitoring networks should be fit for purpose and suitably time-resolved to ensure the data collected can be used in an effective and timely manner. ▪ Methods should be selected according to individual site considerations and must be appropriate for the intended purpose of the monitoring. The EPA recommends monitoring methods be selected in accordance with the following hierarchy: 1. method published by Standards Australia designated as an Australian standard or joint Australian/New Zealand standard 2. method that has been demonstrated via AS/NZS 3580.9.17 to have equivalence to an AS or AS/NZS 3. method published by the International Organisation for Standardisation 4. method designated as a reference method in a comparable jurisdiction, such as the USA, United Kingdom or Germany 5. method designated as an equivalent reference method in a comparable jurisdiction 6. method published in a comparable jurisdiction non-reference/non-accredited method. Monitoring methods other than an Australian Standard should only be used if: a. the method can be demonstrated to be fit for purpose and b. calibration and validation studies show that the measurement range, accuracy and precision of the method are appropriate for the intended purpose and reporting requirements.

Condition Key Requirements	Context & Approach
The results from the annual monitoring must be evaluated as part of the Compliance Assessment Reporting process under condition 6.	Jacobs have included input to the Compliance Assessment Report as a deliverable, in addition to a standalone monitoring report. As per Condition 6 this monitoring needs to be undertaken annually.

In selecting an appropriate method for ambient annual monitoring, Jacobs has considered the following key considerations.

- Methodology should target the highest risk pollutants as identified in the AQIA, and with consideration given to air quality standard updates.
- Methodology should consider the practicalities, financial considerations and technical outcomes expected for the monitoring method selected.
- Sampling methods should appropriately consider the assessment criteria averaging period for the pollutants being measured.
    - It is noted that the assessment criteria published in EPA 2022a, and adopted in the AQIA is an hourly average, however EPA 2022a states that '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 premises or nearest sensitive receptor cannot be readily determined for regulatory purposes).'
    - Therefore, it has been assumed that the primary assessment criterion for ambient monitoring is the Air Toxics NEPM, which has annual criteria for Benzene, Toluene and Xylenes and 24-hr criteria for toluene and xylenes.
    - Note: It is not practically feasible to monitor the ambient VOCs identified for this assessment in hourly increments.
    - Method sensitivity should be appropriate to the anticipated ambient concentrations.

The outcomes of the AQIA modelling assessment are summarised in Table 3. All assessed VOCs were below 10% of the Impact Assessment Criteria (IAC) except for benzene and cumene. The method selection therefore focussed on the key considerations for assessing benzene and cumene ambient concentrations.

Given the key consideration is focused on Benzene and Cumene concentrations in ambient air, the hierarchy recommended in EPA 2022b (numbered items below correspond to numbered hierarchy in Table 2), is addressed in that:

1. There is no Australian standard or joint Australian/New Zealand for benzene and cumene monitoring
2. The referred std AS/NZS 3580.9.17 is relevant only to particulate monitoring and therefore not applicable
3. Jacobs are not aware of any methods published by the International Organisation for Standardisation which cover Benzene and Cumene. There is an instrumental method, EN 14662-3, applicable for Benzene, however it does not cover Cumene and may not be a practical or financially acceptable method for this project.
4. Jacobs are not aware of designated reference methods, other than the European Std mentioned above
5. Jacobs are not aware of designated reference methods, other than the European Std mentioned above.
6. Jacobs are not aware of commonly deployed methods from comparable jurisdictions, other than US EPA compendium methods i.e. methods TO-14 and TO-15. These are SUMMA canister methods as discussed and an option considered below.

Therefore, Jacobs have considered US EPA compendium methods, and non-reference/non-accredited, both of which are methods commonly deployed in Australia. The methods selected are defendable and extensively validated.

Table 3 Modelled VOC GLC (hourly maximum)

VOC	Max. 1h GLC (µg/m³)	IAC (µg/m³)	Result as fraction of IAC
Benzene	7.4	29	25.6%
Cumene	18.7	21	89.2%
Cyclohexane	24.2	19000	0.1%
Ethylbenzene	5.7	8000	0.1%
n-Hexane	119.7	3200	3.7%
Toluene	1.5	360	0.4%
Xylenes	12.9	190	6.8%

There are four methods routinely employed for VOC monitoring of ambient air in Australia. The methods and advantages / disadvantages are listed below in Table 4. A comparison of laboratory practical quantitation limit (PQL) is given in Table 5 for the Summa canister method versus diffusion tube with thermal desorption (24-hr and 2-week sample exposure periods).

Table 4 Summary of VOC sampling methods.

Method	Sensitivity / technical complexity	Advantages	Disadvantages
Summa canister sampling with laboratory analysis by GC-MS	Med-low sensitivity Low technical complexity	No power requirements Method referenced in Air Toxics NEPM Relatively cheap per sample	24-hr average is longest sampling time per sample.
Diffusion tube sampling (Radiello) with analysis by solvent extraction and GC-MS	Medium sensitivity Low technical complexity	No power requirements Relatively cheap per sample	Typical 24-hr to 2-week exposure of sampler
Diffusion tube sampling (Radiello) with analysis by thermal desorption and GC-MS	High sensitivity Low technical complexity	No power requirements Relatively cheap per sample	Typical 24-hr to 2-week exposure of sampler
On-line gas chromatography – real-time analyser	Medium sensitivity High technical complexity	Hourly average data	Requires mains power. Fixed location once established. Requires specialised technical expertise to setup, operate and maintain Relatively expensive Usually only deployed for BTEX, and other VOC may not be included.

Table 5 Typical laboratory practical quantitation limit (PQL) – canister method vs diffusion tube with thermal desorption

Method	Canister Method µg/m³	Radiello TD µg/m³ 24-hr sample	Radiello TD µg/m³ 2-week sample
Benzene	1.6	0.26	0.02
Cumene	2.5	0.023	0.0016
Cyclohexane	1.7	0.025	0.0018
Ethylbenzene	2.2	0.027	0.0019
n-hexane	1.8	0.027	0.0019
Toluene	1.9	0.23	0.016
Xylenes	6.5	0.082	0.0059

Summary

In summary, Radiello diffusive samplers for VOC with analysis by thermal desorption and GC-MS was selected for annual BTEX and TVOC monitoring for the following reasons.

- Radiello samplers with thermal desorption provide the most sensitive method, ensuring that meaningfull results from the monitoirng should be obtained. For background ambient monitoirng, the lower detectiion limit of diffusive samplers with thermal desorption GC-MS was an important consideration.
- Of the other methods considered, the following points excluded those methods from being selected;
    - instrumental methods as per EN-14662-3 would require permanent powered site with anticipated long lead times for installation, and would be complex in regard to negotiating an appropriate site, electrical connection etc. On technical grounds the method may not be able to measure Cumene. It would require specialised technical expertise not easily sourced in Darwin.
    - The NEPM referenced method for VOC sampling using a specially prepared (Summa) canister is typically used for maximum 24-hr duraation sampling. The method would therefore not provide continuous coverage over the yea unless daily samples were collected which would be prohibitively expensive. Laboratory detection limits are poor compared to diffusive samplers (Radiello).
    - Diffusive sampler with solvent extraction and GC-MS has laboratory detection limits which are poor compared to diffusive samplers with thermal desorption and GC-MS.

Samplers shall be deployed for 2-week periods at one location with samplers exchanged each 2-weeks. Monitoring will provide full coverage over the year and providing a true annual average for TVOC, BTEX, cumene, cyclohexane and n-hexane.

The location for sampler deployment will be determined at the time of first deployment, however it is anticipated that the location will be either on the site boundary in the direction of the nearest sensitive receptor, or between the site boundary and the nearest sensitive receptor.

Samplers will be deployed by Jacobs with analysis sub-contracted to Envirolab who hold accreditation by NATA for BTEX measurments by this method, although other VOC may not be covered by the accreditation.